# ORTHODONTIC PEARLS

SECOND EDITION

# ORTHODONTIC PEARLS

## A Selection of Practical Tips and Clinical Expertise

**Edited by**

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CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742


Version Date: 20141223

International Standard Book Number-13: 978-1-4822-4195-2 (eBook - PDF)

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# ACKNOWLEDGEMENTS

I acknowledge and I am extremely grateful to all original and new co-authors for the tremendous effort they have put in to produce the material for the second edition. It is a testament to the quality and standing of our profession that clinicians, busy in their own practices, continue to give of their time to ongoing education whether it is in the formal academic environment or in the contribution of material provided for this publication. They understand that education continues to be the backbone and foundation on which the future of our profession depends.

I must also acknowledge with many thanks the tolerance and understanding of my wife in accepting the disruption of our home lifestyle over the last number of months.

**Eliakim Mizrahi**

# INTRODUCTION TO FIRST EDITION

I acknowledge that the formal education provided by most dental schools as well as existing textbooks and journals equip the contemporary orthodontist with an excellent foundation in the science and art of orthodontics. However, I believe there is a pool of knowledge and information that is not provided by formal education and only becomes available and acquired with time and experience in clinical practice.

The administration and running of an orthodontic practice is not an aspect of orthodontics that is taught extensively or formally in most schools; it is information that students, as well as young and old orthodontists glean with experience, from interchange with professional colleagues and from general reading. In time it comes to reflect the individual nature of a practice and becomes a component of the practice driven and moulded by the personality of the individual orthodontist.

In this book I hope to present the reader with information on administrative and clinical aspects of practice sourced from experienced orthodontists worldwide; to show how they manage their patients and their practices. What patterns do their conversations follow, what do they say to their patients at different appointments and what do they say to parents? It is important to know just how much clinical information to give to patients and what information should be provided in correspondence to both the patient and the referring dentists. I hope the sample letters used by orthodontists in different parts of the world will be of assistance and will reflect the varying nature of practices.

With regard to the clinical aspect, current teaching on the theory and technique of orthodontics continues to evolve and expand and cannot be faulted. However, with the development of prescription-type brackets and the concepts of straight wire and pre-formed arches, students over the last few years may not have been exposed to some of the intricacies and complexities of wire bending. While it is commendable that clinical procedures should continue to be simplified and streamlined, there are a number of occasions in practice when the orthodontist is presented with different malocclusions and individual situations where additional wire bending or the use of an additional auxiliary will facilitate and improve the treatment and final result. This concept is well described in an editorial by Robert Rubin 'Why we still have to bend wires'.[1] He concludes in his last sentence 'In fact, in some areas of the arch, the risk benefit ratios suggest that wire bending will always be a wise choice'.

With time and experience orthodontists learn many technique adjuncts that work for them and which facilitate the clinical treatment of their patients. A number of these adjuncts are published in different journals. In this book I tried to collate some of these clinical tips and to present information from an international selection of orthodontists using varying techniques. I hope that this component of the book will be of value to the graduate student, the neophyte orthodontist as well as the established orthodontist wherever he or she may be practicing.

This book is not intended to compete with the major texts on the theory and techniques that form the basis of contemporary orthodontic teaching and practice. I hope that in an informal style, more akin to a seminar or tutorial, this book will provide the reader with information which will be helpful in both the administrative and clinical components of orthodontic practice.

I concede that it has not been possible to cover the complete orthodontic scenario; there

are omissions particularly in the areas of non-compliance and functional appliances. I have no doubt there are many clinicians who have ideas, tips and techniques that have not been included, perhaps these gaps could be filled in future editions.

Much of the information submitted by different clinicians has been gleaned from experience, lectures, courses and journals; where possible references are listed at the end of each chapter. Unfortunately, in certain cases the exact reference or source of an idea or a technique cannot be recalled, in such cases, none of the contributing authors knowingly claim originality for any idea or technique described.

The literary style varies with each contribution and I have tried not to alter this variation but rather to retain the individuality of each author. In certain sections the reader may encounter some repetition, once again this has been retained with the intent of maintaining the integrity of each individual contributor.

A hallmark of our profession is the diversity of individual opinion on both clinical and administrative issues, this diversity on the management of certain aspects of practice may be apparent to the reader. I have made no attempt to try to achieve consensus but have chosen, once again, to retain the individuality of the contributor. I hope the reader will benefit by being exposed to the different views and will take from the text what suits his or her own circumstances, personality and practice environment.

## COMMENT

I believe that orthodontics is one of the finest professions; it combines the best of both the science and art of dentistry. We are privileged to treat a group of patients who actively seek our services, and the general level of work satisfaction and patient appreciation is high, I have yet to meet an unhappy orthodontist. Whether you run an individual single practice or a multiple surgery/operatory type of practice is an individual choice and I believe is more related to personality and character type rather than to financial consideration. Which of these makes for a happy orthodontist? I don't know. In our professional context, what is happiness, how do you define it? A simple definition given to me by a friend states: 'Happiness is when your earning power equals your yearning power'. By all means be ambitious but above all be honest with yourself and with your patients. Be happy and content with what you do.

I would like to acknowledge and thank every contributor for his or her effort and input. No matter how small or large their contribution, it takes time and effort to put pen to paper, and for this I and I am sure our readers are grateful. I must also thank my colleagues and postgraduate students at the Department of Orthodontics, Whipps Cross Hospital, London, for their stimulus in the initiation of this work, I hope the end result is worthy of their confidence.

Finally, let me say to every reader, the greatest appreciation you can demonstrate to your profession is to impart and pass on your knowledge and expertise to your students and fellow colleagues. To those of you already involved with teaching we acknowledge your services. To the others, I encourage you to get involved with teaching to a level and extent that suits you. I hope that, via this book, our colleagues who have put pen to paper are in their way giving something back to the profession they so enjoy. I leave you with what has probably been the best pearl in my career.

**Pearl:** For me the most satisfying professional experience has been the mix of clinical orthodontic practice combined with part time teaching.

## INVITATION

I would like to take this opportunity to invite any reader who believes that they have one or more pearls of information that could be included in any possible future edition of this book, to feel free to contact me. (My address is included in the List of Contributors.)

**Eliakim Mizrahi**

## A LITTLE PHILOSOPHY

The following are a few experiences and lessons gleaned as I travelled as a practice manager for thirty-six years through the life of an orthodontic office. I learnt that:

- Orthodontists hold in their hands a capacity to generate financial benefits allowing them to lead a comfortable and generous lifestyle.
- That all of this is irrelevant if they do not acknowledge that their opportunity of altering the position of the teeth should be joined with a positive experience in the lives of their patients.
- That it is important to remember that as each potential patient walks through the door they do not only bring misaligned teeth with them. They are part of a social structure interwoven with expectations and dreams of their own. They belong to a family, whether it is a nuclear or single parent family. They belong to an educational facility or the workforce. They each have a life outside of their teeth. Consideration of their individual circumstances helps to form a bond between clinician and patient early on in treatment. This individual consideration will also assist greatly in their cooperation during treatment. It is as well to remember that this 'customer' or 'consumer' is going to share at least eighteen months of their life's experience with you.

**Pearl:** Cultivate, as much as you can, to share this experience on an individual basis with your patient and if possible without another family member being present.

**Effie Patrikios**

## REFERENCE

1. Rubin RM. Why we still have to bend wire. The Editors Corner. *J Clin Orthod* (1996) 30:541–542.

# INTRODUCTION TO SECOND EDITION

The basic premise and rationale on which the first edition of *Orthodontic Pearls* was originally based remains the same. For this reason, the original introduction has been retained allowing both new and old readers to acquaint themselves with the original objectives of *Orthodontic Pearls*. I do hope that readers will take the opportunity to read the original introduction.

When it comes to writing the second edition of a textbook, clearly, the editor is faced with the dilemma of how to manage the balance between the inclusion of new material and the exclusion of old material. I hope that this introduction will help the reader understand how I, as the editor, tried to manage this dilemma.

Any clinician who has been in practice for some years comes to realise that firstly, there is a life outside the office (see "A little Philosophy" at the end of this introduction *Harold M Shavell*) and secondly, in order to keep up to date with our professional life, education is an essential continuing process. This theme has been expressed in Chapter 1 where the importance of continuing education is well described and written by two orthodontic educators of international standing: *Nada M Souccar* and *Lionel P Sadowsky*.

Bearing in mind the original concept that this book is not an in-depth text on any one particular subject, I have sourced the experience of new authors on a variety of subjects which I believe widens the scope of the book and will be of interest to readers. To the credit of the first edition co-authors, some of their original contributions have been expanded and updated. The advances in digital technology have already influenced clinical dentistry and orthodontics. Clearly the digital age is upon us and we need to examine how this impacts our clinical practice. Its effect on radiology (see Chapter 5, *Iain Macleod*), photography (see Chapter 6; *Jonathan Sandler* and *Alison M Murray*), and digital intraoral scanning (see Chapter 16; *Rohit CL Sachdeva* and *Nikita Sachdeva*) is presented by a variety of experienced co-authors.

The impact of risk management in clinical practice continues to grow in importance and is well covered in Chapter 8 by *Laurance Jerrold*, a co-author well qualified and experienced in this field. The related Appendix B has been completely rewritten.

The expanding use of auxiliary personnel in clinical practice is changing the way many orthodontists run and manage their practice. A perspective on this subject is also comprehensively described in Chapter 9 by *Liz Hopkins*, an orthodontist closely involved in this aspect of education and practice.

Clinical practice continues to flourish in a competitive market. Marketing and attracting patients to our practice continue to be an important consideration. The co-authors of Chapter 10 provide the reader with basic marketing principles (*Winston B Senior* and *Renton Tindall*) and *Asif Hassan Chatoo* introduces the concept of marketing through the currently popular and influential social media.

Chapters 12, 14, 15 covering practical clinical pearls have also been expanded with contributions of varying lengths submitted by a number of original and new co-authors. Self-ligating brackets continue to be used extensively and their benefits are well described in Chapter 13 by *Nigel WT Harradine*, an orthodontist highly experienced in this subject.

Chapter 16 written by *Rohit CL Sachdeva* and *Nikita Sachdeva* introduces the reader to the developments in digital technology that are currently being incorporated into clinical orthodontics. Clearly, clinical practice in the 21st century will proceed along this pathway.

The growing influence of temporary anchorage devices as an alternative source of

intraoral anchorage is presented by co-authors familiar with these devices (see Chapter 17; Miniscrews by *Eliakim Mizrahi* and Zygomatic Anchor Plates by *Antony GH McCollum*).

The growing importance of interdisciplinary treatment has been recognized and presented in Chapter 18 covering, the orthodontic interface with restorative dentistry (*Eliakim Mizrahi*); periodontial therapy (*W Aubrey Soskolne, Ayala Stabholz*) and orthognathic surgery (*Antony GH McCollum*).

Impacted canines continue to be a feature of clinical practice that taxes the diagnostic and technical skills of clinicians. This subject is comprehensively covered by *Adrian Becker* and *Stella Chaushu*, co-authors considered to be authorities in this field (see Chapter 19).

With an increasing number of patients requesting lingual orthodontic treatment, more orthodontists are taking up the challenge and the use of the technique is growing internationally. As with conventional labial techniques there are a variety of lingual techniques currently available. In Chapter 20 readers are introduced to some of these techniques by *Alan Rumbak*, an orthodontist with experience in the use of lingual techniques.

Temporomandibular joint disturbances have been studied and reported on extensively over the years, yet the diagnosis and management of this clinical entity continue to be of concern to orthodontists. *Brian Nebbe*, a co-author familiar with this topic, has in a limited space attempted to clarify the subject in Chapter 21.

The question then arises what do I leave out? After due consideration, the answer is, very little.

Most of the material presented in the first edition is still very relevant.

I accept that cephalometric films have been largely replaced by digital images which can be digitized and analysed by many software programs, however, the technique of tracing and understanding the information derived from this task is still something many clinicians consider important. This section has been reduced but still retained (Section 4.6).

I understand that due to considerations of compliance and risk management, the use of headgear is tending to decline; however, for some clinicians' headgear is still an important form of therapy for maxillary related malocclusions, so I decided to retain the following sections: 14.1.3 to 14.1.7.

The chapters on fixed appliances, auxiliaries and removable appliances (Chapters 12, 14, 15, 22 and 23) did give me a dilemma. The fact that orthodontic techniques continue to develop and progress does not mean that many of the older techniques and concepts should be discarded. In the past they have contributed to excellent treatment results achieved by orthodontists worldwide. Furthermore, if we accept that orthodontists internationally do not all use the same techniques and they do not all move in the same direction at the same pace, then it makes sense to retain in this new edition many of the older concepts and techniques published in the first edition.

Retention still continues to be a very controversial issue. Well trained and experienced clinicians still have widely differing views on this subject particularly on issues such as the retention protocol, the duration of retention and duration of clinical responsibility. To this end, I have included expanded contributions from original co-authors as well as new contributions from new co-authors (see Chapter 24).

## A LITTLE PHILOSOPHY

### *"… And Then It Is Winter"*

Harold M Shavell

You know … time has a way of moving quickly and catching you unaware of the passing years. It seems just yesterday that I was young, just married and embarking on my new life with my Donna. Yet in a way, it seems like eons ago, and I wonder where all the years went. I know that I lived through them all, through thick and thin … through all the blood, sweat and tears. Over the years I learned that good judgment comes from experience and that often experience comes from bad judgment; that learning without thought is labour lost, and thought without learning is perilous. I learned that when you choose an action, you choose the consequences of that action. The corollary of this axiom is even more compelling: when you

desire a consequence you had darn well better take the action that would create it!

But, here it is … the winter of my life and it sort of catches me by surprise … how did I get here so fast? Where did the years go and where did my youth go? I remember well seeing older people through the years and thinking that those older people were years and years away from me and that my winter was so far off that I could not fathom it; I was young and hadn't really pondered mortality and the inexorable coming of winter. And now I'm retired, and yes, I do have the luxury of being owner of my own time … yet, truth be told, it took me some time to get used to that 'ineffable luxury'.

But, now it's clear my winter has drifted in almost without notice … and also for many of my friends who have retired and are getting grey, they too move slower. Some are in better and some in worse shape than me. I see great changes that have taken place; they're not like the people I remember who were young and vibrant … our age is beginning to show, and we are now those 'older folks'. We've finally gotten our heads together, but our bodies start falling apart!

And so now I enter into this new season of my life, I'm not sure how long it will last, and I was unprepared for all the aches and pains and the inevitable loss of strength, agility and ability (as well as volition!) to go and do things that I wish I had done but never somehow found the time to do. Yes, I do have regrets. There are things I wish I hadn't done … things I should have done … but still, there are many things I'm happy and proud to actually *have* done. You can't control the wind, but you can adjust your sails; some men can live up to their loftiest ideals without ever going higher than a basement. It's all in a full lifetime. The trick, I found, is to combine your waking rational abilities with the infinite possibilities of your dreams. Unfortunately, many of us lead lives of quiet desperation and then we go to the grave with the dream still in us. So never give in – never, never, never, in nothing great or small, large or petty – never give in except to convictions of integrity, honour, morality, just causes, and good sense. Keep to this premise, and you just can't go wrong.

Well then, if you're not in *your* winter yet … let me remind you that it will be here faster than you think. The more sand that has escaped from the hour-glass of our life, the clearer we should see through it. So, whatever you would like to accomplish in your life I suggest you do it quickly! You are today where your thoughts have brought you; you will be tomorrow where your thoughts will take you. Don't put things off too long. Life goes by more rapidly now; remember, winters have shorter days. So, do what you can now, *today*, as you can never be sure whether or when *your* winter is approaching, or how dark and cold it will be. You have no promise that you will continually see all the comings and goings of all the seasons of your life … so live, and do things for today and say all the things that you want your friends and loved ones to hear and remember and hope that they understand, appreciate, and love you for all the good and decent things that you have tried to accomplish in your life.

**Editor's comment: Eliakim Mizrahi**
Following on Dr Shavell's sobering, and beautifully expressed thoughts, may I suggest that those of you still enjoying the warmth in the summer of your life, do not forget to buy an overcoat (financial planning) because winter without an overcoat can be very cold and miserable. Just a thought.

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# 1 THE RELEVANCE OF CONTINUING EDUCATION TO ORTHODONTIC PRACTICE

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Orthodontics, as well as general dentistry and other clinical dental specialties, is undergoing significant change in research, information, technology and delivery systems.

**Pearl:** More specifically, in contemporary orthodontics with the rapid evolution of products and technologies, practitioners are required to make every effort to keep their knowledge and skills current and evidence based.

Continuing education (CE) is defined by the American Dental Association[1] as 'educational activities designed to review existing concepts and techniques, to convey information beyond the basic dental education and to update knowledge on advances in scientific, clinical, and non-clinical practice-related subject matter, including evidence-based dentistry'.

**Pearl:** The American Dental Association and other equivalent international bodies recognize continuing education to be a lifelong process that aims at providing the highest quality of service to patients, the public, and the profession by preserving, enhancing and refining the practice of dentistry.

Interestingly, this definition combines the practical and business side of dentistry, but also introduces the newer concept of evidence-based dentistry that will be further discussed later in this chapter.

The orthodontic specialty has been rapidly evolving and integrating new diagnostic tools as well as various advances in appliance design, treatment approaches, and multidisciplinary techniques, including soft tissue lasers, temporary anchorage devices, three-dimensional treatment planning, to name but a few. In today's fast-paced world, it becomes increasingly challenging for orthodontists to acquire and refine knowledge, particularly when scientific data is published at a rapid rate.[2,3]

## 1.1 VEHICLES OF CONTINUING EDUCATION

Traditionally, clinicians seek CE for two particular reasons. The first reason is to maintain active practice licences, memberships and certifications. The list of requirements varies from state to state in the United States and is available on the American Dental Association website. Similar requirements exist for different

countries and their own governing bodies. While most useful, this requirement does not usually lead to the most dynamic learning outcome. The second reason is when clinicians are faced with a difficult treatment decision or desire to learn more about a particular treatment or technology. In the latter situation, practitioners seek information using different formats, didactic courses, live activities, electronically mediated learning, and self-instructional activities that collectively fall under the umbrella of CE.[1]

The medical literature has reported investigations as to the best way to design and deliver CE seminars. The aim was to insure that the latest scientific findings are relayed to clinicians, thus improving their daily clinical practice. In an effort to evaluate the effectiveness of continuing medical education, a series of articles specifically looking into the impact of CE on knowledge, attitudes, skills practice behaviour and clinical practice outcomes was issued.[4–8] By comprehensively reviewing the available literature at the time of publication, the authors recommended using continuing medical education to improve physician's knowledge, favouring multimedia interventions and multiple instructional techniques instead of single-medium intervention and single techniques, as well as repeating the intervention rather than limiting it to a one-time experience. A recent publication by The National Dental Practice-Based Research Network indicates that a medium-range concordance exists between the clinical practice of dentistry and available research data.[9] Interestingly, this study showed that dentists who most commonly integrated research findings into clinical practice were females, those practicing within group dental offices, and those who received their degree prior to 1990. However, the authors were not able to provide definite explanations for their findings, and advocated more research to clarify them. These conclusions can be easily extrapolated to orthodontics. In choosing their CE courses, orthodontists can select their preferred media method, technique, and frequency of such courses. Media methods include live media, such as meetings and lectures; internet media such as webinars, online courses, and online communities; and print media, such as journals and textbooks.[7] Combinations of those vehicles are possible and make CE courses more appealing to clinicians.

The most traditional vehicle for CE is live media. The American Association of Orthodontists and various orthodontic organizations hold frequent national and local meetings to disseminate clinical knowledge among their communities, but also to inform their members about any guidelines, changes in legislation, advances in technology and practice management. The materials are usually available to orthodontists in hard copy at the end of the meeting. By combining two or more methods of data delivery, for example attending the meeting and then acquiring an audio-visual recording or a printed summary of the session, clinicians probably retain more information and increase the repeatability of their exposure. More importantly, by having frequent access to the lectures, orthodontists get an opportunity to compare this recent set of data to their acquired knowledge, and can make the decisions on whether to integrate the new information in their daily decision-making process. While it is easy to get influenced by charismatic speakers, the fact remains that each orthodontist has supposedly received a sound education during their residency programmes, and should be able to discern the commercial propaganda from sound scientific findings. In this context, it is interesting to note that many companies nowadays tend to bypass the orthodontist and advertise directly to the consumer, that is, the patient. Patients seem to be an easy target, because they generally lack the background needed to evaluate the validity of commercial claims. In this regard, it still is the orthodontist's responsibility to ensure that CE opportunities fulfil their stated purpose: an education that shapes their minds to make better chairside decisions for the best benefits of their patients, instead of being a mere technical repetition of procedures or training.

Internet media include webinars, online workshops, and virtual communities. The most important resource the Internet offers is perhaps the ability to access different portals of peer-reviewed publications. This wide topic will be discussed in the following section, and aims at integrating evidence in clinical practice. An investigation of the behaviour of physicians in seeking information to better

treat their patients highlighted the growing trend of searching the Internet for answers.[10] This tendency is exacerbated in the fresh graduates group who grew up using digital technology. Those young orthodontists feel comfortable accessing various websites and answering their queries in a timely manner. More senior clinicians might be intimidated by the tremendous volume of information available at their fingertips, and therefore may prefer the use of traditional learning resources versus online communities of practice for work and training.[11]

Webinars combine the advantages of live media and the convenience of learning from a remote location. They have steadily increased in popularity, as have online workshops which offer the possibility to interact with the speakers through teleconferencing and/or live chatting. Online communities are web-based groups that focus on orthodontics. They aim at disseminating orthodontic knowledge through continuing education, printed magazines and live events. Members of those communities can create their own profile, organize their activities and prioritize their interests. Online communities offer the ease of learning at one's own pace. They also constitute a good support system, mirroring the more customary study groups. These appear to be extremely appealing, particularly to young graduates, because they provide access to multiple media supports and offer various levels of evidence ranging from expert opinion (the 'how to' level, particularly suited for basic technical skills) to higher levels of evidence. The Internet is, however, just a tool to access various resources. Again, all online resources are not of equal validity, and a rigorous search of publications through various scientific portals varies tremendously from answers found in a discussion forum.

An interesting concept of web-based orthodontic education was recently tested in the United Kingdom.[12] A virtual learning environment was coupled to a regular academic setting. The advantages were time flexibility as well as a higher quality of presented data, and the opportunity to attend a lecture multiple times using the available library of presentations and topics. The low points of this investigation show that residents still like the interaction with instructors and peers. Those results can easily be extended to practicing orthodontists, and may represent the tipping point between exclusive web-based learning activities and in-person access to education.

## 1.2 INTEGRATING EVIDENCE BASED ORTHODONTICS IN CONTINUING EDUCATION

All methods of CE rely, among other important factors, on the quality of the promoted data. Aside from purely commercial communications, it is important for every orthodontist to be able to recognize the different levels of available evidence. The single most important advantage the Internet offers is the ability to access the most current literature and be aware of the scientific advances in our specialty. The American Association of Orthodontists[13] recently launched an application for electronic tablets that can be used to search its website and journal, recognizing by this move that many orthodontists nowadays are familiar and comfortable with technology.

Evidence-based medicine is defined by Sackett[14] as the 'conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research'. The American Dental Association[1] further emphases the importance of the three pillars of evidence-based dentistry, namely, published evidence, clinical experience and patient's desires in its adopted definition:

> **Pearl:** 'Evidence-based dentistry is an approach to oral health care that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences'.

It seems then that the best way to provide the highest standard of treatment is to be aware of the published literature and couple it with one's

own clinical judgment. However, all publications do not carry the same weight. In the accepted hierarchy of evidence for scientific articles, the scale going from weakest to strongest levels of evidence is as follows: editorials, expert opinions, case reports and case series, cross-sectional studies, case-control studies, cohort studies, randomized controlled trials, systematic reviews and meta-analyses.[15]

The volume of yearly publications requires clinicians to devote considerable amounts of time and effort to absorb and categorize the literature, and reach an informed approach to care. In this quest, it is very easy to ignore parts of the published materials, and limit one's knowledge to the most quoted articles or the most popular sayings. Moreover, the highest levels of evidence are only as good as the clinical trials they rely on, making them sometimes weak in nature. In addition to printed publications and continuing education programmes supported by dental schools and other official organizations, there are some web-portals that are excellent sources of information. The two most used platforms using the English language are the Cochrane Collaboration and Medline.[16]

The Cochrane Collaboration is a nonprofit organization whose aim is to collect independent research findings into evidence-based data about healthcare. It is regarded as one of the best resources for systematic reviews, mainly because of the rigorous methodology methods used to assess the available literature. The reviews are published in the Cochrane Library and organized by topic. They are updated periodically to reflect the latest advances in various medical fields. Dentistry and oral health topics are extensively reviewed, and orthodontic analyses are grouped under the craniofacial anomalies subheader.

Medline is the United States National Library of Medicine database for abstracts and citations related to biomedical information and clinical sciences. It is freely accessible on the Internet through the PubMed website which uses Medical Subject Heading (MeSH) terms to index citations. MeSH terms represent a controlled vocabulary that categorizes information for future retrieval. Medline can also be accessed through other interfaces such as Ovid and Ebsco, but these providers are restricted by license. The European equivalent of Medline is Embase, and is available via subscription though various gateways. Using the different databases, it becomes possible to critically review the literature and seek the best available evidence.

The concept of evidence-based orthodontics has generated heated debates in the orthodontic community, probably because of the versatility of orthodontic mechanics.[17] Two conflicting lines of thought clearly appeared: on the one hand clinicians who only trust their experience, and on the other researchers and academics who present the evidence-based approach as the only future of the specialty. The whole debate stems from the apparent contradictions between published research results and daily practitioner's observations. Significant topics such as intercanine distance, maxillary expansion, functional appliances, cephalometrics, and aesthetics highlight the divergence between the two camps.[18] It seems obvious at the present time that the specialty of orthodontics cannot survive without a commitment to excellence. Excellence comes from reflecting on past experiences and/or experiments and moving forward in a predictable, reproducible and innovative but safe way. There currently are increasing efforts to bridge the gap between academics, research and private practice through regional and national networks that investigate common clinical behaviour in relation to published evidence.

**Pearl:** It is essential to build partnerships between educators and clinicians and to recognize the importance of each of the party's contribution in order to achieve the best benefit for the patient.

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# 2 ADMINISTRATION: THE PRACTICE

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CONTENTS



## 2.1 PHYSICAL APPEARANCE AND LAYOUT

It is important to appreciate and understand that for a new patient, or for that matter any visitor, the external approach, the entrance, the appearance and atmosphere of the reception and waiting area, all contribute to create the first and lasting impression of your practice. The whole environment should appeal to the eye and give the impression of being bright, clean and airy. Whether you prefer modern contemporary or older period style as your personal taste, but the overriding principle still holds: keep it bright and light.

Lighting should be bright but not necessarily harsh. Bright areas help to elevate the mood of both the staff and the patients. This theme of brightness and light should be carried throughout the entire practice. The choice of colours and decor once again is a matter of personal taste and choice; try to select light as opposed to dark and oppressive colours and furniture.

**Pearl:** Keep it bright, light and clean.

Cleanliness should be a given and not need to be mentioned but this issue is so important I feel it needs to be stressed. Both clinical and nonclinical areas need to be kept spotless. Whether in-house staff members are responsible for cleaning or you employ a cleaning service, it is not always easy to get staff to clean to the standard that we would like. Unfortunately, it is an area of administration that needs constant monitoring.

**Pearl:** To make cleaning easier, try to keep the area uncluttered, use simple lightweight furniture, easy to move and easy to clean under.

### *2.1.1 Physical Layout*

Remember, buildings and alterations are long-term investments and physical structures that cannot easily be changed; you need to do some careful research and plan well. Consideration of the physical design and layout are important at the new surgery/office planning stage, during the lifespan of the surgery/office, and as the working life of the clinician starts tailing off. The latter scenario is seldom given adequate consideration, Hamula points out that when the time comes to either sell your practice or take in an associate, a refurbished, modernized surgery/office is more marketable and will attract a higher price.[1] He believes that money spent in refurbishing an old, tired-looking practice will be more than recovered in the final sale.

At an early stage in your planning, I would strongly recommend a visit to the American Association of Orthodontists website, go to

'practice management' and click on the 'office design manual' (https://www.aaoinfo.org/practice/office-design-manual).

Two major issues will govern the physical layout. First, are you designing the practice from scratch with an open area available to you, or are you limited by an existing physical structure? Second, and probably more important, what is your available budget? Within the constraints of these limitations, there are some overriding principles that should be borne in mind.

#### 2.1.1.1 Patient Flow

A patient entering the reception room will generally be seen first at the reception counter/desk and depending on the nature of the visit, the new patient will either be guided to a seat in the waiting area, or directed through to a consulting office or for patients under treatment, directed through to the surgery/operatory.

**Pearl:** Access to these two areas should be as direct as possible without the patient having to pass through any other rooms.

From these two areas, there should be access to the radiology room or other such designated area reserved for radiology. If possible access to the radiology room should be direct so that patients attending specifically for radiographs would not need to pass through other areas, such as the surgery/operatory or consulting office, where other patients may be under treatment. It is not necessary for patients to have access or sight of the accounts office, the laboratory, or the sterilizing area. On the other hand, staff should be able to move easily to all areas without too much interference with patient flow. If possible, it is an advantage to have a second private entrance to the premises, this allows the orthodontist and staff to arrive and leave whenever necessary without having to pass through the main entrance where there may be patients sitting in the waiting area.

#### 2.1.1.2 Budget

Once again this is a very personal consideration specific to each individual and his or her particular circumstances; however, there are certain principles and generalizations that can be discussed. With regard to the cost of the physical structure, there is not much that can be said except that it is important to get more than one quote for the job; building costs do vary with different contractors. Try to get references on the contractor and speak to people for whom they may have worked for in the past. If possible, do not use a contractor who is a personal friend or a relative. Very often disputes arise regarding failure to meet certain specifications or time-related deadlines. It is far easier to be objective, demanding, and firm when dealing with a stranger on a purely business basis than when dealing with a personal friend or family member.

As opposed to the physical structures, the furniture and fittings can be more easily adapted to suit various budgets.

**Pearl:** For clinicians with a limited budget such as the newly qualified practitioner starting a new practice, keep the costs as low as possible particularly if the alternative will mean going into debt.

Shop around for furniture and equipment. There is available, low budget equipment and furniture, which looks good, and functions well. It may not last forever, but that is not so serious; once the practice is well established and there is a good income, you can afford to change or upgrade equipment and as a bonus there may be possible tax advantages. Very expensive equipment, which will probably last for many years, is a disadvantage, in some cases. Often, when you have been functioning for some years, you may find that the practice needs a refurbishment or you may feel that you would like to change the image of the practice. If the fittings and equipment were originally very expensive then you may be reluctant to change; however, if they were low budget items, you may well be happy to change or upgrade.

### *2.1.2 Reception Area*

**Pearl:** Remember, this room creates the first impression and sets the tone for the entire practice.

Keep it bright, airy and clean. If your budget will allow, seek the advice of a professional interior decorator.

The front desk, depending on the size of the practice, can vary from a single desk to a large counter; either way, keep the counter level low, a high counter makes the room feel smaller, and sets up a physical and psychological barrier between the patient and the practice. Even with a low counter, it is still possible, with tops of varying widths, to keep any private documents and appointment books out of direct sight of the patient. As a rule, try to keep the counter surface free of clutter, keep patient cards or files and any other papers on counter levels below the main top. Make adequate provision for computer terminals and keyboards.

Pay careful attention to the selection of floor surfaces, furnishings, lighting, and seating. Remember that hard floors and surfaces contribute to higher noise levels. Try to keep the room warm, bright, and easy to clean.

In a practice with a large, young patient caseload, parents, siblings and friends often accompany these patients; these extra people take up space and adequate seating needs to be provided. Unfortunately, some parents do not exercise adequate control over accompanying smaller children who can create considerable turmoil and mess, so consider providing toys and books for young children. The furnishings should allow for a quick clean and tidy up.

Many practices now provide facilities for patient self-check-in (see Chapter 9). If you do intend to provide such a facility, make sure that is correctly situated with regard to visibility and accessibility.

## *2.1.3 Surgery/Operatory*

### 2.1.3.1 Chair Layout

Whether you opt for single chair surgeries or open-plan multiple chair surgeries is your personal choice. Orthodontics is the one branch of dentistry that lends itself to open plan surgeries. The concept has been used for many years; it makes efficient use of space and equipment, it contributes to informality, which in turn makes for a pleasant and relaxed working atmosphere. The layout of chairs and cabinets are dependent on the shape of the area available. Square areas allow for a circular wheel-and-spoke, staggered, four chair corner, or straight-line chair layout, whereas, rectangular areas usually limit you to a staggered or straight-line option.

### 2.1.3.2 Cabinets

Generally, surgery cabinets are custom-made and fitted for each surgery/operatory. These are not cheap items. However, as an alternative, consider visiting office furniture showrooms. Office furniture and accessories, such as desk extensions, can easily be adapted as surgery items. Colours can be changed; legs can be chrome-plated or powder-coated and most important they can be made mobile by fitting castors. While custom-built cabinetry is usually fitted to the walls and floors, there are advantages to making them mobile. If you need to move premises, expand or change the practice layout, moving fixed cabinets is a problem. In spite of manufacturers' claims that the cabinets are demountable, invariably this process results in damage to the cabinets and walls.

**Pearl:** Mobile cabinets are easy to move, and facilitate layout changes.

This mobility also helps in cleaning and maintaining the floor areas and surrounding walls.

Every building authority has its specific health and safety codes and specifications with which the contractor should be familiar; these are usually fixed and inflexible.

Two aspects specific to dental/orthodontic surgeries with which contractors are not always that *au fait* with are the positioning of electrical outlets/points and plumbing requirements.

### 2.1.3.3 Electrical Outlets

Plan to have more than the minimum number of electrical outlets/points: do not skimp. Once the practice is up and running, invariably you will over the years keep purchasing appliances and gadgets which require power supply and with time you often find yourself

running out of electrical outlets. Site them correctly in relation to the working areas and at the correct heights. Depending on your cabinets, the electrical outlets should be at counter height for appliances that will rest on the counter tops and at skirting board heights for the rest. Try to avoid having a lot of loose wires hanging around particularly in the surgery/operatory. Included in the electrical planning, make adequate provision for telephone and computer terminals and links. It is advisable to have the power for computers on a different circuit to the general equipment circuits.

Many of our IT components, such as tablets mobile/cell phones, computers, modems, and printers, are capable of wireless communication. Bearing this in mind, take advice from the right consultants and check that the internal walls and partitions are not shielded with some form of metal lining that could interfere with wireless transmissions.

#### 2.1.3.4 Plumbing Items

Plumbing items are fixed and need careful planning, if budgets and space allow, try to provide for extra key sites and junction boxes which may not be required at present, but will be valuable for future expansion. Plastic pipes incorporated in dental equipment may, with wear and tear, burst or become disconnected. Invariably, this will happen at night when mains water pressure increases.

**Pearl:** To prevent such accidents, it is advisable to provide for one valve or key (solenoid switch) strategically situated near the suite exit, which allows the last member of staff leaving the rooms at night to switch off both water and electrical supply to the entire suite (but not the power for computers).

#### 2.1.3.5 Floor Covering

Whereas some areas of the practice offer you the choice of soft carpeted or hard flooring, the floors of the surgery must be of the hard type, either plastic, rubber, or ceramic. Each surface type has advantages and disadvantages. The surface must be easy to wash and clean, and in some countries it is a requirement for all joints in the floor surface to be sealed including the skirting board area. Ceramic surfaces may be attractive, but remember that if you drop orthodontic pliers on the floor, and at some stage you will, ceramic tiles will eventually start to show evidence of small chips. The surface should allow free movement of the operator's stool. Floor colouring is part of the overall decor; however, when choosing a colour, remember plain colours readily show shoe prints while mottled colours make it difficult to find any small item, such as a bracket or even a band that may fall on the floor. Floor colours or patterns can be used in an attractive manner to demarcate different areas in a multi-chair surgery.

#### 2.1.3.6 Ambient Lighting

The modern operating light as a component of the dental chair unit provides more than adequate light. However, the ambient light in the surgery is an important feature that is often neglected. Dentistry/orthodontics is an activity that requires precise visual and digital activity. The eye performs increasingly better as illumination is increased but levels off as the light intensity reaches above 20,000 lux. Operating lights generally exceed 22,000 lux, consequently, if there is a large difference between the light intensity in the mouth and outside the mouth, the eye is forced to adapt to a continual change in light intensity as you focus in and out of the mouth. This continual adaptation induces excess eyestrain and fatigue. Not only is the intensity of light important, but also of equal importance is the quality and colour temperature of the light. It is believed that working under the correct kind of light is physiologically beneficial to the operator's health; we need to work under lighting with a colour temperature of 5000 kelvin or above. There are European and International Standards for dental surgery illumination levels. Din standard 67505 and ISO 9680: *The Right Light for Dental Surgeries*. The standards lay down the amount of light, its distribution, and its quality.[2] All these factors need to be taken into consideration when planning and designing your surgery/operatory, particularly

as we often spend more time at work than we do at home.

Contemporary low voltage halogen and LED lights have just about replaced the standard fluorescent light tubes. These small ceiling mounted lights lend themselves to variations in light intensity and also allow variations in design that make them useful as decorative features. There are special lighting consultants who could contribute significantly to your surgery/office lighting design.

Furthermore, the incorporation of hand-held IPad technology for the remote wireless control of lighting, sound, and audiovisual equipment adds a new and exciting dimension to the contemporary surgery/office of the twenty-first century.

### 2.1.4 Consulting Office

Ideally, this is a room apart from the surgery. If space and budget allow, try to include an examination chair in this room. It is very useful to have the facility to examine a new patient in a nonsurgical environment. It is a less threatening environment for the child patient and a more private environment for an adult patient. It also allows clinical work to carry on uninterrupted in the main surgery. The examination chair located in the consulting office need not be a large or fancy expensive dental chair, as an alternative, look for semireclining office chairs, or look through catalogues of hairdresser chairs. There are neat, modern, attractive low voltage lights on flexible arms, which can be used for the clinical examination. With the current mandatory use of gloves, it is preferable but not essential to include a washbasin in such a consulting office; if you do go out the room to wash your hands, it is advisable to let the patient see you fit on a new pair of gloves before carrying out any examination.

The design, shape, and placement of the desk should also lend itself to being informal. If your practice is still using conventional radiographic films, then a viewing box may either be cut into the desk top or placed as a standalone box at the side of the table. However, if you have converted to digital technology, then flat-screen monitors must be available either on the desk or on the wall. Whether you have multiple small screens or one large screen, make sure you have the facility to display, radiographs, photographs and scanned virtual study models either individually or simultaneously.

**Pearl:** Keep the desk surface uncluttered; clutter on a desk distracts the patient's attention and does not contribute to a professional atmosphere.

### 2.1.5 Radiology/Photography Room

While this facility could be incorporated into the clinical area of a large surgery/operatory, it is preferable to have a separate room for radiology and photography. The design and size of the area will depend on the equipment available. The essential components are

- Intraoral x-ray unit
- Panoramic x-ray unit
- Cephalometer
- Photographic set up for extra- and intra-oral photographs
- Conventional radiograph tracing table, or a digitizer
- Provision for any of the above to be digital either from the outset, or for future conversion with the possible incorporation of scanners, computers and all the other necessary supporting hardware
- Provision for a facility to darken the room to assist in tracing or digitizing radiographs

**Pearl:** The physical structure of the room and walls will need to comply with ionizing radiation regulations specific to the local or national building and planning authorities.

### 2.1.6 Laboratory

The size and sophistication of the laboratory will depend on how much in-house laboratory work you intend to do. Make provision for adequate sinks and hot and cold water taps.

Possible components for a small in-house laboratory are

- A model trimmer, which will need to be placed on a firm base and have a connection to both the cold water supply and to the drain.
- A plaster trap is essential to prevent blockage of the main drain.
- A laboratory handpiece.
- A polishing lathe with a pumice trough.
- Vibrator for casting models.
- A pressure or vacuum-forming machine for retainer and appliance fabrication.
- Depending on the amount of trimming that will take place; a dust evacuation system is desirable.
- A Bunsen burner and a soldering flame connected to either the gas mains or an independent gas tank. There are some very neat, small, stand-alone soldering gas torches available either from orthodontic supply houses or general hardware shops.
- Good lighting and ventilation. If the laboratory is to double up as a model storage area, then make provisions for the maximum amount of shelving the room will allow. Model storage is a problem that compounds itself with the ageing of the practice.
- A number of in-house laboratories are now incorporating model scanners.

**Pearl:** Make sure that the noise and smells from the laboratory do not permeate the rest of the suite: fit a good quality door.

### 2.1.7 Accounts Office

This office can be out of sight of the patients. The requirements of an accounts office will vary with the size of the practice. Some of the basic requirements are

- Adequate desk space
- Provision for telephone and computer terminals
- Filing cabinets
- Adequate storage space for stationery and any other office requirements; remember many practice are going paperless

If this office doubles up as the office for the practice manager, and if the sighting in the overall plan will allow, place a one-way mirror overlooking the reception area. This allows the practice manager to view and control this very important area.

**Pearl:** The more you can keep in this office the less clutter you will have at the front reception desk.

### 2.1.8 Cloakroom

The cloakroom and toilets must conform to planning authority requirements. This facility may be part of the main building or it may be an integral part of your suite. If it is your responsibility, then provide mirrors and counter space for ladies' toiletries and make-up requirements. Keep the area fresh and clean, and continually replenish all toiletry requisites.

## 2.2 STAFF

You will probably find over the years that managing staff and their related issues and problems will tax and stress you more than any malocclusion. We are trained to treat patients with malocclusions; we are not trained in the philosophy and psychology of human nature nor are we trained in employment laws and their practise.

Second only to patients, the staff comprise the most important component of your practice; they can almost make or break your practice. It is necessary for you to devote a major percentage of your energy and time to the management of your staff. The following suggestions may help you manage this difficult and sensitive component of clinical practice.

- Whenever possible attend courses on staff management, you will invariably learn something helpful.
- When selecting new staff, have a structured interview protocol.

- Understand that selection criteria for a front office/receptionist will be different to the criteria for a chairside assistant.
- For a young practice, where running costs are a significant factor, keep staff numbers to a minimum. As the practice grows, so you will increase the number of staff. When you can afford the salary, aim to employ more than the minimum number, an extra member of staff acting as a back-up helps to reduce the stress generated by absenteeism. If possible consider appointing one member of staff as the practice manager.
- Study the labour rules and regulations as they apply to your area and your practice. These laws are important and at all costs try to avoid and prevent any confrontation with staff that may result in legal proceedings. It is often more expedient to swallow one's pride, settle, and avoid litigation.
- If you are unhappy with a staff member early on in their employment, replace the individual. Experience has shown that individuals do not easily change their character; the problems you experience with an employee in the early days, do not disappear, in fact they get worse. Unfortunately, the more time and effort you expend on training, the more hesitant and reluctant you become to change staff and as time passes you may tend to settle for second best.

**Pearl:** Once you have good staff, make every effort to keep them.

Discharging a member of staff is probably one of the most unpleasant tasks we occasionally need to perform. Before confronting a member of staff, make sure that you conform with the current labour laws as they apply to you. In an editorial, White gives some thoughts on firing staff, but unfortunately there is no easy way to fire an individual.[3] Whatever the reasons that led to the need to fire a member of staff, it is essential that you remember to conduct yourself in a professional manner, protect the dignity of the employee, be courteous, be understanding, and never embarrass the individual.

Depending on the stage of your career, you may consider moving over to the concept of the 'extended duty orthodontic team' (see Chapter 9).

Health and safety legislation will vary with every country so make sure you are familiar with the requirements as they apply to a clinical environment. In the UK, the recent establishment of the Care Quality Commission (CQC) has added further requirements with regard to staff and patient protection.

Clearly, we expect our employees to have many virtuous qualities; one of these qualities is honesty. Invariably one or more of our staff handle money in one form or another. Over the years we have heard of cases, sometimes from colleagues who we know personally, where money of varying quantities, has been embezzled by a member of staff. How can we reduce this risk?

In a short article, Greco[4] explains a theory put forward by sociologist Donald K. Cressey (1919–1987) who points out that there are three essential conditions to induce dishonesty – Cressey's 'fraud triangle'. Firstly, pressure: the individual is under financial pressure. It is possible that the employer may have heard either from the individual concerned or other members of staff that there is a financial problem. Be sensitive to this type of information. Secondly, rationalization: the individual believes his/her action is justifiable. Perhaps they have asked for a salary increase that has been denied on more than one occasion. Be aware that this may induce a sense of dissatisfaction and possibly encourage rationalization of dishonest behaviour. The third leg of this triangle is opportunity. If the individual concerned has access to unsupervised or uncontrolled cash and the above two legs of the triangle are in place, then there is a fair chance that some dishonesty may manifest itself.

**Pearl:** An employer who is aware of the fraud triangle–pressure, rationalization and opportunity–has a chance to minimize the effect of each leg and so reduce the overall risk of dishonesty.

## 2.3 FORMS AND STATIONERY

All forms required for the administration and running of the practice can be purchased or custom-designed to suit your requirements. Before settling on a final design, why not first design the form on your own computer, print out a few, use them, and alter them until you are happy with the final design. The forms can then be produced commercially or printed in-house. Desktop publishing can add a new dimension to the administration of your practice. The content and design of the forms will be dictated by your personal preferences. Essentially, you will need standard information for administrative purposes, forms for medical and dental history, and for clinical examination, and a record card for noting all treatment procedures. Many contemporary practices have dispensed with paper forms and all data and clinical procedures are computerized. Before deciding on your own preference it is essential to research the subject extensively,[5] and consider some of the following issues:

- Your own level of computer literacy and technical know-how; your dependence on the computer and the effect any computer breakdown will have on your practice.
- The availability and the quality of support for both hardware and software.
- The reliability of back-up systems and the quality, reliability and discipline of your staff to maintain the back-up procedures.
- The admissibility of electronic data as evidence in the medicolegal context. Digital data, such as record cards, photographs, and radiographs, can all be altered and their reliability questioned.

**Pearl:** Both the paper and paperless systems have their advantages and disadvantages. There is no 'all or nothing' rule, each clinician should take from each system what he or she feels comfortable with.

For a detailed discussion of inter-, intra- and extraoffice communication as an orthodontic risk management tool, see Chapter 8.

## 2.4 STAFF MOTIVATION

Victor Lalieu

We have a 'Staff Social Club' – all members of staff contribute a small weekly amount to this fund and this is used to help fund various staff social functions with accompanying partners, for example, canoeing, weekends away to Sea World or to the wine-making district, 'skirmish' encounters, various dinners, go-cart racing, etc. I find that if the staff members have at least contributed some money (I make up the difference), they are more appreciative and involved in the outing (they want to get the most out of their contributions!). At our monthly staff meetings, each staff member must provide one point of interest or a new idea to improve the practice.

### *2.4.1 Staff Relationships*

Effie Patrikios

I believe that it is imperative to understand that running a successful practice depends on several people and circumstances. I believe certain standards need to be maintained within the office procedures. A major part is the understanding of the needs of staff and your expectations of the delivery of their duties. You need a team that can be relied upon to work together for the ultimate benefit of all in the field. Just as a driver in a racing car on the race track needs to have so many different items serviced as he pulls into the pit so too does the orthodontic practice need to function. Each member of the team has a function to fulfil, together with the absolute consideration of all concerned in the team. Staff meetings provide a necessary and functional forum to assist in the process. Just as each patient brings their social structure to the practice so too does each member of staff (including the orthodontist). Consideration and intuitive recognition of these individual circumstances are vital.

**Pearl:** Each day, each patient and each member of staff will bring something different with them through the door.

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## RECOMMENDED READING


*Orthodontic Office Design: A Guide to Successful Design of the Orthodontic Office*. Available from the American Association of Orthodontists, 401 North Lindbergh Blvd, St Louis, MO 63141-7816, USA.

Series of 49 articles on office design and related issues published in the *Journal of Clinical Orthodontics* from 1977 to 2000.

# 3 MANAGEMENT OF THE NEW PATIENT

Eliakim Mizrahi

CONTENTS



## 3.1 FIRST CONSULTATION

Before new patients arrive for their consultation, they invariably will have experienced their first contact with your practice via the telephone. The importance and the art of managing the initial call has been the core of many courses and articles. This issue is succinctly described in an article by Thompson, who explains that there is a science and art to the correct handling of the initial call.[1] The science covers the information to be gathered and the information to be given, and the art is the ability to communicate what is relevant to each individual patient.

Understandably, every clinician will have, or will in time develop, his/her own particular style of welcoming and handling new patients. Apart from my personal views expressed in this chapter, the reader will find different views well expressed in Chapters 9 and 10.

On arrival at your office, the new patient will be seen first at the reception desk where all the basic administration data are recorded. From the reception area, the new patient should be escorted into the consulting office. Before seating the patient in a dental or examination chair, let them first sit at the desk. Depending on the configuration of the desk, you may sit on the same side (some orthodontists feel this arrangement is less intimidating for the patient) or more conventionally on the opposite side of the desk.

When more than one individual is sitting across the desk, such as a parent, spouse, or friend, direct most of your attention and conversation to the patient. Talk to the patient and try to establish why they have come to see you, what their complaint is and who referred them. Obviously, you will vary your approach and language depending on the age of the patient. Particularly with children, try to keep the conversation at an informal level, joke with them and try to make them smile. Try to gauge the patient's attitude to wearing appliances, the sullen teenager who is reluctant to engage in conversation with you, keeps looking away from you, and is disinterested, is not going to be a good orthodontic patient (see Chapter 11). At the other end of the age spectrum, the very young patient who is reluctant to let you touch his or her teeth is also going to give you a hard time and make your day more stressful.

Adult patients have become, for many orthodontic practices, a significant component of practice and there is little doubt that the number of adult orthodontic patients will continue to grow. Adult patients are generally good orthodontic patients, their level of cooperation is high and their degree of appreciation is gratifying. However, there are a few adult patients, who have an unrealistic level of

expectation; it is important for you to recognize the adult patient who has some other problem in life and expects orthodontic treatment to solve some social or emotional shortcoming (see Chapter 10).

After the initial opening conversation invite the patient to the examination chair; at this stage, before examining the patient, it is essential to take a medical and dental history.

### 3.1.1 Medical and Dental History

Taking a comprehensive medical and dental history is accepted as standard clinical practice. It is essential that, as the clinician, you are aware of any local and systemic conditions that may have a bearing on your management of the patient. Apart from the obvious relevance of the dental history to orthodontic treatment, questioning the patient also gives you a good insight into their dental IQ (awareness), and their motivation. This can help to assess the degree of compliance you might expect. Some clinicians prefer to have the relevant forms completed by an assistant prior to the clinical examination while others prefer to ask the relevant questions face-to-face with the patient.

### 3.1.2 Initial Clinical Examination

For the initial clinical examination, the only instruments required are: a mirror, probe, and tweezers, preferably still sealed in a sterilized bag/pouch and placed on a disposable plastic or paper tray. The sterilized bag/pouch should be opened in sight of the patient. It is not necessary to invest in a fixed bracket table for the consulting office. A small mobile trolley is very useful; it can be used in lieu of a bracket table during the initial examination and then easily rolled out of the way. After examining the patient and recording the relevant notes, let the patient hold a face mirror and if relevant invite the parent to come closer and briefly show and explain the problem to them. Once the examination is completed, explain to the parent or patient what the next step will be and your reasons for the recommendation. Depending on the physical layout, this can be done at the chairside or you can all move back to the desk.

Before taking a decision on which of the treatment options should be proposed to the patient or parent, I believe that it is essential for a full mouth panoramic radiograph to be taken. As a specialist, you cannot afford to be surprised by some abnormal development of the dentition at a later date; you need to know how that particular dentition will develop over the next few years. Explain to the patient why it is necessary to do a preliminary radiographic examination. After viewing the radiograph, you should be in a position to explain the following treatment options to the patient or parent.

## 3.2 TREATMENT OPTIONS

### 3.2.1 Too Young

The patient is still too young and will be placed on a recall system. Recall patients are an important component of the practice. These patients form a pool of patients, which over the years will continue to feed the practice. They should be nurtured and carefully managed. Your preference will dictate whether you use a computerized or manual recall system. Depending on the patient's age and the presenting malocclusion, they will generally be recalled at 6 or 12 monthly intervals. Some of the patients in this group may require extraction of certain deciduous teeth. Whether you wish to do a full orthodontic investigation for these patients depends on your philosophy; in today's climate you must be aware of the resistance to the taking of unnecessary radiographs.

**Pearl:** You must be able to justify the need for such radiographs.

### 3.2.2 Ready to Start

The patient is ready to start treatment and the next step will be a full orthodontic investigation requiring a comprehensive clinical examination, study models, radiographs, and

photographs (see Chapters 4 and 6). A separate appointment is scheduled for the investigations. In some practices, this investigation is carried out at the first consultation. I prefer to give the patient and the parent a chance to go home and have an opportunity to think about my recommendations. Particularly when a financial consideration is involved, I have found that giving the other parent, spouse, or partner a chance to have some input into the decision making process helps to avoid later problems.

The group of patients who are ready to start active treatment, comprise two categories: those in the full permanent dentition requiring a single phase of comprehensive treatment, and those in the mixed dentition who might benefit from a two-stage approach to treatment. There is no doubt that certain cases need a first stage of treatment; however, the benefit of two-stage treatment for many cases is an issue that is still extensively debated in the orthodontic literature.[2] Your philosophy on two-stage treatment will dictate how you handle the early mixed dentition patients. Be aware that very young patients may not cooperate as well as you would hope for and furthermore, with time, the majority of young first-stage treatment patients will need a second stage of comprehensive treatment; this may in time increase your practice caseload above that which you can manage satisfactorily.

### 3.2.3 Place on Waiting List

The patient is ready for treatment but because of the demand for treatment and the current clinical caseload of the practice, the patient will be placed on a waiting list. If you are fortunate to be in an area where the demand for orthodontic treatment exceeds availability of orthodontic services, it is necessary to establish a waiting list. This list can be organized on a purely sequential basis where patients are entered on the list when you believe them to be ready to start active treatment, or where patients entered on the list are prioritized according to need, urgency, and severity. The former system is more objective and the easier to handle, whereas the latter may be more subjective and possibly more applicable when treatment resources are limited.

### 3.2.4 No Need for Treatment

The patient does not need orthodontic treatment. Until quite recently the decision taken by the orthodontist that 'the malocclusion is mild and does not need treatment' would have been accepted without question by the patient or parent. Currently, however, the concept of patient empowerment and the establishment of a Patient's Charter UK are tending to shift a degree of decision-making from the doctor to the patient. The belief that 'the doctor knows best' is no longer generally accepted. This subject and the concept of the acceptability of treatment plans directed at satisfying the patient's wishes is well debated in an editorial by Gotlieb.[3] Despite these developments, I believe that your clinical freedom to treat what you believe is in the best interests of the patient remains a pillar of ethical practice and, with good communication skills, will continue to be acceptable to your patients.

A different approach to the management of a new patient and possibly a more contemporary but less personal approach is for the patient to be seen first by a clinical auxiliary who will take initial notes and digital photographs. These are then displayed on a computer screen in the consulting office following which the orthodontist enters the scene and picks up on the conversation (see Chapter 9).

**Pearl:** For the smooth and efficient running of a practice, all the above options require the correct administrative procedures to be in place and for the correct correspondence to follow.

Every clinician will develop his or her own style of delivery related to their personality and to the level of formality they choose to adopt in their relationship with their patients. However, irrespective of the style of delivery, the content of the discussion and the explanations given should convey certain basic information.

Depending on your philosophy, you will explain to the patient or parent why one of the preceding treatment options applies to this case. It is important that you start to give an indication of the costs involved for each of the options. Tell the patient/parent exactly what you charge for a recall appointment, what you charge for a full investigation, and give an indication of the approximate range of fees for the treatment. Explain that the exact cost and the method of payment will be presented to them at the case discussion.

## 3.3 CORRESPONDENCE

**Pearl:** The main avenue of documented communication between you the clinician, the referring dentist, and the patient, is an efficient system of correspondence. It is an essential component of practice marketing, and is a crucial element in the medicolegal field (see Chapter 8 and appendices).

It is difficult to imagine a contemporary orthodontic practice that does not have computerized word-processing facilities. The addresses of all referring dentists and letters for most conceivable situations can be preformatted and stored in a word-processing package or in a comprehensive orthodontic software package. For each group of letters, there will always be certain options; these can be stated in different paragraphs. Use a number to designate different letter subjects and letters of the alphabet to designate different paragraphs. When dictating the letter, it will only be necessary for you to state the letter number and then identify the required paragraphs. Within each paragraph, if there are variations for insertion, such as teeth or patient's name or gender, then leave identifiable blank spaces (see Appendices). Irrespective of the system used, there are certain principles to follow and basic information that needs to be conveyed in the correspondence.

- Respond promptly: all your correspondence should be dealt with on a daily basis, either you deal with it at odd intervals during the day whenever you get some time, or it is placed on your desk and you deal with it at the end of the day.
- Personalize all letters: the letter should address each dentist by his or her name and each letter must be signed by you.
- When writing to a patient use language that the patient can understand. Whereas the dentist will understand the term Class II, for the patient, 'a retruded lower jaw in relation to the upper jaw' would be more meaningful.
- Following your consultation with a new patient, a letter of thanks and appreciation should be sent to the referring dentist. This letter should contain a very brief statement of your clinical findings. (Remember you have not carried out a full investigation at this stage.) Explain that the patient will either be placed on a recall system, a waiting list, or an appointment will be scheduled for a full investigation to be carried out following which you will send the dentist a full report.
- If at this stage you recommend the extraction of certain deciduous teeth, then include the request in this initial letter. One assumes that you will not request the extraction of permanent teeth without having carried out a comprehensive orthodontic investigation.
- If another patient of the practice referred the patient, send a letter of thanks to the referring patient.
- Make sure to use a tooth numbering system that is well understood by all your referring dentists.
- Double check the teeth to be extracted with your clinical notes.

**Pearl:** Copies of all correspondence should be kept in the patient's file. If you are using a paperless system make sure all correspondence is attached to the patient's electronic file and is adequately backed up.

## 3.4 PERSPECTIVE ON THE TECHNOLOGICAL REVOLUTION

An editorial by Keim gives a good, brief description of the dramatic changes that

technological progress has induced in orthodontic practice.[4] Haeger also highlights this in an article in the same journal.[5] (See Chapters 5, 9, 10 and 16.) There is no doubt that the contemporary orthodontist must and will incorporate these technological advances into clinical practice, but in the midst of all these remarkable changes, it is as well to remember that the tooth, periodontium, bone, and facial muscles are unaware of these changes – they still react to pressure and tension in the same way as they did 50 or more years ago.

**Pearl:** Despite modern computerized and digital office management systems, diagnostic aids, brackets, and wires, it is still your hands and fingers in the patient's mouth that will place, activate, and control any tooth-moving device.

It is your decisions and your hands, not the computer, that will determine the standard of your finished cases.

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# 4 ORTHODONTIC INVESTIGATIONS

Eliakim Mizrahi, Pieter van Heerden, Antony GH McCollum, Luc Dermaut, Matie Grobler, Colin Wallis, Alexander Jacobson and Demetri Patrikios

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Prior to establishing a diagnosis and treatment plan, it is essential to carry out a comprehensive orthodontic investigation consisting of

- Medical and dental history (Chapter 3)
- Clinical examination
- Study models
- Bite registration
- Radiographs (for cone beam computed tomography – Chapter 5)
- Photographs (Chapter 6)

The importance of taking high quality pre- and post-treatment records, as well as maintaining good case records throughout treatment, cannot be over emphasized.[1]

## 4.1 CLINICAL EXAMINATION

This should comprise a comprehensive clinical extraoral and intraoral examination with all findings recorded clearly on a record sheet or electronically entered on the patient's computer file. The record sheet can be customized to suit your own requirements then either printed commercially or computer-generated in house. The recordings should include both morphological and functional features.

**Pearl:** Remember your patient is a three-dimensional object and as such must be examined in three planes: sagittal, vertical and coronal.

## 4.2 STUDY MODELS

Full upper and lower impressions are generally taken in alginate. While explaining to an apprehensive patient exactly what you intend doing, select impression trays carefully, and make sure they are large enough. If a tray is too small, it is not possible to seat the impression deeply enough and if the rim of the tray touches the alveolus, it can be extremely painful. Use a deep tray that extends well into the sulcus. Trays can be either metal or disposable plastic. The metal trays will last many years but they need to be cleaned and sterilized after each impression. Disposable trays will be more expensive but the cleaning and sterilizing procedures are eliminated. If the trays do not have

sufficient perforations, they will need to be coated with a tray adhesive. If possible, use the paint-on adhesive and not the spray adhesive. If you use the spray adhesive, the atomized adhesive in the air gradually settles on the floor and with time, the floor surface becomes tacky and dirty as the dust and debris stick to the floor surface. Use a fast-setting alginate; having an impression taken is not a comfortable procedure so for the patient's sake you should remove it from the mouth as soon as possible.

To routinely obtain a good impression free of air bubbles and well extended, it is advisable to first load the labial sulcus in the incisor region for both upper and lower impressions. Always take the lower impression first, for the patient, it is the more comfortable of the two and it helps to familiarize the patient with the procedure before the more uncomfortable upper impression is taken. Do not overload the upper tray particularly in the posterior region. If the patient starts to gag, quickly use the mouth mirror to clear away any excess moving down the throat, tilt the head down on to the chest and ask the patient to concentrate on breathing deeply. Reassure the patient and explain that you cannot remove the impression until the material has set, otherwise it will stick to the teeth and palate and to make matters worse, you will have to retake the impression. By the time you have gone through this routine, the impression should be ready to be removed. For removal of the upper impression, ask the patient to seal their lips and blow as if they were blowing up a balloon. This lifts the soft palate and helps to break the air seal at the back of the palate, as they blow, tilt the tray down at the back and it will come away from the palate easily. The patient can assist by using the tongue to lift the lower impression.

**Pearl:** With patients who have tight hypertonic lips, be careful when removing the tray; the lips may easily dislodge the posterior buccal part of the impression from the tray. If this goes unnoticed, you end up with a model showing distorted molars.

Once the impressions have been removed from the mouth, they should be well rinsed in running water, sprayed with a disinfectant spray, wrapped in a wet paper towel and sealed in a plastic bag. If the impressions are processed within your in-house laboratory, they should be removed from the surgery, still wrapped in a wet paper towel, and cast/poured in white stone as soon as possible.

With the continuing advancements in digital computer technology it is now possible to obtain scanned images of study models that can be manipulated and viewed from different angles (OrthoCad Cadent, Inc., Fairview, NJ, USA). As with computerized cephalometrics, measurements and analyses of the dental arches are incorporated in the provision of digital study models; there is little doubt that this form of study model presentation will continue to expand and in time may well replace conventional study models. Apart from the extra diagnostic data provided by digital study models, the saving in storage space alone will be a driving force in the development and acceptance of this new diagnostic tool.[2,3]

The developments of advanced versions of intraoral digital scanners that do not require the teeth to be precoated with titanium oxide are increasing in popularity. The validity, reliability, and reproducibility have been studied and found to be clinically acceptable and accurate.[4] Scanning times are decreasing and the costs are becoming more affordable. As we progress into the twenty-first century, the balance between the use of conventional impressions and digital scanning will probably change dramatically (see Chapter 16).

## *4.2.1 Alginate Impression Technique*

Pieter van Heerden

The following procedure is used as an alternative to mixing alginate impression material using the conventional mixing bowl and spatula. The aim of this procedure is to provide a reproducible technique that minimizes mess and requires very little cleaning.

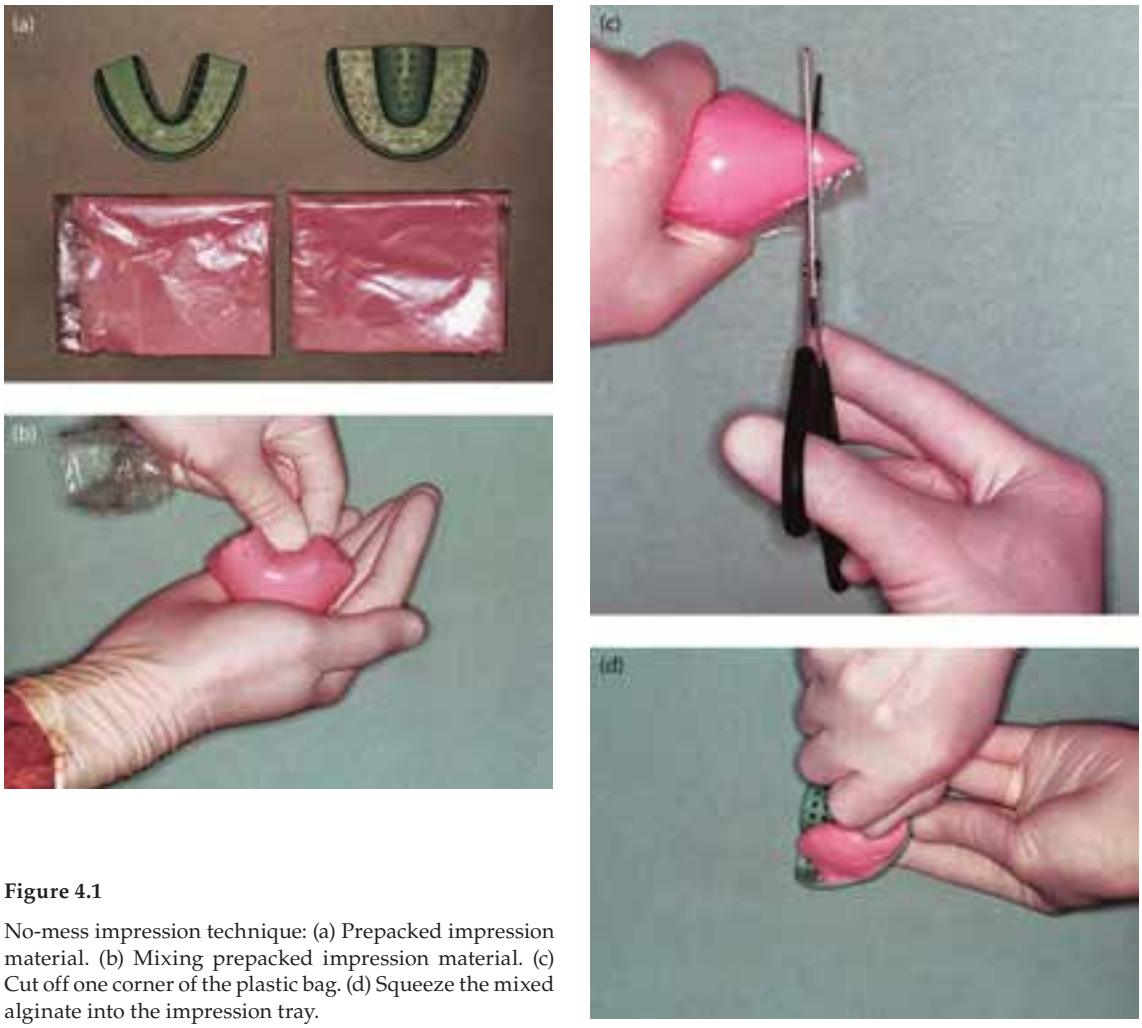


**Figure 4.1**

No-mess impression technique: (a) Prepacked impression material. (b) Mixing prepacked impression material. (c) Cut off one corner of the plastic bag. (d) Squeeze the mixed alginate into the impression tray.

- Alginate impression material is prepacked into small plastic sandwich bags: measure the correct amount of powder according to the manufacturer's recommendations or your personal preference. Separate bags are made up for upper and lower impressions and stored in study model boxes or with the impression trays (Figure 4.1a).
- The correct amount of water is poured into the plastic bag, holding it in such a way that the powder and water will run down and be located towards one of the corners of the bag.
- The open end of the bag is then twisted up tightly to prevent water and powder leaking out.
- Mixing takes place by placing the corner of the bag filled with water and powder in the palm of your left hand and by using a circular motion with your right hand and gently pushing down into the palm of your left hand the alginate and water will mix into a paste (Figure 4.1b).
- You will find that an air gap appears during the mixing process as the water is absorbed into the powder.
- Untwist the bag to let out the air then reclose the open end of the bag as described above. Following this step will ensure that air is not incorporated into the mixture and will eliminate unnecessary air bubbles.

- You will have a very direct feel for the consistency of the alginate impression material. Once mixing is complete, cut off the corner of the bag with a pair of scissors (Figure 4.1c) and gently squeeze the alginate into the tray (Figure 4.1d).
- The plastic bag with alginate residue and the tip of the bag that was cut off is then discarded. This technique eliminates the use of a spatula, mixing bowl, and the associated cleaning procedures.

### *4.2.2 Tips for Impression-Taking*

Antony GH McCollum

Taking an impression provides an opportunity for you to gain the confidence of your patient. A close, confident relationship will enhance the vital cooperation of the patient, so necessary in ultimately obtaining an excellent orthodontic result.

Patients often have negative preconceived ideas at the thought of having an impression taken, this may be due to friends, colleagues or siblings having imparted their experiences to them; if you or your oral hygienist performs the impression-taking process with sensitivity and a touch of humour it could go a long way to cementing a close relationship.

The patient's apprehension can be allayed by using humour, for example tell the patient that the impression material is 'quite edible and the staff have it for lunch'. The patient does not know whether to believe this or not and this kind of comment has the effect of defusing their anxiety. Encourage them to smell the alginate in the plastic bag or tin, as most manufacturers today add a pleasant odour (e.g. vanilla); this action can further reduce anxiety.

With supersensitive, nervous patients, it is often wiser for you to take the impression yourself rather than the oral hygienist/therapist/nurse. While not wishing to reflect on the ability of the oral hygienist/therapist/nurse, taking the impression yourself demonstrates to the patient that you really care. If this kind of patient is not treated with special consideration, they are often quick to spread harmful comments about the practice, particularly with adult patients.

The selection of impression trays is important, warn the patient that the tray will stretch their cheeks a little and that they should relax and not attempt to over open and stretch their mouth in an attempt to assist the placement of the trays.

It is always helpful to fit the lower tray first as it can be used to detect whether the patient has an enhanced gag reflex. These patients require more counselling; tell them to relax, not to hyperventilate but instead to breathe steadily and calmly through the nose. Ask the patient to tip the head down and forward so that the chin touches the chest. This seals the pharynx in a more anterior and elevated position, thus diminishing the gag reflex. This technique is very successful in preventing this reflex and it is very seldom necessary to anaesthetize the dorsum of the tongue with topical anaesthetics.

When taking the lower impression, it is important to tell the patient to elevate and protrude the tongue, as this will ensure accurate definition of the floor of the mouth. For example tell them to 'point your tongue at me, this is your last chance'. This helps to distract their attention.

When the upper impression is seated it is important, especially in children, to continue to divert their attention. There are many examples and techniques – consider some of the following; tell them to wink with one eye and then the other. They often cannot do this, closing both eyes at the same time. Tell them to concentrate on winking with alternate eyes or as an alternative tell them to lift one foot and then the other. Ask them which one is left and which one is right and they should indicate this with a hand or by lifting the leg. Confuse them by answering to the opposite. All these suggestions help to divert their attention and raise a little humour.

The removal of the impression is done gently and if the suction or vacuum effect of the impression is too great, ask the patient to close their lips and nose and to blow hard into their mouth. This helps reduce the suction effect and facilitates its removal.

**Pearl:** Try to convert impression-taking from a fearsome, daunting process into a 'fun' process.

Each practitioner can develop his or her own individual techniques to divert attention and if done with honesty and a sense of humour will greatly enhance patient confidence and trust, improving the prospects of an excellent treatment outcome.

**Editor's comment**
The dimensional stability of stored alginate materials has generally been recognized as questionable. Recently, manufacturers of alginates have claimed dimensional stability for periods of 100 hours before pouring. This claim has been questioned by the results of a study that showed these newer alginate materials to exhibit significant dimensional changes at 24 and 100 hours in all storage conditions tested.[5]

## 4.3 BITE REGISTRATION

Before taking a bite registration, check the bite carefully; look for posturing of the mandible particularly in young patients. Explain to the patient what you will be doing with the wax wafer and what you require the patient to do, let the patient practise closing on the molar teeth. Use a horseshoe or V-shaped wafer rather than a sheet of wax extending across the mouth and interfering with the tongue. Place the softened wafer on the upper teeth then watch the path of closure as the mandible closes up into occlusion.

Wax bite wafers can be purchased commercially or premade by your staff. Cut across a sheet of modelling wax into strips 2 cm (1 inch) wide (Figure 4.2a–c). Warm the strip of wax either in hot water or with a flame, fold it lengthwise to double the thickness then twist it in the centre to create a V-shaped wafer.

### *4.3.1 Wax Bite*

Matie Grobler

When taking a wax bite, while the wax is still soft, squash the wax with your thumb and forefingers on to the buccal surface of the teeth. This gives better stability when articulating the study models. Cut off any wax extending distal to the last molar, it interferes when occluding the maxillary and mandibular models.


**Figure 4.2**

Making a bite wafer: (a) Score and cut a sheet of wax into strips 2 cm (1 inch) wide. (b) Warm and fold into double thickness strips. (c) Warm and twist the folded strip into a V-shaped wafer.

### *4.3.2 Taking the Bite*

Luc Dermaut

If the patient has trouble biting correctly, you should let him or her hold a hand mirror to see what they doing and how they should close correctly.

**Editor's comment**
There is some debate as to the need for mounting all study models on an adjustable articulator. Currently, I believe the majority of orthodontists do not routinely mount their study models. If it is necessary to mount the models on an adjustable articulator, then a facebow reading will need to be taken.

## 4.4 ORTHODONTIC SPACE ANALYSIS

Colin Wallis

A common problem in the clinical practice of orthodontics is the lack of an objective and

easy-to-use method by which to quantify crowding during routine orthodontic diagnosis. In assessing crowding two features require measurement: mesiodistal tooth width and arch length. Although it is possible, given the time, to accurately measure mesiodistal tooth widths, the determination of arch length is considerably more difficult, as it is both complex and highly variable.

**Pearl:** To further complicate matters, diagnosis and treatment planning requires not only a consideration of spacing and crowding, but also skeletal and soft tissue factors as well as potential facial growth.

This mass of diagnostic information becomes highly individualized in the sense that it not only reflects patient characteristics, such as facial appearance, but also the instinct and experience of the clinician and their preferred treatment modalities. The value attributed to various aspects of diagnosis therefore depends to a degree on the operator, and it may be argued that at some point there is a departure from science into art when making diagnostic decisions. Some experienced clinicians may therefore question the value of numerical diagnostic data, such as might be gained from a cephalometric analysis or space analysis. However, it is widely accepted and often taught that numerical diagnostic data is nonetheless helpful in directing, particularly the inexperienced clinician, towards an appropriate treatment plan.

Despite significant advances in orthodontic science and technology, there are few tools available at the present time to assist the clinician to more accurately quantify crowding. As a result of this, many clinicians depend only on a potentially unreliable visual assessment. Studies have shown that in the majority of cases, study models alone provided adequate information for treatment planning, and incremental addition of information from other types of diagnostic records make small differences.[6]

An everyday challenge for the orthodontist, therefore, is to process a large amount of diagnostic information, some of which may be conflicting, and crystallize this into a decision as to whether or not extractions are indicated. Since extractions are usually bilateral, in many cases more space is obtained than is actually required. In a number of patients there is a borderline need for extractions presenting the clinician with a 'double-edged sword'. This is because extractions may lead to difficulties of space closure, while a non-extraction approach may in some cases necessitate significant arch expansion, interproximal tooth reduction, cause flaring of the teeth, and contribute to lifelong retention (see Chapter 24).

Poor diagnosis related to inadequate space analysis not only leads to difficulty in case management, but may compromise facial appearance and the integrity of the dentoalveolar complex. This uncertain aspect of orthodontic treatment planning does have the potential to contribute to medico-legal problems, therefore orthodontists should be mindful of the need for risk management in this aspect of diagnosis.

**Pearl:** Since challenges to diagnosis may arise at a time considerably beyond the point of consultation, it would be advisable, with the benefit of having the patient present, to make a brief individualized note of the justification as to whether or not extractions were prescribed.

This may be particularly relevant in borderline situations, with some degree of crowding, when it has been observed that other specific factors influenced your decision one way or another. It may be easier, with individualized notes, to defend a subsequent challenge by pointing out that retrospective orthodontic diagnosis based on original archived records alone is unsafe.

### *4.4.1 Curve of Spee*

From a practical viewpoint, the curve of Spee has significant implications in terms of space analysis since additional arch perimeter is required if it is to be flattened. A common manifestation of increasing arch length is labial movement of the incisor teeth.

It is clearly important to quantify this component of a space analysis as it could influence

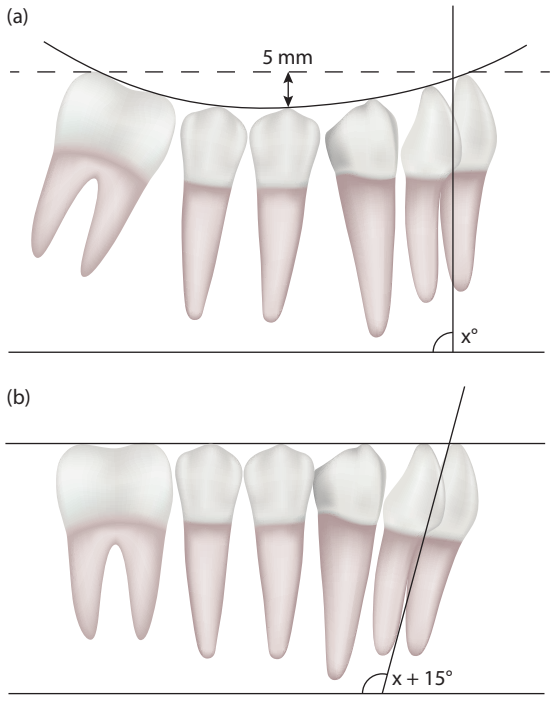


**Figure 4.3**

(a) Deep curve of Spee – 5 mm. (b) Levelling the curve of Spee will procline the lower incisors 15° (schematic representation not to scale).

the decision regarding the extraction of teeth.[7] Although the majority of cases levelling a mild curve of Spee may only require 1–2 mm of additional space, levelling deep curves can require as much as 5 mm of arch length.[7] A 15° proclination of lower incisors may occur in non-extraction cases when levelling a deep curve of Spee (5 mm) (Figure 4.3a,b).[8] Failure to consider the space implications of a significant curve of Spee could make a seemingly mildly crowded arch, with 2–4 mm of incisor crowding, difficult to manage.

**Pearl:** Assuming also that in the majority of fixed appliance cases the curve of Spee will be levelled, the available arch length should be measured as a *flat line 'in space'*, from the distal contact points of the first or second molars and in a smooth curve that crosses the maximum number of contact points.

The amount of crowding present will be the sum of the total mesiodistal widths of the teeth minus this arch length.

### 4.4.2 Arch Form and Asymmetry

Although work has been carried out on arch form and the curve of Spee, the contribution of arch form and asymmetry is often overlooked in any space analysis.[9–15] It is taken for granted that the orthodontist will aim for symmetry at completion of treatment, yet, unless the asymmetry is major, they give little attention to assessing the effect of correcting minor asymmetries. Studies have shown that crowding is greater on the right side in males and females; it is therefore important to adopt a method of space analysis that accommodates these differences.[16,17]

At the point of initial diagnosis, when crowding is quantified in millimetres, it is generally assumed that in a number of cases, the lower incisors are to remain in the same labiolingual position, and that the lower molars are unlikely to be moved distally. Furthermore, the arch form will not be significantly changed by the treatment.

### 4.4.3 Commonly Used Methods

Visualization, despite being the most commonly used method, has been repeatedly shown to be unsafe in quantifying crowding.[18,19]

The brass wire method of quantifying crowding will lead to an incorrect measurement where a curve of Spee is present.[20] If an aim of treatment is to level the arch, it is inappropriate to place the wire into the curve as the measured arch length will be too long. When this measurement is deducted from the total mesiodistal tooth widths, it will therefore underestimate the amount of crowding.

The Royal London method of estimating crowding relies on assessing the space needed to align each individual tooth into the existing arch form.[21] In some cases, however, it may be difficult to be mindful of the exact arch form while adding fractions of millimetres. The

Royal London method does draw attention to the need to assess the curve of Spee.

A widely used contemporary textbook recommend segmental arch length measurement, typically in three segments from the first molars to the canines for the distal segments and between the canines for the anterior segment.[22] There are three problems inherent with this technique. Firstly, the curve of Spee tends to be overlooked; secondly, the selected points may not represent the underlying arch form; and thirdly, the mathematical resolution of a curve into a series of straight lines will always underestimate arch length. When this length is deducted from the total mesiodistal tooth widths, it will inevitably over-estimate crowding.

### 4.4.4 Computerized Scanning

Computerized scanning is an increasingly popular method of assessing crowding. Many software programs are equipped with a facility to plot contact points in order to identify the arch form, as well as a 'virtual ruler' that can measure mesiodistal tooth widths. The software uses a popular mathematical function called a spline, which calculates how curved the arch form should be between contact points. Arch forms are extremely variable and errors in the identification of contact points will lead to a false reading of arch length. Individual measurement of teeth with the virtual ruler may be unreliable because tipped teeth will appear smaller when scanned from above.

### 4.4.5 Recommended Method

The best method currently available to quantify crowding is to measure arch length by digital scanning (ESM Scanner, ESM Digital Solutions, Dublin, Ireland) (Figure 4.4a,b) and mesiodistal tooth widths directly from the study model with either digital callipers (Digital Caliper: Series 500, Mitutoyo UK, Ltd., Andover, Hampshire, UK) or standard dividers. Digital scanners are increasing in popularity for use in archiving study models and usually have a facility to measure arch length. The main advantage of digital scanning for the purposes of quantifying crowding is that it will provide a two dimensional measurement of arch length, that is, it is measuring in a flat plane. The ESM software program automatically adds the measurements between each plotted point to give a total arch length (Figure 4.5).


**Figure 4.4**

(a) 3Shape D700 Digital Scanner with plaster model for scanning. (b) 3Shape D700 Digital Scanner with impression for scanning.

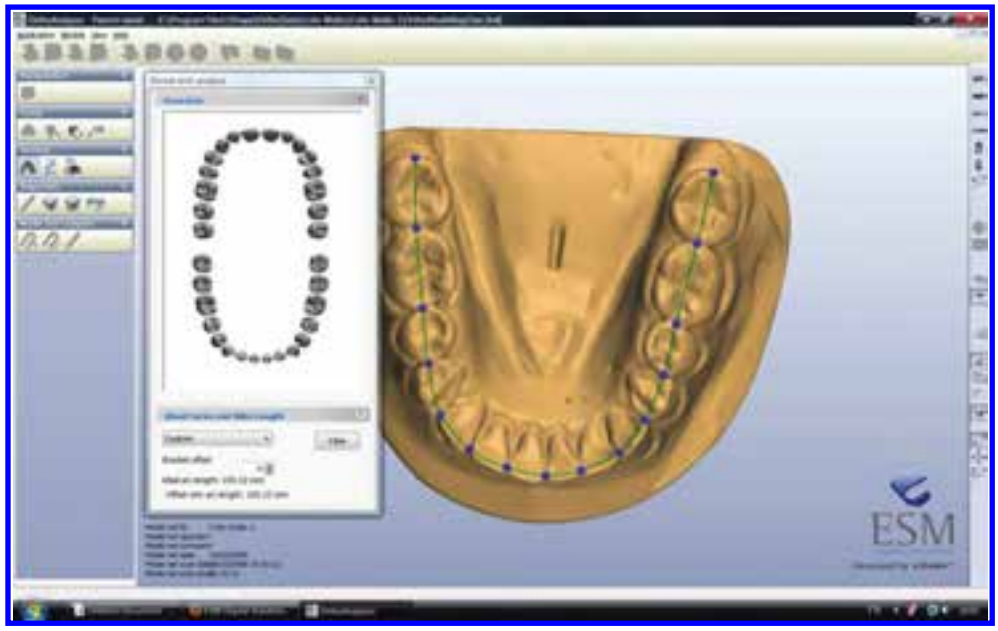


**Figure 4.5**

Digitally scanned model with software to measure and calculate tooth sizes and arch length.

**Pearl:** As explained earlier, assuming that arch levelling is an aim of treatment and that for the purposes of quantifying crowding, the molars and incisors are to retain their current positions; this is the correct (2D) length that should be deducted from the total mesiodistal tooth widths.

### *4.4.6 Flat Orthodontic Ruler*

In the absence of a scanner, a simple orthodontic ruler with a series of common flat arch forms in increasing sizes may provide similar information (Figure 4.6).

Irrespective of the continually changing forms of mechanotherapy in contemporary orthodontics and irrespective of the technique used to carry out space analysis, clinicians still need to be aware of the continuing importance of accurate space analysis in diagnosis and treatment planning.

## 4.5 RADIOGRAPHS

Eliakim Mizrahi

A comprehensive radiographic examination is an indispensable component of an orthodontic investigation. It should provide data on the dental, skeletal, and soft tissue elements of the dentofacial complex. As with photography, the advent of digital and computerized radiography has introduced a new dimension into this aspect of clinical practice. Fully digital x-ray machines using charge-coupled device (CCD) imaging are commercially available as well as facilities for changing conventional cassettes used with standard x-ray machines to photostimulable phosphor cassettes that produce digital images. The advantages and disadvantages of both the conventional and digital systems have been extensively debated, and there can be little doubt that as we progress into the twenty-first century, digital systems will replace the older conventional systems. If you are starting a new practice, I would recommend that

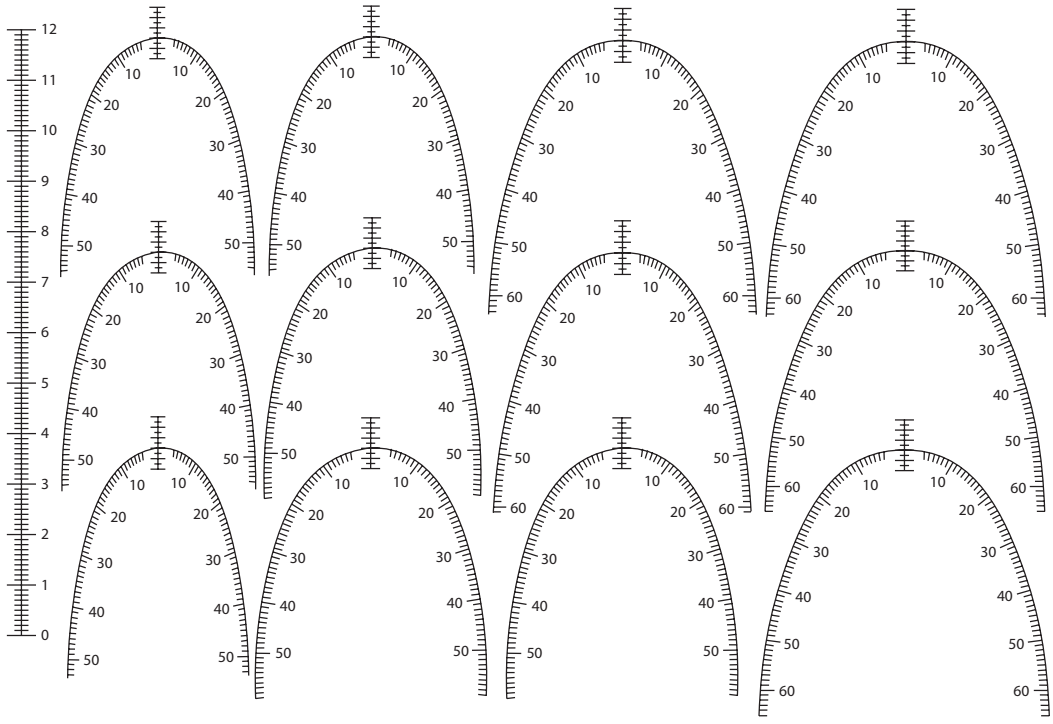


**Figure 4.6**

Orthodontic ruler.

you purchase a digital system. Those of us already in practice will gradually convert to digital, as and when individual circumstances indicate the need to change. Irrespective of the system used, the principles of good radiography should still remain unaltered.

The attitude of both patients and the profession to radiographs and exposure to ionizing radiation has changed over the last few years. The current principles regarding radiographs in clinical orthodontics are well documented and presented in a publication by Isaacson and Thom.[23] They state that: 'Radiographs are justified only when the management of a patient is dependent on the information obtained.' In the past, it was common practice to take initial radiographs, progress radiographs, and finally post-treatment radiographs; now this approach must change in view of their recommendations.

**Pearl:** Due consideration for patient safety dictates: 'No patient should be expected to receive additional radiation dose and risk as part of a course of dental treatment unless there is likely to be a benefit in terms of improved management of the patient.'

While there is general agreement on the need for initial radiographs taken at the start of treatment, the need for progress and final radiographs may be questioned. If you need clarification or confirmation of root angulations or the degree of torque achieved or any aspect of treatment that cannot be clinically visualized, then taking radiographs prior to the removal of appliances could be justified. Taking final radiographs following the removal of appliances cannot, in most cases, be considered as being of benefit for the patient.

### 4.5.1 Dental Panoramic Tomogram

Good quality dental panoramic tomograms (DPTs) give excellent views of the dental and skeletal structures extending from the left to the right mandibular condyle. Areas of the radiograph where the clarity of the image may be suspect usually occur in the maxillary and mandibular incisor regions. The clarity of this region is dependent on the quality of the equipment and the accuracy of positioning the dental arches within the focal trough of the machine. Reference to the specifications related to your x-ray machine should be read in conjunction with information provided by many textbooks on dental radiography.[24,25]

### 4.5.2 Occlusal Radiographs

Structures, such as supernumerary teeth occurring in the incisor region, are often palatally displaced and consequently out of the focal trough of a DPT machine resulting in an indistinct unidentifiable opacity. For this reason, some clinicians maintain that for all patients receiving their first orthodontic radiographic examination, occlusal or periapical radiographs of the anterior teeth should be taken to supplement the DPT. Using an occlusal film folded in half and placed between the incisors, it is possible to expose both upper and lower teeth without removing the film from the mouth. This view gives a good image of the roots and supporting alveolar bone in the incisor region but a limited view of the palate.

### 4.5.3 Bitewing Radiographs

These may be considered essential for certain caries-prone patients and they are also useful for assessing alveolar bone levels. Conventional bitewing radiographs can be supplemented by the vertical bitewing view when clinical examination suggests excessive alveolar bone loss. These views are more relevant and essential for adult patients particularly those presenting with mutilated dentitions.

**Pearl:** The accuracy, reliability and clinical usefulness of intraoral radiographs are greatly enhanced by the use of film-positioning devices.

### 4.5.4 Radiographic Techniques for Locating Impacted Teeth

Locating the position of unerupted and impacted teeth is an essential component of diagnosis and treatment planning. Of particular concern is the labiolingual position of impacted teeth in relation to the roots of the adjacent teeth. There are many radiographic views available for such diagnosis and these are well described by Becker.[26–28] The most frequently used technique is the parallax method where two periapical views of the same subject are taken from two different angles. The tooth furthest from the tube will appear to move in the same direction as the x-ray tube (see Chapter 19).

Computerized tomography (CT) scanning can also be used for identifying the exact position of an impacted tooth; unfortunately, the high radiation dose and high cost discourage the common use of this technique (see Chapters 5 and 19).

### 4.5.5 Palatally Displaced Canine

Luc Dermaut

On a panoramic radiograph, a unilateral palatally displaced canine will appear enlarged compared to the contralateral canine. This enlargement is due to the fact that canine-film distance is larger for a palatally positioned canine than for a normally positioned canine since the film is in front of the teeth and the x-ray source behind the head. This results in a larger image of a canine in the palatal position.

### 4.5.6 Lateral Skull Radiographs/ Cephalographs

Eliakim Mizrahi

Lateral skull radiographs routinely taken in a standard cephalostat are considered a standard

requirement of any comprehensive orthodontic examination. A good quality film should show clearly all the dental and skeletal elements of the craniofacial structures. There are a number of auxiliary components either built into the cephalometer or placed on the cassette that will also allow visualization of the soft tissue profile. Accurate positioning of the head is essential and this may be gauged by the concentricity of the ear rod rings.

A lateral skull radiograph without a corresponding cephalometric tracing and analysis is of limited value. There are many analyses available to the contemporary clinician and with time and experience; each individual tends to favour a particular analysis that suits his or her requirements. Since its inception, lateral skull radiographs have been traced using conventional light boxes and acetate tracing paper; however, once again with the development of digital technology, radiographs may now be digitized either on a digitizing tablet or directly on a computer screen. There are numerous software packages which provide facilities for computerized drawing, different analyses, automatic angular and linear measurements, comparisons of values with standard norms, superimpositions, visual treatment projections, as well as orthognathic surgical projections and visualizations. The visual treatment objective is an important tool often used by orthodontists to predict treatment and growth changes that will take place in the growing patient. The early workers in this field were Magness,[29] Rickets,[30,31] Holdaway,[32,33] and Jacobson and Sadowsky.[34] How much dependence each clinician places on the analysis is a matter of personal choice, but crucial to any evaluation of whatever analysis is used, is the accuracy and reliability of the original landmark identification.

## *4.5.7 Lateral Cephalometric Measurements – How Accurate?*

Alexander Jacobson

Lateral cephalometric measurements are often used to measure growth and/or treatment changes in patients. Lines connecting specific anatomical points many times are used as baselines from which angular and metrical measurements are made. Two such popular parameters are the Frankfort Horizontal and the linear distance from condylion to gnathion, which is a measure of effective length of the mandible.

To test the accuracy of landmark identification, three faculty members were asked to select from their private practices two of their best lateral cephalometric radiographs. Of these, three were finally selected as being the best. Three crosses were scratched through the emulsion of each of the selected radiographs for purposes of accurate superimposition. Eight experienced clinicians were asked to identify specific landmarks. To ensure consistency, definitions of the landmarks were provided. A dot pencilled onto the acetate paper was used to identify each landmark. On completion, the eight tracings were placed on top of each other on a transilluminating table with the three crosses accurately superimposed. The dots representing the specific landmarks were scattered in the vicinity of each landmark. The smallest circle was drawn to encompass all the dots representing each landmark; the smaller the circle, the more readily identifiable the landmark (Figure 4.7).[35]

Sella, nasion and articulare were shown to be relatively easy landmarks to identify (the latter, however, not being an anatomical landmark).

**Pearl:** The larger circles embracing the cluster of pencil dots in the region of landmarks porion, condylion and orbitale suggest an inability to accurately pinpoint these anatomic points.

### 4.5.7.1 Linear Measurement Considerations

The images of anatomic structures closer to the anode and furthest from the central ray are magnified more than those closer to the film and central ray, leading to different film images of the left and right craniofacial landmarks. This poses a question: in measuring the effective length of the mandible (condylion to gnathion), does one register left or right condylion, or a point midway between them? What in fact is measured is an oblique line, condylion being

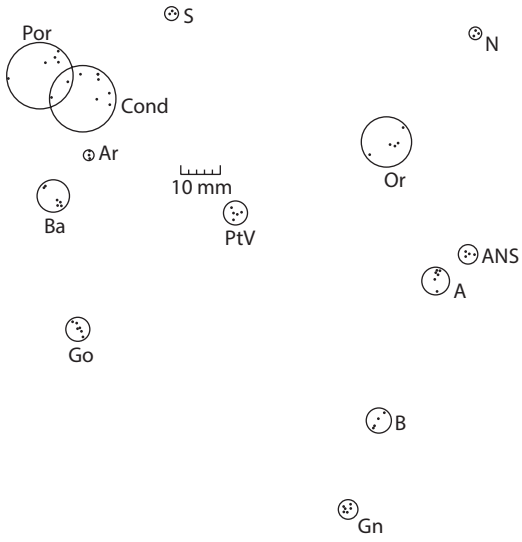


**Figure 4.7**

A scatter diagram showing the distribution of dots representing certain cephalometric landmarks. The smaller the circle, the more readily identifiable and more accurate the localization of the landmark. A = A Point, ANS = Anterior nasal spine, Ar = Articulare, B = B Point, Ba = Basion, Cond = Condylion, Gn = Gnathion, Go = Gonion, N = Nasion, Or = Orbitale, Por = Porion, PtV = Pterygomaxillary fissure, posterior convexity, S = Sella.

a lateral landmark and gnathion a midsagittal point.

Additional factors that can cause lateral anatomic landmarks to be spaced are ear rods of the cephalometer not properly inserted into the external auditory meatii, and lack of symmetry of the auditory meatii in the skull, both anteroposteriorly and vertically. All the above, and sample size, are factors that warrant consideration when interpreting data gleaned from serial head film tracings. How accurate are our tracings?

**Pearl:** Possibly best summed up in the words of Richard L Feynmann, Nobel Prize winner in physics, who stated: 'Scientific knowledge is a body of statements with varying degrees of certainty – some most unsure, some nearly sure, none absolutely certain.'

## 4.6 CEPHALOMETRIC TRACING

Demetri Patrikios

### *4.6.1 Basic Principles*

Over the years, I have tried many methods and analyses before finally settling on a few principles that I now wish to share with colleagues. These principles have been tried and tested until they satisfied my desire to be as accurate as possible and at the same time they allow the operator to develop a more complete appreciation of the malocclusion.

The term 'cephalometric' comes from two Greek words meaning 'head' and 'measurement' and the procedure is nothing more or less than that.

When measuring and evaluating the bony and soft tissue relationships, we need to consider *all* the measurements and their interactions with one another. To base a treatment plan on the angle of one or two measurements exclusively, such as the lower incisor to the mandibular plane or the anteroposterior line (as I have seen done many times), is not cephalometrics since the rest of the head is not involved. All hard and soft tissue measurements need to be integrated and understood to even begin to suggest a line of treatment. Of course, many other factors are involved, but my comments will be confined to cephalometrics.

It is infinitely more valuable to the treatment planning process if the orthodontist personally does the tracings. I have found that when I am presented with a set of measurements that someone else has done or computer-generated measurements, I lack the intimate contact and understanding that comes with tracing and measuring the films myself. In doing the latter, a depth of feeling for a particular case develops that goes beyond the measurements and this feeling allows you to understand, evaluate and possibly adjust the measurements with due regard to the extremes of normal ranges. Using a computer is mathematically accurate, but it cannot compete with the 'computer between your temples' when the fine nuances of heredity, presenting morphology and psychological make-up of the patient need to be evaluated to help you decide on the correct line of treatment.

When tracing and measuring a cephalometric radiograph, the latter needs to have certain essential characteristics if your tracing is to be accurate, meaningful and capable of scientific comparison with subsequent films. The characteristics can be listed as follows:

- Anode to midsagittal plane distance of 1.5 m (5 feet).
- Place film as close to the patient as the cephalostat will allow. This will reduce magnification to about 7% or 8%.
- Place the horizontal edge of the film cassette parallel to the floor. I prefer this to be in landscape mode, this view includes more of the head in the anteroposterior dimension.
- The patient's teeth must be in centric occlusion. If the ear rods of the cephalostat are pushed too far into the soft tissue external acoustic meatus, when the teeth are brought into occlusion the condyle presses against the ear rods and this may be painful; consequently, the patient will simply not keep the teeth in centric occlusion. To make sure the patient is comfortable, place the ear rods in the ear and then back them off a little.
- The patient's head must be orientated so that the Frankfort horizontal plane is parallel to the floor. For this purpose most cephalostats have a pointer that can be placed on orbitale. This pointer should be mounted in such a way so that if a horizontal line is drawn it will be tangent to the top of the ring around the ear rod of the same side (effectively cephalometric porion) and this should in turn be parallel to the floor. This is very important in order that the head and profile are always orientated in the same relationship to the film edge. This aids in tracing and later comparison with subsequent films.
- The lips should be closed gently without undue pressure. This allows for the measurement of lip strain and its incorporation in treatment planning with the intention of normalization of the lip relationships without undue strain.[36] I am aware that some clinicians prefer to have the patient relax their lips.
- Now, the problem of exposure of the radiographic film arises. What we require is a clear film allowing us to trace both the hard and soft tissues with equal ease. The roentgenographic problem is that it is virtually impossible to get both the hard and soft tissues clearly defined on the same film. The drape of the soft tissues cannot be appreciated on the average film even though some of the soft tissue outline may be discerned. When one can see the drape of the soft tissue well, the bone appears too light (underexposed) and cannot be traced accurately. A film that is in between both is equally frustrating as point 'A' is almost impossible to visualize.

The reader will note that I have repeatedly used the terms 'film' and 'tracing', I am aware that currently most practices are in the process or have already converted to digital radiographic units. The output from these machines is an image on the computer screen and no longer a film and furthermore, most clinicians no longer trace cephalometric radiographs. Digitization has replaced the art of tracing. However, the basic principles listed above, still apply.

Digital images have advantages and disadvantages, listing them is outside the scope of this article; however, one advantage I would like to mention is the ability of the operator to vary the brightness, intensity, and contrast of the image. This has overcome the difficulty we had in the past with conventional films where an exposure adequate to identify all the bone structures was too dark to view the soft tissue drape or in some case accurately visualize structures, such as the subnasale or anterior nasal spine.

For those readers who still have conventional radiographic machines and are interested in how to overcome this problem, I have described the technique in the first edition of *Orthodontic Pearls*.

## *4.6.2 Tracing the Cephalometric Radiograph*

### 4.6.2.1 The Tracing Film

I am aware that if required, digital images can be printed out on transparent film so for the

benefit of those clinicians who wish to trace their cephalographs, I will describe my recommended technique.

The acetate tracing film supplied by orthodontic companies is thin and quite transparent. However, it is only coated on one side and as a consequence tends to curl up especially after the tracing has been done. The other disadvantage is that unless the pencil you are using is quite soft (at least HB or softer), it does not show up the drawn lines in a satisfactory manner. The tracing is therefore only seen well when placing a sheet of white paper under it. Furthermore, this acetate picks up marks from the natural oils of the skin. To overcome these problems, I visited drawing office supplies where a range of tracing film is available. The film is generally coated on both sides (and therefore stays completely flat) and comes in varying thickness and opacities. No smudging from fingers occurs, and a harder pencil can readily be used to obtain thin, clean, crisp lines. You can order any size you wish and it is usually cheaper than that obtained from orthodontic companies.

#### 4.6.2.2 Tracing

We have all traced x-ray films and this is a relatively simple procedure. However, there are a few pointers that I have found useful:

- First, the x-ray film must be stuck down on to the tracing box screen square to your position as you sit. Ideally, the Frankfort plane is parallel to the edge of the radiograph. Use masking tape to secure the radiograph rather than 'sticky tape' as the former peels off more cleanly when removed. Stick down only the two corners away from you so that the radiograph can be lifted up from the bottom if so desired. The overlying tracing film should be similarly stuck down.
- With the radiograph in position and before placing the tracing paper in position, draw the Frankfort plane directly onto the radiograph. I use a blue pencil in order to clearly see this line once the tracing paper has been placed in position.
- At this stage, it is necessary to identify and mark the true porion. This is defined as the uppermost point on a circle representing the bony external acoustic meatus, which is located up and back from the ear rod porion. To establish the true porion, I generally outline the articular eminence (found by looking directly below the sella turcica) and the condylar fossa. Then using a Ricketts Dome tracing template I outline these and the corresponding bony external acoustic meatus, which is adjacent on the tracing template. The orbitale is easily identified and then the Frankfort plane can be drawn to the true porion. I do not use the ear rods as representing the porion.
- Now, the tracing film is placed over the radiograph in such a way as to have the long edge (the tracing film is used in landscape mode) parallel to the drawn Frankfort horizontal and covering the image adequately. The reason for this is that all films traced in this way will have the drawing of the head orientated in the same position on the tracing film. This makes comparison of subsequent tracings of a particular case much easier and the eye can pick up changes in the soft tissue profile more readily.
- To help with paralleling the tracing paper edge to the Frankfort horizontal, a W + G Douglas combination protractor and parallel rule is used. This instrument has many uses and I would not be without it (found in drawing office supplies). You can set the edge of the tracing film parallel to whatever line you wish and you can draw lines parallel to other lines or at right angles to chosen lines and measure angles. It is possible to measure angles between lines that do not meet on your tracing paper by placing one edge of the W + G protractor against a line while sliding a protractor at right angles along the adjacent edge of the W + G protractor until the appropriate point on the sliding protractor intersects the other line, then taking the 90 degree mark as zero, you need to read off the angle between the two lines.
- The tracing is now done in the usual way. I use an H pencil on the drafting film and when drawing lines, the pencil is simultaneously rotated in the fingers to keep the lines crisp and not to wear a 'flat' on to the pencil point. The pencil is sharpened at the beginning and at least once during tracing. I also

use clutch pencils with different hardness lead inserts and also different colours.
- A good quality protractor is also a good investment. Tracing paper is harder than ordinary paper and tends to wear the markings on poor quality protractors rather quickly.
- When tracing I like to draw in the ala of the nose to visualize the nasal opening and to outline the vermilion border of upper and lower lips in the same way as Ricketts does. This imparts a 'human' quality to the tracing so that it does not look too sterile. I also include an outline of the back of the head (as far as possible) as this completes the picture and gives a proper perspective to the head you are viewing.
- As a general rule, the initial tracing is in black, the visual treatment objective in red, progress in blue and the end of treatment tracing in red.

Should any reader require more comprehensive information on the Holdaway soft tissue analysis and visual treatment objective, the author will be happy to provide details on the technique.

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# 5 CONE BEAM COMPUTED TOMOGRAPHY

Iain Macleod

CONTENTS



With the advent of dental implants, cross-sectional imaging became necessary in order to avoid damage to fragile anatomical structures and to allow accurate measurements for implant placement.

Imaging modalities available in dental practice only provide limited information necessary for this purpose with the result that practitioners were resorting to conventional computed tomography (CT). Obviously, these machines are not suitable for dental practice and are usually undertaken in collaboration with hospital radiology departments where access could be problematic.

**Pearl:** CT scans do provide extremely useful information but it is by nature a high dose modality and in the oral cavity images can be severely affected by streak artefact from metallic dental restorations.

In view of the problems with CT, there was a need for an imaging modality designed for purpose.

Cone beam computed tomography (CBCT) technology has been available for over two decades, and in recent years CBCT has found its place in dental and maxillofacial practice. A variety of manufacturers have produced machines specifically targeted for the 'high street' dental practice, in particular those specializing in implants and orthodontics. As an imaging modality, it has been shown to be a valuable asset in head and neck imaging.[1,2] CBCT is different to conventional CT in the way in which it acquires data. Conventional CT uses a fan-shaped x-ray beam, rotating around a patient lying either supine or prone (Figure 5.1a,b).

In effect the unit acquires a volume of radiographic information and is frequently referred to by its alternative names, 'cone beam volumetric imaging' or 'digital volumetric tomography'. The scan time is rapid, where only one revolution of the tube is required to obtain the necessary data within a time exposure of 10 to 40 s. The series of 'basis' images, which are similar to a series of offset lateral cephalometric (skull) images, form the projection data.

**Pearl:** CBCT works through delivering the radiation as a cone-shaped beam, rotating around the patient in a similar fashion to a dental panoramic tomography machine.

Complex algorithms, including filtered back projection, are applied to the data to provide primary reconstruction images in three orthogonal planes (Figure 5.2).

Effective dose does vary depending on the manufacturer and on the volume acquired, but are usually between 0.035 and 0.10 mSv, (milliSieverts) where as a typical effective dose for CT facial bones is 0.40 mSv (milliSieverts) (Table 5.1 values are in MicroSieverts).

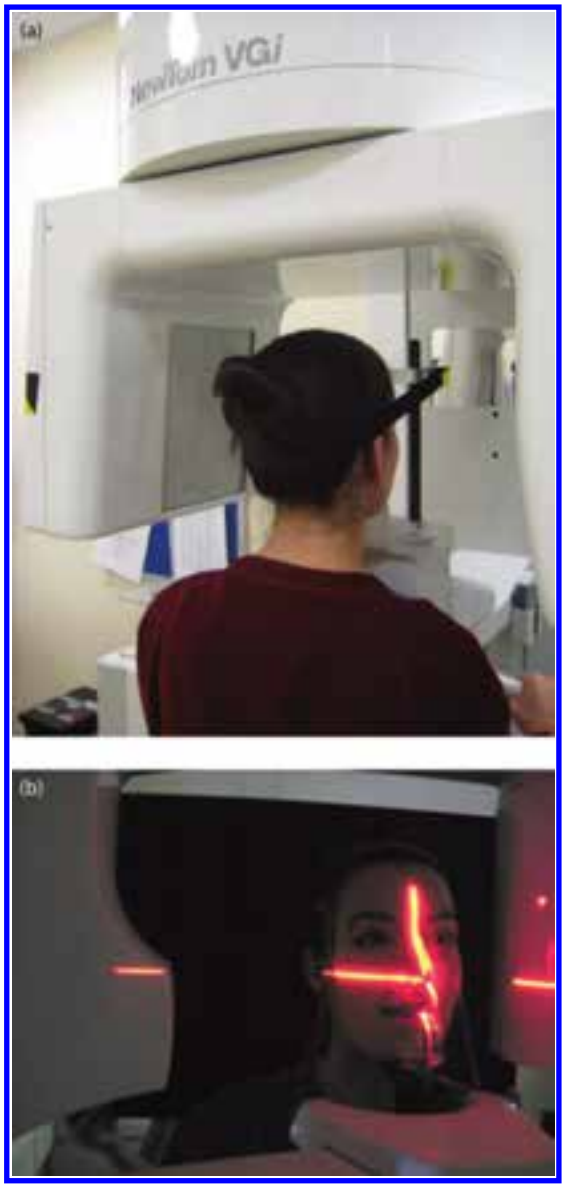


**Figure 5.1**

(a) CBCT is becoming more widespread in orthodontic practice with several manufacturers producing units and the mean purchase cost decreasing. It is slightly more forgiving in positioning than dental panoramic tomography but very susceptible to movement artefact. Despite the impressive images it can produce, it does give a higher radiation dose than conventional dental imaging. (b) Dental panoramic tomography is an extremely useful imaging modality for orthodontics but is very prone to creating artefacts. Accurate patient positioning is essential to producing a reliable image.

The clinical application of the modality is broad, where potential maxillofacial uses include:[1–5]

- Evaluation of dental and maxillofacial trauma
- Assessment of bony pathology
- Establishing the relationship of the inferior alveolar nerve and lower third molars for pre-surgical assessment
- Assessment of unerupted teeth and evaluation of possible effects such as resorption of adjacent teeth/structures
- Alveolar bone assessment during presurgical implant planning
- Investigation of the maxillary, paranasal, ethmoid, and frontal sinuses

CBCT is particularly good at evaluating bone and the dental hard tissues, and produces less streak artefact than conventional CT, which means it is more usable when large dental restorations are present.

**Pearl:** Quality images are very dependent on the patient keeping still during acquisition, which can limit its use in very young children or patients with movement disorders.

For the orthodontist, incorporation of the acquired data into various software packages such as those produced by the US company, Dolphin Imaging & Management Solutions, (9200 Eton Avenue, Chatsworth, CA 91311, USA) considerably enhance the value of this imaging modality in its diagnostic potential.

Furthermore, a three-dimensional evaluation of the computed tomographic images of maxillary and mandibular dentitions has been put forward as an alternative to conventional plaster models.[6] While we recognize the side benefits of this form of radiographic analysis, it is hoped that the reasons for subjecting the patient to the required radiation would be based on more biological and diagnostic reasons.

A disadvantage of, in particular, large volume CBCT is that anatomical structures not normally seen in conventional dental radiography are being imaged with CBCT, such as the base of the skull and the middle ear. This leads to a potential for missing pathology in these areas.

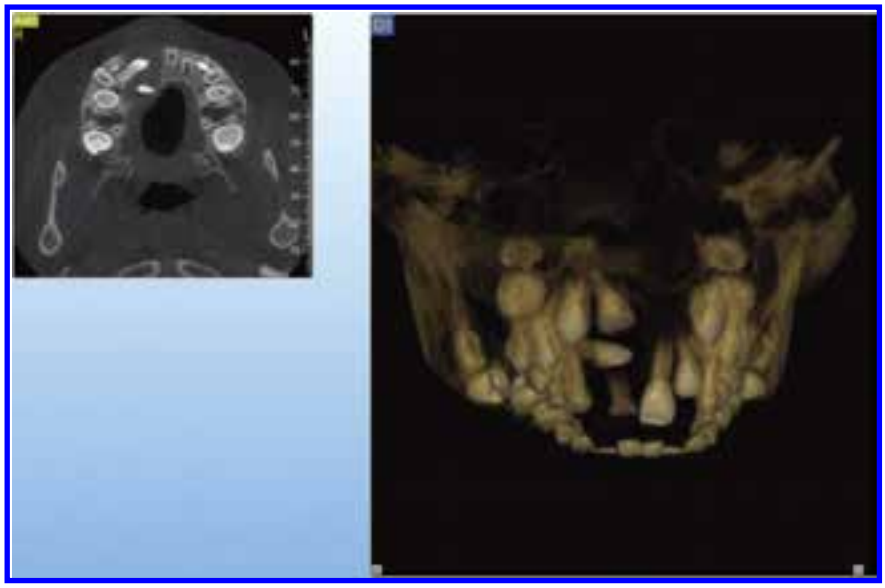

**Figure 5.2**

CBCT provides the ability to look at a clinical situation in any plane including 3D. Although this has obvious benefits, these must be balanced against the radiation risks. Using more conventional techniques might give enough information. Image shows displaced teeth as a result of a palatal cleft.

In many regards, dental cone beam technology has been developing at a faster rate than its evidence-based clinical usage, with a tendency in some countries for it to be used when more conventional methods would provide similar and more dose-effective information (Table 5.1).[7]

The use of ionizing radiation for clinical use is controlled and regulated in the UK by Ionising Radiation (Medical Exposure) Regulations (IRMER) which complies with the Euratom directives established for Europe. On an international basis, undoubtedly different countries will have their own controlling bodies.

Although discussion of the details of such regulations falls outside the scope of this chapter, it is essential to emphasize that for any radiographic investigation, the responsible clinician is required to prescribe the correct radiograph and is obliged to report on the relevant findings (a legal requirement in the UK). This implies that the responsible clinician is able to

**Table 5.1**

Typical Doses from Dental X-ray Examinations[a]

| | Technique | Effective Dose (microSievert) | Equivalent Background Radiation | Cancer Risk (per million exams) |
|---|---|---|---|---|
| Single Periapical or Bitewing | Digital | 1 | 4 hours | 0.05 |
| Dental Panoramic Tomogram | Digital | 2.5 | 10 hours | 0.125 |
| Lateral Ceph | Digital | 2.2–14 | 1.7 days | 0.5 |
| Transatlantic Flight | 6 hours | 24 | 4 days | 12 |
| Cone Beam Computed Tomography | 20 second scan | 35–90 | 6–15 days | up to 5 |
| Conventional Computed Tomography | Maxilla | 250 | 42 days | 13 |
| | Mandible | 480 | 80 days | 24 |

[a] Data compiled from several sources.

interpret and report on any normal and abnormal findings. Following on this obligation, it is essential that the clinician prescribes only the relevant radiographs and more important, in the case of CBCT, reduces the field of exposure to a minimum. This view is further supported by the results of a study carried out by Drage et al.[4] who concluded that because incidental findings seldom have an effect on the treatment plan, the smallest field of view required to answer the clinical question should be used and thoroughly analysed.[8]

More recently, manufacturers have developed units with a smaller field of view, which are less likely to demonstrate anatomy outside the dentists' usual remit. Many of these features are now components of 'hybrid' dental panoramic units.

An interesting view on the ethics of CBCT usage in orthodontics is discussed by Greco in a recent publication.[9]

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# 6 ORTHODONTIC PHOTOGRAPHY: AN UPDATE

Jonathan Sandler and Alison M Murray

CONTENTS



Photographs are an essential component of comprehensive orthodontic investigations; they have historically be taken as conventional colour prints, Polaroid photographs, colour slides, or digital photographs.[1] Personal preference, of course, will dictate which of these formats you choose, but the convenience of digital photography provides the clinician with not only a clinical record but also the facility to instantly use the image to educate the patient as well as providing the option to print hard copy for the patient, when required.

Photographs are an invaluable aid at the start, during and at the end of treatment, and are arguably the most important clinical record we take.

## 6.1 TREATMENT PLANNING

When devising treatment plans in the confines of your office, without the presence of the patient, it is not always possible just from clinical notes, radiographs, and study models, to recall the important features of each patient as well as the finer details of their malocclusion. High quality photographs will assist you in recalling both intra- and extraoral features which will have an influence upon different possible treatment plans.

As long as the clinical notes have recorded the exact relationship of the upper centre-line to the mid-face and the presence or absence of a mandibular displacement on closure all other relevant features can be ascertained from high quality clinical records (Figures 6.1 and 6.2a,b).

## 6.2 CASE DISCUSSIONS

When consulting with a child and their parents or an adult patient, they are immediately drawn to and fascinated by their own photographs on the flat screen monitor (Figure 6.3).

**Figure 6.1**

Upper or lower dental center line deviation from mid-face must also be recorded on the clinical notes.

**Figure 6.2**

(a) Initial contact position, mandible nondisplaced. (b) Intercuspal position, mandible displacement must be noted on clinical records.

They have rarely seen their teeth from this aspect and close up photographs highlight the detail of the malocclusion. Photographs aid in explaining to the patient adverse tooth positions and gingival conditions, as well as relevant features of the patient's smile and profile. The photographs can also be used to demonstrate what kind of appliance therapy might be used to correct the malocclusion or what the effects of treatment might be (Figures 6.4 and 6.5a,b).[2]

## 6.3 AS AN AID DURING TREATMENT

Many times during treatment it is helpful for you to recall the original malocclusion and even what teeth looked like at the last visit. Instead of having to retrieve the study models, it is far easier to access the photographs, which ideally should be available on a computer screen at the chair side (Figure 6.6).

Only by studying the changes achieved on a visit by visit basis can the clinician learn which

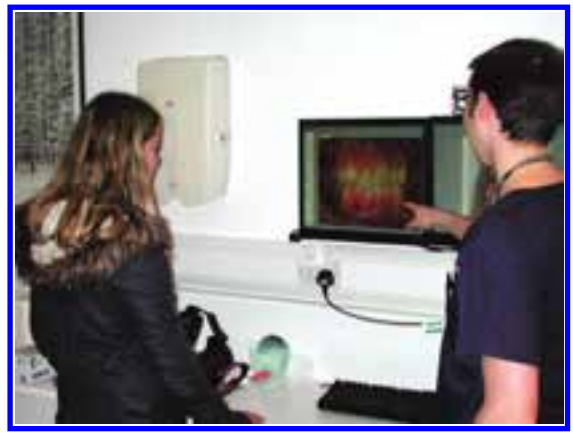

**Figure 6.3**

Consultation with parents and children greatly aided by clinical photographs.

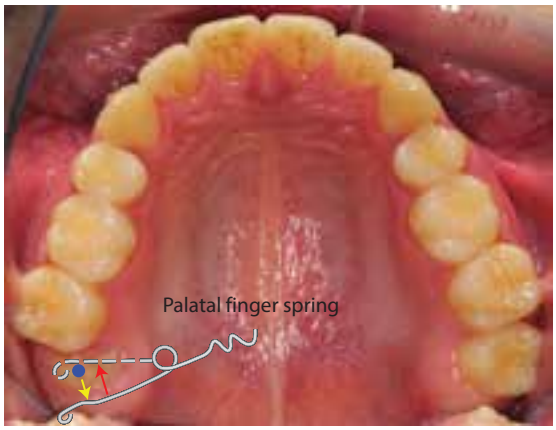


**Figure 6.4**

The type of appliances to be used can be illustrated on the photograph.

treatment techniques are the most efficient and which are least effective. For postgraduates in training this is an invaluable tool for them to learn the art and science of orthodontics.

## 6.4 PATIENT REMINDER

Photographs are also a tremendous aid to remind patients what their teeth looked like before treatment. Patients and parents have notoriously short memories; they routinely forget what their teeth were like before treatment. Showing the patient and parent during treatment, what they originally looked like and explaining just how far they have progressed in a comparatively short time encourages enthusiasm for treatment and enhances cooperation and is an excellent motivator (Figure 6.7).

## 6.5 PRACTICE BUILDER AND MARKETING TOOL

At the end of treatment, when the patient is looking in the mirror and seeing their actual teeth after debond, showing them the original photographs boosts their feeling of satisfaction and appreciation for what you have done for

**Figure 6.5**

(a) Initial photograph showing absent lateral incisors can be doctored in minutes. (b) 'Kesling setup' done digitally can reproduce the projected orthodontic and restorative changes required.

**Figure 6.6**

Clinicians can benefits enormously from having original and last visit photographs instantly available.

**Figure 6.7**

Significant changes appreciated when photos viewed side-by-side.


**Figure 6.8**

Degree of anterior open bite closure, demonstrated by (a) before and (b) after photographs.

them. Printing out the start and finish photos for the patient will provide them with something they can show all of their friends and word of mouth recommendation for the quality of your services is arguably the best form of advertising.

It is also very useful to send a 'before and after' set of photographs, with the patient's permission, to the referring practitioner to demonstrate the quality of treatment that you would be willing to provide for their patients. Again an impressive treatment result will no doubt be shown to other clinicians in the practice which should lead to further referrals in the future (Figure 6.8).

## 6.6 AS A DEFENCE TOOL IN MEDICO-LEGAL CONFLICTS

Claims by patients or their parents that certain conditions, such as enamel fractures, chipped incisal edges or demineralization were caused by treatment, can in many cases be refuted by showing the patient that this particular condition was actually present at the start of treatment. Such photographic evidence can in many cases defuse a potentially explosive situation and prevent a complaint progressing to a more serious level.

Photographs can also help enormously to document the case when you last saw the patient. Occasionally patients fail to attend their follow-up appointment and despite your best efforts sometimes slip through the net and get lost. When they do eventually return for brace removal you want to be able to demonstrate they were in good shape when you last

**Figure 6.9**

(a) Extended period away from the orthodontist showing evidence of neglect. (b) Last photo taken 9 years earlier show teeth in good shape.

saw them and that efforts had been made to follow them up (Figure 6.9a,b).

## 6.7 CAMERA REQUIREMENTS

The camera setup chosen, particularly if for a multiuser setting, should require as few adjustments as possible to ensure it is used effectively and regularly. Change of lenses between intraoral and extraoral or adjustment to many of the settings will unfortunately discourage the photographer from using the camera frequently. A point-and-shoot system is possible for intraoral photography with only a slight aperture adjustment for mirror shots or for extraoral photographs.

These adjustments are to open up the aperture by one full stop for the occlusal mirror views. The reason for this is that the light has to travel twice the distance from the camera to the mirror and reflected light is rarely reflected at 100%. The slight loss of light will mean the mirror shots are noticeably darker than the direct intraoral photographs unless this aperture adjustment is made.

**Pearl:** The camera to be used in a busy multiuser situation should be kept easily accessible and capable of producing high quality images over and over again, with few camera adjustments required.

Whichever camera system is chosen, it will need to be calibrated by doing a test run on a volunteer. Extraoral, intraoral and close-up views should be taken using a variety of settings to establish the optimal settings required to obtain high quality exposures.

If digital photography is your choice, then the Canon 70D camera is an excellent option. It needs to be purchased with a Canon EF 100 mm f/2.8 Macro USM lens which is perfect for both intraoral and extraoral portrait type photographs. It also has a dedicated Canon MR-14EX Macro Ring Lite flash which will guarantee constant reproducible exposures time after time. This camera system is at the bottom end of professional models but will provide the quality required for orthodontic clinical photography.

With this digital camera system the only adjustment that is required is to change the f stop from f/32 used for the front and buccal intraoral views to f/20 for the mirror shots and f/5.6 for the extraoral views.

**Pearl:** The advantage of taking the intraoral views at f/32 is the enormous depth of field, which ensures that the maximum amount of the area of interest is in crisp focus.

Each orthodontist may take slightly different views on a routine basis. The basic minimum data set however, should include standardized extraoral full face, three-quarters and profile

views with the lips in a relaxed pose and also in full smile, intraoral front, and two buccal views with the teeth in occlusion and mirror views of the occlusal maxillary and mandibular arches using good lip retraction.

For aesthetics and smile evaluation, a close-up view of the smile without the use of cheek retractors is sometimes useful to allow assessment of the soft tissues in relation to the teeth. Remember, patients have never seen their teeth with their lips pulled to the side with retractors, and they relate much more easily to a view showing their teeth smiling without retractors in place. Some operators also like to take a close up of the overjet just showing canine to central incisor taken at 90 degrees to the midsagittal plane and occasionally an oblique anterior view showing whether or not the overbite is complete to hard or soft tissue.

## 6.8 OTHER CAMERA EQUIPMENT REQUIRED

### *6.8.1 Orthodontic Retractors*

It is essential to have two sizes of double-ended cheek retractors. For the front intraoral view the large end of the larger retractor is appropriate in 95% of cases (Figure 6.10). The only cases that will not be able to tolerate the large end of the larger retractor are very small children or patients with markedly reduced lower facial height (Figure 6.11). These two groups of patients find it impossible to close in centric relation with the large end of the large retractors in place.

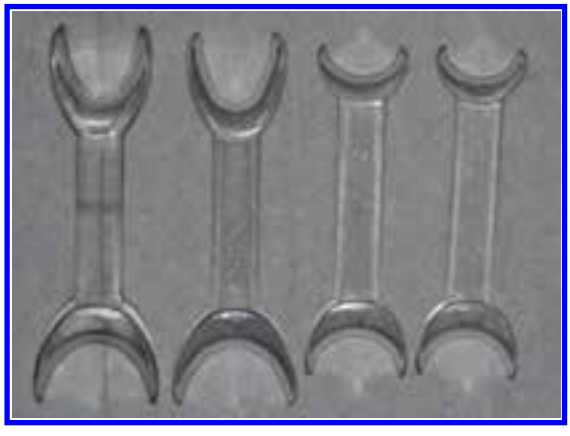

**Figure 6.10**

Both pairs of retractors required for every set of intraoral photographs.

**Figure 6.11**

Patients with reduced lower facial height struggle to close on large end of large retractor.

It is extremely important to instruct the person doing the retraction to pull the retractors not only laterally but also forwards, *away* from the patient to allow them to close up comfortably. Any attempt to pull the retractors backwards, towards the person doing the retraction will mean that the patient will find it difficult to close on the retractors due to impingement of the alveolus on the edge of the plastic retractors. Also pulling the retractors backwards will cause the lips to furl over the alveolus covering the area of interest to the clinician.

For those few exceptional patients, who just cannot cope with the large end of the larger retractor, use the large end of the smaller retractor for the front shot to again ensure vertical not horizontal retraction of the lips.

For buccal views we want to ensure the opposite type of retraction on the side of

**Figure 6.12**

Photographer holds large end of large retractor on side being photographed.

interest that is horizontal not vertical retraction of the lips. Therefore on the side of interest, the large retractor is turned to 180 degrees, to utilize its slightly smaller end, thus maximizing the amount of horizontal retraction and cutting down on the amount of vertical retraction of the soft tissues. On the side that is not being photographed, the large end of the larger retractor is left in place (Figure 6.12).

For the occlusal views, the small end of the smaller retractor is used to pull the lips laterally, upwards away from the teeth but also outwards towards the photographer (Figure 6.13).

Special single lip retractors to hold the lip away for occlusal views are commercially available; however, we feel that these add to the 'noise' in the photograph and do not produce as high quality result as with the smallest retractor pulled appropriately.

**Pearl:** The most important pieces of equipment for securing high quality clinical views, once the correct camera has been selected, are the cheek retractors, which must be used correctly to ensure success.

### 6.8.2 Orthodontic Mirrors

The next most important piece of equipment is the mirror chosen to record the orthodontic views. Intraoral photographic mouth mirrors

**Figure 6.13**

Smallest end used and pulled laterally and forwards and up – all simultaneously.

are essential for occlusal views of the maxillary and mandibular arches. The mirror recommended for both maxillary and mandibular occlusal views is the long-handled 'mirror C' produced by Filtrop AG (American Orthodontics, UK). The advantage of this mirror is primarily its size, which allows recording of the entire dental arch in almost every patient (Figures 6.14 and 6.15).

Very occasionally, with small children or adults with tiny mouths, the smaller occlusal mirror is required; however, this would perhaps only be appropriate for fewer than 5% of patients.

**Pearl:** It is important to instruct patients to tilt the head back as far as possible when taking occlusal views and just before the photograph is taken ask them to 'open about twice as wide'. The Filtrop mirrors provide the best chance of a quality result.

The other advantage of mirrors is their long handle that, while the photographer is setting

**Figure 6.14**

Long handled Filtrop AG mirrors – the best that money can buy.

up the shot, allows the patient to hold it in position. Once the photographer has used the aspirator to completely remove all saliva, the mirror handle can be taken from the patient to allow the photographer to move the mirror into the ideal position to record a perfect plan view of the teeth.

In the plan view the palatal surface of the upper incisors or the lingual surface of the lower incisors are recorded on the image. If the labial surface of the incisor teeth can be seen then the patient has not opened the mouth sufficiently wide and further encouragement is required.

It must be remembered that the person doing the retraction has the most difficult job during orthodontic photography. They cannot see the image the photographer can see through the viewfinder so they must be given the information when the lips or soft tissues are impinging on the area of interest, so that they may rectify this situation.

For certain patients, where it is difficult to obtain good buccal views of the occlusion, there are mirrors available which can be placed in the buccal vestibule. These act as cheek

**Figure 6.15**

The entire arch is easily accommodated with the largest occlusal mirror.

retractors and at the same time show a reflected view of the occlusion extending back as far as the first and in some cases the second molars. Occasionally they can offer a significant quality improvement to the photograph.

**Pearl:** With all mirror shots, it is possible to reduce the problem of fogging by warming the mirror in hot water just prior to use in the mouth.

## 6.9 FLASH LIGHTING

Flash lighting is an essential component of clinical photography. The two options available are the ring flash and the point flash. A ring flash provides good even lighting to almost any area of the mouth; however, it does eliminate shadows. Certain intraoral views lose their sense of depth and appear flat. By contrast, with a point flash intraoral views have a feeling of depth where the three-dimensional perspective of the teeth and surrounding tissues can be visually appreciated.

If a point flash is used for the buccal shots, it is essential to avoid the flash throwing a

shadow of the cheek over the buccal teeth. To avoid this problem, the flash should be positioned on the left of the camera (photographer's left) for the patient's left buccal view and on the right of the cameras for the patient's right buccal view. If the flash is fixed on one side, then the camera can be inverted (turned upside down) for the contralateral view.

The current 'gold standard' equipment is to use the dedicated Canon MR-14EX flash with the Canon 100 mm lens and the Canon 70D body. Any compromise on the lens or flash or both will inevitably lead to a compromise on the picture quality.

The Canon 430EX accessory flash is also a very useful addition to be used to improve the quality of illumination for the extraoral photographs. It is automatically compatible with the Canon's flash metering mode and works wirelessly providing the correct channel is selected on the ring flash. The ideal setup is to have one flash ahead of the subject bouncing off the ceiling and a second accessory flash behind the subject illuminating a white background. This will effectively 'white out' the background, which gives the shots a very effective look.

## 6.10 DIGITAL PHOTOGRAPHY

As far as the digital camera is concerned it offers many advantages over previously used slide or print photography. Initially, when digital cameras came on the market the issue of image quality was first and foremost. A conventional 35 mm slide was believed to hold the equivalent of about 25 million pixels (picture elements), whereas the original charged couple devices (CCDs) only recorded about 1 million pixels of information. Nowadays it is common to record 10–20 million pixels of information on a single image so we are getting very close to the quality of image that could be produced on a 35 mm slide.

For orthodontic use this provides more than enough information to allow a high quality image to be recorded and reproduced.

Digital cameras offer the photographer instant feedback as to whether the area of interest has been recorded and whether a high quality in focus picture has been taken. The image can be instantly discarded if not of sufficient quality and the photographer can improve the image on the second attempt.

With the Canon system recommended, the high quality flash is sufficiently powerful to allow images to be recorded using very small apertures of F32. This ensures that the area of interest in crisp focus on the intraoral images will extend from the labial surface of the upper incisors brackets to the buccal tubes on the molars.

The autofocus systems are now sufficiently well developed to allow sharp focusing both on the intraoral and extraoral views. The shutter button should be depressed half way to select focusing on the area of interest; which on the front intraoral photos is the distal of the lateral incisor and on the buccal photos is the first premolar. Provided the correct apertures are selected everything of interest will be in focus. On the extraoral shots the lower eyelid is the areas to select for the automatic focusing, which will again ensure all the area of interest is in crisp focus. Prior to taking any images it is important for each user to set the diopter adjustment on the viewfinder (if present) to their particular eyesight. Again this will ensure the photos are as sharp as possible.

Other advantages of digital photography are that there should be no ageing of the images as seen with conventional prints or 35 mm slides.

> **Pearl:** Storage of the images is much less of a problem and the images are very easily retrieved, duplicated, and transmitted around the world at the touch of a button.

In addition, there is no film purchasing or processing costs, as is the case with conventional systems. Because of these myriad advantages, in orthodontics digital has completely taken over from conventional photography.

## 6.11 IMPROVING IMAGE QUALITY

### *6.11.1 Use of an Aspirator*

If a few seconds are used to remove saliva from the field of view, a far superior quality of

image will be obtained. Any clinical photographer should therefore ensure photographs are taken with the subject in a chair that has an aspirator on hand. This will prevent the all too frequently seen photographs, which appear as if the patient has just had a 'liquid soap' mouth rinse. The problem with saliva-drenched photos is that details of the case, such as relative marginal ridge heights or contact point discrepancies, are masked, or detailed finishing techniques cannot be discerned clearly.

### 6.11.2 Timing of Photographs

The photographs should be taken before the other clinical records are taken, particularly study models. Alginate in the embrasures between the teeth or smeared over the patient's face significantly detracts from the overall quality of image obtained. Also, patients occasionally find it slightly uncomfortable to have their lips retracted during the intraoral photography and therefore, if the extraoral photography is done before the intraoral photography, there is a better chance of getting a smile out of a patient!

### 6.11.3 Tongue Retraction

During intraoral views if the tongue is retracted away from the teeth a darker background is obtained, which contrasts nicely with the enamel of the teeth and therefore gives a better quality image. If the tongue is pressed up between the teeth it tends to squeeze saliva between the teeth, which once again detracts from the quality of the image obtained.

### 6.11.4 Image Reproducibility

Consistency in patient positioning and image size is important particularly when projecting start and finish views next to each other. Of course with digital photography all these things can be manipulated 'postproduction' but for a busy orthodontist taking very many images per day, significant postproduction work is not an attractive option. It is therefore important to use a constant magnification for all intraoral views in one series, both mirror views and all the extraoral views.

An attempt should also be made to get the patient to position the head routinely in one position to allow direct comparison between the before and after treatment photographs. The Frankfort plane should be horizontal for extraoral views or an attempt made to photograph the patient in 'natural head position'. This can be done by having a mirror on the surgery wall and asking the patient to look at the reflection of his or her own eyes, in this mirror.

**Pearl:** A major advantage of the digital camera is the ability to view the image immediately which instantly allows an out of focus shot to be repeated.

### 6.11.5 File Size of Digital Photographs

If the images are to be used merely to show a picture on the computer screen or to perhaps incorporate into a PowerPoint presentation, there is no point recording more pixels than the computer can actually display. There is little advantage recording many millions of pixels only to have to compress the image size into a PowerPoint slide. It is necessary to experiment with a digital camera and record the smallest file size that will still provide a satisfactory output. This will ensure the images are 'fit for purpose' but also that they transfer to the computer and into slideshows easily and effectively.

The only reason for recording a very high number of pixels would be if the image were to be used in a subsequent publication in which case it is recommended that the image is stored as a TIFF file.[3] This uncompressed image will then allow the maximum quality image to be reproduced on high quality photographic paper when required. JPEGs are much smaller files and easier to share and work with; however, a small amount of information is lost from the picture each time they are adjusted.

### 6.11.6 Avoid 'Noise' in Clinical Photographs

A neutral background should be chosen, either a dark colour to reduce the amount of shadow, or an illuminated white background behind the patient, to completely eliminate shadowing. Any extraneous items within the background will act as 'noise' and will only serve to distract the viewer. The patient or photographer should be moved vertically to reduce the distractions wherever possible.

### 6.11.7 Important Points to Note When Taking Extraoral Photographs (see Video 6.1)

- Have different sized steps available, to get the photographer and the subject at the same height
- Have a non-reflective background behind the patient
- Consider back lighting the patient to illuminate the background using an accessory slave flash

### 6.11.8 Important Points for Intraoral Photographs (see Video 6.2)

- Get the dental chair at the correct height and tipped back
- Use the dental light to illuminate the mouth to aid focusing
- Place the correctly sized retractors
- Ask the assistant to pull retractors laterally and forwards towards the photographer
- Use the aspirator for every photograph
- Get the patient to close in retruded contact position
- Get occlusal plane horizontal: left to right *but* also front to back
- Ask the patient to retract tongue away from the teeth
- Focus on lateral incisor/canine area
- For buccal shots, reverse the large retractor on the side being photographed
- Patient to turn head right around to one side
- Re-aspirate all saliva
- Photographer must hold the retractor on the side being photographed
- Retract a further 5 mm to show distal of 6 s at least, the moment before the shot is captured
- For opposite buccal shot, both retractors reversed
- Patients head turned through 160 degrees
- Photographer hardly moves at all
- Re-aspirate
- Photographer must hold the retractor on the side being photographed
- Retract a further 5 mm to show distal of 6 s at least, the moment before the shot is captured

### 6.11.9 Important Points for Mirror Shots (see Video 6.3)

- Tip back of chair back further
- Other, smaller pair of retractors used
- Small end used to retract lips: pulled laterally up and forwards
- Large occlusal mirror placed, patient to hold mirror handle
- Aspirate all saliva
- Photographer now takes mirror handle and positions mirror
- Patient to hold their breath
- Patient told to open 'twice as wide'
- Move mirror off distal marginal ridges of last molar tooth to ensure they are on the photograph
- Repeat for lower shot *but* back of chair moved even further back
- Patient to extend head as much as possible
- Place mirror, patient can hold handle
- Aspirate all saliva
- Photographer now to hold mirror handle
- Patients tongue above mirror if possible
- Patient to hold their breath
- Open 'twice as wide'
- Move mirror off distal marginal ridges of last molar tooth to ensure they are on the photograph

## 6.12 SUMMARY

The final quality of your photographs is dependent on both the photographic technique

used and on the camera equipment and accessories available. Critically evaluate the colour, the sharpness, the size of the image, the angle of view, the presence of shadows and the background. If the final product is not up to standard, then consult with either a colleague who understands photography and is routinely getting good results, or seek professional advice.

## VIDEOS

6.1 Short video showing the clinical procedures for taking extra oral full face, 45° profile and full 90° profile views. Note the non-reflective white background and the patients head positioned (using a step) at the same level (height) as the camera. (Available at http://goo.gl/gZ53fH)

6.2 Short video showing the clinical procedure for taking intra oral front, left buccal and right buccal views using cheek retractors. Note the retractors being reversed by the nurse and the aspiration of saliva before taking the shot. (Available at http://goo.gl/zDc6xv)

6.3 Short video showing the clinical procedure for taking intra oral maxillary palatal and mandibular occlusal views. Note the position of the lip retractors for both upper and lower views as well as the photographic intra oral mirror. (Available at http://goo.gl/oVKxms)

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# 7 CASE DISCUSSION

Eliakim Mizrahi

CONTENTS



The case discussion appointment is an extremely important session and I believe crucial to establishing the all-important correct relationship with the patient and, where applicable, the parent. It is your main opportunity to present yourself as the professional, an expert in your field who understands the patient's problems and is able to provide the relevant treatment. This session should not be rushed and it should be presented in the correct setting, with appropriate decorum.

It is difficult to predict how long a case discussion appointment will last, some patients or parents have very little to say while others can keep asking questions and drag the discussion out for much longer than you expected.

**Pearl:** For this reason it is advisable to schedule the discussion appointment for the end of the day. If you start to run late at the end of the day, it is not too serious, there are no patients waiting, you do not get stressed and the patient does not get the feeling that they are being rushed.

## 7.1 PHYSICAL ENVIRONMENT

The case discussion with an adult patient or a child and parent should be held, if at all possible, in a consulting office away from the clinical surgical environment. The office plan should incorporate a desk or table allowing the patient to sit either opposite or on the same side as the orthodontist; as an alternative, all participants sit at a round table. The idea is to make the arrangement as nonintimidating as possible for the patient. The room should be well lit either with artificial or natural light and the desk surface clean and uncluttered. Clutter on the desk will distract the attention of the patient. Close the door so that external noises and conversations do not distract from the case discussion and make sure no telephone calls are put through to you. Educational and promotional material, such as case photographs, charts, pamphlets, and magazine articles, could be displayed on the walls of such an office. Depending on the system adopted by the practice, it is essential to have a viewing box and/or a computer screen easily accessible. The viewing box may be cut into the desktop.

### *7.1.1 Layout of Records*

All the relevant records should be neatly set out on the desk prior to the patient being escorted into the office; do not start searching for records while the patient is sitting at the desk. The photographs should be laid out in front, closest to the patient, next in line place the study models; the radiographs should be clipped to the viewing box but the light should be off at this stage. If you are using digital records, make sure the relevant programs are up and running, but the screen should be off

until you are ready to discuss the relevant material on screen. The patient should not be distracted from your discussion; they need to concentrate on what you are saying and describing. Some practitioners will leave the patient alone for a few minutes before entering the discussion office. This gives the patient an opportunity to look at their records before the clinician begins the presentation.

## 7.2 CASE DISCUSSION DIALOGUE

At the outset, it is important to realize that in general, patients and/or parents have little or no clinical background, what you are going to explain to them is new and strange; therefore, it is essential to talk in terms that they can understand rather than confuse them with clinical or anatomical terms. However, it is important not to talk down to the patient. Today, many patients may carry out a prior search on the Internet and have a surprising amount of information on the subject.

When the patient sits at the desk his or her attention is immediately drawn to the photographs; this is something they can recognize and relate to and this is where you should start your discussion. Remind the patient of their original 'main complaint' and relate this to the relevant features portrayed in the photographs. Comment on the smile displayed on the extraoral photographs, then move on to the intraoral pictures; remember they have never seen their teeth with the lips retracted. Show them relevant features on the photographs, such as crowding, spacing, irregularities, chipped edges, and discoloration, and do not forget the soft tissues, such as swollen gums and possible areas of plaque accumulation.

Next, move on to the study models; if they wish, let them hold the models for a short time. When the patient or parent has finished examining the models, place them on the desk and start explaining the relevant features of the models in a logical sequence. Using a pointer or a pen, discuss the lower model first, identify the permanent teeth and the deciduous teeth, show them the spacing or crowding or rotations or whatever other condition exists. Then do the same for the upper model. Now, place the models in occlusion and point out the excessive protrusion or retrusion of the incisor teeth, the deep bite, show them where the lower incisors are impinging on the palate, show them the crossbite of the molar teeth, explaining all the time what the correct or normal situation should be.

> **Pearl:** Do not forget to keep asking the patient or parent if they understand what you are describing and ask if they wish you to repeat or explain any particular feature again.

From the study models move onto the radiographs; now switch on the viewing box or the computer monitor, a panoramic (dental panoramic tomogram) radiograph should be in position. Identify the lower and upper jaws; point out the deciduous teeth, unerupted teeth, and any other relevant features, such as obvious crowding or impactions. In the case of adult patients, take time to explain the possible loss of alveolar bone and associated periodontal conditions. You should remember that it is difficult for a layperson to understand the concept of radiographs and to understand what they are seeing even when it is explained to them.

Next, clip up the lateral skull radiograph; this never fails to draw their attention and make some impression. With the tracing flipped up off the radiograph, orientate the patient by identifying the main anatomical features. Once again start by identifying something they can relate to; point out the soft tissue profile, the forehead, nose, lips and chin. Next, point out the upper and lower jaws, and the upper and lower incisors highlighting any marked overjet that may be present. That should be sufficient information regarding the actual radiograph; now flip the tracing on to the viewing box or place a sheet of white paper between the tracing and the radiograph and place it on the desk in front of the patient. Explain to them that this is a tracing of their skull radiograph and not a random freehand drawing. Orientate the patient to the tracing by identifying the same profile and major features as you did for the radiograph. Now, using an analysis of your choice, explain, in

very simple terms, how you determined that the lower jaw is behind or in front of the upper jaw, how far the upper and lower incisors are out of position and what effect this has on the position of the lips and relate this to the fullness or flatness of the lips. Depending on your perception of how much the patient or parent understands, you may increase or decrease the detail of your presentation.

Many practices today are completely paperless and the same approach and pattern of presentation may be used for computer-based data. Instead of the physical material laid out on the desk, all the same material will be presented on the computer screen. Computer-based data allow for the presentation of animated graphics. There are programs available that show teeth and facial structures moving from the original malocclusion to the final predicted position. In fact the computerized animations are so sophisticated and the detailed movement of individual teeth, dental arches jaws, and facial structures are so realistic that the patient/parent may be so impressed by the computer graphics that they lose the actual message you are trying to convey. I believe it is easier for them to relate to a physical model than to a virtual model.

When showing the prediction of the final occlusion or facial features, make sure you stress that these images are computer generated and the clinical reality may not always achieve the projected result. Explain that every patient is different and that every treatment plan is dependent on a number of unpredictable factors such as growth, cooperation, adherence to appointment schedules, appliance breakages, etc. Most important, you must record in the notes that this limitation of computer prediction has been explained to the patient/parent.

### 7.2.1 Treatment Plan

Having presented the patient and/or the parent with all the relevant information, summarize the problem and start to explain how you propose to treat it. Start by explaining and showing, with the help of models, what type of appliances will be necessary to correct their problem. Have sample models with both stainless steel and porcelain fixed appliances. In certain cases, particularly with adult patients, you may wish to show examples of lingual or invisible thermoplastic-type appliances. Follow this by explaining your treatment plan, if for example, the case presents with dental crowding, show them on their study model that the only way you can accommodate the teeth is by either expanding the incisors forward into a wider arc of a circle, or moving the molars back or extracting certain teeth. If the case requires extractions, explain and justify your reasoning for extractions so that they can understand. Explain that the lips and the incisor teeth are already too far forward as you had shown them on the models and tracing, and the only way you can reduce the crowding and improve the profile is by extracting certain teeth. Conversely if the lips are too flat explain why you are reluctant to extract teeth. If you need to use headgear, explain its action, and show them what it looks like and when you expect them to wear the headgear (see Chapter 14).

Where relevant, explain to the patient or parent the need to consult with another specialist, such as a periodontist or a maxillofacial surgeon, and assure them that this will be done with the prior approval of their general dentist.

Complete your discussion of the treatment plan by giving an estimate of the duration of treatment stressing that this is only an estimate and treatment duration can vary greatly; explain that it is dependent on many factors not least of which is patient cooperation.

### 7.2.2 Retention

Having completed the treatment plan component of the discussion, lead into the concept of retention by asking the patient: 'What happens when I remove the appliances from your teeth? Your teeth will be straight and beautiful, but teeth are not embedded in concrete, they are in bone, and they will move, they tend to want to move back to where they were, so we need to hold them in the new position.' Now you explain the importance of retention and how it

relates to their particular case. In certain adult cases where you know the end result will be unstable, it is necessary to explain the concept and the reasons for permanent fixed retention. Some clinicians include the cost of retainers in the overall treatment fee; others charge separately for retainers, you will decide which system suits you (see Chapter 24).

**Pearl:** Whatever system you choose, it is important that you tell the patient and/or parent at this discussion whether or not there will be a separate charge for retainers at the end of treatment.

### *7.2.3 Costs*

Having completed your explanation of the existing problem and how you propose to treat the case, it is now time to disclose the cost of treatment. Irrespective of how you originally calculated your fees, or whether you base them on the type of malocclusion or on the type of appliance used, you will find that, generally, clinicians have a range of fees to cover most malocclusions presenting for treatment. The level of your fees is inevitably influenced by two major factors: first, the fees generally charged by colleagues in the surrounding areas, and second, by market forces as they impact on the socioeconomic status of your patient base.

**Pearl:** If you ignore these two major influencing factors when determining your fees, irrespective of which end of the scale you aim for, the economics of your practice will suffer.

Having previously calculated the fee for this particular case, you now tell the patient or parent exactly what the fee will be. Also, that this fee is payable by means of an initial payment at the start of treatment of usually a third or a quarter of the total, and the balance by means of a monthly payment extending over approximately 18 months or whatever you believe will be the duration of treatment.

**Pearl:** It is important to explain that the monthly payment (or whatever instalment plan you choose) is not related to a monthly visit, it is only a means of paying for the treatment costs, and if you see the patient two or three times within one month or possibly once in six weeks, this has no bearing on the monthly payments.

Each clinician, to suit his or her own philosophy, often varies this scheme, some charge quarterly, some use a banker's standing order, some use a coupon or a series of post-dated cheques. Whatever system you choose, make sure it is efficient and works with the minimum of complications. Most importantly, ensure it maintains your cash flow commensurate with the rate at which you are proceeding with treatment. Do not fall into the trap of routinely finishing your cases and finding that the patient still owes a large amount of money. This can happen occasionally, but if it happens often then your monthly payments are too low and your cash flow will suffer.

**Pearl:** Make sure that the patient or parent sees you reading the fees from the card; they should feel that you have calculated the fee and not just sucked some figure out of your thumb.

Internationally, the involvement of third party payment plans by either private insurance companies or corporate/government/state funded institutions has become an increasing feature of the financial component of orthodontic practice. Clearly, each orthodontist needs to evaluate how this will impact his/her practice and how this is handled by the accounting system of their practice.

Irrespective of which third party payment system is involved, from the orthodontist's point of view, certain principles should apply.

1. The system should not affect the clinical independence and integrity of the clinician. Clinical judgments and decisions should not be dictated to by the third party with regard to the formulation or execution of the treatment plan.

2. The orthodontist should retain the responsibility to decide on the continuation or cessation of the clinical treatment based on his/her judgment regarding the level of patient cooperation or a breakdown in patient/clinician relationship.
3. Failure to adhere to the originally agreed financial payment plan by either the patient or the third party. No clinician should be expected to work for no payment. However, no patient should be clinically prejudiced by the non-payment of a third party payer. If such a situation should arise, it needs to be discussed with the patient/parent and they should be presented with the option of taking over the total outstanding account for the remainder of the treatment, or seeking treatment elsewhere. In the case of a state/government provider where the patient actually belongs to the provider, then the provider must take responsibility for the transfer of the patient.

It is a given that all the above is carried out only after all the necessary notices and warnings have been given in writing, in good time and clearly recorded in the patient's notes.

### 7.2.4 Compliance

Having explained everything about the case, now you need to tell the patient what you expect from them as far as cooperation is concerned. You need to clarify and stress, in layperson terms, what you require regarding changes in eating habits, oral hygiene, appliance care, and appointment scheduling (see Chapter 11).

### 7.2.5 Side Effects

How much should you tell the patient and parent about the possible side effects and complications of orthodontic treatment? This subject still continues to be hotly debated.

> **Pearl:** There is no question that where there is clinical or radiological evidence of an existing condition or a predisposition to the further development of a condition, these must be pointed out and the possible consequences explained to the patient or parent.

Conditions that fall into this category are: existing temporomandibular joint symptoms (see Chapter 21), evidence of root resorption, loss of alveolar bone, gingival and periodontal pathology (see Chapter 18), existing apical pathology and anticipated adverse growth patterns in either the sagittal, vertical or coronal planes. Where impacted teeth are present and surgical exposure or removal is anticipated, it is important to explain the possible complications related to root resorption of adjacent teeth and the risk of occasional ankylosis (see Chapter 19).

Root resorption *per se* is a large subject and falls outside the scope of this article, suffice to say that if the clinician suspects that there is radiographic evidence of a possible risk that this may progress during treatment, the patient should be made aware of the possible outcomes.

In the majority of cases where there is no evidence of any abnormal conditions, I do not believe the majority of orthodontists list all the possible complications at the case discussion. However, it is prudent to have all the possible risk factors listed in a document, which can be included in the correspondence to the patient with a request that this should be read prior to signing the consent form (see Appendix A).

### 7.2.6 Closure

Most patients or parents will not have contributed very much to the discussion up to now, and it is at this stage that you now invite them to ask as many questions as they like and the discussion becomes a two-way dialogue. Once the questions have stopped and the patient understands what the case and the treatment is all about, you need to explain what the next procedures will be. Tell them you will be sending them a written report that will briefly summarize the salient points of the discussion, that the costs will be detailed and you will include a consent form that needs to be signed and returned before commencement of treatment. Inform them that you will also be sending their dentist a report on the case. Explain the appointment scheduling you require for placing separators and fitting the appliance. If there are extractions to be done, inform them that their dentist will carry out this procedure

as well as any other general dental work and they must arrange the necessary appointments prior to the fitting of appliances. Some patients will leave your office and immediately arrange the necessary appointments at the reception desk while others will prefer to go home to think over all you have told them; others will want to discuss the issues, particularly the financial issues, with their spouse or partner, while others will wish to receive your written report before taking a final decision.

**Pearl:** I believe that one should never try to pressurize or talk the patient or parent into making the next appointment.

The following questions now arise. Do you keep track of those cases that do not make an immediate appointment for fitting appliances? Do you follow them up with an enquiry after a few weeks? Or, do you adopt the attitude that if they want treatment they will contact you and if they do not want treatment there is no point in pursuing them? Your response to these questions will depend on your marketing and practice philosophy, I tend not to follow up on these cases, as I believe that if the patient or parent is sufficiently motivated and is happy with my approach and my practice, they will proceed with treatment, but I do understand the thinking of those who are concerned and who do follow up on such cases.

## 7.3 CORRESPONDENCE

**Pearl:** It is essential to promptly follow the case discussion with the necessary correspondence. Both the patient and the referring dentist were informed that they would receive reports, the patient at the case discussion and the dentist in the original letter of acknowledgement.

I assume that most orthodontic practices have a word processing or some orthodontic management software package. The framework of letters for most case scenarios can be stored; using a Dictaphone or even a small tape recorder, preformatted paragraphs can be identified, and the information specific to a patient can be entered. How much detail you wish to provide in these reports, is a matter of personal preference. However, I believe that it is not necessary to provide too much detail. Most patients or parents will not understand clinical detail and most general dentists do not wish to wade through pages of orthodontic diagnostic and treatment detail. However, irrespective of your personal preferences, certain basic information must be conveyed to both parties.

### *7.3.1 Letter to the Patient/ Parent (Appendix A)*

- The letter confirms the discussion.
- Describe the skeletal pattern in layperson terms: '. . . has an acceptable or protrusive or retrusive lower jaw in relation to the upper jaw. . .'.
- The state of the dentition: mention conditions, such as crowding, spacing, protrusion, and any other relevant features.
- The proposed treatment plan: mention the type of orthodontic appliances, if necessary, the need or possible future need for extractions.
- Where relevant, mention the need to consult with another specialist.
- Indicate the approximate duration of active treatment.
- Indicate the importance of retention.
- Detail the proposed costs including the method of payment.
- Other items, such as the need to continue visiting the general dentist, the need for cooperation, should be included.
- Currently, it is considered good practice to include, either as a separate enclosure or as part of the letter, a listing of the possible hazards and risks associated with orthodontic treatment.
- As confirmation of having read and understood your letter, include a request for the patient or parent to sign and return an enclosed consent form.

### *7.3.2 Letter to the Referring Dentist*

- Start this letter by thanking the dentist for his referral. (This is the second 'thank you'.)

- Briefly outline the essential clinical findings related to the skeletal, dental and soft tissue elements.
- List the features of your treatment plan.
- Request for any procedures you wish the dentist to carry out including possible extractions and restorative work.
- Where necessary, inform the dentist of your intention or desire to refer the patient for a consultation with another specialist. You should be aware, either from past experience or by calling the dentist, of their attitude to further referral, some dentists prefer to do their own minor oral surgery or periodontal therapy.
- Confirm that you would wish the dentist to continue to monitor the patient's general dental requirements throughout orthodontic treatment.

As mentioned previously, copies of all correspondence should be kept either as hard copy or electronic files.

There are a number of letters that form the correspondence inventory of an orthodontic practice; most are common to all practices with variations dependent on the type of practice, location, and individual preferences of each clinician (see Appendices A, B, C, D and E).

# 8 INTER-, INTRA- AND EXTRAOFFICE COMMUNICATIONS AS AN ORTHODONTIC RISK MANAGEMENT TOOL

Laurance Jerrold

There are three types of communications that are utilized in an orthodontic office: intraoffice, interoffice and extraoffice. Intraoffice communiqués are all the internal forms and documentation that one uses to accomplish your day to day operations, policies, and procedures. Two nonexclusive examples would be your medical history form and your informed consent documentation. Interoffice communiqués entail all communications between you and other medical personnel who are concurrently caring for the patient. Some examples of those are, firstly, referral forms and synopsis letters that would go to other healthcare professionals and, secondly, insurance forms that would go to third party payers. Extraoffice communications might entail such things as website content and financial agreements given to the patient. Obviously, there are many types of communications that will overlap categories because they serve dual functions. This chapter discusses the orthodontic risk management principles behind these various interoffice communications. Forms referred to in this chapter are provided in Appendix B.

When a new patient calls the office for an initial evaluation, it triggers the first in a succession of risk management concerns that are based on the myriad of all three types of communications. Addressing these concerns as they come into play along the time line of rendering orthodontic therapy is a good way to examine these issues. Let's start at the beginning. A general dentist informs a parent that her daughter might need braces. He gives her the name of an orthodontist or two in town and she now must do her due diligence which entails asking her friends and neighbours if they have ever used an orthodontist, if they know of any good ones, and of course last but not by a long shot least, she goes to the Internet. Lo and behold one of the names the general dentist recommended has this great website. The site shows off the office, extolls the virtues of the specialist, has a lot of information about orthodontics, philosophy, the appliances used, testimonials from patients (some real, some not), a map to get to the office, and so on.

**Pearl:** One of the tabs on the home page directs mum to a section that is brochure-like in content and which, from a legal perspective, can be viewed as nothing more than an offer of one's services extended to the public for the sole purpose of soliciting and inducing prospective patients to accept these services based on the statements made therein. In legal parlance, the statements can be viewed as promises.

If it can be found that these photographs, statements, innuendo, etc., form a material basis on which the patient accepts treatment, then it can also be argued that liability may attach for breaching the expectations expounded within the communication. Consider the following statements, all of which were found in various office brochures collected over the years, that arguably can be claimed as false and misleading: 'Convenient flexible hours to suit your needs'; 'All insurance plans accepted for payment'; 'Available for emergencies 24 hours a day, 7 days a week'; 'Our treatment is quicker, less painful, and carries less risk ….'; 'Our state of the art facility exceeds all governmental rules and regulations regarding sterilization ….'; 'We promise to be prompt and respectful of your time'.

Consider also the following sentences derived from mission statements obtained from various practices that once again can be construed to be promising far more than the doctor ever intended to deliver: 'We are dedicated to providing you with the highest quality of orthodontics available today'; 'Your total dental health is our highest concern'; 'We will be in constant communication with all of your other health care providers during your treatment'; 'With the advances in technology that today's modern orthodontics has to offer, there is no reason that an ideal result cannot be achieved'. Keep these promises/inducements in mind as we will refer to them later on.

Next, and this is no longer in the temporal context of the pre-doctor–patient relationship but is still within the timeframe of pretreatment, consider the role that video imaging plays in creating a specific expectation on the part of the patient and whether or not this form of inducement regarding obtaining a specific result can create a promise on which a patient has a right to rely. If this is so, then any result falling short of this promise may result in a breach of contract claim by the patient. This subjects the doctor to liability for the value of the contract, in other words, having to return the fee that the patient paid you for specific results that were not received, as well as for any differences in fees charged by the subsequent treating practitioner whom the patient now hopes will be able to fulfil those lost expectations.

Finally, in another commonly encountered pretreatment scenario, consider the promise made by the office's insurance coordinator, that a patient's insurance will cover the cost of treatment; a scenario most often encountered when providing services for temporomandibular dysfunction secondary to a traumatic event resulting in a whiplash type injury. If reimbursement is not forthcoming and the patient can successfully claim that he or she was induced to accept therapy based on this unfulfilled expectation, it is easy to ascribe liability for the breach of this promise to the doctor for the unanticipated financial loss suffered by the patient.

Breaking down the legal elements involved, what we have is a statement, otherwise known as a promise, made in some form of intra- or extraoffice communication by a doctor's office that the doctor intends to be taken seriously and at face value.

**Pearl:** The patient then relies on the statement, and accepts treatment from the doctor based on the expectation that the promise(s) will be fulfilled.

As a result of relying on the given promise(s), the patient suffers damages. The damages usually claimed are for additional financial expense, and/or increased treatment time resulting from having to go elsewhere to correct the breached promises that induced the patient to accept and undergo treatment with the first doctor. While the doctor may be afforded a chance to 'cure' (correct) the breach, at this point the doctor–patient relationship may have been strained to the point where it is very uncomfortable for one of the parties to continue, given the personal service nature of orthodontic therapy. Such is the nature of breach of promise claims in the healthcare arena.

Another potential area of prepatient contact exposure occurs when medical history forms are sent out (or filled out online) prior to the patient's first visit to the office. Even when the orthodontist has reviewed this information before patients arrive for their consultation appointment, there have been a number of instances where the lack of verbal

communication between doctor and patient has resulted in significant injury to the patient because medical history information was incorrectly transmitted via the form by a patient who didn't understand the language used or the questions asked.

**Pearl:** The bottom line here is to take your medical histories verbally, face to face. In this manner, you can never be found to have treated a 'stranger'.

In short, pretreatment communication, while not high on the list of orthodontic risk management concerns, has the potential to, and at times has, exposed practitioners to liability. The caveat is that if you are going to promise the patient something, make sure that your promises are yours and not generic statements purchased by vendors and inserted into commercial communication products. Ensure that they represent assurances that you believe you are able to deliver.

**Pearl:** Remember that in essence you are a guarantor of the inducements used and your goal is to ultimately meet or exceed the patient's expectations in regard to the communications (the promises) you proffered.

Continuing on our time line, the good news is that mum is tickled pink, she has found her orthodontist – you. She calls the office to set up an initial appointment. The first communication that occurs from this point is a note to thank the doctor for referring the patient; or in the case where the GP was not the referral source, to allow you to notify him or her that you have seen the patient. Either way, what you are doing is establishing that you are undertaking the creation of a doctor–patient relationship. From a legal perspective physicians do not owe patients any duty to conform to a given standard unless a doctor–patient relationship is in existence. By using Form A in Appendix B you are confirming the existence or denial of that relationship as you are saying that treatment is either (1) recommended; (2) the patient's problem is best treated via recall observation until a more opportune time to initiate treatment arrives; or (3) that the patient has decided not to take advantage, for whatever reason, of the benefits of orthodontic treatment.

**Pearl:** This is important because often the orthodontist will be able to defend against a claim of misdiagnosis such as a failure to recommend treatment when it was indicated; or conversely, neglecting to treat if treatment was indicated, when in reality it was the patient who refused to accept therapy; in essence, it will indicate that it was the patient who chose to forego recommended therapy at this point in time.

This scenario most commonly occurs in root resorption cases involving maxillary lateral incisors as a result of ectopically erupting canines.

If you encounter the situation where the patient does not have a general dentist and you now have the opportunity to refer them to one, send your standard introduction (referral) letter to three local referrers, allowing the patient to choose between them. Thus, you are now able to reciprocate and refer back to three different referral sources; in essence, killing three birds with one stone.

Once a treatment plan has been determined and accepted by the patient, most offices send out synopsis letters. Virtually every orthodontic practice management software package contains a type of this inter- and extraoffice communiqué. Many offices send out two such letters; one to the patient and one to the GP. The synopsis letter is both a great practice management and a risk management tool.

**Pearl:** A common risk management problem comes about when the synopsis letter to the patient paints a 'sunny, blue skies' kind of picture, while the letter to the dentist depicts a 'storm clouds on the horizon' image.

Imagine the following; the synopsis sent to the patient notes that the patient's malocclusion is 'ABC' and that with good cooperation

there is no reason not to expect 'XYZ' result. On the other hand, the synopsis letter that is sent to the dentist, notes that the patient's 'ABC' problem also carries with it concerns about the patient's periodontal support, the potential for root resorption, the need for permanent post-treatment stabilization, etc. It is amazing how often the two letters seem to be about two different patients – think Rembrandt versus Picasso. If the case goes south and the parties are in court, it is difficult to reconcile the discrepancies between the letters. Usually the result is that the patient claims that vital information was withheld from them resulting in a claim for lack of informed consent, an easily reached conclusion based on the orthodontist's reluctance to note any of the potential negative sequelae or problems in the patient's letter that was prominently mentioned in the letter to the GP. The risk management caveat here is to ensure everyone is on the same page through your inter- and extraoffice communications.

Now that treatment is about to begin, there are a number of interoffice forms and letters that the orthodontist needs to keep in his communications arsenal. Besides being great risk management tools, they have a strong practice management component as well. The first one is a general letter to the patient's physician inquiring into whether or not the patient has any medical conditions that might be impacted secondary to undergoing orthodontic therapy (Form B).

While all of this information should have been ascertainable from the patient's medical history form, it is a belt and suspenders type of risk management posture that prudent practitioners should adopt. In addition to its low cost and high return value ratio, it carries the potential to become another referral source as well, particularly if the patient's primary care provider is a paediatrician.

The next interoffice letter is specific to those patients who present with a positive history of cardiopathy that may require antibiotic prophylaxis for infective endocarditis (Form C). It asks the cardiologist about the nature of the disease, whether or not infective endocarditis prophylaxis is recommended, and if so, what regimen to follow.

**Pearl:** If you send out this letter or make a phone call to elicit the same information, make sure you get a response. There are only a few things worse from a risk management perspective than knowing that you need to make a referral, making it, and then ignoring the response or not following up on not having received one.

The next letter is for the ENT physician, allergist, and/or paediatrician. It alerts the medical specialist to your clinical and radiographic findings, and enquires into whether or not there is a history of, treatment for, or recommendation regarding nasorespiratory embarrassment, for example: tonsils, adenoids, turbinates, sleep apnoea, etc., and if there is, for the specialist to treat appropriately and keep you in the information loop (see Form D).

Forms B through D should be used as often as possible for the patient's protection, your protection, as well as to keep your name in the forefront of the local dental and or medical community. One clinical problem area concerns the use of 'clearance letters'. These types of communications request evaluation of a patient's condition and a request to opine whether or not the patient's oral health status is compatible with either the initiation of or continuation of orthodontic treatment. There are numerous instances of doctors having requested clearance regarding whatever the clinical issue of concern is only to find that (a) a response was never received and the doctor went ahead anyway; or worse, (b) a response was received recommending 'xyz' treatment before initiating or continuing orthodontic therapy but the recommendation was ignored (see Forms E, F).

The next pretreatment type of communication is both intra- and extraoffice and is one that forms the basis for many an orthodontic malpractice suit. It documents the obtaining of the patient's informed consent. While an in depth discussion of informed consent is outside the scope of this chapter, it would be an error not to discuss the communicative aspects concerning this legal tenet. In essence, patients must be told in a language they can comprehend such things as what the problem

is; how you propose to correct it; what alternative methods exist for dealing with the problem; the risks, limitations, and compromises inherent in each approach; the risks associated with foregoing treatment; the opportunity to ask and have answered all of their questions, etc. There are two standards for disclosure depending upon the applicable law regarding the location of your practice. The more traditional standard is the professional-based one holding that the only information you need to disclose to your patients is the information that would usually be disclosed by other doctors under the same or similar circumstances.

**Pearl:** The more modern approach is the patient's 'need to know' standard wherein one must give the patient all of the information that a reasonable person in the patient's position would deem material in order to make a decision to accept or reject the proposed treatment.

From a communications perspective, the information can be given by anyone in the office and in almost any medium. Each of us should develop our own style of information transmission. Some practitioners will go high tech via computer imaging and prepackaged interactive CD programs, or proprietarily produced information packages. Others will find that educational brochures or forms work best. For some, a good old-fashioned conversation with the patient is the way to go.

**Pearl:** How it is done and by whom is irrelevant; the key is to ensure that regardless of how it's done or who does it, the patient or parent understands the information being transmitted. It is important to understand that we don't give informed consent. What we do is give the patient the required information and in return they can now give us their consent.

How do we prove we did this? We document it in some fashion. These methods of documentation, think of them as return communications, take the form of video or audio recording of the discussion; having the patient acknowledge they have read and understood a variety of audiovisual presentations, forms, pamphlets, or letters; or notations made by the doctor in the patient's record as to the gist of the informed consent discussion. Form G is a common type of form used for this purpose and highlights the material risks associated with orthodontic treatment and asks the patient to verify that they have read and understood each paragraph. Form H is a checklist that can be used by those who wish to have more interactive discussions and can be appended to the patient's record to indicate the topics covered. Form I is specific to temporary anchorage devices. Form J is specific to limited treatment. Form K is specific to interproximal reduction.

Before treatment begins, there is one final area of communications that needs to be addressed. It's a nasty little area that deals with money. Orthodontists engage in a personal service industry; the *quid pro quo* being that we are handsomely compensated for our ministrations. As part of this exchange, we have to follow certain legal requirements because in actuality, because of the payment schedules we create, we are extending credit and doing so triggers certain consumer advisory mandates. The bottom line is that our patients, read that as orthodontic consumers, have to be apprised of any finance charges or interest being charged on the 'loan' we are extending (our payment plan). In addition, we often charge the patient additional fees for such things as expenses incurred relating to the collection of past due accounts including legal fees, fees for returned cheques, late payment fees, fees for lost or excessive breakage of appliances, missed appointment fees, etc.

**Pearl:** The general rule is, if patients are not specifically advised of additional charges that may be levied before they begin treatment, then those charges should not be imposed or added on once treatment has begun.

Traditionally, this responsibility has been handled through the use of a contract letter that has often been supplanted by using a

Truth-in-Lending Statement in the USA (see Forms L, M and N). Form L is a version of a typical contract letter and it incorporates all of the required disclosures noted above. Forms M and N are versions of Truth-in-Lending forms that are stylistically different but substantively the same. The bottom line is that all fees, but specifically interest and/or finance charges, are discussed with and accepted by the patient prior to treatment.

With all of the administrative duties out of the way, it is time for active treatment to begin. Your intake form should have provided you with the identity of the patient's other treating dental healthcare providers and you should have a stable of letters for various clinical situations that unfold. The requisite communiqués include at a minimum, a periodontal evaluation letter and a caries exam note (already discussed in Forms D and E), a surgical procedure prescription memo (Form O), and the like.

**Pearl:** While these forms are merely examples of the type required, from a risk management perspective, the only real requirement is to maintain a copy of all referral or consultation communications whether sent or received in the patient's record.

There are times when all is not going as planned. For these instances, you must have two poor cooperation letters. The first is commonly found in every orthodontic practice management software program and need not be shown here. It alerts every patient or parent that without the necessary level of cooperation on their part, treatment results may be compromised. It also states that in the event the lack of cooperation continues and rises to an unacceptable level, you may be forced to either discontinue treatment prematurely or terminate the doctor–patient relationship altogether. The other communiqué documents notification sent to the general dentist that patient cooperation is lacking and request that they intercede if at all possible (see Form P). They also need to know that treatment may be compromised and that there is the possibility that treatment may be discontinued early because of the poor risk benefit ratio of continuing to treat a noncooperative patient.

**Pearl:** As noted previously, all clinical and administrative obligations we owe the patient are based on the existence of there being a doctor–patient relationship in force. This legally recognized relationship is easily formed. Once a doctor consensually agrees to treat a patient and the patient consensually agrees to accept the doctor's ministrations the relationship has been established.

The venue in which advice or treatment is rendered and the fact that money has or has not been exchanged is irrelevant. This relationship is a type of contract and as such there are duties and obligations on the part of each party, the doctor and the patient. Our duties to our patients derive from professionally accepted policies and procedures, the dental practice acts governing where we practice, codes of ethics, and legal precedent established by the courts. The obligations our patients owe us are limited to keeping appointments, following instructions, paying for services rendered, conforming to accepted modes of behaviour, and cooperating truthfully and in a timely manner regarding all valid clinical administrative inquiries.

**Pearl:** While forming the doctor–patient relationship is relatively easy, breaking it is somewhat harder.

The accepted reasons for the termination of a doctor–patient relationship are

1. The patient is cured and no further treatment is necessary.
2. Both parties mutually agree to end it such as in the case of the patient relocating.
3. The doctor or the patient dies.
4. The patient decides to unilaterally terminate the relationship.
5. The doctor decides to unilaterally terminate the relationship.

The first three are almost never problematic. When the patient decides to terminate the relationship there may be some repercussions based on the reason, but for the most part they are unhappy with some aspect of the doctor's

practice, usually administrative in nature and usually dealing with subjective or financial issues. When this occurs the patient is effectively abandoning the doctor and from a risk management perspective you need to tell the patient that they still need continued care and you will help them in any way possible in this regard. You will want to have the patient sign an 'Against Medical Advice' form (see Form Q). Reason 5 is far more problematic and deals with those instances when the doctor wants to unilaterally terminate the doctor–patient relationship.

The five legally accepted reasons for unilateral termination by the doctor follow the five contractual obligations that our patients owe us. In essence, they are based on the fact that the patient has breached one or more of these obligations.

They are

1. The patient is not following instructions.
2. That they are not keeping regularly scheduled appointments; both of which have the potential to negatively impact the ability to achieve a successful result. In other words, the patient is impairing the doctor's ability to adequately render appropriate care.
3. The patient is not conforming to accepted modes of behaviour (being threatening or abusive in the office) thus negatively impacting the doctor's ability to provide a safe working environment for staff and patients alike.
4. The patient is not cooperating with reasonable administrative inquiries such as providing truthful medical histories or not providing employment information thus impacting your ability to be reimbursed by third party payers.
5. The most vexing is when patients do not meet their financial obligations. You are under no obligation to treat without being compensated; however, the one caveat is that you cannot terminate the doctor patient relationship if the patient is *in extremis* which is defined as exhibiting signs of infection, bleeding, intractable pain, swelling, etc., (something is medically wrong and needs to be treated), or when they are at a particular stage of treatment that is active in nature and if left unsupervised may result in iatrogenic harm to the patient.

**Pearl:** Your obligation is to stabilize the patient via treatment, referral, and or removal of the active appliances. Once the patient is 'safe', unilateral termination may then be undertaken. This holds even if permanent teeth have been extracted so long as the patient's clinical treatment has been stabilized.

You must provide the patient with notice and basis, meaning they have to be informed of the reasons you are choosing to terminate their care. You must inform them that continued treatment is still required and that you will help them to obtain such care if they so desire. You must give them an adequate period of time to seek substituted care and you must make yourself available for any emergencies or for referrals during this period of time. Finally you must make their records available to them or any duly designated subsequent practitioner. Ideally this should be done in a style of writing similar to Form R.

**Pearl:** In those instances where you and the patient have decided to resolve your difference and provided you agree to refund a portion of the fee already paid to you, you need to have the patient sign a release (see Form S).

While this will protect you from further legal troubles when the patient is of legal age, it is important to remember that releases signed by parents on behalf of a child are not binding on that child unless the release is approved by a court of competent jurisdiction such as a Family or Surrogates Court. Even if the patient's parent signs the release, when the minor patient reaches the legal age of majority, he may then sue in his own name. However, the reality is that most of the time the return of money and the signed release is the end of it.

Finally, if the patient declares bankruptcy and names you as a creditor, whatever they owe you is gone. Understand that the doctor–patient relationship is still in existence. You

cannot dismiss a patient because they declared bankruptcy. However, as there is still treatment that needs to be rendered, you should treat them like you would any transfer case that needs to be completed. In essence, you should evaluate the status of the case and determine what prospective treatment still needs to be rendered. You can then determine a fee for the remaining treatment (no, you cannot incorporate the amount protected by the bankruptcy courts). You now present the patient with a new Truth-in-Lending form or a new contract covering their financial obligations from this point forward.

**Pearl:** If they refuse to agree to the new fee, this lack of agreement gives you the right to refuse further treatment.

Patients are free however to reaffirm their financial obligation to you and may do so by signing a reaffirmation agreement (see Form T).

These various types of communications described thus far have saved many an orthodontist from having to undergo the trauma associated with being a defendant in a malpractice suit. In addition, even if one does have to go to trial, utilization of the forms in question are often sufficient evidence to either result in a favourable defendant's verdict or in some instances in which negligence is found, to have the jury award reduced as a result of comparative negligence on the part of the patient.

**Pearl:** The caveat is that after a certain number of warning letters have been sent, you must act affirmatively regarding patient dismissal. To do otherwise is to engage in what is known as supervised neglect.

Now that active treatment is concluded, you need to have four completion letters; two for phase one treatment and two for comprehensive treatment; in each case, one goes to the patient/parent and one goes to the GP. Again they need to say essentially the same thing. The Phase I letter (Form U) alerts both the GP and the patient that:

a. The first phase of treatment has been completed.
b. The treatment goals were or were not met.
c. That the patient will be kept under observation in order to determine whether or not a phase two will be necessary.

Everyone needs to be on the same page that Phase I was only that, it was not comprehensive therapy, and was merely undertaken to address a specific problem at a specific point in time, and that fully addressing the patient's orthodontic needs will occur after completing a second phase of comprehensive therapy.

The second set of letters is again for both parties and again outlines what was and was not accomplished, what type of retention is required and whether or not long-term observation is necessary and for how long. It should also indicate who is responsible for monitoring any long-term/lifetime fixed retention employed (Form V). Finally, it informs that patient that the doctor–patient relationship ends with the conclusion of the period of retention.

So far, we have discussed various forms of communications that one should have in the patient's dental record or chart. The reasons for maintaining copies of all these communications aside from the obvious risk management ones are based on the importance of the patient's record as a legal document having the following purposes: first and foremost, the patient's record provides documentary evidence of the evaluation and diagnosis of the patient's condition. Next, it reflects the treatment plan chosen and the patient's informed consent to that effect. It also notes all treatment rendered and by whom, including referrals, consultations, and recommendations. It indicates the results achieved and the retention modality employed. The patient's dental record memorializes all communications with the patient, relevant third parties, and all other concurrently treating healthcare providers. Finally, the dental record provides data for continuing education, quality assurance, research, administrative functions included mandated privacy laws, and billing.

The final area of intraoffice communications deals with the area of employment law.

**Pearl:** It can be an extremely taxing ordeal both financially and emotionally to have to defend oneself when charged with discrimination and/or unlawful termination of a staff member's employment.

As a small business employer, orthodontists must be wary of this minefield as well as those relating to our clinical activities. In this regard, you as the employer should be performing staff performance reviews at least twice annually. Forms W, X and Y are good examples of evaluation forms and can be easily adapted to suit the needs of most practitioners. The bottom line is that you want to have documentation of staff members who are underperforming; evidence that you have given them notification of any shortcomings, and have these evaluations span a period of time during which your staff will not be able to claim that they did not have the time to correct or remediate any noted deficiencies.

There are two tangential issues that warrant discussion. The first is when one doctor, we'll call him junior, works for another doctor, we'll call him senior. If junior leaves, what is his obligation to his patients, if any? The answer is unfortunately grey. It basically depends on whether or not junior is an employee or an independent contractor.

**Pearl:** Legally, and from a simplistic standpoint, this determination is based on who has the ability to control, whether exercised or not. If senior can control most of junior's activities, then junior is an employee; if senior does not have that ability, then junior is an independent contractor.

If junior is an employee, the patient's records (not the patient as we don't own our patients) belong to senior. While junior certainly has a doctor–patient relationship requiring him to adhere to a defined standard of care regarding the orthodontic treatment he renders, just about every other obligation to the patient is born by senior as he is the principle – it is his practice, and junior is merely the agent.

In a true independent contractor relationship what is really happening is that there is a practice within a practice. Senior merely provides physical space, equipment, and possibly staff for junior; but junior runs his practice how he sees fit. We're talking about such things as records acquisition, diagnostics, treatment plan, mechanotherapy employed, fees, and most of the other clinical and administrative decisions associated with providing orthodontic care.

So, if junior is an employee and leaves senior's practice, senior is responsible for findimg a replacement. Suffice to say that junior should provide reasonable notice to minimize any claim that he participated in having abandoned the patient. An exception would be if junior became disabled or died wherein notice would not be possible. If on the other hand junior was an independent contractor he could no more abandon the patients he is treating in senior's facility than could any solo practitioner in his own office.

The second issue involves transfer patients and deals with intraoffice records. It is a fairly common occurrence as we have a fairly mobile society.

**Pearl:** When a patient transfers out of your practice you are only responsible for the treatment you rendered up to the point that the patient leaves your practice. When a patient transfers in to your practice mid treatment, you are only responsible for the treatment you render from that point going forward.

How does one determine this? The answer is simple – records.

In the transfer out scenario, you need to be able to prove the status of the patient at the time they left your office. How? An appropriate clinical exam, a set of good quality clinical photos, and a panoramic film are the minimal records required. Models may be required if the photographs cannot adequately reflect the occlusion; and a cephalometric radiograph may be required if the patient had a skeletal component that was either to be addressed or not addressed as the treatment plan called for.

In the transfer in situation, the corollary applies. Here you need whatever records will definitively show the status of the patient when they presented to your office for the

continuation of their treatment. Again, an adequate clinical exam (this of course includes a periodontal assessment) photos, and a panoramic radiograph are a must. You need to show the occlusal status and the status of the roots as well as the supporting hard tissues. Periapical radiographs, maybe. A cephalometric radiograph, possibly.

This is especially important in the situation previously described relating to professional employment. There are numerous instances of senior doctors employing any number of junior associates over a given period of time. The young doctors come for clinical experience and often leave after a year or two to go do their own thing. The senior doctor welcomes the extra set of hands for a variety of reasons.

**Pearl:** This revolving door of orthodontists often leads to claims of professional negligence as too many cooks can and do spoil the broth.

Differences in orthodontic philosophies, diagnostics, therapeutics, mechanics, etc., may lead to extended treatment times and a myriad of left hand right hand problems. Throw in transfer cases and the potential for a true 'horrendenoma' is easy to visualize. From a risk management perspective, appropriate and adequate mid treatment records may be the difference between legal success or professional liability.

While there are certainly other interoffice communications that occur on a daily basis, the ones previously referred to have important risk management components. Properly structured and worded intra-, inter- and extraoffice communications can mollify the daily stresses associated with practicing in an ever increasing litigious atmosphere.

**Pearl:** Having your practice management advisor or legal counsel review your communication forms is an important component of prudent contemporary practice.

# 9 THE EXTENDED DUTY ORTHODONTIC TEAM

Liz Hopkins

CONTENTS



Incorporation of extended duties clinical and administrative teams into contemporary orthodontic practice is the key to practice development.

## 9.1 WHY IS A TEAM APPROACH IMPORTANT?

Dentistry in the 21st century is increasingly delivered by high quality teams; the General Dental Council (GDC) in the UK have recognized the importance of the dental team in the delivery of high quality patient care, with dentists as the leaders of highly skilled and qualified teams. Contemporary orthodontic practices working with extended duties teams, find that both orthodontists and patients see the great benefits of training and working with an enthusiastic, extended-duty team.[1]

In business or in clinical practice, it is generally accepted that you have one chance to create an exceptional first impression; therefore, it is vital that all staff demonstrate knowledge and understanding of every aspect of patient care and can communicate them in response to initial enquiries.

**Pearl:** To achieve the highest level of patient care combined with maximum practice efficiency, the specialist orthodontist needs the support of the clinical team members who have had additional training to enable them to assist in the provision of orthodontic care throughout treatment.

Training of the entire orthodontic team, both administrative and clinical is required to ensure an outstanding patient experience throughout their journey. The patients expect to be fully informed and involved in their treatment process and to have all the information provided in a patient friendly manner throughout their journey. Every team member has the opportunity to create a positive impression and to contribute to the patient's perception and for them to feel appropriately cared for. Satisfied customers will recommend others to the practice.

**Pearl:** Empowerment of the whole team develops a sense of ownership, which increases morale and job satisfaction.

Compulsory registration for all dental care professionals (DCPs) with the GDC was introduced in the UK in 2008. This change opened up the pathway for exciting career opportunities for dental nurses and enabled the GDC to regulate the dental team. The aim of team development is to expand the skills base and produce a team of knowledgeable and caring DCPs who work together to increase the quality of care and increase job satisfaction. The various categories of DCPs registered with the GDC each have an individual Scope of Practice, which registrants must adhere to. Extended duties teams have increased responsibilities and present significant opportunities for the specialist orthodontist in contemporary orthodontic practice, allowing time for practice planning, training, and business development.

The specific role of orthodontic therapists within the extended duties clinical environment is pivotal and is further considered in this chapter. The GDC have produced formal documents outlining the learning objectives, with training moving increasingly to outreach teaching with the educators and students being based in primary care outreach training centres.[2] The vision of the Department of Health was set out in 2011 with orthodontics to be delivered by the extended duty team.[3] For the Department of Health quality of care is paramount, but the key factor is a value for money team which will contribute to the safe and effective care of orthodontic patients.

**Pearl:** The demand of meeting increasing expectations is impossible to achieve unless a team approach to patient care is adopted.

## 9.2 WHAT IS A TEAM?

A team is a group of people with complementary skills, committed to a common purpose, performance goals and approach, for which they are mutually accountable. Team members operate with a high degree of interdependence but each and every person within the team must take responsibility for their own actions and have a strong sense of mutual commitment.

**Pearl:** The key to developing your orthodontic team is to involve the current employees in the business planning, engage in persuading and converting the entire practice to the team approach, by education of the team; show employees the benefits for them, the patients, and the purchasers.

## 9.3 WHO IS IN THE ORTHODONTIC TEAM?

The GDC's document *Scope of Practice* lists the various skills and abilities each registrant group should have (Figure 9.1).[4]

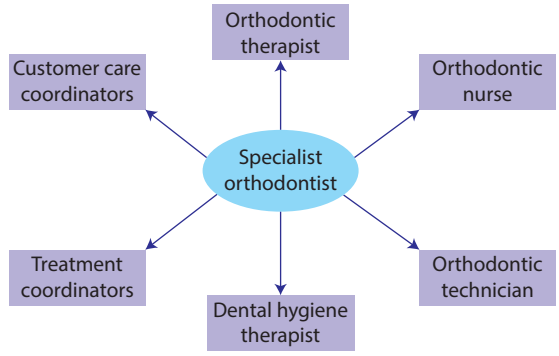


**Figure 9.1**

Who is the orthodontic team?

**Pearl:** Registrants should only carry out tasks following appropriate additional training to acquire the necessary skills.

There are also additional more complex skills which require training to be delivered by an approved educational provider and include some form of assessment. An individual will need to gain an appropriate qualification to allow them to carry out 'reserved duties' in different registrant groups (Figure 9.2).

The skills required are divided into four domains:

- Clinical
- Communication
- Professionalism
- Management and Leadership.

Orthodontic Team Training (OTT) was formed in 2005; it is a specialist orthodontic education and training group, created to meet the training and development needs of today's orthodontic practice. OTT is committed to provide the very highest quality, innovative training and development. The training is directed to qualified nurses wishing to pursue extended duties and more specialist roles as well as an integrated career pathway for the nonclinical members of the orthodontic team. The company is based in Leamington Spa, Warwickshire, UK, and whilst many students will attend the centre, there is the opportunity for online training for some courses, thus extending it to other parts of the world.

The team are directly involved with patient care in all areas and key skills are required in both verbal and written communication. The clinical team must demonstrate competency in all practical tasks such as taking clinical photographs, radiographs, and impressions, before they should be allowed to carry out these procedures. DCPs need to access quality-assured training and to gain recognized transferrable qualifications to show their expertise. In the USA dental nurse training requirements, to be considered qualified to carry out certain duties, vary from state to state; similarly in parts of Europe dental nurses may carry out specified duties following recognized training protocols. Also, with the requirements in the UK laid down by the Care Quality Commission, it is absolutely vital for the dental administrative team to be appropriately trained. Every orthodontic team member needs to see a career pathway, which is mapped out with a qualification structure of real value.

A structured training programme must be followed to ensure that individuals can demonstrate that they are trained, competent, and indemnified to carry out a task. The extended duties orthodontic team will be composed of individuals at varying stages of skill enhancement with the specialist orthodontist overseeing to ensure the most effective skill mix is used.

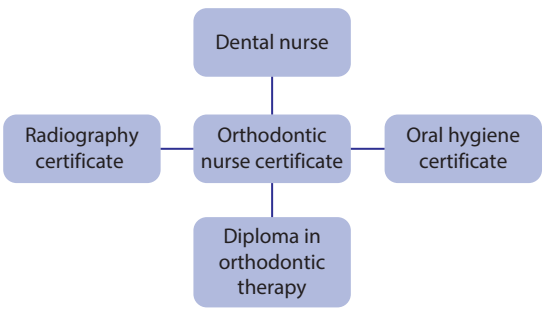


**Figure 9.2**

Dental nurse training pathway.

## 9.4 WHAT IS THE ROLE OF AN ORTHODONTIC NURSE?

Examples of the varied skills a dental nurse may develop are shown in Table 9.1. Following

**Table 9.1**

Additional Skills Dental Nurses Could Develop Relevant to Orthodontic Practice

| |
|---|
| • Further skills in assisting in the treatment of orthodontic patients |
| • Intra and extraoral photography |
| • Tracing cephalographs |
| • Pouring, casting and trimming study models |
| • Further skills in oral health education and oral health promotion |
| • Further skills in assisting in the treatment of patients with special needs |
| • Taking impressions to the prescription of a dentist |
| • Apply fluoride varnish on prescription of a dentist as part of a structured dental health programme[5] |

**Table 9.2**

Orthodontic Nurses Will

- Take clinical extra and intraoral photographs
- Produce cephalometric assessments
- Be involved in the case assessment process
- Undertake orthodontic record keeping

registration as a dental nurse and a period of post registration working in a specialist orthodontic practice, nurses may choose to undertake additional formal training to be eligible to use the title Orthodontic Nurse (Table 9.2).

Post qualification certificates in orthodontics, radiography, oral health education, and further qualifications in impression taking and model casting are also available. A certificate in dental radiography requires a significant level of commitment to learning and the challenging content is viewed as a determiner of academic ability. Individuals choosing to work in specialist orthodontic practices will be able to increase their core knowledge and understanding in this speciality prior to progressing to further training in orthodontic nursing and orthodontic therapy. It continues to be essential to demonstrate additional training, practical skills, and orthodontic knowledge prior to successfully progressing to train as an orthodontic therapist.

## 9.5 WHAT IS THE ROLE OF AN ORTHODONTIC THERAPIST?

Orthodontic therapists carry out certain parts of orthodontic treatment under prescription from a dentist (Table 9.3).

**Pearl:** In the UK, an orthodontic therapist, upon qualification may be employed by a dentist; it is therefore essential that all training programmes provide the students with an understanding of the process of diagnosis and treatment planning, such that if they were asked to carry out inappropriate treatment they would be in a position to question the prescription, to ensure that they act at all times in the patient's best interest, and that they have a full understanding of ethical responsibilities.

**Table 9.3**

GDC Scope of Practice for Orthodontic Therapists

- Clean and prepare tooth surfaces ready for orthodontic treatment
- Identify, select, use and maintain appropriate instruments
- Insert passive removable orthodontic appliances
- Insert removable appliances activated or adjusted by a dentist
- Remove fixed appliances, orthodontic adhesives and cement
- Identify, select, prepare and place auxiliaries
- Take impressions
- Pour, cast and trim study models
- Make a patient's orthodontic appliance safe in the absence of a dentist
- Fit orthodontic headgear
- Fit orthodontic facebows which have been adjusted by a dentist
- Take occlusal records including orthognathic facebow readings
- Take intra and extraoral photographs
- Place brackets and bands
- Prepare, insert, adjust, and remove archwires previously prescribed or, where necessary, activated by a dentist
- Give advice on appliance care and oral health instruction
- Fit tooth separators
- Fit bonded retainers
- Carry out Index of Orthodontic Treatment Need screening either under the direction of a dentist or direct to patients
- Make appropriate referrals to other healthcare professionals
- Keep full, accurate, and contemporaneous patient records
- Give appropriate patient advice

Additional skills which orthodontic therapists could develop include:

- Applying fluoride varnish to the prescription of a dentist
- Repairing the acrylic component part of orthodontic appliances
- Measuring and recording plaque indices
- Removing sutures after the wound has been checked by a dentist

In other countries orthodontic auxiliaries may not be allowed to carry out many of the above procedures; the training programme regulated by the GDC in the UK is extensive, therefore, it is appropriate that unless a recognized approved training programme is undertaken

that orthodontic auxiliaries should be restricted in their scope of practice.[5]

## 9.6 ORTHODONTIC TECHNICIANS

Technicians should be encouraged to work closely with the orthodontic team to embrace the wider dental team.

## 9.7 DENTAL HYGIENE THERAPISTS

Together with the dental nurse with oral hygiene education certificates, these therapists have a key role in the orthodontic team. Through appropriate prior planning and patient education, problems during orthodontic appliance therapy can be reduced.

## 9.8 TREATMENT COORDINATORS

**Pearl:** Good communication between clinician and patient is the key to successful treatment and exceptional patient experiences.

Clinical treatment coordinators will generally be registered DCPs holding additional post registration qualification in orthodontics and can significantly influence the uptake of private treatment. They must be good communicators who build rapport with potential clients, explain the benefits of orthodontic treatment, discuss the financial aspects, and offer advice and support throughout the patient's treatment; some practices will offer an out of hours helpline manned by clinical treatment coordinators to cover out of hours care. With the continuing advances in digital-based orthodontic appliances, the patient's understanding of these appliances, based on Internet-sourced information, may be confused. The treatment coordinator can answer patient queries and explain in more detail the proposed treatment plan thus ensuring to his/her satisfaction that valid consent to all aspects of care has been obtained as well as completing the financial aspects of the treatment.

## 9.9 CUSTOMER CARE PERSONNEL

Currently nonclinical team members are not required to register with the GDC, although training in information governance and appropriate patient care is essential. Increasingly the merits of a highly knowledgeable front of house team are recognized and additional training to ensure excellent product knowledge is essential, and there are advantages of some of the customer care team having formal dental nurse qualifications. The customer care team need to liaise with the clinical team on appointment scheduling to ensure that the practice works in the most effective and efficient manner. In the past the career development opportunities for the nonclinical orthodontic team were limited but qualifications for this group are now available with the Diploma in Dental Practice Administration and Management. The Award in Dental Nursing has been developed to be appropriate core foundation training, for both nonclinical and clinical team members, affording practices the opportunity to set their training standards and appraisal processes from the outset.

## 9.10 WHEN AND HOW CAN THE EXTENDED DUTIES ORTHODONTIC TEAM CONTRIBUTE TO THE PATIENT JOURNEY?

**Pearl:** The extended duties orthodontic team are able to significantly contribute to both administrative and clinical procedures throughout the orthodontic patient journey, from referral to discharge, initial assessment to retention.

The clinical team complements the specialist orthodontist who is able to delegate certain tasks to appropriately qualified personnel. Through delegation the specialist orthodontist is able to spend time in developing the business, exploring new technologies, engaging with stakeholders, training and managing the team. A high quality team trained and qualified to carry out GDC approved duties enable more time to be devoted to each patient.

The orthodontic nurses develop their core record taking, communication skills, orthodontic knowledge and confidence, prior to being considered to move on to train as an orthodontic therapist. Patients become accustomed to being treated by different members of the team from the initial visit and recognize that each member of the team has a specific role in aspects of patient care.

## 9.11 THE ORTHODONTIC PATIENT JOURNEY

The customer care team respond immediately to new patient referrals contacting both the referring dentist and the patient by email to confirm the contact information is accurate and introducing the patient to the practice, providing details of the practice website and information on patient choices and what to expect at the first visit, as well as opportunities for private or National Health Service consultations. New patient appointments may be accessed, by the patients, online to assist in coordinating the availability of the patient and accompanying parent's, with their various work and school commitments.

On arrival at the practice, a new patient is greeted by a member of the customer care team who checks that all patient contact details are accurate and assist the patient in using the electronic technology to self-check in and upload their medical history. Time invested at this appointment is rewarded during treatment and demonstrates a modern caring approach. The patients will be advised if the clinic is running to time and parking arrangements will be reviewed to check that sufficient time has been arranged for the anticipated appointment duration. Many patients are apprehensive at the initial consultation; reassurance by a friendly face negates any preconceived negative impressions.

### *9.11.1 New Patient Assessment Clinics*

New patient clinics are run by orthodontic therapists and orthodontic nurses who are trained in recording the malocclusion and assessing the Index of Orthodontic Treatment Need (IOTN). Orthodontic nurses and orthodontic therapists are familiar with IOTN requirements and will discuss the need for treatment on dental health grounds with the patients. Extra- and intraoral baseline photographs are taken of all cases; these records enable the opportunity for aesthetic improvement to be outlined.

**Pearl:** The patient is introduced to the specialist orthodontist and as the case is presented to the orthodontist he/she assesses the malocclusion and requests radiographs, as appropriate prior to making the diagnosis, problem list, and formulating the treatment plan.

Patients will be advised of their treatment options by the clinical team and further discussions arranged at this stage with the treatment coordinators as appropriate. Nurses with additional skills in dental health education assess the oral hygiene levels and provide oral health education, the use of disclosing tablets, and demonstrating brushing techniques prior to patients being accepted for active treatment.

### *9.11.2 Record-Taking Clinics*

Specific sessions are also set aside for record taking clinics run by extended duties clinical and administrative teams, increasing efficiency, and enabling waiting lists to be appropriately managed.

**Pearl:** The specialist orthodontist requests a dental nurse with additional skills to take orthodontic records; impressions for diagnostic study models, radiographs, and extra- and intraoral photographs of patients who require treatment.

The dental nurses routinely take photographs and an orthodontic nurse who has the certificate in radiography will be allocated to the clinic to take radiographs to the prescription of the orthodontist, and the orthodontic nurse

will assess the quality of the radiographs and review the radiographs with the orthodontist whose report will be added to the patient notes. The nurse will then show the radiographs to the patient and accompanying relative and explain the findings. The radiographs are downloaded into the patient's records and the orthodontic nurse will complete the cephalometric tracings immediately thus ensuring that all the information is available to the specialist orthodontist for treatment planning at that visit. This orthodontic nurse will also compose the letter/email of the assessment and treatment plan to the referring general dental practitioner using the practice software templates and codes, for the orthodontist to check and complete as required.

Nurses with additional skills in dental health education explain the importance of good oral hygiene and general compliance at the record-taking clinics. Patient motivation is assessed prior to embarking on active treatment. A dedicated oral health education area is set aside for this purpose and patients are able to access it prior to their appointments.

Once the specialist orthodontist has formulated the treatment plan and discussed it with the patient and parent, the orthodontic therapist or orthodontic nurse will then further explain the treatment plan and commitments to the patient to ensure the patient is fully informed, prior to completing the consent form and arranging the appliance fit appointment.

### *9.11.3 Preparation for, and Procedures during Active Treatment*

**Pearl:** The orthodontist will provide the prescription for the appliance bracket system, position of auxiliaries, bite disclusion turbos, and archwire material and dimensions, and this is recorded in the notes ahead of the procedure.

The orthodontist requires that the orthodontic therapist reviews the patient records and discusses the specific features of the case with them prior to the fixed appliance fit appointment.

A dedicated DCP runs the decontamination room, which ensures that the surgeries are always stocked with appropriate instrument trays.

Parents are encouraged to attend with patients for the bonding of their fixed appliances but advised that the appointment will be approximately 1 hours and they may wish to return to the waiting room during the procedure.

The orthodontic nurse assists the orthodontic therapist in the active treatment procedures, provides appliance care instructions and takes intraoral photographs at each visit to enable the orthodontist and orthodontic therapists to assess and monitor treatment progress. Photographs are also used to aid patient motivation; the orthodontic therapist will review the photographs with the patient and demonstrate the clinical changes.

The clinical team all develop their case presentation and record-keeping skills and are involved in assessing the malocclusion at each visit; a record of the malocclusion is made at each appliance adjustment appointment, with the incisor relationship, overjet, overbite, molar and canine relationship, centre lines, and cross bites recorded on a separate page in the clinical notes; this provides a clear record of the treatment progress and is reviewed by the orthodontist. The record of the intraoral assessment together with visit by visit intraoral photos provides a clear record of treatment progress; this is used in internal and external audit, appraisal, and performance management of the team.

The specialist orthodontist will prescribe the necessary clinical procedures which are recorded on dedicated software the 'Orthochart' (Assisortho) allowing each procedure and adjustment to be clearly documented. The introduction of cameras mounted on the overhead lights has also further enabled supervision and comments to be made. The use of close-circuit television enables the orthodontist to oversee the general patient flow, checking on the number of patients in the waiting room, and to act to protect both the team and the patients.

A member of the clinical coordination team is available to oversee the clinical floor and direct the specialist to the orthodontic therapist who requires a patient to be checked. A traffic light system has been developed to enable the

orthodontic therapist to alert the orthodontist that he/she is required with codes to identify which nurse/therapist is next in line.

Patients requiring disclosing or oral hygiene advice during treatment are seen by the extended duties nurses at the adjustment appointment.

### *9.11.4 Completion of Treatment*

Following confirmation from the orthodontist, the orthodontic therapist will check that the patient consents to appliance removal and will then remove the appliance and either they or the dental hygiene therapist will remove the adhesive and take the impressions for retainers.

**Pearl:** Orthodontic therapists are permitted to use a slow handpiece and tungsten carbide burs and are also taught how to use hand instruments for removal of adhesive or supra gingival deposits.

Extra- and intraoral photographs are taken by the assisting nurse who explains the retainer wear and care requirements. The orthodontic nurse will also review the retainer consent forms with the patient, prior to obtaining both patient and where the patient is under 16 years of age, the parent or guardian's signatures, confirming that they fully understand the ongoing commitment to the retention regime and that failure to comply could result in relapse of the alignment, at any stage. It has been shown that patients rarely remember all information whatever form this is provided in and at whatever stage, whilst the importance of lifelong retention is clearly stressed at the outset prior to commencing active treatment the benefits of reconfirming this consent at the appliance removal stage are recognized. Removable and or bonded retainers are fitted by orthodontic therapists. Retainer check appointments are run by the team who take intraoral photographs and check compliance referring to the end of treatment photographs and final study models to check that there has been no relapse. Any concerns are raised with the orthodontist who will see the patient and records.

## 9.12 PRACTICE STRUCTURE

**Pearl:** Modification of the typical hierarchical structure of many specialist orthodontic practices with the introduction of the coordinator team has some significant benefits over the classic single practice manager approach.

Strengths and weaknesses of individuals are addressed and individual roles created to enable each person to develop in a role best suited to their personality. To promote effective team communication and involvement the team coordinators will explain the daily requirements and planning at the start of day with a team brief. Everyone, both clinical and administrative teams, join the briefing before the start of the day and at the end of the day.

Structured full session practice meetings are booked in the practice diary and the individual teams work in groups to complete aspects of training or audit and discuss aspects of clinical care; thus the team are empowered to contribute.

## 9.13 SPECIALIST ORTHODONTIST SUPERVISOR

The role of the orthodontist supervisor during the training of extended duties clinical teams must be carefully considered. In-house training is common in many countries but a recognized training programme should be undertaken to ensure that the student is fully trained and competent at the delegated task.

**Pearl:** The trainer should be present at all times when the student is working clinically during training.

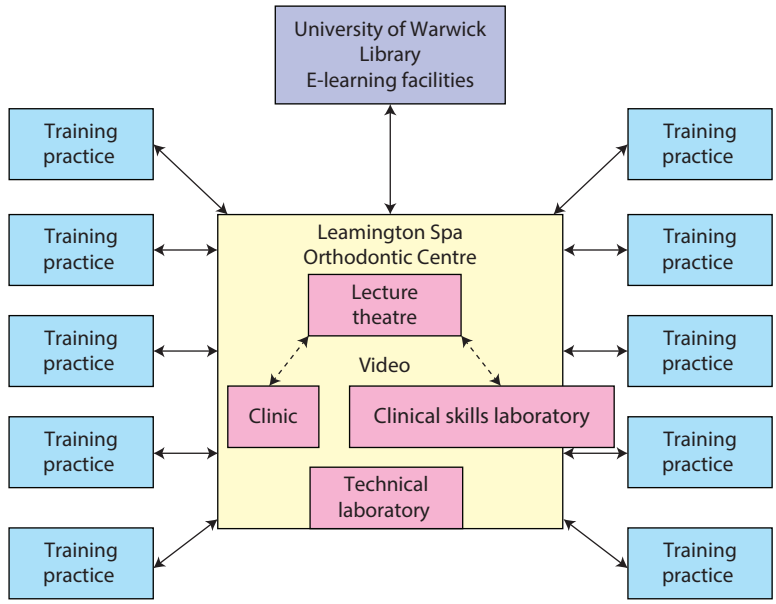


**Figure 9.3**

The interrelationship of the central training facility and the 10 students based at outreach training facilities (clinical practices).

The trainer for an orthodontic therapist will be an orthodontist, whilst a qualified orthodontic therapist may supervise a student orthodontic nurse and a dental hygiene therapist and a dental nurse undertaking training in dental health education. Tutor development at all levels helps to create further development of skills within outreach centres and increase job satisfaction and career development (Figure 9.3).

During training, the specialist orthodontist will see the patient at the start and end of each appointment and will often need to be available during the procedure. Once qualified, the orthodontic therapist is required to work to the prescription of a dentist; patients in active treatment should still be closely supervised by the orthodontist. The orthodontist will oversee the extended duties clinical team, it is suggested that supervising a maximum of four DCPs is appropriate if the appointment times are not to be adversely affected and to avoid patients being kept waiting. Adjustments must be made to the supervising orthodontist's appointments book; if they are busy treating patients, they will not also be able to oversee others simultaneously.

## 9.14 PLANNING FOR THE EXTENDED DUTIES TEAM

**Pearl:** The set-up costs of modifying and equipping existing practices to provide appropriate clinical facilities to be able to accommodate extended duties teams should be considered.

Additional dental chairs are required and during their outreach training orthodontic therapists must be closely supervised; the layout of student and trainer surgeries needs to be considered carefully. The surgery planning will be an ongoing development for a practice moving forward. Some premises may not be suitable for the modifications required to incorporate a team of orthodontic therapists and extended duties clinical teams. Surgery layout is an important factor: open plan or surgeries on one floor work well where supervision of the extended duties clinical team is required. In open plan surgeries attention to sound insulation should be given if a complaint about

confidentiality is to be avoided. Specific areas should be identified where confidential discussions can be carried out.

As for the waiting room, additional space will be required as appointments will be longer and more dental chairs will be operating. Orthodontic therapists and orthodontic nurses will take significantly longer during their training to carry out clinical procedures, together with the additional waiting time required for the orthodontist to review each procedure before and after adjustments. Appointments with the orthodontic therapist, once qualified, will in general be longer than equivalent appointments with orthodontists.

In the staff room, additional space is required for staff changing, relaxation areas, and toilet facilities as the practice personnel increases. The practice should have library facilities and an area set aside for tutorials. Internet access is required so that student logbooks can be completed electronically and full use made of the university library's e-journals.

Additional inventory of instruments and equipment will be required, including additional decontamination equipment.

The merits of working with orthodontic auxiliaries had been recognized in the USA, South Africa and in more than half the countries in Europe.[6] It was identified that public access to specialist orthodontic services could be improved by increasing the orthodontic workforce manpower through the introduction of orthodontic therapists. The GDC set up the Dental Auxiliaries Committee in 1996 and the first training programme to train orthodontic therapists commenced in 2007.[7]

Potential patient numbers continue to increase but the training pathway to allow inclusion on the specialist register in orthodontics in the UK is a lengthy process, and employment of orthodontic auxiliaries was seen by the Department of Health to be the way forwards. Specialist orthodontists will have acquired many relevant skills during this time and through the team approach they will be able to appropriately delegate tasks to the members of the team; in reality orthodontic therapists will bring about a fundamental change in the orthodontic workforce.[8]

**Table 9.4**

Is it for You?

- Do you like to do everything?
- Do you employ a hygienist?
- Do you have extended duties nurses?
- Do you take the impressions photos and X-rays?
- Is it right for your team?
- Do you have a suitable candidate?
- Do you have additional support staff?
- Can you afford it?
- Do you have sufficient surgeries, waiting area, discussion areas, parking?
- Does your staff share your views?

**Pearl:** Are you ready to incorporate an orthodontic therapist into your practice? Have you already embraced the extended duty team approach? (Table 9.4.)

Prior planning is crucial when considering whether to train an orthodontic therapist. Preparation for training in orthodontic therapy requires the trainer to

- Understand the responsibilities of training an orthodontic therapist;
- Understand the adjustments required to the orthodontic practice trainers appointments diary and daily life;
- Provide a well-structured clinical team with adequate orthodontic nursing support;
- Provide an effective team with excellent communication skills;
- Engage the whole team in the process.

## 9.15 WHERE IS ORTHODONTIC THERAPY TRAINING AVAILABLE IN THE UK?

There are currently eight General Dental Council approved centres for the training of orthodontic therapists in the UK. Further information on training is available from the websites of the University if Warwick (http://www2.warwick.ac.uk/fac/med/study/cpd/dentistry/therapy/) and the British Orthodontic Society(http://www.bos.org.uk/public-patients-home/careers/orthodontic-careers-for-nurses-technicians-and-therapists)

### 9.15.1 Expectations of the Trainers

Trainers, who must be on the specialist list in orthodontics, have high expectations in general. They should, however, remember how long it took them to train as an orthodontist and must realize that whilst at the end of the core weeks training the student will be competent in all clinical tasks, the various tasks will need significant practice and a considerable amount of time before they will be able to be efficient at them. The trainer will need time scheduled in their own appointments book to monitor and oversee the students as every patient will be seen by the trainer at least once and usually twice at every appointment. Trainers will expect a return on their investment of training costs both in terms of financial considerations and in their time commitments.

### 9.15.2 Expectations of the Team

An experienced supportive orthodontic nurse will be of great assistance to the student orthodontic therapist during the first few months, when the student may find tasks more demanding than they had anticipated. Care should be taken to pick up on any jealousy from orthodontic nurses who might feel overlooked and also wish to train as an orthodontic therapist.

### 9.15.3 Expectations of Patients

The patients are accustomed to having different team members carrying out various procedures and the student orthodontic therapist will be more easily accepted. Team communication skills are essential in dealing with any patient concerns. Patients should be advised that some of their treatment will be carried out by a student and consent obtained before any tasks are undertaken. Patients are generally very supportive and pleased to be involved in the career development of the team, but they must feel fully informed.

### 9.15.4 Expectations of the Student Orthodontic Therapist

Tasks that a specialist orthodontist has done for many years can look easy to the assistant; however, the reality is that orthodontic therapist students are often frustrated that their expectations of how easy the practical aspect will be do not match the reality, which can cause initial loss of confidence and upset. This is where preparation of the supporting team is especially important. The Diploma in Orthodontic Therapy programme is modular to allow for assimilation of both theoretical knowledge and practical skills. The student must demonstrate competency in clinical skills prior to progressing to undertaking these procedures on patients (Figure 9.4).

Students will complete a clinical reflective portfolio, a clinical logbook of all activity during training, every activity is monitored graded and acknowledged by the trainer's contemporaneous signature.[9]

**Pearl:** Individual development for the benefit of the team, leads to the concept – the whole is greater than the sum of the parts.

**Figure 9.4**

Training students working in the laboratory training facility.

## 9.16 SUMMARY

The report from the educational meeting *Looking forward: Educating tomorrow's dental team* states that dental education must ensure that new members of the dental profession are fit for purpose and remain lifelong learners, with a clear understanding and commitment to their new professional responsibilities.[10] http://www.bos.org.uk/public-patients-home/careers/orthodontic-careers-for-nurses-technicians-and-therapists.

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# 10 MARKETING AN ORTHODONTIC PRACTICE

Winston B Senior, Asif Hassan Chatoo and Renton Tindall

CONTENTS



## 10.1 MARKETING AN ORTHODONTIC PRACTICE AND MANAGING A NEW PATIENT

Winston B Senior

Before describing a philosophy, which has facilitated the growth of a successful, all private orthodontic practice in a nonaffluent area of Manchester, UK, I believe it is relevant to present some of the general business principles I have learnt and applied.

While I accept that marketing techniques have changed over the years, I believe that the basic principles remain valid. Much of what I have applied can be summed up in a statement made by Conrad Levinson in his book, *Guerrilla Marketing*.[1]

'Marketing is everything you do to promote your business, from the moment you conceive of it, to the point at which customers buy your product or service and begin to patronize your business on a regular basis. It is the name on the building. It is where you are located. It is how you answer the phone. It is the quality of the service you provide. It is how you conduct your consultations and it is who you are.'

Today's orthodontic graduates are taught high standards of therapy involving clinical care and diagnostics, as well as the theory and use of different mechanical techniques. These are core product skills vital to overall patient management.

**Pearl:** The management of a new patient calls for the clinician to use noncore product skills, the importance of which is seldom addressed at dental school.

The success or failure of a practice does not only depend on what happens in the practice. That is on *internal strategy* alone. The architecture, decor, staff and treatment are important but before these become relevant, the right type of patient needs to be attracted to beat a path to the front door of a private practice. This depends on *external strategy*; a discipline concerned with marketing activity outside the practice, either by professional associations (the American Association of Orthodontists is superb at this) or the practitioner himself.

**Pearl:** Marketing a practice can be regarded as a two-fold process comprised of external and internal strategies.

### 10.1.1 External Strategy

This should be directed both to potential patients in the general population and to professional colleagues considered as referral sources. It involves the application of nonclinical disciplines, a simple example of which is to stand back and try to view the practice building and garden objectively and ask yourself questions such as: Does it give a message of quality? Is parking adequate?

For a deeper understanding of noncore skills needed for the successful applications of external and internal strategies, one needs to turn to subjects researched and taught at business school, such as

- *Segmentation*: Deciding which segment or section of the public you wish to treat
- *Public relations*: Telling members of the public what you do and making them like you for doing it
- *Marketing*: Presenting a favourable image of a product and making it desirable

#### 10.1.1.1 Segmentation

The principle of segmentation is graphically illustrated in Figure 10.1. Segmentation is particularly important to an external marketing strategy. It is important because no organization could possibly satisfy all sections of the population. Clearly, for a dentist seeking to provide private cosmetic dentistry, targeting older people in the lower socioeconomic groups is unlikely to yield worthwhile results. A dentist wishing to practice a specific type of dentistry must identify the segment of society most likely to accept the type of treatment he or she has to offer and then plan an external strategy targeting the identified niche market. Likewise, patients seeking high-class cosmetic dentistry are unlikely to obtain satisfaction from every member of the dental fraternity. They must be alerted to the need to identify a segment of the dental profession likely to satisfy their needs.

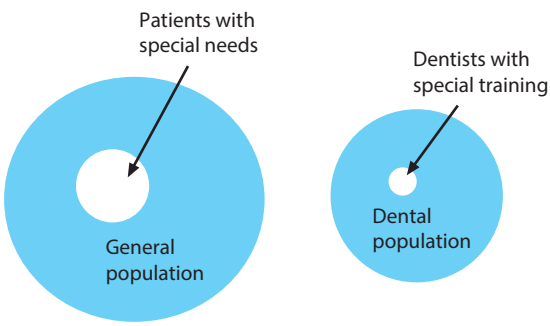


**Figure 10.1**

Segmentation. No dentist could deal with the whole population. They must attract a segment of society containing a specific type of patient. No patient with an orthodontic problem could obtain treatment from all members of the dental profession. They must seek out a segment of the profession trained to deal with their specific problem.

Before considering how a dentist identifies a segment of society needing his or her particular specialist skills, it is worthwhile considering the factors that determine how a patient chooses a professional practice.

#### 10.1.1.2 How a New Patient Chooses a Professional Practice

Three factors influencing this choice have been identified. These can be referred to as the 'Three Hierarchy of Needs':

1. *Accessibility.* How convenient is it to get to the practice? Is the practice near to home? Is there traffic or a parking problem? Are the office hours convenient?
2. *Affability.* Are there any adverse reports regarding the principal and/or staff in the practice?
3. *Ability.* Note that this lies third down the list. The reason given for the low status of ability in the hierarchy is that in the eyes of the man in the street, all professionals are perceived, unless otherwise proven, to be equal. They have a dress code in the case of dentist, technical equipment, and uniformed staff. They all have a university qualification often seen as incomprehensible letters after their name. These are, understandably, taken as an acknowledgement that all dentists have attained, from a respectable authority, a 'state of the art' standard of ability, which is (assumed) to be frequently updated and will be used to their benefit without restriction of clinical freedom being placed by a third party health plan.

In most countries any qualified dentist is entitled to practice any branch of dentistry whether trained to specialty level or not. Consequently, the choosing of a dentist by the public to carry out a specialist service, such as orthodontics, is more likely to be based on affability and accessibility rather than ability!

**Pearl:** A patient setting out to find a professional advisor does not know what he wants until he does not get it!

#### 10.1.1.3 How Specialist Orthodontists Should Select and Attract their Patients

To identify and target a particular segment of the population, there are four fields that a clinician needs to evaluate. These have been described as

1. Research
2. Activity
3. Communication
4. Evaluation

##### *10.1.1.3.1 Research*

This section starts with the questions: 'What product is being marketed?' 'What socio-economic class of society would be likely to pay for the product?' 'What geographic area should be targeted?' It is essential for the clinician to consider these questions, research the subject and try to answer them before proceeding further.

**Pearl:** The question of the cost of the product is not a factor considered at this stage. When marketing a service to a chosen segment of society marketing the service by offering low fees can be counterproductive.

Theodore Levitt, head of marketing at Harvard Business School wrote in the *Harvard Business Review*, June 1981, an article entitled 'Marketing Tangible Products and Products Intangible'.[2] Like most papers on marketing it highlights well-known but often not appreciated facts of life in a consumer society. He points out that there are two types of marketable products. Both have a visible and a nonvisible component.

1. *The tangibles.* These are those products that can be directly experienced; seen, touched, smelled, or tasted, as well as tested. Examples of these are refrigerators and cars, and in dentistry, orthodontic braces and dentures. These are commodities and the customer can compare and contrast these products before purchasing.
2. *The intangibles.* These are such products as insurance, banking, education and health services. These cannot be compared or judged by the customer until the product is delivered and the results evaluated. Products such as these are more difficult for a potential purchaser, accustomed to purchasing commodities and not services, to appreciate. Consequently, a cost quotation for an intangible product, such as a comprehensive orthodontic service consisting of many invisible components, is more likely to be challenged.

Levitt points out that many individuals sell intangibles in the marketplace. The usefulness of the distinction between tangibles and intangibles becomes apparent when one considers the question of how the marketing of intangibles differs from the marketing of tangibles. The tangible product in orthodontics is easily identified by a patient, it is the appliance; it can be demonstrated photographically or on a model.

The full benefits and performance, that is, the intangible component of the appliance to correct dental irregularities unique to the patient, unlike the benefits and performance of a shiny new car or refrigerator, cannot be appreciated by the consumer until its effectiveness has been witnessed by the consumer (the patient). Therefore, before the product is put to use there is an element of intangibility.

Other intangible components of an orthodontist's service to the patient include technical training and retraining, time spent on treatment planning, record-keeping, and the cost of laboratory bills. All of these are invisible to the patient but very necessary and expensive to the practice. Unless the patient appreciates these invisibles or intangibles, the fee quoted for orthodontic treatment, which may seem to the

patient to only involve the fitting of an orthodontic appliance, may be regarded with suspicion.

**Pearl:** The intangible products are the largest and most expensive components of an orthodontic practice.

Following comprehensive research, strategies (both external and internal) have to be designed to make the patient aware that the provision of the orthodontist's tangible product, the appliance, constitutes only a small part of the service necessary to deliver a high standard of orthodontic care.

#### 10.1.1.3.2 Activity

This involves planning and executing an approach based on answers to the research previously carried out. If, for example, research shows that the reputation of the district where the practice is situated is poor and likely to deteriorate, parking is difficult, and it is unsafe to park or walk about during hours of darkness, it may be prudent, before capital is spent on expensive activities, to relocate.

When research has highlighted the segment of the population you wish to attract, a plan to satisfy the special needs of potential clients must be addressed. Examples of such actions would include special staff training on: 'How to make the client feel important'. Other actions might include a change in practice decor or determining where and how to direct advertising. If the practice is far away from the homes of the targeted population segment, external strategy in the form of improved or altered communication has to be designed to encourage referrals from practices far afield.

#### 10.1.1.3.3 Communication

Telling people who you are, where you are, what you do, and making them like you for doing it, is the communication component of public relations. This can be achieved through lecturing, writing articles in local newspapers, and other forms of hard copy advertising. Marketing via the various forms of social media has become an indispensable component of both initial marketing and maintaining continuing patient contact and communication. This may be done on a personal in-house basis or by specialist consultant companies. The practice brochure still remains an important component in the marketing and practice exposure scenario. Which of these methods you select depends largely on your personality and your communication skills.

Lecturing to colleagues, parent/teacher groups, Rotary Clubs, etc. may be the vehicle of your choice. However, the results of such an approach need to be carefully evaluated. If this avenue is not effective, it may be due to poor lecturing technique. Lecturing does not suit everyone and everyone is not a born lecturer but training and observation of lecturing techniques can help.

Writing articles in local newspapers can be helpful and professionals can be employed for this. However, be aware that the wrong type of communication may result in the wrong type of person being attracted to a practice.

In the author's case, a practice brochure and in the past the Yellow Pages advertising have proved to be effective means of targeting the chosen segment. Other forms of advertising, such as a website and video promotion in medical centre waiting rooms, have not proved to be effective. Whatever form of advertising you chose, remember it needs constant reinforcement to be effective.

The author's brochure is designed to target a middle-class segment of society interested in investing money and time to improve their appearance. It consists of two sides of an A4 sheet folded into three. This gives one outside column carrying the logo 'It's Never Too Late to Create The Perfect Smile'. This logo is sited under a picture of a mature female. The other columns give a simple explanation of what the author's specialty is, how long the first visit will take, and what will be done to assess the patient's particular needs. It is designed to highlight in simple language:

- The practice is exclusively orthodontic
- What the specialty of orthodontics is and what training is needed to become a specialist

- The practice offers easy access and good parking
- How a patient's specific needs are investigated
- After consultation, full and comprehensive written reports will be sent to both the patient and their dentist
- Treatment will be carried out in cooperation with the patient's dentist

The message of any advertisement and brochure should have a 3-second impact. Research has shown that unless this occurs, promotional literature is likely to be mentally or, in the case of a brochure, physically binned.

**Pearl:** A brochure should be designed to give a subliminal message that there is something more to treatment than fitting a brace. It should emphasize the benefits of the practice services to the patient and not, as many contemporary brochures do, lay too much emphasis on the qualifications and ability of the dentist. The patient will assume ability.

#### *10.1.1.3.4 Evaluation*

This endeavour, like the research, activity and communications steps, should be ongoing. The results of all the previously described external strategy steps can be continually evaluated by looking at the following parameters:

- How many patients are contacting the practice?
- How many are making consultation appointments?
- How many are having treatment?
- How many patients are satisfied with the tangible and intangible products received?
- How many patients would recommend their friends to the practice?

A post-treatment questionnaire given at the end of active treatment in a stamped addressed envelope is used in the author's practice.

The research, activity, communication and evaluation (RACE) process does not terminate with one evaluation. It has been described as a continuous spiral where each evaluation provides leads to a further spiral of research highlighting what improvements are needed to better the practice's external strategy. This process is shown graphically in Figure 10.2.

### *10.1.2 Internal Strategy*

Internal strategy is directed at establishing and consolidating confidence in a new patient who enters the practice as a result of the *external strategy* outlined above. Internal strategy covers the following procedures:

- The first telephone contact
- Making the first appointment
- The patient's first visit to the practice
- The first consultation
- The first examination
- Acceptance to proceed with comprehensive investigations
- Carrying out comprehensive investigations
- The second consultation
- Correspondence

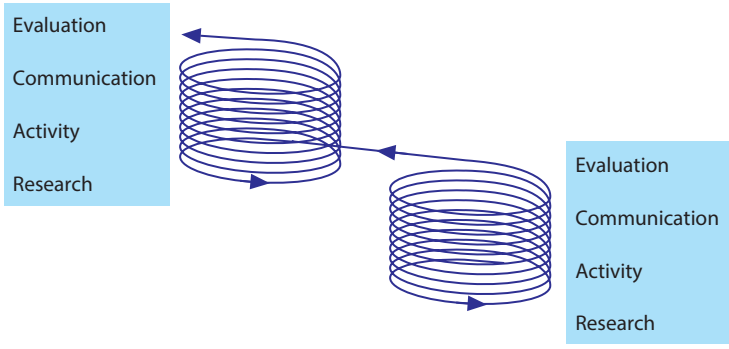


**Figure 10.2**

The RACE process does not terminate with one evaluation. It has been described as a continuous spiral where each evaluation provides leads into a further spiral of research highlighting what improvements are needed to better the practice's external strategy.

### 10.1.2.1 First Telephone Contact

The first contact with a practice will undoubtedly be by telephone. The way that this is handled can create a good or bad first impression. Affability should be apparent at the outset. Research has shown that more than 14 rings before a phone is answered engenders aggression. If the receptionist is busy she should answer the phone with a smile, give the name of the practice, her name, and a reason why she must ask the caller to hold or be called back. Electronic messages about queuing and instructions to press keys for further information have become common usage for many commercial companies, but for clinical practice where a prospective patient/parent is embarking on or seeking a one-to-one relationship with a clinician involving a health issue, I believe that such electronic messaging can put off a potential patient.

The use of a telephone referral information form is a useful adjunct and should always be left on the desk near the telephone. An example of a referral sheet to be completed at the time of the first phone call is shown in Figure 10.3.

Currently, many practices have encompassed the concept of fully digitized systems which include digital appointment diaries and patient data records. However, for these systems to work efficiently and to avoid blocking the telephone lines for extended period of time, the individual taking the call must be well trained and well versed in taking down the relevant information. It does not inspire confidence when the individual answering the phone, clearly, does not know how to handle the computer, how to enter the patient data, and how to create the next appointment.

The notes made at the time of the initial phone call give important signals. A patient phoning to ask the question: 'How much will it cost to have my teeth straightened?' is unlikely to come from a suitable population segment. A more enlightened question may be: 'How much does a course of orthodontic treatment cost?' A polite method of dealing with this is to explain that:

- There are many types of treatments each requiring a different series of braces.
- A full assessment to be carried out by the orthodontist is always necessary to ascertain what a patient's individual needs are.
- Only when the orthodontist has had the opportunity of assessing the patient's needs could the type of treatment, type of braces, and the cost be outlined.

**Pearl:** To avoid misunderstandings, a patient should know before they attend for the first consultation what the maximum cost of the first and second consultation, records, and reports are likely to be. This carries the message that a full diagnosis is needed before a treatment plan can be formulated.

Date of referral .....
Name of patient ..... Date of birth .....
Address .....
.....

Phone: Home ..... Business ..... Mobile ..... Fax .....

Self-referred: Y ..... N .....

Name of dentist .....

Has the patient been:
Given a quote of fees?
• Y ..... N .....
Informed that payment is by cash or cheque?
• Y ..... N .....

Further notes of conversations

**Figure 10.3**

An example of a telephone referral form.

#### 10.1.2.2 Making the First Appointment

If the patient confirms they wish to make an appointment, a letter is sent the same day confirming the appointment. It also assures the patient that they will receive a courtesy telephone reminder of the appointment about 48 hours before the appointment. A practice brochure is enclosed that includes a map showing location and parking facilities and outlining what will happen at the first consultation. Many practice management programmes have the facility to automatically send text messages as reminders to mobile/cell phones at a preselected time prior to the patient's appointment.

**Pearl:** These procedures are designed to elevate the practice above others, which rarely offer such a personalized service.

Such nonaffable remarks by a receptionist as: 'Make sure you are not late' or 'Don't forget your chequebook' should never be made. Patients have, on more than one occasion, reported such remarks as reasons for severing their contact with dental/medical practices.

#### 10.1.2.3 The Patient's First Visit to the Practice

From a patient's point of view, the first visit to an orthodontic practice may be likened to a customer unaware of the product they are being asked to purchase. Patients may have been shopping around various practices or browsing the Internet and be confused about the different types of treatments advertised, such as 'invisible' braces. The task of the orthodontic team should be to convince a patient that their practice is unique and to this end, the staff should be trained to advise and to delicately inform patients that:

- The practice is conversant with different techniques but not tied to a particular system of treatment.
- That there are braces, which may or may not have to be worn all the time or be conspicuous. The appliance design depends upon the orthodontist's analysis of the patient's problem.
- The provision of braces is only part of the service the practice is offering.

To reinforce and encourage the efforts of the staff, the physical environment of the reception area needs attention with regard to

- Magazines should be few, up to date, and of high quality. An abundance of reading material sends messages of long periods of waiting.
- If walls have to be adorned it should not be with posters.
- A drinking water dispenser emphasizes health/comfort concern.
- Most new patients attend early. Keeping them waiting gives a wrong first impression and on future occasions they may consider it reasonable to attend late. The greatest cause of discontent amongst clients whether on a telephone or in a queue, is to be kept waiting and not be told why. It has been suggested that the term 'waiting room' should be replaced with the term 'practice lounge'.
- The author does not recommend asking a new patient to fill in forms before seeing the orthodontist as he considers that a patient makes an appointment for a private consultation in order to have individual attention. Form filling is common in public institutions as a means of categorizing patients to save time.

**Pearl:** If a new patient is impressed with a high quality of care received at the first visit they are more likely to see the long-term benefit of choosing a practice which explains and is focused to their individual overall needs.

### *10.1.3 The First Consultation*

The patient and any accompanying person are invited into a private area, preferably a separate consulting office, where they may be seated in a relaxed atmosphere. Ideally, the consultation area should be out of sight of the treatment area at the time of a consultation. Whether the patient is seated in an office chair or a dental chair, try to avoid having the patient seated at a lower level than yourself, and do not peer down over a

mask and half-moon glasses – this can feel threatening for the patient.

A recommended way of starting the discussion is to ask the patient if there were any difficulties in finding the practice and if so in offering to help for the future. Encourage the patient to talk about him or herself by asking why have they come, what is their problem, and is there any relevant medical history?

**Pearl:** Patient's response to these questions can be surprising. The perception of the patient and perception of the clinician as to what is a problem may differ widely and it is always better to hear what the patient has to say before jumping to any conclusions as to why they are coming to the practice.

The patient should be assured that you are only going to examine them and make some notes, and that no other procedures will take place. This sets a precedent in the patient's mind that they will be told what is going to happen to them and that consent will always be sought before anything is done.

#### 10.1.3.1 The First Examination

Following the initial introduction and discussion, the patient is then asked to sit in the dental chair either in the consulting office or in the treatment area. The dentist can sit at the 12 o'clock position to the patient and drop the chair back. An extraoral palpation of the submaxillary glands, investigation of temporomandibular joints, and an intraoral examination of the configuration of the dental arches both in and out of occlusion is all that is usually needed for the experienced clinical eye to form an opinion as to which direction a more detailed examination should take. The patient can at this point be given a hand mirror, and any accompanying person invited to come to the side of the dental chair; avoiding the use of dental jargon, the presenting problems and types of records needed to investigate those problems are simply described. A rapid assessment is carried out and a clear yet brief explanation of what has been assessed will be an assurance to the patient that the orthodontist is an experienced professional. If the patient appears unhappy at this point and sometimes they may say that they are worried because what has just been said seems to indicate that there are complicated problems, they can be reassured by informing them that: 'there is nothing unusual to be worried about and that there is nothing that can't be solved'. All that has been done so far is to focus on the reasons they have given for attending the practice. Emphasis on the individuality of occlusal patterns can be made by describing how everybody has a different dental history, that all faces are different (a fact that is universally accepted), and that this variation is in keeping with the arrangement of an individual's teeth.

Following this pattern of examination and presentation, it becomes apparent and logical for the patient to understand and accept that what is now needed is a full set of records and an opportunity to study them. Explain that once you have the records, you will then carefully plan the proposed treatment and present it to them at a second consultation.

**Pearl:** Do not, at the first visit, outline in any form whatsoever, a definitive treatment plan. Do not suggest what will have to be extracted, worn, or how much it will cost because whatever is said may be misunderstood and subsequently regretted. Be aware that an average patient only retains 10% of what a medical practitioner tells them. The message should be simply: 'There are different ways of treating each patient's problems.'

At the conclusion of the first consultation seek acceptance to proceed with a comprehensive investigation. The patient is asked if they wish to take the matter further and have a full set of records taken so that their individual needs can be assessed and an ideal treatment plan formulated. The type of records including the number and type of radiographs, photographs, and study models required should be described.

#### 10.1.3.2 Comment

The evaluation of a new patient should be completed in two visits, each lasting no longer than 30 minutes. These are referred to as the *first* and *second consultations*. The reason for managing the new patient in two visits is that the first impression formed by both the patient and the clinician is a two-way process. The orthodontist needs time between the first and second consultation to assess the needs of the patient and the patient needs the time and opportunity to assess and reflect on the orthodontist. To arrive at a diagnosis and work out a detailed treatment plan requires evaluation of the study models, radiographs, cephalometric tracings, photographs, and written records. The findings are presented to the patient at the *second consultation*.

**Pearl:** In a state-funded system, it is rare that adequate time is spent with a patient during the first and second consultation. Using a first and second consultation strategy will contrast with a patient's previous experiences leaving a lasting impression of the benefits of this difference.

The second consultation is necessary for explaining to the patient their specific treatment requirements, costs, and any other items pertinent to their treatment.
A fee for the two consultations can never reflect the true cost of both of them. This service includes the time spent with the patient, the preparation of study models, photographs, tracings, and preparation of reports, etc. and is part of the invisible intangibles referred to earlier in the chapter.

**Pearl:** It is suggested that the orthodontist's fee for the two consultations should be quoted at 50% of the fee that it normally charged per hour for active treatment.

If the first and second consultations are conducted as recommended, the patient will conclude that what has been charged is exceptional value and will be more ready to accept the fee quoted for the active treatment. In other words, the first and second consultation should be regarded in commercial terms as 'loss leaders'.

**Pearl:** It is wise to have the patient pay at least 50% of the total cost of the consultations before leaving the practice for the first time. Reluctance to pay is a bad omen for payment of future accounts.

### *10.1.4 Carrying Out a Comprehensive Investigation*

While orthodontic records are generally standard, there are individual variations among orthodontists. In this section I will only discuss the items that may differ from those described in Chapters 4, 5 and 6.

All noninvasive procedures are carried out first; taking impressions is uncomfortable for some patients so this procedure is carried out last.

#### 10.1.4.1 Radiographs (See Chapters 4 and 5)

While some clinicians take the lateral skull radiograph with the teeth in occlusion and the lips at rest, I believe that this radiograph should be taken with teeth in centric occlusion and the lips sealed, no matter how difficult this may be for the patient. Ideally, this radiograph should be checked before the patient is dismissed, as centric occlusion can often be difficult to achieve when the patient strains to achieve a lip seal.

#### 10.1.4.2 Photographs (See Chapter 6)

As with lateral skull radiographs, some clinicians prefer extraoral photographs to be taken with the lips at the habitual rest position, I prefer the extraoral profile and full-face photographs to be taken in centric relationship with the lips sealed. This can often be difficult for the patient to achieve; however, it allows for muscle strain to be evaluated. It is important that the quality of the photographs should be as high as possible. Excellent images are always appreciated. Poor images create doubts in the mind of a

new patient about the excellence of practice equipment. Currently, digital cameras have virtually replaced the old conventional film cameras. The images produced can be viewed immediately on a monitor or if preferred hard copy prints can be produced (see Chapter 6).

#### 10.1.4.3 Study Models (See Chapter 4)

Two sets of study models are ordered from the laboratory. One set will be given to the patient at the second consultation in a special box.

#### 10.1.4.4 Clinical Examination (See Chapter 4)

A systematic examination is carried out in the form of a logical sequence of facts recorded on a Dictaphone at the chairside. The examination starts with medical history and ends with a description of dental abnormalities. By speaking aloud into the Dictaphone at the chairside the patient is made aware that a structured and holistic view of his or her needs is being considered.

### *10.1.5 Provisional Recommendations*

Following the clinical examination, provisional recommendations are dictated and typed on a separate sheet. This records the orthodontist's impressions of the patient as well as the possible treatment options. This forms a useful memory aid when preparing the second consultation. An example of my examination and treatment report template is presented in Appendix D. I am aware that currently most practice management software programs incorporate many standard forms and letters.

Once the comprehensive investigations have been completed, the patient is encouraged to book an appointment for the second consultation. They should be told that the case discussion will last about 25 minutes and will be used for a chat covering a full description of the problems as well as details and a logical explanation of why a particular type of treatment has been chosen to fulfil their personal needs. It should be emphasized that it is *not* to start treatment. Tell the patient that after the second consultation they will receive a set of plaster models of their own teeth and a letter confirming the details of the proposed treatment as well as the fee and payment plan. This will enable them to decide in their own time whether to go ahead or not.

#### 10.1.5.1 The Second Consultation (See Chapter 7)

The structure of the second consultation or case discussion has been developed to reinforce the message of the first consultation and make the patient aware of behind-the-scenes services, the invisible components of the practice sometimes not appreciated by the patient. The consultation should be carried out in quiet surroundings. As in the first consultation every effort should be made to see the patient on time. The records should be laid out on the desk or displayed on well-situated flat screen monitors and the seating arranged so that no physical barrier is placed between the patient, accompanying persons, and the orthodontist.

It is recommended that the orthodontist familiarizes him/herself with details of the case, by researching all records a few hours before the appointment, in the same way as a conscientious barrister would before appearing in court.

**Pearl:** When the patient attends for the second consultation, have a member of the staff seat the patient in the consultation area for a few minutes before the orthodontist arrives. This gives the patient time to familiarize him/herself with the surroundings and to see the records laid out on the desk. This will make the patient aware that a considerable amount of time has been spent with the records and planning treatment.

The orthodontist then asks the patient to sit briefly in the dental chair assuring them that no more records are required but that he would

just like to check the models against the patient's bite. This is a useful tip as it allows the orthodontist, armed with knowledge recorded at the first consultation and knowledge of the static records to clinically check such factors as bites of accommodation and asymmetry. The patient is then asked to take back their seat in front of the orthodontist or at the desk side.

The personality of each individual orthodontist will dictate the manner, language, and nuances of a case discussion; I have found the following sequence to be effective.

*Orthodontist*: 'I will divide this consultation into three parts and with these records, I'll be able to show you: First, what exists in terms of teeth, etc.; second, what your problems are; third, what should be done about these problems and approximately how long the treatment will take.'

Starting with the orthopantomograph or dental panoramic tomogram on which the teeth have been previously numbered in accordance with Palmer's Notation, demonstrate that this is a flat representation of the left/right curve of the face. A pencil should be used as a pointer to attract the patient's eye to the salient features, such as missing teeth, overcrowding, etc.

With a pencil, mark on the study cast the upper and lower centre lines and the teeth according to Palmer's Notation. Patients usually comprehend Palmer's Notation very well. Because patients are given one set of marked study models to take home it is possible to refer to the numbered teeth in the letter that will be sent to them confirming the recommendations (see Appendix D).

With the aid of the models and radiographs explain the problems of overcrowding and overjet/overbite.

Refer to the cephalograph as a silhouette of the profile and describe it in conjunction with the extraoral photograph of the patient's profile and the lateral view of the models. These records, together with the *en face* extraoral photograph, can be used to explain asymmetry and any disharmony between the lengths of the upper to lower jaws: in other words, a description of the architecture of the face. This fascinates most patients. As currently all medical data are assumed to be measurable, show the patient the cephalometric tracing and analysis. If facilities are available, produce a second tracing in the form of a visual treatment objective which can show dental changes as well as changes in soft tissue profile which will occur as a result of orthodontic treatment. There are also computer programs that provide a facility to view predictions of what the dentition and face will look like at the end of treatment. However, take care to inform the patient that such predictions are not always 100% accurate.

#### 10.1.5.2 Outline of Treatment

I always try to divide the treatment plan into phases and present these both at the consultation and in the contents of subsequent correspondence.

*Phase I:* Any extractions and the wearing of nonvisible appliances, such as removable appliances, palatal arches, and/or buccal sectional appliances.
*Phase II:* The wearing of fixed appliances to align and correct the relationship of the upper and lower teeth.
*Phase III:* The retention phase, using either fixed or removable retainers.

**Pearl:** Bearing in mind that orthodontics is, to the patient, an intangible product; it is useful to have a practice album showing before and after results of treatment carried out in the practice. This helps to make what has just been described to a patient more tangible.

### *10.1.6 Correspondence*

The final step in the management of a new adult patient is the follow-up letter. The patient should be assured that this will be received within one week and will confirm the treatment plan, the type of appliances to be worn and when, how much the treatment will cost and how long it is estimated to take.

The purpose of this follow-up letter is that it solves the problem of the patient only being able to recall 10% of what they were told at the

consultation. It is always advisable to overestimate the duration of treatment, when treatment takes less time it is cheaper for the patient and consequently the fee for visits during Phase III (retention) will be more readily accepted. Furthermore, if you are using an open-ended payment plan, a patient who does not cooperate or fails appointments can gently, without offence, be advised that treatment is falling behind schedule and consequently becoming more expensive. In other words, the total cost of treatment can be reduced by the patient's compliance with instructions.

The final paragraph asking the patient: 'to make another appointment if they find the arrangements acceptable', avoids going through the bureaucratic process of drawing up and getting the two parties to sign a contract. If the patient phones to make another appointment, I believe they have agreed to the clinical and financial obligations laid out in the letter. I am aware that in today's litigious society, it is mandatory to obtain written consent from all patients/parents/guardians. Clinicians are advised to check on the rules as they apply to their country and their governing bodies.

A letter is also sent to the referring dentist together with the clinical report completed after the second consultation (see Appendix D).

Copies of all correspondence are always kept in the patient's file and can be referred to during treatment.

## 10.2 DIGITAL MARKETING AN ORTHODONTIC PRACTICE

Asif Hassan Chatoo

The dynamics of marketing have changed dramatically over the last decade thanks to both the Internet and the technology we use to access it.

**Pearl:** The reality is that if your business does not have an online presence, it might as well not exist.

This chapter discusses your choices and the tools you have at your disposal to market your practice to optimum effect.

Historically, most practices depended on their referring dentists to supply them with patients. In the last decade, there has been a huge growth in the number of adults willing to consider orthodontics and, at the same time, the development of marketing strategies to attract these patients. Most patients will use the Internet either to find an orthodontist or to check the practice recommended to them and they will carry out a simple search using one of a number of internet search engines, usually Google.

Marketing is a novel activity for many of us. Our name and brass plate used to be our brand and this was considered sufficient and professional. Now it is essential to market your practice, so orthodontists may face two major challenges: learning to adapt to the world of marketing as well as the digital age.

### *10.2.1 The Website*

All orthodontic practices would be well advised to have a website that provides practical information about the services offered and gives clear directions so patients can find them. With increasing competition it is essential that the practice website is also easily found online. Identifying an effective domain name which precisely describes either what you do, where you are, or who you are is imperative. The starting point, however, should be your brand and how you want to represent yourself or your practice. Your web designers will expect you to have a logo as well as brand values and for these to be consistent across all online platforms.

**Pearl:** Choose an effective domain name which conveys what you do or where you are, or both.

Two other important aspects of a website are design and optimization.

#### 10.2.1.1 Website Design

By design, I do not just mean appearance. Your website needs to be structured so that search

engines and your visitors find it easy to navigate. A website which looks wonderful is all very well, but how easy is it for patients to get the information they need? Search engines are perfect for marketing because they provide targeted traffic to your site, in other words people looking for what you offer. The objective of the site should be to educate your potential patients so they can make an informed decision and are inspired to make contact.

The following considerations may be important (Figure 10.4):

1. *Establish your unique selling point.* What is it that sets you apart from other orthodontists and other practices? How will you be able to look after the patient so that they feel special? Have you had any experience in treating a patient with a similar concern? To facilitate this it may be useful to have videos of patients sharing their experiences.
2. *Contact information for the practice.* The contact information for the practice should be found on each page of the website. Most Internet users want to find their information quickly. If they are required to spend time searching out a specific page with the contact details, such as the telephone number, they are likely to navigate away from your website.


**Figure 10.4**

Basic elements of website design.

3. *Optimum functionality.* Check your website's functionality regularly and if you have links, either internal or external, make sure they work.
4. *Responsive web design.* An increasing amount of internet browsing is being carried out on mobile phones and tablets. A site designed with responsive web design can be easily read by all sorts of mobile devices.
5. *Conform to regulatory body guidelines.* In the UK, our regulatory body, the General Dental Council has published guidelines on the information which should be provided on your website.[3] It is worth checking that you comply with your regulatory body's guidelines.

**Pearl:** A website is an essential part of an orthodontist's marketing strategy, and it needs to be practical, inspiring and up to date.

#### 10.2.1.2 Optimization of the Website

Given increasing competition and the fact that most people only browse the first listings page on any given search engine, what can you do you make your website appear there?

Search engines will favour sites which they consider to be important and relevant. One of the ways this is measured is by the use of key words, the very same terms used by your potential patients when they search for you. By increasing the number of keywords found on the pages of your website, you will increase the influence they have on the search engine and improve your ranking.

While search engine optimization refers to fine tuning of the website to improve its ranking, it is not as simple as writing effective text with specific keywords since Google claim to use over 200 parameters to categorize and rank a website.

The following rules for search engine optimization may help improve the visibility of your practice online (Figure 10.5):

1. *Research your keywords.* The website should include the relevant key words that will help identify the practice.
2. *Update content frequently.* It is advisable to update content or add new content to the website on at least a monthly basis. When

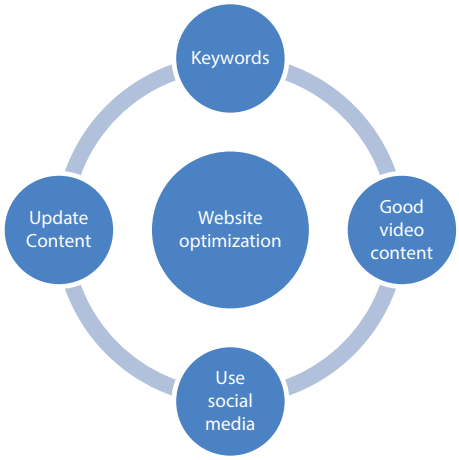


**Figure 10.5**

Factors involved in website optimization.

the search engine crawlers search your website, the presence of new data is perceived favourably and improves the overall ranking of the site.

3. *Feature good video content.* Videos that help engage patients are useful for improving the ranking of websites on search engines. An effective video is likely to capture prospective patients' attention and keep them on your website for longer.
4. *The use of social media to link to your website.* Your website content should be shared and talked about in order to demonstrate its relevance and popularity. Social media is a great tool for promoting engagement and is discussed later.

#### 10.2.1.3 Increasing Visibility of Your Website

With a growing number of businesses using specialists to construct or advise on their websites, improving your visibility on the search engine may seem challenging, but you can stay competitive. For instance, getting listed on Google maps will help. Then there is Google+, a free online platform. It has two main purposes: to help business owners increase their online visibility and to help people find, engage with, and review businesses in their local area.

As the number of reviews for a business increases the position on the search engine automatically improves.

#### 10.2.1.4 Reviewing the Website Performance

It is imperative to assess whether your investment in the website is paying dividends and what can be done to enhance its benefits to you. Website programs, such as Google Analytics, enable an effective analysis of any website. It can help identify the key word searches and the number or visitors to your website.

**Pearl:** Get your practice featured in online listings which link to your website.

However, in order to achieve a website which is continually updated and optimized, you may feel you need a good team managing your website and optimization. It is not easy to pay attention to the intricacies of an ever-changing and rapidly developing system following a busy day at the practice. It is worth making sure that the teams you employ work well together and communicate and co-ordinate.

### *10.2.2 Social Media*

Social media may be defined as forms of electronic communication (as websites for social networking and microblogging) through which users create online communities to share information, ideas, personal messages, and other content.[4]

The main reason for the greater importance of social media in marketing our practices is that it allows an effective and efficient way of forming a direct relationship with a more diverse group of potential patients.

Care must be taken not to post information about patients on social media. In the UK we have regulatory guidance on the use of social media by dentists and their teams.

#### 10.2.2.1 The Building Blocks of Social Media

A number of social networks sites are available for patient contact and these include Facebook, Twitter, LinkedIn, YouTube, Pinterest and Google+. It's worth taking time to decide which platforms you should concentrate on when first starting social media in your practice.

The honeycomb framework helps explain seven social media building blocks. Each block represents a facet of the social media experience and how it may help actively engage with your current and prospective patients.[5]

Elements of the Honeycomb framework:

- Identity: The identity block represents the amount of information that the user will reveal about their identity in a social media setting.
- Conversations: This block of the framework represents how users communicate with each other using social media.
- Sharing: The amount of information and content users may receive exchange or distribute.
- Presence: The ability to inform other users that you are online and accessible.
- Relationships: Allowing conversation between individuals as they have some form of association.
- Reputation: The extent to which users can identify the standing of users in a social media setting.
- Groups: The extent to which users can form communities and sub-communities. As the group becomes bigger with more followers and contacts, it is deemed more 'social'.

The framework may also define how each social media platform focuses on one or more of the seven functional building blocks. This helps further appreciate the needs for engagement of the social media audience. For example, LinkedIn users are thought to care mostly about identity, reputation, and relationships, whereas YouTube's primary features are sharing, conversations, groups, and reputation. On the other hand Facebook is about relationships, conversation, reputation, identity, and presence. Hillstead and Park pointed out that by 2012 more than half of all Americans age 12 and over had created profiles on one or more social-networking sites. It is not unreasonable to assume that this figure is replicated in many other countries. They concluded that by creating positive connections on your Facebook page and keeping the content relevant, you will greatly add and improve the success of your marketing strategy.[6]

As there are an ever-increasing number of social media sites, it is difficult to predict whether they will capture the imagination of the users and survive in the long term. An important consideration when adopting a new platform is whether your patients are adapting equally to the site. For this reason, though it is important to explore and embrace new and emerging channels for patient communication, it is equally important to evaluate and monitor their impact on your social media strategy.

**Pearl:** Develop a social media strategy.

#### 10.2.2.2 Key Principles of Social Media in the Orthodontic Practice (Figure 10.6)

1. Get connected: Social media is about getting involved in communities, engaging with other people, generating conversations and building relationships.
2. Conversation: For successful interaction it is important to create dialogue that is authentic and honest.
3. Listening and responding: Social media provides a useful tool for telling patients about you and your practice. However, it is also valuable to hear what people are saying about your clinic, for instance, some people may be more willing to provide a testimonial on Facebook than in the practice.
4. Keep it current: It is important to try to be current about the information and news

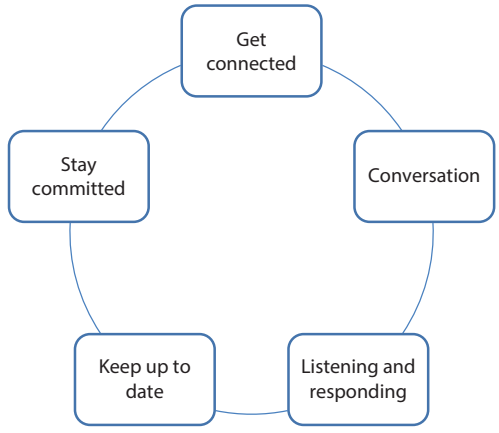


**Figure 10.6**

Key principles of social media.

that you are generating. It must be interesting, useful, and allow further positive engagement.
5. Social media is only worth doing if you can commit to it. The other key reason for taking your marketing online is to engage – whether with patients or other businesses in your area. You will lose your audience if they sense you are not really committed.

#### 10.2.2.3 How Social Media Can Benefit the Orthodontic Practice

##### *10.2.2.3.1 Credibility*

Increasing numbers of studies are being carried out to assess the impact of social media.[7] Some recent statistics are indicative of its importance and may be extrapolated to understand the potential pros and cons for orthodontic practices.

In North America, 89% of all internet users do an online search before making a purchase. Potential patients may associate a good website and significant online presence with credibility of a practice.

##### *10.2.2.3.2 Forming a Network*

Current social network sites such as Facebook, Twitter, LinkedIn, YouTube and Pinterest all provide a convenient method for patient contact. As described previously they all have a slightly different emphasis and benefits. It may be useful to engage on more than one platform so that the target audience is increased.

##### *10.2.2.3.3 Blogs*

A clinic blog provides a simple and effective way to share information about the practice through articles, photos, and videos. It may also be used as a useful tool to educate patients on new developments within dentistry, dental health, and orthodontics, helping to differentiate you from your competitors.

##### *10.2.2.3.4 Generating Referrals*

Another interesting aspect of communication is that between, patients. Recommendations from existing clients online will reach a far wider audience and add a layer of credibility to your practice.

#### 10.2.2.4 E-mail Marketing

Accumulating the e-mail addresses of your existing patients can provide the basis of a successful marketing campaign. It is an effective and economic method of staying in touch with your existing patients. It may be used to send reminders, promotional offers, and even birthday wishes. Collecting the e-mails of patients who make enquiries can increase the spread of your message to a captive audience who are interested in the services that you offer.

The benefit of e-mail marketing is that it saves on postage, printing costs, and enables communication instantly.

We know from a survey by Ipsos MORI that one fifth of people in the UK believe they would benefit from orthodontic treatment.[8]

**Pearl:** Monitor the efficacy of all your online communications regularly.

That group of prospective patients need to be able to access us both as a profession and as individual orthodontists, online.

The Internet is still evolving and its influence in every facet of our lives is growing. In the highly competitive dental market your online presence and profile is crucial. Developing a successful practice requires time being devoted to building up your brand and reputation, both in real life and on the Internet.

Most of us do not have time for such a commitment and my concluding pearl is to:

**Pearl:** Employ specialists for web design, web optimization, and on line communication to ensure you have the digital presence you deserve.

## 10.3 MY PHILOSOPHY OF ORTHODONTIC PRACTICE

Renton Tindall

My efforts to develop a busy orthodontic practice have always been centred on marketing and education, and I have also endeavoured to

provide a service and treatment that are perceived by patients as value for money.

### 10.3.1 Marketing and Education

For me, this involves selling myself to every patient with whom I come into contact with a very positive, friendly, and accommodating approach. My objective is to make every patient my friend and to develop a relationship that is expected from a good friendship (i.e. respect, honesty and reliability).

**Pearl:** I always shake hands with every patient and meet and greet each one by name.

Children must be made to feel that they are the most important individuals, not the parents; after all they are the ones who need to cooperate with the treatment.

Successful orthodontic treatment is a team effort involving the orthodontist, staff and the patient. Forming a friendship goes a long way towards establishing the cooperation required. It is therefore absolutely imperative for each member of staff to be an extension of the orthodontist in this approach. Everyone must have exactly the same attitude and form a happy, enthusiastic, informed orthodontic team. Communication at all levels is therefore absolutely essential and I have regular staff meetings to reaffirm policies and approaches.

It is essential to establish a very high level of communication among the orthodontic team, the patients and the referring dentists.

**Pearl:** I never stop explaining, while I am working, and make sure the patient fully understands what is going on especially with the use of a mirror. 'I inform before I perform'.

This is part of the education process. I encourage parents, brothers, sisters, friends, etc. to accompany the patient into the surgery in order for them to be exposed to the process of being educated in orthodontics. They are all potential patients.

I never carry out in a single visit a records/treatment plan and discussion. I prefer to arrange a subsequent half hour to formally present the treatment plan, which gives me another opportunity to impress the patients with my orthodontic knowledge. Again, I encourage patients to bring wives, partners, brothers and sisters along who will also have the opportunity to become more educated in orthodontics.

A good marketing/education ploy is a large notice board that has examples of before and after treatment photos as well as another area with only the smiling photo of the most recently de-banded patients of the past six weeks placed and constantly updated. I find that new patients who may notice someone they know will be more inclined to accept treatment.

While I realize that the display of photographs of current or previous patients is a useful marketing tool, I am aware that in certain countries the patient's right to confidentiality ('Data Protection') has become an important feature of clinical practice. All clinicians are advised to check the legal implication of this issue with their local governing Orthodontic Society.

### 10.3.2 System of Correspondence

All referring dentists are supplied with preprinted referral pads in order to facilitate a referral. They are also supplied with a promotional brochure, which explains the general philosophy of the practice, the fee structure, a map, and a brief CV with a photograph. On receipt of the referral, a letter is immediately dispatched addressed to the patient (whatever age) inviting them to attend a free-of-charge consultation appointment. At the consultation appointment, a personalized fees letter is provided outlining the various costs, payment plans, and includes photographs of the different types of fixed appliances. If the patient decides to proceed with the records, then a fee is levied, which includes the subsequent treatment plan discussion appointment. If the patient then accepts treatment, the records fee is deducted from the treatment fee.

A brief letter of thanks is sent to the referring dentist with the promise of a full report once a full investigation with records has been carried out. This report is designed to be concise and in point form, and will include copies of digital photographs and radiographs when extractions are required. The patient receives a similar report in layman terms and the appropriate fee is clearly laid out. I do not include any negative comments in the letter, such as fees for failed appointments, breakages, or interest on late payments. I do not believe in charging for any of these but prefer to counsel the patients positively about paying, keeping appointments, and breakages without the threat of a fine. However, before embarking on treatment, patients are asked to sign a 'consent to treatment' form, which does point out a few problems and risks that could arise during orthodontic treatment.

Any cooperation problems that arise during treatment, such as poor oral hygiene, breakages, and poor elastic/headgear wear, is discussed, and the patient re-motivated. I always follow up such a conversation with a personal letter to the patient reaffirming the concerns we have.

I used to supply every patient with a treatment manual, which had information regarding all aspects of orthodontic treatment. I now prefer to supply single page information sheets, which specifically apply to the procedure that has just been carried out. These are all computer-generated and easily reprinted on demand. I find this to be far more effective and also cheaper than having manuals written and printed, which are often mislaid by the patient and then need to be resupplied.

I rarely communicate with the referring dentist during treatment unless I have concerns about oral hygiene control or need further extractions. At the completion of active treatment I send a letter advising the dentist that active treatment has been completed, retention commenced, and that I would like them to see their patient for teeth cleaning and fluoride treatment.

Patients will receive a leaflet about the retention programme. I monitor retention for one year and then provide another information leaflet at the end advising them how to continue with retention themselves.

### *10.3.3 Treatment Philosophy*

I try to remain focused throughout the treatment on the patient's primary concerns, especially with adults. I also try not to enforce my concerns regarding both functional and aesthetic issues without being absolutely certain that the patient is happy and fully understands my advice.

I do not believe that it is imperative that every malocclusion needs to be treated to result in a Class I occlusion. I will give every patient the opportunity to achieve the ideal result. However, in my experience not every patient is capable of achieving that result and often I have to accept a Class II occlusion. I am very conscious of facial-lip support and will accept an overjet rather than over-retract upper anterior teeth. The option of surgery is then always available and the philosophy of permanent part-time retention will maintain the final result.

I generally see patients for adjustments at six to eight week intervals; this varies with each individual patient and their level of care.

I offer a range of fixed and removable appliances; I do try and accommodate all the patients' needs but more actively try and encourage all patients to have the self-ligating metal fixed appliance system.

I almost exclusively use the upper Hawley retainer and either a lower fixed canine to canine or spring retainer. This, I feel, gives me more control during retention and allows more vertical settling-in of the occlusion.

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# 11 PSYCHOLOGY FOR PATIENT COMPLIANCE

Kees Booij, Victor Lalieu, Effie Patrikios and Colin Wallis

CONTENTS



From experience in the medical field, we know that a relatively high percentage of patients do not follow instructions, whether it be the taking of medicines or the carrying out of certain exercises. The same phenomenon applies to the compliance of orthodontic patients. This is in contrast to what one would expect from youngsters and even adults who actively seek our advice and treatment. Cooperation with complete discipline, on which our work is absolutely dependent, is not something automatic. We should actively introduce our patients to their task and to our expectations.

**Pearl:** We need to explain the Why and How at the case discussion before we start, and to make patients aware of the close partnership that must exist throughout the period of treatment and retention.

At this stage, it is necessary to stress that compliance from the patient also depends to a large degree on us; it is incumbent on us, to build up, to control, to cultivate, and to maintain this cooperation for an extended period of time. Unfortunately, we know from experience that we need to remain vigilant and at times suspicious because even our best patients can deceive us. Do not trust or assume that they will do what you ask of them. Despite all our years in practice, certain patients may still delude us.

There is a striking difference between orthodontics and other fields of dentistry. In general dentistry, after an extraction or the placing of a restoration, the work is generally completed.

**Pearl:** In orthodontics, fitting the appliance is only the start of the process; orthodontics is a continuing story and the mutual long-term interrelationship should be realized and maintained to optimize the chances of attaining our treatment goals.

To nurture this interrelationship, we should be very careful not to accuse patients falsely of failing to comply with our instructions. False accusation has a long and negative memory.

## 11.1 EVALUATING BODY LANGUAGE AND PATIENT ATTITUDES

Kees Booij

It makes sense to find out what the new patient knows about orthodontics. They have often been

exposed to either siblings or friends who have had or are currently receiving orthodontic treatment. Try to establish if they already have some negative preconceived opinions. It is advantageous to be aware of such opinions at an early stage so that the subject can be more tactfully handled. Patients often have negative opinions on the wearing of headgears, elastics, and the use of functional appliances. It really is our business to detect and to foresee possible difficulties and to act accordingly. Judge the burden that each patient will be able to carry and make sure your treatment plan and the consequences of noncompliance are well understood.

**Pearl:** Understanding and evaluating body language is very useful. A patient exhibiting an absence of interest, unease, impatience, nervousness, playing with the taps, and buttons of the chair while you are talking, are all silent warnings; make a note on the card.

If you have some doubt about the patient's ability to comply, it may be expedient to adopt a flexible approach and avoid irreversible options, such as extractions, until you are sure of attaining adequate compliance. In some cases it is not always possible to start off with the ideal treatment plan; under certain circumstances, it may be necessary to water down our goals. As treatment progresses and cooperation improves, it may be possible to readjust to a more ideal treatment plan. To quote Milton Sims: 'stay out of trouble', an important general rule to be remembered.

Further opportunities for evaluating patient attitudes present themselves early on. Taking the initial impressions yourself provides you with a considerable amount of information about the patient's attitude towards you and your treatment. Is there a willingness to undergo some inconvenience; is there hesitation, obstruction, reluctance or aversion? Remember that we need their active participation in a pleasant, unrestrained atmosphere for a long time. Irritation between patient and orthodontist can work both ways, try to be tolerant. Exhibiting a vomiting reflex when having an impression taken is normal, but assess how the patient behaves, is there panic or self-control, what is the body language? Talking to the patient at the first consultation and at the case discussion, gives you a chance to let them talk. Is he or she answering the questions or is the mother answering for the patient? Listen to the speech and evaluate any tongue habits. Look at the hands, even in the absence of open-bite tendencies there may be a thumb or finger habit. Compare the hands, even the slightest spot on the skin, not only on the thumbs but also on the fingers, can reveal a whole story. Persistent habits lower the threshold for cooperation.

**Pearl:** If you notice such habits without having asked for any specific information, both the patient and the parent will understand and acknowledge that they are dealing with an individual who is an authority and who knows his or her subject.

Do not be deceived by both the mother and child downplaying the habit or remarking: 'he hardly does it anymore'. Marks on the fingers or thumbs are evidence.

Perhaps I have overstressed the negative aspects of poor cooperation, but I believe it is important for the clinician to build up experience in this field. Once you have seen what a really cooperative patient can attain in a reasonably short period of time, particularly with regard to headgear and functional appliance therapy, you will be better placed to judge and evaluate those whose compliance is suspect.

Do not fall into the trap of praising a patient before carefully evaluating their progress. Often they know what you want to see – 'Sunday-bites' are notorious. If you praise before checking the bite carefully, they may feel justified in continuing with their poor level of elastic or headgear wear.

It is essential that before criticizing a patient, you need to be sure that the fault for poor progress is not iatrogenic and does not reside in the appliance.

## 11.2 CLINICAL CLUES TO PATIENT COMPLIANCE

Victor Lalieu

Remove the archwire yourself; if an assistant removes the archwire before you see the

patient, you may lose some information. Active archwires should be passive when removed. If not, then the timespan between the visits may have been too short. Some patients react faster than others – wait longer, do not intensify the activity, and give the appliance a chance to work; with sliding arches check for any binding. It is interesting to notice, following a long holiday, how much progress has taken place; the teeth have had a chance of moving without interference. For me this is a lesson to keep my hands off.

**Pearl:** Changing the forces while the archwire is still active slows down the rate of movement, the periodontium has to readjust to the new force values and that takes time.

To help in evaluating the possible causes of slow progress, it may be advisable to make a new set of study models that allows you to examine the occlusion from the lingual; look for occlusal interferences that may be hindering tooth movement. As stressed earlier, only after having checked everything, are you entitled to accuse the other party in the partnership. Keep the discussion pleasant; explain to the patient that he or she is misleading him/herself, and that is not very smart. Try to reach a mutual solution for improvement in co-operation. A personal letter addressed to the patient can be of great help in such a case (see Appendix E). The letter should be designed to avoid the risk of a false accusation of noncompliance. If you believe a patient is not cooperating, use a tactful approach even if you are sure of yourself. Making a mistake by accusing a patient unjustly may ruin a potentially good relationship forever. My advice: the letter should not convey an attitude of authoritarianism. This concept has served me well over many years.

In certain cases, some patients are too clumsy to fit rubber bands; make it a habit to let them place the elastics themselves in the surgery, the ease or difficulty with which they carry out the procedure, gives you a hint of the level of cooperation. If, despite your efforts, nothing happens after ample time, then there must be a problem. Show your sympathy; good cooperation does not last forever and remember that puberty has its problems.

**Pearl:** Remember that at times we may be asking too much from certain patients. Lack of cooperation may in certain cases be related to problems at school, or at home, a family illness, a sore throat, or a blocked nose.

One of the traps that a young clinician may fall into is to believe that he or she is better than his or her older colleagues, and to expect that he or she will have more success where others failed. Beware of patients who come to your newly opened office with a history of previous treatment, where another orthodontist may have done his or her best. Do not believe everything the patient says, try to get the other side of the story and there is usually a good reason why the original orthodontist either stopped treatment prematurely or dismissed the patient.

Set aside your pride; we all hope to have a reasonable amount of psychological acumen and experience but always ask yourself: Am I good enough to master the difficulties that certain patients present? We have to work on establishing mutual understanding, but if it starts to fade it is very difficult to regain.

**Pearl:** Know your customers, make friends, and be honest about the inconvenience you are inflicting on them.

## 11.3 PATIENT COMPLIANCE WITH FIXED APPLIANCES

Effie Patrikios

Certain patients and parents are often under the misapprehension that fixed appliances do not require patient cooperation. Often, the parent will express a desire for fixed appliances as opposed to removable appliances because, to quote some mothers: 'If it is fixed to his teeth, he will not lose or break it, I know that if he can take it out of his mouth, he will lose his plate.' The mother's understanding of her son is clear; unfortunately, her understanding of orthodontics is poor and once under treatment her son's noncompliance becomes evident in his forgetfulness to wear elastics, headgear, and to generally care for his appliances.

In an attempt to cater for such a group of patients, orthodontists have developed a group of noncompliant appliances, such as the Herbst appliance, bonded functional appliances, bonded Hyrax rapid expansion appliances, quad helix expansion appliance, palatal bars, lingual arches, and the fixed pendulum appliance. Despite these types of appliances, in most cases it is still necessary at some stage to fit conventional fixed appliances incorporating bonded brackets and/or bands.

**Pearl:** With patients who always seem to have 'bad luck' and repeatedly loosen their brackets, my policy is to replace fractured brackets with fixed bands.

## 11.4 PARENTAL INFLUENCE

Colin Wallis

Before starting treatment, it is essential that patients and parents should be well informed at a case discussion about the consequences of orthodontic intervention (see Chapter 7). The parents must be informed of the prognosis for treatment, type of appliances, the anticipated duration of treatment as well as the cost of treatment. They should be made aware of the possible need for the extraction of both deciduous and/or permanent teeth prior to or during orthodontic treatment. It is also important to warn them of the need for retention following orthodontic treatment.

Explain to the parents that their task is to support their child but still show a positive attitude towards our work. If they fall short in this aspect of parental care, then we have a problem. If they show too much pity or if the child is a victim of a divorce situation, cooperation may be further compromised. When a mother asks at the banding appointment: 'Does my child have to wear that thing?' then you are off to bad start. It may be wise for you to stop and explain once more to the parent that you need their support and that positive comments will be more helpful.

At the outset, it is important to ask if the husband/father/partner agrees to orthodontic treatment for the child; positive all-round family support is essential. If there is a difference of opinion between parents especially under divorce circumstances, we may once again be faced with a cooperation issue.

In the majority of cases we find good parental involvement and support. However, we do find a few parents who want to know every little detail of what is happening and at the other end of the spectrum we have parents who show no interest at all. This latter group are not aware of the problems we face treating their children and if treatment does not go according to plan, they may remark 'Doesn't the appliance do the job?' This attitude and any accompanying remarks should be noted in the patient's file.

**Pearl:** Irrespective of the parent's attitude, it is incumbent on us to report to the parents any signs of declining cooperation and to note the facts on the patient's file.

It is not often that I find it necessary to write a noncooperation letter (see Appendix E), but I have found the effect of this letter to be quite dramatic. Certainly, the parents wanted to know from the saboteur what the message was – the victim had to confess and in many cases life improved. Another policy is to send the patient home without an appointment pointing out that they should return when they are prepared to do their share. Once again the parents must be informed.

We all develop our own way of handling compliance issues, however, if you are suspicious of poor cooperation before starting treatment, it is advisable to send a letter to the parents expressing your fears and recommending that the patient seeks treatment elsewhere. Remember: 'You can lead a horse to water but you cannot make him drink.'

## 11.5 ADULT PATIENTS AND THEIR MOTIVATION FOR TREATMENT

Adult patients are generally more compliant than children. There are some adult patients who seek extra care: they live by their mirror and they can be very demanding (see

Chapters 10 and 18). Generally, orthodontic treatment of adult patients can be very rewarding.

**Pearl:** It is important to realize that the older patient has gone through a lot of 'soul searching' before crossing your threshold. They expect and should be given our full attention. Take ample time to establish their complaint, their past history, and the reasons for seeking treatment at this stage of their life.

As a consequence of a generalized reduction in dental caries, many older dentitions are well preserved. Certainly, in the eyes of the orthodontist there is always something that could be considered for improvement yet it would be unwise to try to 'normalize' every irregularity. Very often, older patients foster the illusion that simple intervention can meet with their desires. Usually, they focus on one or more teeth and they have the impression that the situation is becoming worse. They have no real idea of how long the condition has existed and are often under the illusion that it has progressed over the last few months. To ease the patient's mind, in cases where you believe treatment is not warranted, it may be an idea to document the current condition with study models and compare the situation in six to twelve months' time. It usually then becomes clear that very little has changed.

Unfortunately, a few patients are overfixated on what we would consider to be a minor problem and it is difficult to convince them otherwise. We then have to explain to them in all honesty that the remedy may be worse than the disease, a simple and clear message, but for some hardly acceptable. The energetic, dashing, modern orthodontist may be inclined to start adventurous treatment. However, always ask yourself if the lifespan of the dentition will be enhanced or reduced by your treatment.

**Pearl:** We should not believe that we are so much better than nature.

Often in the older patient, the problem is centred on one or two displaced teeth. While this may appear as a simple problem, always remember to try and establish the aetiology of the problem. Whether the aetiology is of skeletal, dental, or soft tissue origin, it has probably existed for many years and is currently in a state of functional equilibrium and exhibits the so-called 'wrinkles of the older dentition'.

**Pearl:** Our task as orthodontists is to achieve an alternative, balanced, stable new arrangement.

If the patient has undergone a previous episode of orthodontic treatment, you need to assess very carefully whether a similar approach at this stage will have any better chance of success. In these cases, the chances of root resorption are increased.

It seems such an easy solution to straighten the teeth and to retain them with fixed bonded retainers. However, we still do not know that if after having forced the teeth into an aesthetically acceptable but functionally unstable position, bonded retainers are without ill effects in the long term.

**Pearl:** It is important to explain to the adult patient the limitations that their age imposes on the orthodontic treatment required to solve their particular problem.

## 11.6 ENCOURAGING PATIENT COMPLIANCE

Victor Lalieu

We have an 'Orthodontic Grand Prix' incentive programme for our patients, every good 'deed' gets rewarded with a stamp, once they have raced around the track, the patient is rewarded with a fairly nice prize.

All proceeds from donations received from patients in 'purchasing' oral hygiene products go to supporting a charity. Our Christmas Charity Competition in which I match our patients' contributions, the proceeds of which are also donated to a children's charity.

### *11.6.1 Empathetic Approach to Patient Compliance*

Effie Patrikios

A few minutes spent with the chairside assistant prior to the orthodontist seeing the patient helps to set the mood. An interest in patients' activities and interests and, more importantly, adverse events, provides a background which is helpful. They may at times, of course, be very unwilling participants in the 'wonderful world of braces' but patience and tolerance on the part of the orthodontist and the team will help to achieve a positive outcome. Certain parameters and guidelines need to be set early on. I recall the case of a teenager (from a single parent family) who had run away from home during her orthodontic treatment. During this time she was exposed to difficult circumstances. She returned to her mother and to her orthodontic treatment. This treatment took twice as long but at the end she turned to her orthodontist and said: 'Doctor, we have been to hell and back twice together haven't we? Thank you!'

**Pearl:** Encouragement and motivation to achieve, even though faced with exceptional circumstances, will assist in more ways than simply the orthodontic outcome.

Whether your attitude and professional deliverance of your service gives encouragement to a teenager to select dentistry/orthodontics as their chosen career; whether you share in the dreams of a girl whose aim it is to be the first woman prime minister of Australia; whether you share in the excitement of two brothers who love to participate in rodeos, or whether you share in assisting a young man to set up his own gardening business, you have played an important role.

## 11.7 RELATIONSHIP BETWEEN PATIENT, PARENT AND CLINICIAN

Colin Wallis

Should you allow parents to remain in the treatment room while you are attending to their child? This is a question asked by nearly all clinicians at some stage in their career. Some orthodontists will encourage parents to remain in the room while others will discourage them: there is no hard and fast rule – it is an issue of personal preference that warrants further discussion.

Before a patient reaches adolescence, a parent can offer valuable reassurance and is likely to have a positive effect on compliance. However, the majority of orthodontic patients will have at least some of their treatment during adolescence and the presence of a parent may need to be reassessed.

As a child approaches puberty their relationship with their parents tends to change. Adolescence is an essential period of adjustment between childhood, which is characterized by dependence on authority figures, and adulthood, which demands self-sufficiency and the assertion of individual values.[1] The transition commonly incorporates an emotional separation from the parent and may surface in the orthodontic environment as a tension between the desired values of the patient and those of authority figures. Further tension may arise out of differing views on health benefits. While adults tend to place a high value on health, adolescents generally consider themselves to be resistant to poor health.

**Pearl:** Peer pressure and sexual maturity are additional factors that create a desire to be attractive.

A visible orthodontic appliance is a clear marker of unattractiveness and inevitably challenges this developing self-image.

The unfortunate coincidence of adolescence and orthodontic treatment places an additional burden on the orthodontist. As well as the problems of managing complex appliances and severe malocclusions during a phase of rapid physical change, it is necessary to negotiate this challenging period of psycho-social development. As compliance is a key to success, the negativity that may arise must be channelled and redirected in a positive way; the orthodontist has a unique opportunity to respond to these issues.

The developing ability of an adolescent to make rational evaluations will, one hopes, direct the patient to agree to treatment at an appropriate time. In a world seemingly dominated by authority figures, the orthodontist can assist this process by seeing the patient alone and asking if they wish to be treated or at least think about whether they wish to be treated. Previous decisions regarding their health and welfare have been made for them and many are surprised or overwhelmed by this radical shift of responsibility. The responsibility should now be extended into the treatment itself, the orthodontist becoming less of an authority figure and enabling the patient to acquire independence and individuality. Small choices taken by patients, such as colours of appliances and modules, can enhance feelings of individuality. Furthermore, the orthodontist frequently has an advantage over parents and schoolteachers in the opportunity to develop a relationship with the patient on an adult level.

**Pearl:** This particular relationship is more readily developed without the inhibiting and distracting influence of a parent at the chairside.

According to Freeman, 'Recent research examining non-compliance has clearly shown that it is the conflict between parent and adolescent that influences the success of continuing orthodontic treatment.'[2] While compliance may be improved by the exclusion of a parent from the treatment area, other issues relating to professional conduct and the law need to be considered.

Parents universally desire optimal health care for their children; therefore, rather than being made to feel excluded from this responsibility, it is necessary for the orthodontist to explain to the parent that this arrangement can carry advantages. In particular, parents should find some comfort in the knowledge that the orthodontist is assuming responsibility for this aspect of their child's care. It is understood that at the outset the diagnosis and treatment plan were explained in detail and parents assured that they will be kept informed of any significant problems or changes to treatment.

**Pearl:** Parents must have access to information from either the orthodontist directly or an appropriate member of the practice team if there are any concerns at any stage during treatment.

Orthodontic procedures are generally painless but may be accompanied by some anxiety. Although some younger patients benefit from the security of a parent close by, Kent and Blinkhorn have observed that: 'in many cases… some parents exhibited behaviour that would tend to increase the child's anxiety'.[3] The ground rules should be established before treatment commences and cooperation sought in terms of flexibility over appointment times and the need for continuing parental support throughout treatment. In the vast majority of cases, parents welcome this shift of responsibility and generally recognize that orthodontic management requires a high level of concentration and the presence of any relative or friend of the patient in the treatment area can create at least some level of distraction.

Health and safety, and also public liability insurance issues may arise if children (siblings and friends) are not closely supervised in the surgery while the orthodontist and nurse are busy treating a patient.

When it is clear that the needs of the patients and parents have been met, it is necessary to ensure that the orthodontist is also protecting his or her own interests.

- First, it should be understood from a legal viewpoint that when a minor is discharged

into their care, they are acting in *loco parentis*. While treating a patient the orthodontist is responsible for all aspects of their care and welfare.

- Second, patients have usually been referred by their general practitioner who has: 'assumed a duty of care which necessitates a willingness to refer… if the task in hand is beyond the dentist's own skills'.[4] The same duty of care applies if the orthodontist requires assistance from other specialties, and it is essential to keep the parent as well as the referring practitioner informed with regard to all aspects of the patient's care.
- Third, in the case of a minor, it is necessary to obtain a valid consent form signed by the parent or guardian prior to commencement of treatment and to ensure that a chaperone (apart from the parent) is always present in the surgery.[5]

**Pearl:** In the event of any misunderstanding by a parent relating to the provision of care of a minor, the voice of authority is quite clear.[6] The orthodontist may always defend or justify his or her position if he or she is seen to be acting in the best interests of the patient.

I prefer not to have parents in the treatment area; whether you choose to practise orthodontics with the parents there or not remains a personal decision. However, it is as well to retain a degree of flexibility and remember that there will be occasions when it will be advisable to vary your rule.

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# 12 FIXED APPLIANCES

Eliakim Mizrahi, Robert A Katz, John Hickham, Luc Dermaut, Ronald G Melville, Anthony Lam, Glenn William Cooper, Jonathan Sandler, Matie Grobler, Victor Lalieu, Pieter van Heerden and Lee W Graber

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## 12.1 STAINLESS STEEL BANDS

Despite the widespread use of bonded brackets and molar tubes, conventional stainless steel bands still have a place in clinical orthodontics, particularly for second bicuspid, first and second molar teeth. Bonded tubes on molar teeth have a high failure rate (33.7%) compared to conventional bands (18.8%).[1] While a number of orthodontists currently bond all teeth including second molars, in many cases the reliability of well-banded molars still provides the clinician with a comfort zone knowing that all molar attachments are well secured throughout treatment.

If you choose to use conventional bands for molar teeth that are in tight contact with adjacent teeth, then it is essential to place interproximal separators at least one week prior to the banding appointment. Schedule a five-minute appointment for placing separators followed by a long appointment for bonding and banding. The long appointment can vary from one to two hours depending on your personal preferences as to how many teeth you intend to bond and the rate at which you choose to work.

**Pearl:** Schedule sufficient time for fitting fixed appliances. Treatment can be either compromised or enhanced at the outset by the calibre of the strap-up placed on the teeth. This was well described by Dr Swain: 'Banding as an investment in efficient treatment: the full service strap-up versus band brinkmanship'.[2]

### *12.1.1 Separators*

All separators work by applying pressure around the contact points and squeezing the proximal tooth surfaces apart. One of the early

forms of separation was achieved by slipping a piece of brass wire (0.7 mm, 0.028 inch) under the contact point from buccal to lingual, then back over the contact point and twisting the two ends tightly on the buccal aspect. Commercially available separating springs and separating elastomeric rings have currently superseded this technique.

Elastomeric separators are conventionally placed with commercially available 'separator pliers'. In very difficult cases where the tips of the pliers impinge on the buccal or lingual alveolar mucosa, a useful alternative is to use two fine mosquito forceps (artery forceps) to stretch the separator and move it down through the contact point.

### *12.1.2 Separator Placement*

Robert A Katz

When using the proprietary separator pliers, the separator is located 10–15 cm (4–6 inches) away from the operator's fingers. This results in loss of control and frequent slippage. If two flat plastic instruments are used with the separator placed between the blades, one has greater control with no slippage and less potential for damage to the gums and soft tissues. It is also significantly cheaper to use this method as a separator plier costs significantly more than two flat plastic instruments (Figure 12.1a,b).

**Pearl:** Warn your patients that while the teeth are not sensitive immediately after placing separators, they generally become sensitive by the next day. This sensitivity is more marked in adult patients.

Separators should be left in place for at least one week; this allows sufficient time for adequate tooth separation and for the tooth sensitivity to abate. If the teeth are still very sensitive at the banding appointment, it will not be possible to seat the band with adequate pressure and there is a danger of selecting a band, which may be one size too large. The pain threshold varies with each patient; adult patients are particularly sensitive to tooth separation so it may be advisable to extend the period of tooth separation for one or two extra days.

**Pearl:** Do not try to fit or cement a band with the teeth in tight contact. While it may be possible to force a band through the contact point, you cannot judge the correct fit of the band in the presence of a tight contact.

## 12.2 BAND SELECTION

Seamless stainless steel bands are currently the standard; it would be an extremely rare

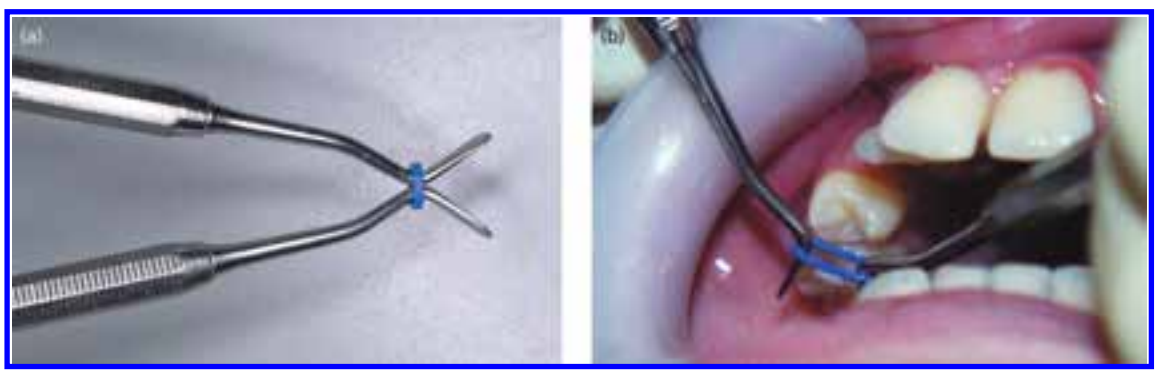

**Figure 12.1**

(a) Elastomeric separator held with two flat plastic instruments. (b) Placing an elastomeric separator stretched between two flat plastic instruments.

occasion that would necessitate the intraoral construction of a pinch band. Seamless bands are purchased as either plain or with prewelded attachments of your choice. Manufacturers are now etching the inner surface of bands to increase their mechanical adhesion to the cementing medium. Before deciding on which brand of bands to use, examine the shape, contour, accuracy of fit to the tooth anatomy, hardness of the band material, range of sizes, availability of easily accessible stock, speed of delivery, and cost. Next, you need to decide whether you prefer to use plain bands or bands with prewelded buccal and lingual attachments. Plain bands, once seated, allow the clinician to mark accurately, using a marking gauge, where the bracket or tube needs to be spot welded. It is necessary to maintain a stock of plain bands as well as a stock of weldable attachments. Prewelded bands must be seated to a position on the tooth, which allows the buccal tube or bracket to be at the correct height as required by your chosen technique. In certain instances, where the anatomy of the crown is unusual; the accuracy of bracket or tube height may be compromised. It is essential to establish the prescription of attachments you require to be prewelded to the bands. Your supplier should record this prescription or you may need to repeat the prescription when reordering your stock.

All molar and premolar bands should have lingual buttons, cleats or hooks. Lingual cleats are the most comfortable for the patient. As Brainerd Swain explained, investment in a good and comprehensive strap-up pays dividends during treatment.[2] The convenience of having lingual attachments available increases the versatility of the direction of force application to be used as and when needed during treatment.

**Pearl:** Malaligned and rotated teeth, buccal and lingual crossbites, tipped teeth, and partially erupted teeth can all be more efficiently moved with the assistance of lingually directed forces generated either by elastomeric threads, chains, or Class I, II, or III intraoral elastics.

### *12.2.1 Fitting Bands*

Get into the habit of always fitting and cementing bands in the same sequence. It is common practice to start with the lower left molar, work around to the lower right, and similarly in the maxillary arch start with the upper left and move around to the upper right. To save clinical time, prior to the banding appointment, auxiliary staff may preselect bands using the patient's study models. In some countries, jurisdiction allows oral hygienists and orthodontic therapists to select and fit bands on patients (see Chapter 9).

Seat the band using finger pressure, the band should move through the contact points almost to the level of the buccal gingival margin and should feel firm. Next, use an amalgam plugger or a band pusher to further seat the band and then final seating should be done using a bite stick. With a bite stick it is possible to use a heavy bite force generated by the patient to seat the band to its final level. The buccal gingival edge of the band should just move into the buccal gingival crevice. Try to avoid leaving a thin section of exposed enamel between the edge of the band and the soft tissue gingival margin; this is a potential site for plaque accumulation and enamel decalcification. For optimal final seating of the band, the patient should close with the metal post of the bite stick resting on the distobuccal margin of the lower band and distopalatal margin of the maxillary band.

**Pearl:** A band will not seat fully to its correct position if it is too small or the contact points are still too tight.

To check where the fault lies, try a larger band; if the contact points are sufficiently open the band will seat down to the gingival margin with finger pressure alone. If the contact points are too tight, even a large band will not seat correctly. If it is possible to rock the band in a buccolingual plane, then the band is too loose or not seated sufficiently.

Bicuspid bands need to be seated with care using finger pressure followed by an amalgam plugger applying seating pressure to the mesial and distal margins of the band. Final seating should be achieved with the metal post of a bite

stick resting on the buccal occlusal edge of the *band*. Beware of applying pressure to the occlusal edge of the *bracket*, it is possible that the bracket can be distorted or even sheared off the band.

**Pearl:** The development of a degree of lateral openbite as the case comes close to completion is the result of inadequate seating of bicuspid bands.

On the other hand, seating a bicuspid band too far gingivally will result in extrusion of the tooth, which in turn will produce cuspal interference and disturb the occlusion.

Once all the bands have been selected and accurately fitted, they should be carefully removed using a universal scaler – be careful not to distort the band during this process. Once again, if the contact points are too tight the band will be distorted when removing it from the tooth. The bands should be placed on a tray with demarcated wells for each band or a tray that has vertical posts for each band (Figure 12.2).

The bands are now thoroughly washed and dried to remove all traces of saliva and blood.

**Pearl:** For maximum retention of the band on a tooth, it is essential to have a tight, well-fitting band. Do not depend on the cement to retain a loose-fitting band; it will become loose during treatment.


**Figure 12.2**

Rigid plastic band rack with stainless steel posts. The rack together with the bands can be immersed in water.

#### 12.2.1.1 Altering Band Shape and Dimensions

Occasionally, due to unusual tooth anatomy, one size band is a little too loose and the next size down is just too tight. Furthermore, there are times when a band becomes dislodged during treatment and you can feel that it is just a little too loose. Under these circumstances you need to be able to improve the fit and slightly reduce the size of a band. There are three techniques to improve the fit of a band:

1. Grip 1 mm (0.04 inch) of the cervical edge of the band with the tips of Adams' pliers (Ash 64) and bend the band margin inwards about 45°; move the pliers in small increments around the cervical circumference of the band bending the margin inwards with each bite of the pliers. This will have the effect of producing a small cervical collar on the band, which in turn enhances retention on the tooth (Figure 12.3).
2. Cut a piece of stainless steel band tape, and spot weld it to the inner surface of the lingual wall of the band. Make sure the patch of band material does not extend on to the interproximal areas of the band. This procedure both strengthens the wall of the band and slightly reduces its internal circumference; once again, improving the fit of a slightly loose band.
3. When trying to band very small molar teeth, where the smallest molar band is

**Figure 12.3**

Using Adams' pliers (Ash 64) to create a cervical collar for increasing band retention.

still too large and the largest bicuspid band is still too small, it becomes necessary to further reduce the size of the molar band. Cut the lingual wall of the band with a crown and collar scissors; overlap the two cut ends by an amount you estimate will correct the size and place one tack weld. Try the band on the tooth, if the size needs to be altered further, break the tack weld; reoverlap with the correction and retack weld, then retry on the tooth. Once the correct size has been achieved, weld the overlap securely and smooth the edges with a mounted stone.

**Figure 12.4**

Bands placed on adhesive masking tape facilitates transfer between assistant and orthodontist and transfer from the orthodontist to the patient's mouth and relevant tooth.

### 12.2.2 Preparation for Cementation

**Pearl:** Any buccal tube, bracket or lingual attachments should have its lumen closed with soft red wax.

The attachment can be drawn along a piece of soft red wax or dipped into a well of semimolten wax. Allowing cement to enter and block the lumen of an attachment causes unnecessary problems during treatment.

As an alternative, the lumen of tubes and brackets may also be closed with toothpaste. When the patient rinses, the taste of the toothpaste is pleasing, fresh, and counteracts the taste of the cementing medium.

A piece of masking tape for each band is cut approximately 3 cm (1–1.5 inches) long. One end is folded on itself to allow the operator to hold the tape without it sticking to the gloves, the occlusal edge of the band is stuck to the masking tape using finger pressure and the assembled tape and bands are laid out on the work surface in the sequence to be cemented (Figure 12.4).

While the bands are being prepared by the assistant, the clinician will have washed, isolated, and dried the relevant teeth. As with the selection sequence, bands should be cemented starting with the lower left molar. Currently, the cement of choice for bands is the group of glass ionomer cements; the hybrid resin reinforced glass ionomer light-cured cements are also advocated as a cementing medium.[3–5] The cement is mixed on a cold glass slab to creamy consistency and placed on the inner surface of the bands to cover the entire metal surface.

**Pearl:** It is essential to ensure that the assistant does not under fill the band, voids left between the band and the tooth surface are potential sites for enamel decalcification. Rather over fill than under fill.

Pick up the folded end of the masking tape, carry the band to the tooth, and seat the band applying pressure on the tape. This procedure forces the cement to fill all voids between the band and tooth surface; it also forces excess cement into the occlusal grooves and fissures of the tooth without getting too much cement on to the operator's gloves. Before moving on to the next tooth, take a cotton wool roll and wipe the excess cement off the occlusal margins and surface of the band and tooth.

On the assumption that the tooth is caries-free, leave some residual cement in the occlusal fissures, as this can act as a fissure sealant and the slow fluoride release from the cement increases caries resistance in these areas. The degree of residual cement should not interfere with the occlusion to any significant extent. At this stage, leave the excess cement around the gingival margins and proceed to the next tooth following the same sequence. Once the cement has started to harden, the excess around the gingival margins can be easily removed with a

universal scaler. It is important to ensure that all excess cement around the gingival margins has been removed, particularly in the area between the buccal tubes and the gingival margins. If excess cement is left to harden on the occlusal surface, it becomes extremely difficult to remove. Gilmore uses a wet disposable toothbrush to remove any excess unset cement.[6]

## 12.3 BRACKETS

Brackets are only a means of transmitting a force, from whatever source and direction, to the crown of the tooth, nothing more and nothing less. Irrespective of the bracket used, your treatment plan and its execution should be based on sound physiological and physical principles that govern orthodontic treatment. Treat with circumspection the claim that expanding an arch with one type of bracket is more stable than expansion achieved with a different bracket; ask yourself if teeth can differentiate between the different brackets that generate an expansion force? However, dependent on the design of a bracket, different tooth movements can be produced by different brackets; as an example, some brackets allow tooth tipping while other brackets allow only bodily movement. Some brackets are designed to reduce friction between the archwire and the bracket slot while other designs maximize contact between the bracket slot and the archwire in all three planes of space.

The design and composition of orthodontic brackets continues to be modified and refined at a rapid pace. Within the two major groups of ceramic and stainless steel brackets, there are numerous designs and variations in prescriptions of torque and tip. In some cases, the archwire slot needs to be placed close to the gingival edge of the bracket base, a useful feature for partially erupted premolars (TP Orthodontics, Inc., USA). As the clinician who will be using the bracket, you should carefully evaluate the brackets commercially available and choose a bracket that suits your treatment philosophy. Become familiar with the bracket and with time become expert at managing and handling the bracket. It is tempting to keep changing as new brackets come on to the market, but do not be taken in too easily by commercial advertising and do not always believe the blurbs. Having a large inventory of different brackets is expensive and inefficient.

Apart from considerations based on your treatment philosophy governing torque and tip, there are certain principles you need to consider when selecting brackets.

- Evaluate the design of the bracket.
- Look at the size of both the base and the arch-retaining components.
- Examine the shape and the fit of the base on the tooth surface.
- Evaluate the retentive characteristics of the base (mesh or undercuts).
- The position of the archwire retaining component in relation to the bracket base is of particular concern for bicuspid brackets where, in many cases, the archwire slot needs to be close to the gingival margin.
- Check the strength, protrusion, and accessibility of the tie wings.

### *12.3.1 Vertical Slot*

Having a vertical slot greatly enhances your treatment options, and once you have become accustomed to utilizing this facility, you will ensure that you always use a bracket with a vertical slot. The vertical slot allows you to incorporate many auxiliaries, which can act in all three planes of space (see Chapters 14 and 15). When a tooth is displaced to the extent that it is not always possible to place a conventional ligature wire or elastomeric tie, it is much easier to thread a ligature wire through the vertical slot and move the tooth into a more favourable position for the subsequent placement of a conventional tie. In the case of partially erupted teeth when it is not possible to place a conventional tie due to the proximity of the gingival margin, once again it is simpler to tie the tooth to the arch with a ligature wire threaded through the vertical slot. If it is not possible to thread the ligature wire through the vertical slot, due to the gingiva or adjacent tooth blocking access to the slot, a ligature should be first threaded through the vertical slot before bonding the bracket.

The vertical slot allows you to place a power pin (TP Orthodontics, Inc.) for the attachment of an elastomeric chain, thread, or intraoral elastic.

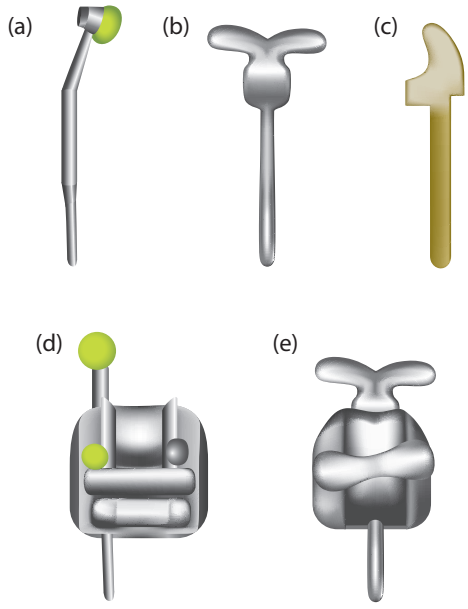


**Figure 12.5**

Different types of vertical pins. (a) Dropdown pin; (b) power pin. (c) high hat pin; (d) dropdown pin in a Damon bracket; (e) power pin in a Tip-Edge bracket.

In some cases, the elastomeric thread can be threaded directly through the vertical slot or through a loop, formed with ligature wire threaded through the vertical slot (Figure 12.5).

While the vertical slot is standard in the Begg, Tip-Edge, Nu-Edge Edgewise brackets (TP Orthodontics, Inc.), and Damon brackets (Ormco, USA), it may also be available in other edgewise brackets, such as the Butterfly System bracket developed by Jay Bowman (American Orthodontics, USA) and the Stealth bracket for the lingual technique (American Orthodontics). Selecting edgewise brackets that incorporate a vertical slot has the potential to increase the overall efficiency of your appliance. Binder shows how standard or prescription twin brackets can allow the placement of auxiliary springs by making use of the central gap (vertical slot) between the mesial and distal tie wings.[7]

**Pearl:** The incorporation of a vertical slot in the bracket is a feature often neglected yet it is an extremely useful adjunct and greatly enhances the versatility of your appliance.

## 12.4 BONDING PROCEDURE

Since the development of the acid-etch technique by Buonocore in 1955,[8] followed by the development of the Bis Gma resins by Bowen in 1963,[9] there have been numerous developments and refinements in both the technique and materials available for bonding orthodontic brackets to enamel, and these have been extensively reported in the literature. However, despite all the improvements that have taken place over the last 50-odd years, bonding brackets to enamel still remains a very technique-sensitive procedure.

Apart from the large family of conventional light and chemically cured resin bonding materials, resin modified glass ionomer cements are also used for bonding brackets.[10]

Recently, the advent of a moisture-insensitive primer and bonding material has introduced a variation, which facilitates the clinical procedure. However, the reliability and bond strength achieved with this technique over the full duration of clinical treatment has yet to be established.[11] It is possible that as further research data come to light this group of moisture insensitive primer and bonding materials may replace the current bonding resins.

**Pearl:** The key features for successful bonding to enamel are good isolation and maintaining a dry field. If either of these is compromised, the bond strength will be reduced and the bracket will fail.

### *12.4.1 Isolation*

There are many ways and aids to assist in isolation. Lip retractors of various shapes and sizes are available from most dental companies; they are an essential requirement and no bonding procedure should be attempted without lip retractors in place. Cotton wool rolls and Dri-angles (parotid shields) may be used in conjunction with lip retractors to further assist in isolating either individual teeth or quadrants.

Controlling the position of the tongue during the bonding procedure is critical to maintaining a dry field. There are a number of plastic tongue

guards incorporating bite blocks, which lie between the maxillary and mandibular molars. These auxiliaries come in different sizes and they serve a dual purpose: not only do they keep the tongue under control, but they also give the patient something to bite on thus stabilizing the mandible and making it much easier for the clinician to work on the mandibular teeth. A tongue restraining or guarding device such as the Tongue Away (TP Orthodontics, Inc.) is very useful in preventing the tongue pushing saliva forward every time the patient swallows.

### *12.4.1.1 Full Mouth Isolation*

John Hickham

I devised a dry field system that does not require cotton wool rolls, absorbent angles, or drugs to be effective when used by a single operator.[12,13] The system has a unique ability to retract the soft tissues, produce an unobstructed view of all the teeth and prevent the tongue from contaminating the prepared tooth surfaces (Great Lakes Orthodontics, USA).

Once the dentition is isolated, then start the standard procedure of pumice, wash, dry, etch, wash, and dry thoroughly. With the direct bonding technique it is generally possible, as a single procedure, to isolate, prepare, and dry all the teeth extending from second bicuspid to second bicuspid in both the maxillary and mandibular arches. If you intend bonding molar teeth, the maxillary and mandibular molars on left and right sides should be done as two separate procedures.

**Pearl:** When cleaning the tooth surface with pumice, use a rubber cup rather than a bristle brush cup. With a rubber cup it is possible to get very close to the gingival margin without traumatizing the soft tissue.

Preparing the surface close to the gingival margin is often necessary, particularly on bicuspid and molar teeth. If you use a bristle brush cup, the bristles can easily scratch the gingival margin and start gingival bleeding and seepage particularly if there is some gingival inflammation. Once there is marginal bleeding or seepage, the integrity of the bond will be compromised, you either have to wait for the bleeding to stop or you end up placing the bracket closer to the occlusal aspect than the case requires.

The final drying stage should not be rushed, each tooth must be well dried, check carefully to see that there is no saliva being pushed by the tongue through the interdental spaces and that the surface is dry right down to the gingival margins where necessary. The air-line should be free of moisture or oil, if in doubt use a hair drier with an adapted nozzle (Nola warm air dryer; Great Lakes Orthodontics). As an alternative you can make your own using a conventional hair drier with an adapted inverted funnel attached to the front nozzle of the drier (beware of overheating the drier).

**Pearl:** When a liquid resin (unfilled) is first applied to the etched and dried enamel surface, this liquid should not be thick or allowed to pool on the tooth surface. A thick layer of unfilled resin will contribute to a weaker bond. The thin layer of unfilled resin should be light cured before applying the bracket.

Remember the thin unfilled resin must penetrate the dissolved enamel prisms to a depth of approximately 25 µm. Light curing before covering the area with an opaque stainless steel bracket will allow the resin tags in the depth of the etched enamel prism to set and reach maximum strength. If the curing is only done after the bracket has been placed, you rely on the setting process to migrate from the periphery of the bracket base through the filled resin paste and then down into the unfilled resin tags. The resin in the tags which, in fact provide the bulk of the bond strength, will take some time to set, thus contributing to weaker bond strength.

Whether you cure one bracket at a time, or multiple brackets, will depend on your preference and the facility to provide adequate moisture control. Although enamel has a degree of translucency, and some light will be transmitted via the enamel, it is important to direct the

curing light all around the periphery of stainless steel brackets for the recommended time.

Irrespective of which adhesive system you choose, make sure that the adhesive is 'well buttered' into the stainless steel mesh or the retentive surfaces of the ceramic brackets.

Start bonding from the lower left and move around to the lower right then follow on from the upper left to the upper right. If you bond the incisor teeth first, then as you move distally to bond the posterior teeth, particularly on the left, there is a danger that your fingers or instruments may displace or disturb the anterior brackets just prior to their setting.

**Pearl:** The mandibular arch is always at greater risk of moisture contamination and should be bonded prior to the maxillary arch.

Take time to accurately check the position of the bracket on each tooth. It is helpful to have the study models at hand; small deviations in tip and rotations are not always clearly visible intraorally at the time of bonding, but they are more clearly noticeable on the models.

**Pearl:** When placing brackets on the teeth, it is essential to view the bracket not only from the side, but also from the occlusal aspect.[14]

For the mandibular teeth, viewing the position of the bracket from the occlusal aspect is simply a matter of direct vision; however, for the maxillary teeth, after initial placement of the bracket or tube, it is essential to use a mouth mirror to view the position of the bracket or tube from the occlusal. Use a probe to move and correct the position particularly where it is necessary to compensate for tooth rotations.

In an attempt to increase the resistance of the labial enamel to decalcification, Bowman recommends that immediately following the bonding procedure, while the teeth are still isolated and dry, a fluoride varnish is applied to the labial exposed etched enamel surrounding the bonded bracket.[15]

A feature of bonding that has been given little attention over the years is the effect of bonding and particularly rebonding on tooth colour. Following preparation of the enamel surface after debonding will restore the enamel surface, but what it does not do is remove the resin tags that have penetrated the enamel prisms to a depth of about 25 µm. This resin remnant will with time absorb stains and gradually start to show as a discoloured area in relation to surrounding enamel. While this may or may not be a clinical observation, a recent study by Al Maaitah et al. using spectrophotometer measurements, concluded that fixed orthodontic appliances caused tooth colour changes irrespective of the acid-etching technique.[16]

## *12.4.2 Bonding Brackets and Tubes*

Luc Dermaut

When bonding brackets, push the bracket firmly against the tooth surface. There should be enough bonding material to create excess around the bracket margin. Remove all excess before curing the material. This procedure saves time when debonding (less material to remove) and contributes to better oral hygiene.

When bonding buccal tubes, parotid shields are useful to control the flow of saliva from the parotid gland. The patient's head should be tilted to the other side so that saliva flows away from the tooth being bonded.

## *12.4.3 Single Arch Bonding*

Ronald G Melville

If only the mandibular arch is to be bonded, do not stick rigidly to conventional bracket height placement. Brackets should be kept out of the occlusion and archwires modified accordingly in order to maintain the relationship with the maxillary teeth if the original intention is not to change this relationship.

**Pearl:** When placing brackets always match the bracket height with the opposite side (e.g. if the maxillary right canine is being bonded, compare its height to the bracket previously placed on the left canine).

It is quite easy to have bracket heights running up or down from one side to the other if this is not checked, particularly if 'eyeballing' is used to place brackets. This type of error can result in changes to the cant of the occlusal plane when viewed from the front.

If only a few brackets are being placed to align a single tooth (e.g. placing brackets from mandibular canine to canine, to align an incisor), always contract the sectional archwire to prevent the canines from moving buccally.

Always telephone patients or parents a day or two after appliances have been fitted and enquire how they are getting on. Patients greatly appreciate this type of concern.

## 12.5 MOLAR ATTACHMENTS

Attachments to molar teeth, such as buccal tubes or lingual buttons, may be either prewelded to stainless steel bands or bonded directly to the enamel surface, the latter procedure is increasing in popularity. I still prefer, where possible, to use buccal tubes and lingual attachments prewelded to stainless steel bands.

The prescription for the buccal tube will depend on your philosophy and the system you use. You have the choice of using single, double, or triple tubes, whichever you choose, it is essential to select the correct torque, distal offset, and tube height.

Irrespective of whether your treatment plan requires the use of headgear or not, it is advisable to use double as opposed to single buccal tubes on maxillary molars.

**Pearl:** Having that extra auxiliary tube increases the versatility of your appliance and provides you with the flexibility of incorporating many auxiliaries at any stage during treatment (see Chapter 14).

## 12.6 INDIRECT BONDING

Anthony Lam

With the advent of preadjusted edgewise appliances, great emphasis is placed on the accurate positioning of brackets on teeth in order to maximize the potential of the preadjusted brackets and deliver efficient and effective biomechanics.

**Pearl:** Accurate positioning of brackets will align the teeth in all three planes of space during orthodontic treatment.[17] One way to optimize bracket placement is through indirect bonding.

Currently there is certainly a resurgence in the popularity of indirect bonding and this can be attributed to a number of converging factors namely, the advent of technological improvements in custom trays (transparent tray and dual transfer tray), bracket placement jigs, adhesives (chemical cure, light cure, and precoated brackets) and the exponential increase in the provision of lingual orthodontic treatment where indirect bonding tends to be the norm.

There are a number of advantages associated with indirect bonding.[18]

1. Precise bracket placement
2. Reduction in clinical chair-side time at bond-up
3. Bonding of posterior teeth easier and more accurate
4. Avoiding need for bands on posterior teeth and hence, eliminating the need for separators
5. Ideally suited for lingual orthodontics because of the greater variation of tooth lingual surface morphology, limited access, tongue interference and shorter clinical crown height

Interestingly, the advantages provided by indirect bonding are not always supported by research. Aguirre et al.[19] reported that indirect bonding resulted in more accurate vertical placement of brackets on upper canines and improved angulation of upper and lower canine brackets, but Koo et al.[20] found no statistically significant difference between direct and indirect bonding techniques in labial fixed appliances as far as angulations and mesiodistal position were concerned.

**Pearl:** Importantly, no significant difference in bond strength between direct and indirect bonding was reported.[21]

However, there are a number of downsides to indirect bonding:

1. Increased laboratory time
2. Additional cost
3. Technique sensitive
4. Removal of excess resin cement around brackets more difficult and time-consuming

The indirect bonding technique is not new and has been modified and improved over the years. In essence, the indirect bonding procedure consists of the following steps:

1. *The laboratory protocol.* Depending on the degree of sophistication required by the clinician, the laboratory procedures can be carried out either in-house or by commercial laboratories.
   a. *Impression taking.* It must be a given that accurate alginate or better still, silicone impressions are required. It is important that the impressions do not have any distortions as this will result in inaccurate bracket placement and an ill-fitting tray. Impressions however will become progressively obsolete with the increasing popularity of intraoral digital scanners. Three-dimensional scanners now operate at high resolution and are becoming much more user-friendly; they no longer require the use of titanium dioxide powders, scanning times continue to decrease, and their costs are becoming more affordable (see Chapter 16).
   b. *Plaster models.* In order to improve accuracy, the plaster should be vacuum mixed so that there are no bubbles in the plaster models. The models should be carefully trimmed and small voids filled.
   c. *Placement of brackets on plaster models.* It is important to thoroughly check the set plaster models for 'positive' bubbles created as a result of air trapped during impression taking. It is best not to scrape off these positive bubbles unless they are situated where brackets or tubes need to be placed. The plaster models are either air dried overnight or in an oven. A separating medium is then applied to the model to ensure ease of removal of the custom transfer trays on completion.

      Once the separating medium has dried, each bracket is positioned on the teeth, based on the prescription of the orthodontist. Precoated brackets are recommended as the thickness of the adhesive tends to be more uniform compared to manually applied adhesive.

      It is important that the plaster models are kept away from ambient light to avoid premature setting of the adhesive.
   d. *Manufacture of custom trays.* Once the position of the brackets has been checked, the adhesive is light cured. It is important that significant undercut areas such as hooks are blocked out. The custom trays can now be manufactured. There are a number of variations in the material used, for example, silicone Memosil, (Heraeus Kulzer) or glue sticks Surebonder, (Wauconda) and in the form of the tray, for example, full arch tray or segmental trays.
2. *The chair-side protocol.*
   a. *Moisture control.*

**Pearl:** It is important to maintain stringent moisture control during the bonding procedure as moisture will adversely affect bond strength.

Specially designed dry field systems are available to isolate the teeth from the tongue and cheeks. Pads such as the Dri-Angle (Dental Health Products) or Dry Tips; ( Molnlyke Health Care), can also be used to restrict salivary flow by covering the parotid salivary duct. Anti-sialogogues are useful but one should bear in mind that they are contraindicated in glaucoma, pregnancy, and patients taking asthma and allergy medications.

   b. *Tooth preparation.* Any ceramic crowns or restorations need to be microetched first using a sand-blaster. When lingual braces are fitted, it is recommended to micro-etch the enamel surface as well.

**Pearl:** Bond strength must not be compromised; bracket failure and rebonding is an unnecessary complication particularly for lingual techniques.

All teeth are then pumiced, rinsed, etched, and thoroughly dried, and the bonding primer applied. In the presence of ceramic crowns, hydrofluoric acid and silane coupling agents are required. For metal crowns, etch is not required but a metal primer is.

c. *Preparation of custom trays*. The custom trays need to be tried-in to make sure that they are a good fit, following which, the bracket bases should be cleaned with acetone and air dried. The clinician's choice of adhesive is then applied to the bracket base.
d. *Insertion of custom trays and setting of the adhesive.* The custom trays, either full arch or segmental, are inserted and fully seated. The setting process for the adhesive very much depends on whether a light cure or chemical cure adhesive is chosen.
e. *Custom tray removal.* Care is required when the custom trays are removed. The clinician should have adequate confidence in his or her bonding technique to avoid any bracket debonding at this stage. Excess adhesive should be meticulously removed.

It is interesting to note that indirect bonding continues to generate intense interest from orthodontists worldwide and Ciuffolo et al. described a new rapid prototyping method using the latest CAD/CAM technology to manufacture highly accurate custom trays from virtual digital models.[22]

The use of indirect bonding also lends itself to the laboratory construction of custom-made stainless steel or nickel titanium archwires for both labial and lingual techniques, for example, Incognito (Bad Essen, Germany) and Sure Smile (Dallas, USA). The technology currently available (Robotics) can produce single or a series of archwires incorporating first, second, and third order bends. There is little doubt that as we move into the twenty-first century, orthodontists will undoubtedly make greater use of these developing technologies (see Chapter 16).

When all is said and done, it is important to note that there are other important variables to consider when discussing errors inherent in orthodontic treatment: mistakes in diagnosis and treatment planning, bracket prescriptions designed for the average dentition, and bracket slot inaccuracies. In order to achieve the ideal treatment result, it is important to not only position the brackets accurately but also to eliminate the aforementioned errors. Precision in all aspects of orthodontic care, not just bracket position, is paramount for an ideal result.

## 12.7 ARCHWIRES

Orthodontists today have at their disposal a multitude of wire sizes, shapes, and metals. There is no doubt that the flexible nickel-titanium based wires must be considered as one of the major milestones in the continuing advancement and development of orthodontic materials. These new generation wires are available as standard nickel-titanium, superelastic nickel-titanium (i.e. changes its state from austenitic to martensitic), heat-activated nickel-titanium and copper-nickel-titanium wires. The degree of flexibility of these wires provides the clinician with the means of engaging an archwire into severely displaced teeth and yet still delivering a light continuous force over an extended period of time, a feat not possible with conventional stainless steel archwires.

Both stainless steel and nickel-titanium based wires are commercially available in preformed format varying in sizes and arch shapes. However, for those clinicians who wish to bend and form their arches either from straight lengths or spools, nickel-titanium poses a problem. Conventional stainless steel wire can be formed using a turret or contouring pliers; neither of which can be used with nickel titanium wire.

### *12.7.1 Contouring Nickel-Titanium Archwires*

To form a nickel-titanium arch from a spool or straight length, measure the arch length required either on a study model or directly in

the mouth, add 2 cm (0.08 inch), and cut off the measured length of wire from the spool.

**Pearl:** Hold each end with an artery forceps or any convenient pliers and pull the length of wire backwards and forwards over a round peg 3–4 mm (0.12–0.16 inches) in diameter.

Any round peg may be suitable; I have used the copper post of an annealing jack on a spot welder as well as the spout of a triplex air water syringe. The degree of arch curvature obtained will depend on the tension applied at the two ends of the wire, the diameter of the peg and the frequency of drawing the wire over the peg (Figure 12.6).

Pulling the wire over the curved 'beak' of contouring pliers or some other instrument, such as the blade of a flexible stainless steel cement spatula, can also curve straight lengths of nickel-titanium wire.[23] The arch should then be fitted into the buccal tubes, and cut to the correct length with 2 mm (0.08 inch) excess at either end.

The distal ends must be annealed using either an annealing jack, a flame from a soldering torch, or a cigarette lighter. If necessary, the buccal sections of the arch may be straightened by counter-curving the wire through the finger and thumb. Once the arch has been tied in, the annealed distal ends should be tucked in to prevent the arch from sliding out of the molar tube. The same technique can be used to place an increased or reverse Curve of Spee.

Straight stainless steel wires may be contoured with either a turret, contouring pliers, or pulled over a post as above, however, the diameter of the peg or post must be much greater (1.5–2.0 cm, 0.6–0.81 inches) than that used for nickel-titanium wires.


**Figure 12.6**

(a) Contouring nickel-titanium wire by drawing a straight length over the nozzle of a triplex syringe or any round tube or peg. (b) Contoured nickel-titanium arch superimposed on a model.

## *12.7.2 Measuring Arch Length*

### 12.7.2.1 Direct Technique

This involves measurement directly in the mouth; the archwire is slipped into the buccal tube and one side and the length is estimated for the other side. It is usual to overestimate and then cut off the distal extensions. The

disadvantage of this technique is the risk of irritation to the mucosa and gingiva distal to the terminal tooth. The archwire can be marked with a wax pencil where required for specific bends and offsets.

Most preformed archwires do have a mark indicating the centre point of the arch. It is essential that the centre point is located between the central incisors when marking offsets, cutting the distal ends, and tying in the archwire.

#### 12.7.2.2 Indirect Technique

The most common method is to form and measure the archwire along the circumference of the dental arch on the patient's study models. A more accurate and more detailed technique has been described by Ribeiro.[24] She used a disposable plastic ruler held along the circumference of the dentition. Measurements are made from the midline to points where archwire adjustments are required. The data are then recorded on a paper Brader archform sheet with a millimetre scale. The archwire is superimposed over the selected archform and the relevant marks are transferred to the archwire using a wax pencil. Baccelli uses a thin strip of carding wax;[25] this is placed in the mouth along the circumference of the dentition, the wax is pressed on to the brackets and tubes, removed from the mouth and flattened. The archwire is placed over the wax strip and cut to the required length; the midline and the position of any bends are marked on the wire using a wax pencil.

The development of thermosensitive wires has added a further dimension to the armamentarium of archwire materials available.

### *12.7.3 Stabilizing Nickel-Titanium and Light Stainless Steel Arches*

Apart from tucking in the annealed distal ends, there are other aids for preventing nickel titanium arches from sliding around the arch circumference.

- A dimple or a notch can be placed in the arch using commercially available pliers (Figure 12.7a).
- Using a cutting disc, precut and keep in stock, a number of 1–3 mm (0.04–0.12 inches) lengths of stainless steel tubing, internal diameter of 0.635 mm (0.025 inch). The archwire may be threaded through a small piece of stainless steel tubing, which is then crimped on to the archwire using crimping pliers.

**Pearl:** These aids are usually placed in the midline as are the dimples on preformed arches. However, if the central incisors are displaced, the tooth alignment is more efficient if the interdental arch section is straight and not dimpled.

In such cases, the dimple or steel tubing can be placed between any other teeth that are in good alignment. Which teeth are involved is irrelevant, as long as the mechanism prevents the wire sliding (Figure 12.7b).

- It is also possible to crimp a short piece of stainless steel tubing on to the archwire just mesial to the left and right molar tubes. This will prevent the arch from sliding around (Figure 12.7c).
- Crimp on the archwire short (1.25 mm, 0.05 inch) lengths of (0.457 mm, 0.018 inch) diameter stainless steel tubing (American Orthodontics); this stop fits between the wings of a twin central incisor bracket.[26]

### *12.7.4 Lip Protection*

Glenn William Cooper

When a bracket debonds or a tooth is too rotated or crowded to bond and the archwire may produce lip trauma particularly in the lower labial segment, this section of wire should be threaded through a latex tubular sleeve. The latex sleeve should be cut 1–2 mm (0.04–0.08 inches) longer than the available interbracket distance and compressed slightly on tying the wire to the brackets. This not only acts as a lip protector, but also has a limited expansion action similar to a compressed coil spring.

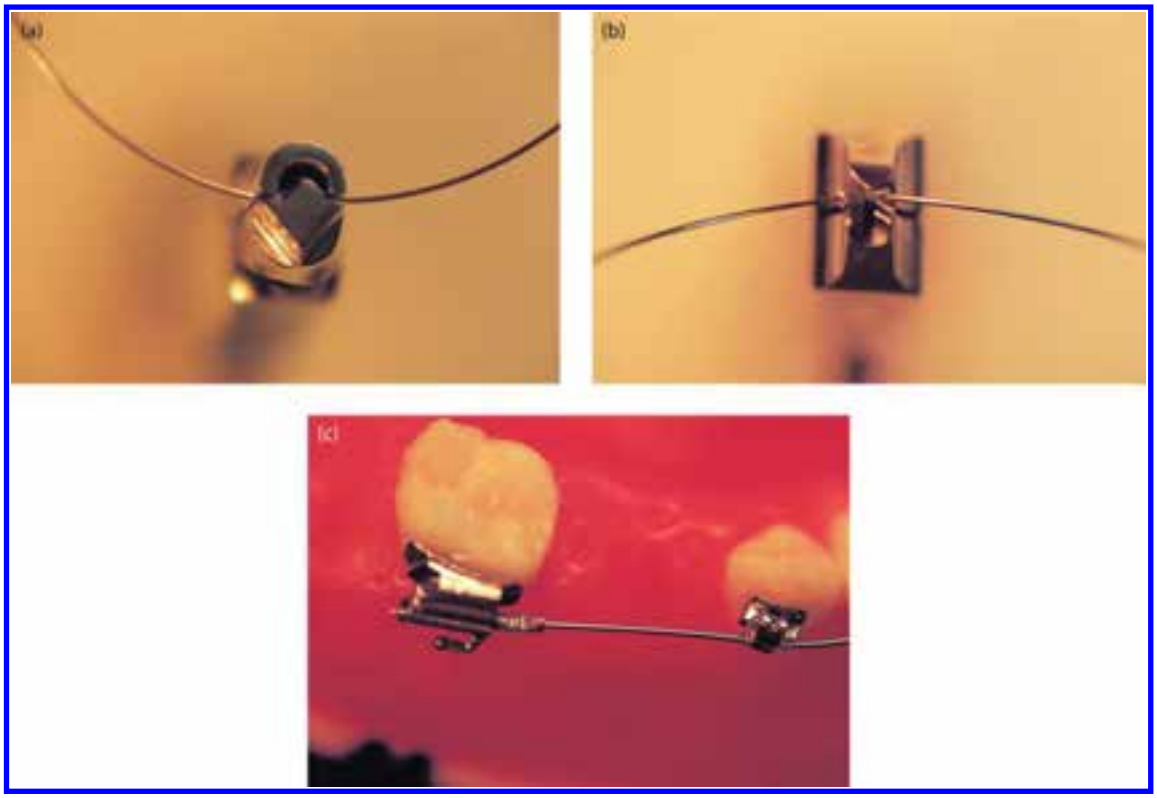


**Figure 12.7**

(a) Pliers used to place a notch (dimple) in a nickel-titanium archwire. (b) Pliers used to crimp a stainless steel tube stop in the midline of a nickel-titanium archwire. (c) Crimped stainless steel tube stops placed mesial to the first molars of a nickel-titanium archwire.

### *12.7.5 Strengthening a Span of Unsupported Archwire*

Jonathan Sandler

In extraction cases or when the premolars have not been bonded, there is a long span of unsupported or untied buccal archwire. In view of the flexibility of nickel-titanium or light stainless steel archwires, they may be sufficiently distorted or displaced during chewing to allow the distal section to slip out of the buccal tubes. The lower arch is particularly susceptible to this problem. To increase the rigidity and stability of these archwires, the buccal sections of the archwire are threaded into measured lengths of stainless steel tubing extending from the canine to the molar. The rigidity and stability given to these sections of the archwire by the stainless steel tubing prevents the wire from slipping out of the buccal molar tubes. Stainless steel tubing of 0.9 mm (0.036 inch) internal diameter may be precut in lengths of 6, 8, 10, 12, and 14 mm (0.24, 0.32, 0.40, 0.48, and 0.56 inch) (Figure 12.8).

In mutilated dentitions, involving the loss of teeth and in cases where overerupted teeth impinge on to the buccal archwire of the opposing arch, the buccal segment of the archwire should be stepped down or up, away from the occlusal plane into the buccal sulcus and the horizontal section of wire may be reinforced with stainless steel tubing as described above. This archwire design cannot be formed in nickel-titanium wire (Figure 12.9).

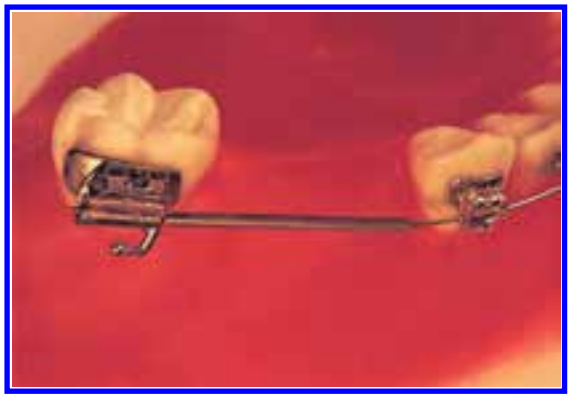

**Figure 12.8**

Stainless steel tubing reinforcing the buccal sections of a nickel-titanium archwire.

**Figure 12.9**

Buccal step-down bend in a stainless steel archwire to avoid occlusal impingement.

## *12.7.6 Archwire Size*

Glenn William Cooper

Following dental alignment with nickel-titanium archwires and prior to placing stainless steel archwires, the study models are measured against a template for archwire size using the lower model that best fits the template. I use a Euroarch guide (Precision Orthodontics, UK). The template size is recorded on the patient's notes and all further archwire changes are maintained at that size.

### 12.7.7 Reinforcing Elastomeric Thread

In cases where it is necessary to attach elastic thread and access is difficult such as with impacted or rotated teeth, a 0.254 mm (0.010 inch) ligature wire is threaded through 0.635 mm (0.025 inch) E-Z tie tubing. This makes the elastic thread more rigid and it can be formed into a hook shape and threaded through attachments. Once the elastic thread is in position, the ligature wire is pulled out of the elastic tubing and tied as required.

### 12.7.8 Sharps Disposal

All cut wire-ends, old archwires, debonded brackets, and bands are placed in a container (I use a disposable plastic cup in a cup holder) that rests next to the instrument tray on the work surface or bracket table. This container is emptied into the 'sharps' container at the end of each session. This reduces the risk of injury to the assistant, particularly when cleaning the instrument tray, and keeps the tray tidy during treatment. The assistant also knows that any wires, brackets, or bands left on the tray are for sterilization and not for disposal.

## *12.7.9 Selection of Coloured Elastomeric Ties*

Robert A Katz

The use of elastomeric ties is commonplace in current fixed appliance therapy. Coloured elastomeric ties appeal to younger patients and the variety of colours available requires the patient to make a choice. To assist in this process, we have devised the following chart:

Construct a minigrid using a spreadsheet program with the colours you stock evenly spaced out; print the sheet. We only stock about 10 colours at any one time. Cut some (6–8) elastomeric ties and stick them to the sheet in their relevant block. Back the sheet on to cardboard and place it in a self-seal plastic bag which should be changed periodically. We give these out to the patients or leave them in the waiting room area so they can choose a colour while waiting. This encourages patient participation and saves a lot of time (Figure 12.10).

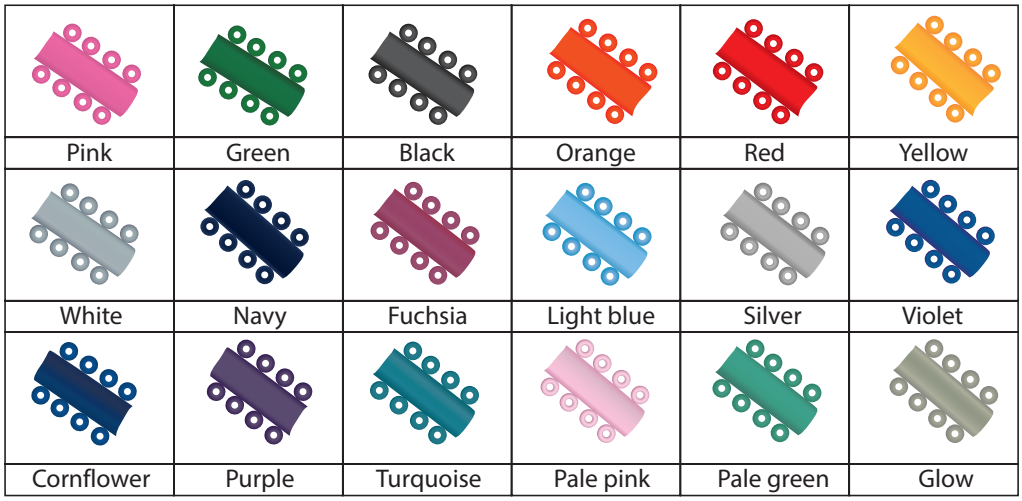


**Figure 12.10**

A selection of coloured elastomeric modules.

## 12.8 INTRAORAL ELASTICS

The use of intraoral elastics is an essential element in the treatment of different malocclusions. Your appliances should provide the facility to use intraoral elastics to generate forces in any direction you require. These elastics can be used for the movement of the entire dental arch or individual teeth in all three planes of space.

Apart from the variations in force direction, there are variations in force levels that need to be carefully selected and monitored. It is important to appreciate and differentiate between the force levels required for regular edgewise appliance systems, and light-wire systems, such as the Tip-Edge technique or the self-ligating techniques. With the edgewise appliance, a high percentage of the force generated by the elastic is lost in overcoming the friction between the archwire and the bracket. In a light-wire free crown-tipping appliance, most of the elastic force is utilized for tooth movement as opposed to overcoming friction. Consequently, the force values used are lighter (42–56 g, 1.5–2 ounces) per side for retracting six anterior teeth than those used in conjunction with the edgewise appliance.

When selecting elastics it is important to determine which tooth movements are required and evaluate the role of friction within the appliance system.

> **Pearl:** Excessively heavy elastic forces can produce undesirable side effects, such as alteration in the cant of the occlusal plane, mobility and sensitivity of individual teeth, extrusion of teeth, and possibly a degree of root resorption.

For efficient tooth movement, elastics need to be worn 24 hours a day; intermittent wear of elastics is not conducive to smooth continuous tooth movement. Once a goal has been achieved, such as a reduction in overjet, then wearing elastics at night only will hold the teeth in the present position rather than move them further.

The force level of elastics reduces as the elastics degenerate in the oral environment; they need to be changed daily or every second day to maintain a reasonably constant force level.

Placing elastics correctly requires a degree of manual dexterity, which some patients struggle to find. Patients should be instructed carefully in placing and removing elastics. It is essential that the patient can place the elastics before they leave the practice. If a patient arrives for their routine appointment without

the elastics in place, you can assume that there are many other occasions when they leave the elastics off.

It is essential that patients have their elastics on when they arrive for their routine adjustment appointments; it is the only way the clinician can check that they are wearing elastics correctly. It is surprising how some patients do not remember the instructions given to them; if possible a parent or some other responsible adult should be present when you are giving instructions.

**Pearl:** The patient, and where applicable the parents, need to be instructed in the importance of elastic wear to the treatment progress.

### *12.8.1 Elastic Wear*

Matie Grobler

If the patient needs to remove the elastics to eat and brush his or her teeth, the elastics should be placed on a finger so that he or she remembers to replace them straight after eating or brushing teeth.

### *12.8.2 Compliance with Elastic Wear*

Luc Dermaut

If you believe that a patient is not wearing intramaxillary elastics, but he or she says they do, place an elastomeric tie on the one side but do not tell them. If at the next visit, that side has improved more than the other side, then you will have some evidence with which to confront the patient.

## 12.9 NON-COMPLIANCE APPLIANCES

Since the revival of the Herbst appliance by Pancherz in 1979,[27] this type of appliance has become more widely used. Currently, there are many variations of noncompliance appliances commercially available for the correction of Class II and III dental relationships; a description of all these appliances falls outside the scope of this book (see Chapter 14).

The recent introduction of implants as a means of securing stationary skeletal anchorage may also fall under the umbrella of noncompliance appliances. Both the conventional osseointegrated implants designed as permanent tooth replacements and the more recent temporary miniscrew implants designed to be removed after a few months, provide stationary skeletal anchorage.[28–31] This field of mechanotherapy has become more widely accepted and used particularly as an adjunct to conventional appliances in adult orthodontics (see Chapters 17 and 18).

## 12.9 ROTARY INTERPROXIMAL ENAMEL REDUCTION

Robert A Katz

Interproximal enamel reduction (IPR) has become an essential part of today's modern orthodontic practice. It is essential in the Invisalign technique, lingual treatment, nonextraction treatment, and tooth reshaping, particularly for assisting in reducing black triangles.

My experience is that patients like the IPR to be done *quickly* and efficiently and I therefore use rotary discs and high speed diamonds in preference to manual strips (Figure 12.11).

I find that manual enamel reduction with metal strips, takes longer, and can be more painful for the patient. More bleeding can also occur and the lips tend to get caught and can be cut. I tend to use manual strips when the contact points are not aligned.

My technique for rotary IPR is as follows:

1. I use a slow speed straight handpiece with diamond disc (Figures 12.12 and 12.13).
2. Single sided discs are used when only one tooth is to be reduced.
3. I use the perforated discs, in preference to the solid discs, as they are more flexible, make less noise, and are more efficient and effective (Figure 12.14). Depending on which country you work in, you will need to

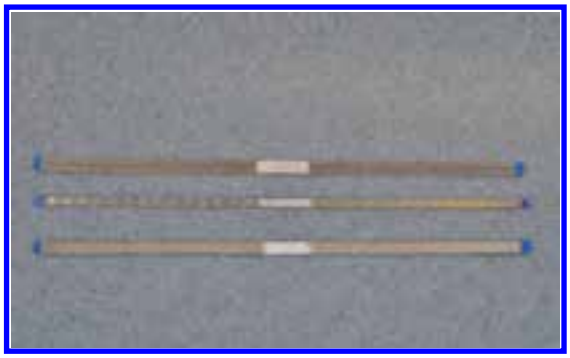

**Figure 12.11**

Manual metal abrasive strips. Perforated or solid strips are available in varying widths and grit size.

**Figure 12.12**

Slow straight hand piece with diamond disc.

**Figure 12.13**

Interproximal enamel reduction between lower left lateral and canine.

**Figure 12.14**

Perforated diamond disc (left). Solid diamond disc (right).

contact your local dental/orthodontic, or laboratory supplier to get the discs that work best in your hands. In the UK, I get my discs from a laboratory supplier as they have the largest range of sizes, flexibility, and diamond grit (course, medium, and fine). (Bracon, Ltd., High Street, Etchingham, East Sussex, TN19 7AL. www.bracon.co.uk. Other UK supplies are www.Orthocare.co.uk and www.tocdental.co.uk.)

4. The discs come in two or three thickness sizes. I use a thicker disc if more reduction is required.
5. The thinnest disc is 0.17 mm (0.007 inch) and this creates 0.2 mm (0.008 inch) space with one pass through the contact point (Figure 12.15).

**Figure 12.15**

Space created using a 0.17 mm thick disc.

**Figure 12.16**

A-shaped diamond burr for smoothing cut surfaces and edges – lingual.

**Figure 12.17**

A-shaped diamond burr for smoothing cut surfaces and edges – labial.

6. The next size up is 0.22 mm (0.009 inch) thick and this creates 0.3 mm (0.012 inch) space with two passes.
7. The last size is a solid disc, 0.25 mm (0.01 inch) thick which creates up to 0.4 mm (0.016 inch) space with three or four passes.
8. If more than 0.4 mm is required I use the rotary disc to create 0.4 mm (0.016 inch) and then air rotor stripping (ARS). ARS diamond kits are available with a variety of burrs and diamonds to obtain the desired space.
9. Following reduction with a rotary disc, the cut surfaces are usually sharp with the incisal/occlusal edges at 90° (Figure 12.16).

With the aid of an A-shaped fine diamond burr the edges can be smoothed to make them naturally rounded (Figure 12.17), so that floss can pass easily. The burrs illustrated can be obtained from Komet/Brassler (Ref No 8833 314 031; www.Kometdental.co.uk).

## 12.10 PRACTICAL TIPS FACILITATING FIXED APPLIANCE TREATMENT

Victor Lalieu

Reactivating nickel titanium open coil spring to open space for blocked out tooth.

- Place appropriately sized (larger diameter) 'sliding' stops (crimpable) on archwire *prior* to fitting/placing archwire (Figure 12.18).
- Light nickel titanium open coil spring active by one bracket width across crowded tooth.
- Place stops distal/mesial to open coil spring where the tooth is blocked out, compress the spring, and close slide on self-ligating bracket to activate the spring.
- At the following visit, slide next stop across to reactivate the open coil spring.

**Figure 12.18**

Place sliding stops (crimpable) on archwire *prior* to placing archwire.

### 12.10.1 Placing Elastomeric Power Chain so as to Avoid Dislodgement While Closing Spaces

- Place the power chain *under* the archwire (gingival to occlusal for upper; occlusal to gingival for lower) in area where pre-soldered post is positioned (usually between lateral incisor and canine).
- Hook end link of the power chain to hook on the molar tube or onto distal end of the archwire.
- Pull the power chain until suitably active, thread it under the archwire then hook the chain over the post on the archwire (Figure 12.19).
- With this configuration, the power chain is very difficult to accidentally dislodge from the post.

### 12.10.2 Engaging a Very Crowded Tooth into a Self-Ligating Bracket

- Engage the archwire into the bracket closest to crowded bracket.
- Pass the floss under the archwire (Figure 12.20).
- Fold floss around the archwire.
- Use the floss to pull flexible superelastic archwire into the bracket (Figure 12.21).
- Close the self-ligating 'door'; the archwire is now engaged (Figure 12.22).

**Figure 12.19**

Pull the power chain until suitably active, thread it under the archwire mesial to the canine bracket then hook the chain over the post on the archwire.

**Figure 12.20**

Pass the floss under the archwire.

**Figure 12.21**

Use floss to pull flexible superelastic archwire into the bracket.

**Figure 12.22**

Once the archwire is fully in the bracket slot, close the self-ligating 'door'; the archwire is now engaged.

### 12.10.3 Archwire Sequence for the Damon System Treatment

'Normal'/prescribed sequence:

| Upper | Lower |
|---|---|
| 1. 0.014 CuNiti | 1. 0.014 CuNiti |
| 2. 0.014 × 0.025 CuNiti | 2. 0.014 × 0.025 CuNiti |
| 3. 0.018 × 0.025 CuNiti | 3. 0.018 × 0.025 CuNiti |
| 4. 0.019 × 0.025 Steel pre-posted | 4. 0.016 × 0.025 Steel |
| Total upper archwires = 4 | Total lower archwires = 4 |
| TOTAL archwires = 8 | |

Since the same size/shaped copper nickel titanium (CuNiti) archwires are used for both upper and lower arches, my sequence saves a few archwires for each patient:

| Upper | Lower |
|---|---|
| 1. 0.014 CuNiti | 1. 0.014 CuNiti |
| 2. 0.014 × 025 CuNiti | 2. Tandem archwires (two 0.014 CuNiti's-use U + L 0.014 arches together) |
| 3. 0.018 × 0.025 CuNiti | 3. 0.014 × 0.025 CuNiti (use previous U AW) |
| 4. 0.019 × 0.025 Steel pre-posted | 4. 0.018 × 0.025 CuNiti (use previous U AW) |
| 5. 0.016 × 0.025 Steel | |
| Total upper archwires = 4 | Total lower archwires = 2 |
| TOTAL archwires = 6 | |

- The pre-packaged CuNiti archwires from Ormco come with two crimpable stops (to prevent the archwire from sliding). Two are required for the upper arch, given the larger interbracket distance anteriorly, but only one for the lower archwire. When placing the previous upper archwire into the lower, just remove one of the stops from the 'previous' upper archwire.
- Since the upper arch is larger than the lower, there will always be sufficient arch length in the upper archwires to fit the lower (must have bonded both arches the same, i.e. 6–6 or 7–7).
- At the appointment when fitting/shaping the upper stainless steel archwire use a wax bite to get the correct arch form/size, coordinate the lower steel archwire to the upper arch form/size. Store the archwire in patient's card for placement at next visit; no 'long' appointment required.
- The only 'long' or 'during school time' appointment required is the one when shaping/fitting the upper steel archwire.
- Used archwires are kept so that they can be used for the same patient if that patient has a fractured lower bracket and it is necessary to step down an archwire size (not suitable for upper arch, since the archwires have been cut to the smaller lower arch length).

### 12.10.4 Mobile Phone to the Rescue

Pieter van Heerden

Mobile phones certainly have their part to play in managing my orthodontic practice. Their integrated camera serves me well in two areas:

1. *Compliance with elastic wear.* You must have also experienced the frustration of patients not wearing their intraoral elastics in the correct configuration. This problem can be addressed by taking a photograph with the patient's smart phone at the visit when the elastics are introduced and placed. This avoids any possible confusion and the photograph serves as a permanent reminder about the correct wearing pattern for both patients and their parents (Figure 12.23).
2. *Emergencies*. I don't know about you but my staff and I sometimes find it hard to determine the nature of an emergency about which the patient or their parents call. We have come up with a solution that is perceived to be very high-tech. Patients are asked to text us a photograph taken with their smart phone or tablet with the help of a friend or family member. We can then more easily assess the nature of the problem and provide appropriate advice or schedule an applicable appointment.

**Figure 12.23**

Class II elastic placement recorded with the patient's mobile (cell) phone.

## 12.11 ORAL HYGIENE

Maintaining good oral hygiene throughout treatment is a continuing issue in orthodontics. Some patients need to be told and instructed only once and they manage to maintain excellent oral hygiene: their appliances are always clean and shining, the gingival margins are pink, firm, and healthy. By contrast, there are the group of patients who, no matter how often you instruct and how often you admonish, still have plaque on their appliances and teeth; their gums are swollen, inflamed, and bleed easily. Fortunately, the latter group is in the minority: most patients, with supervision and reminding, manage to maintain a reasonable standard of oral hygiene.

The importance of maintaining good oral hygiene throughout orthodontic treatment is first explained and stressed at the case discussion. It is then incumbent on the clinician or the ancillary staff to instruct the patient, usually at the banding appointment and then to monitor the standard at each appointment (see Chapters 9 and 18). There is extensive literature on the risks of poor oral hygiene as well as the techniques and aids available to promote and maintain a healthy oral environment.

At the banding appointment we give our patients an oral hygiene pack containing the following: conventional toothbrush, travelling toothbrush, toothpaste, fluoride mouthrinse, disclosing tablets, super floss, mouth mirror, protective wax, and literature. The patient is instructed on brushing and flossing techniques and told to carry the travelling toothbrush at all times. They are informed that when at school or out socially it is not necessary to carry toothpaste, using the brush and water is adequate. As evidence of carrying the toothbrush with them, they must have it with them at every appointment and they must brush in the surgery before any treatment is started. If they do not bring a brush to their appointment, they are expected to purchase a new one at the reception desk. This regime applies to both children and adults. In adult malocclusions where large interdental spaces are present, the use of interdental brushes can assist in the maintenance of good oral hygiene.

**Pearl:** If oral hygiene is assessed to be inadequate at any stage during treatment, it is essential that this is noted on the treatment card and both patient and parent informed.

At first, a verbal discussion should take place but then if the problem persists, a letter should be written to the parent informing them of the problem and pointing out the risks and reminding them of their original commitment to full cooperation. Some clinicians would copy such a letter to the referring dentist.

### *12.11.1 Oral Hygiene Maintenance*

Lee W Graber

One of the major concerns for patients in fixed appliances is the response of soft and hard tissues to retained plaque. We are well aware that often patients are at risk for increased caries with or without appliances. The placement of attachments to the teeth just makes the problem worse. As a result of concerns for tissue hypertrophy, decalcification, and caries, we have adopted the following protocol in our office. The results have been excellent, with local dental colleagues who provide general

dental and prophylaxis service reporting our patients to be the best they see.

At the start of treatment, we request that each patient obtains a lighted magnifying mirror. This can be a 'make-up mirror' for a girl or a 'shaving mirror' for a boy. The important point is not the name used, but the fact that there are lights at the level of the mirror and the image is magnified for the patient. This allows patients to see past the incisors and clean more carefully around the posterior teeth and appliances. In reality, we instruct our patients to brush using their normal mirror and to use the magnifying mirror as a check. They must do the 'magnified check' twice a day.

Prior to going to bed, each patient must use an oral fluoride rinse to further help protect the teeth.

All patients are on minimal four-month recall appointments for prophylaxis, further decreasing the potential risks of undiagnosed decalcification or caries.

Certainly not every patient follows the hygiene recommendations. However, we 'grade' the patient at each appointment and thus are able to assess when care is inadequate and communicate our concerns with the patient, parents, and family dentist. The result is that we rarely see serious gingival problems and almost never have concerns with decalcification and/or caries in our practice.

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# 13 PRACTICAL TIPS FOR GETTING THE BENEFITS FROM SELF-LIGATING BRACKETS

Nigel WT Harradine

CONTENTS



Over the last decade, the popularity of self-ligating brackets has rapidly grown worldwide. This growth has occurred in spite of several factors which weigh against their adoption. Firstly, some very enthusiastic proposals for specific, different, and better effects of these brackets have not to date been supported by random controlled trials. Secondly, these brackets are more expensive and only recently have brackets been developed which do not have practical drawbacks; for example, becoming jammed if calculus build-up occurs. Thirdly, and perhaps surprisingly, the best way of applying the inherent advantages of these brackets is still insufficiently understood and the optimal use of these brackets has therefore yet to be tested in a random controlled trial. This section of the book aims to focus on this last factor and provide practical suggestions which should help clinicians to get the best from self-ligating brackets.

## 13.1 THE UNDERLYING BIOMECHANICAL DIFFERENCES WHICH NEED TO BE UTILIZED

Self-ligating brackets usually offer more convenient, less cluttered, and more rapid ligation.

> **Pearl:** Although these are very nice to have, the more significant and less widely understood differences arise through their unique combination of excellent full archwire control and the significantly reduced friction between bracket and archwire.

Robust studies from a number of sources have provided good evidence that self-ligation reduces the resistance to sliding to a clinically significant extent in all clinical circumstances.[1,2,3,4] The binding element of the resistance to sliding is unaffected and indeed in

many circumstances binding is essential for the forces from the archwire to be transmitted to the teeth.

**Pearl:** It is the completely unnecessary and potentially detrimental *friction* component which is greatly reduced.

These and other investigators have also demonstrated and measured the corollary, namely, that since the total force in the system for any given archwire in a malocclusion is the same regardless of the bracket type, any increase in friction must be accompanied by a corresponding decrease in some other force. In fact, the force that is reduced is the residual force available to produce the desired tooth movements. The figures from these studies indicate that the size of this difference is likely to be of clinical significance. A good example, investigated by several research groups, is that of a significantly malaligned tooth. In that situation, full engagement of that tooth reduces the aligning force to near zero with conventional ligation whilst if self-ligating brackets are in place, a large proportion of the force remains available for alignment of that tooth.

## 13.2 TIPS FOR HARNESSING THESE BIOMECHANICAL ADVANTAGES

Two evidence-based changes in biomechanical technique should logically flow from these differences.

### *13.2.1 Tip A: Full Engagement*

Firstly, it is sensible and productive to fully ligate as many malaligned teeth as is clinically possible if self-ligating brackets are used. When conventional ligation is used, not only would this full engagement greatly reduce the desirable aligning force on such irregular teeth, but since the total force in the system is the same, it redistributes that force to other teeth, often with undesirable consequences. This is illustrated in Figures 13.1 and 13.2.

The adverse effects of engaging very irregular teeth when using conventional ligation underlie the conventional wisdom of not engaging or only partially engaging very irregular teeth. This conventional practice, ingrained for generations applies to a much smaller extent with self-ligation where more complete engagement of irregular teeth is a sensible course of action and leads to a better pattern and extent of tooth movement. If the situation in Figure 13.1 had been treated in the same way but with conventional ligation, the reduced ability of the wire to flow distally through the premolar brackets, would have considerably reduced the residual extrusive force on the canine and would have left proclination and intrusion of the incisors as the most probable results of the forces in the system. This undesirable pattern of tooth movement if conventional brackets are used in the same way is illustrated by the case in Figure 13.2, included with kind permission of David Birnie.

Taking advantage of the reduced friction and yet secure archwire engagement to fully engage irregular teeth to beneficial effect has the advantage of increasing the range of action of a given archwire and hence the extent of alignment before the next adjustment. It therefore reduces the need for more frequent archwire changes which a more sequential method of partial and progressive engagement involves. This advantage is also illustrated in Figure 13.3 where a non-extraction alignment has been achieved without the need for initial space creation with a compressed coil-spring.

**Pearl:** With self-ligation, fully engage the maximum number of teeth to achieve more alignment with fewer adjustments and reduced adverse tooth movements.

As with most matters of treatment mechanics, the application of this significant advantage of self-ligation can be taken too far. Figure 13.4 shows engagement of an extremely ectopic canine with self-ligation. Whilst no adverse tooth movements can be detected, the resistance to sliding has left no effective aligning force on the canine and no movement of that tooth has occurred. The well-quantified differences in force distribution with self-ligation

**Figure 13.1**

Full ligation of a markedly irregular canine tooth with self-ligating brackets results in the movements which laboratory research predicts. (a) A fully engaged 0.356 mm (0.014 inch) NiTi wire. (b) The next visit. (c) The next visit: note the derotation of the canine. (d) Engagement of 0.356 × 0.635 mm (0.014 × 0.025 inch) NTi wire at the following visit. Low friction ensures that sufficient extrusive force remains to align the canine whilst the reciprocal force causes very little incisor extrusion and the excess wire escapes distally with no detectable incisor proclination.

were insufficient in that extreme engagement, so different biomechanics were employed until the tooth was more favourably aligned.

**Pearl:** With self-ligation, as with all appliances, the potential advantages and consequent changes in best practice can be taken too far. Biomechanical problems can be greatly reduced but not abolished.

### *13.2.2 Tip B: Early Elastic Traction*

The second change in biomechanical technique which logically flows from the combination of reduced resistance to sliding and excellent archwire control is the use at a much earlier stage in treatment of various forms of traction that are traditionally reserved for use with later stiffer wires. The reasons behind this recommended difference of approach are based on the greater effectiveness of light forces when the adverse friction forces are enormously reduced. When the applied elastic force is reduced, so are the potentially adverse effects of applying traction to light, flexible wires. Traditional teaching has described the early, light flexible archwires as aligning wires which serve to permit the subsequent use of 'working archwires'. Only when these thick more rigid archwires are in place has it been seen as sensible to apply the heavier forces necessary to significantly move individual teeth along an archwire or to correct

**Figure 13.2**

(a and b) Initial engagement of the canine with 0.356 mm (0.014 inch) nickel titanium archwire. (c and d) The next visit.

interarch relationships. This general rule, which is indeed sensible when high friction requires higher applied forces to achieve these movements, is much less applicable when using self-ligating brackets.

Figures 13.5 and 13.6 illustrate in a class II division 2 malocclusion the effectiveness of early, light intermaxillary elastics and the lack of adverse and unwanted tooth movements. Three second premolars were congenitally absent and LR6 was removed because it was ankylosed and had resulted in a lateral open bite on the right.

**Pearl:** Self-ligation enables light, early class II traction to be effective (as it was with the Begg appliance, but with excellent archwire control).

Figure 13.6 is the same case as Figure 13.5 and shows the good rotational control which self-ligating brackets maintain on light wires when intermaxillary (or intramaxillary) traction is applied.

**Pearl:** Drop-in hooks placed into a vertical slot are a rapid and convenient way of applying elastic traction without compromising the archwire control and low friction which self-ligation provides.

## 13.3 SEPARATION OF LIGATION AND TRACTION

The use of drop-in hooks (see Chapter 12) is one example of this advantage. With conventional ligation, a compromise has to be struck between tight ligation in order to maintain control and loose ligation to permit the tooth to slide along the wire. If you wish to add intermaxillary elastics to that tooth, do you use a Kobyashi ligature which is rather too rigid for maintaining good archwire engagement but rather flimsy as a hook for elastics? These conflicting requirements are one of the reasons for

**Figure 13.3**

Full engagement of an 0.356 mm (0.014 inch) nickel titanium archwire, using self-ligating brackets and an initial eyelet on LR3. (a) Initial 0.356 mm (0.014 inch) archwire at bond-up. (b) The next visit. Archwire left unchanged. (c) The third visit. Eyelet swopped for a self-ligating bracket. (d) End of treatment.

the lack of popularity of retracting single teeth along a wire with conventional ligation. Do you place a wire or elastomeric ligature plus elastomeric chain on the tooth you wish to move or just place the elastomeric chain?

**Pearl:** Self-ligation eliminates this conflict between easy sliding and good tooth control.

Figure 13.7 shows the best way of gathering spaces together with self-ligating brackets, place the elastic chain *under* the archwire. In that position, it avoids all additional friction and leaves the metal labial face of the self-ligating bracket to ensure good archwire engagement and tooth control. Although this does necessitate removal and replacement of an archwire if the elastic chain is refreshed at a later appointment, this extra task is very rapidly done because self-ligation has been shown to be significantly quicker and easier, even with types of self-ligating brackets which are now obsolete and were trickier to open and close.

**Pearl:** Place elastomeric chain under the archwire with self-ligating brackets if more than minimal space closure is required.

## 13.4 AIDS TO ARCHWIRE ENGAGEMENT WITH SELF-LIGATING BRACKETS

Although archwires can be tied to a self-ligating bracket on a displaced tooth, self-ligating


**Figure 13.4**

Excessive resistance to sliding even with self-ligating brackets. (a) Initial engagement with 0.33 mm (0.013 inch) nickel titanium wire. (b) 8 weeks later, no detectable movement of the canine. (c) The same visit, starting different mechanics. (d) 8 weeks later, the canine has moved well and archwire engagement of the eyelet is now appropriate.

brackets put a premium on full archwire engagement and do not permit the incomplete ligation which is so often accepted with conventional ligation. If the wire is naturally engaged labiolingually, closure of the slide is, of course, very easy. If irregularity of a tooth means that slight assistance is required to fully engage the wire, the readily available finger will suffice or alternatively pliers can be used to hold the wire in the slot whilst the finger shuts the slide. However, if archwire engagement and clip/slide closure is more difficult for a particular tooth, two practical techniques are worth knowing.

- *The Cool Tool*. This simple tool straddles the bracket and has a notch on each side, so that a seating pressure can be applied across the whole bracket face. One advantage of self-ligation is that any such seating force can be opposed by lingual pressure using a labiolingual 'squeeze technique'. As you push on the Cool Tool from the labial also reciprocally push the tooth from the lingual/palatal with a thumb of the same hand. The net force on the tooth is greatly reduced and the wire is fully engaged more easily and comfortably. This contrasts with the pulling on an elastomeric module in a figure eight

**Figure 13.5**

Early 50 g (TP green) class II elastics applied to 0.356 mm (0.014 inch) and then 0.356 × 0.635 mm (0.014 × 0.025 inch) archwires. (a and b) Day of bond-up and placement of bite turbos. Class II elastics were applied. (c and d) The third visit. Canines class I. Overbite corrected. Note the drop-in hooks placed in the vertical bracket slot for application of the elastics. Class II elastic traction was stopped at this visit and the drop-in hooks subsequently removed. (e and f) End of 14 months of active treatment. Some space was left in the lower right quadrant to enable good occlusion with UR7.

configuration which is a force that cannot be opposed and is therefore inherently more uncomfortable for a patient when an archwire needs a seating force to be fully engaged (or in fact not fully engaged as is often the case with an elastomeric ligature) (Figure 13.8).

- *The floss trick.* With flexible archwires and very small interbracket spans, dental floss can be very helpful in getting full archwire

**Figure 13.6**

The same case as Figure 13.5. Traction applied to drop-in hooks on the canines achieves good tooth movement and maintains good rotational control. (a) Day of bond-up and start of class II traction on 0.356 mm (0.014 inch) wires. (b) Next visit 10 weeks later 0.356 × 0.635 mm (0.014 × 0.025 inch) archwire then placed. (c) The third visit, 10 weeks later. Class II elastics stopped and drop-in hooks then removed.

engagement and not obstructing the closure of the slide which is then very easy. Floss is looped over the archwire enabling a lingually directed force in a confined interbracket space (Figure 13.9).

**Pearl:** Get some Cool Tools for use with some thicker wires and remember the floss trick for use with some flexible wires.

## 13.5 TIP IF THE CLIPS OR SLIDES ARE HARD TO CLOSE

Ensure the wire is fully engaged. There should then be no problem

## 13.6 TIPS IF THE CLIPS OR SLIDES ARE HARD TO OPEN

In the past, some self-ligating brackets were prone to becoming jammed with calculus. There are now several makes of self-ligating bracket on the market which are essentially immune to this problem and to any other cause of difficulty in closing. These brackets tend to be those types which have a slide that only moves on the labial aspect of the bracket slot. With brackets which have a spring clip with a tail which travels vertically behind the bracket slot, it is still possible to obstruct the movement of the clip with excess composite during bonding. If you are experiencing problems with clip/slide closure, consider changing your make of bracket.

**Figure 13.7**

Elastomeric chain placed under the archwire.


**Figure 13.8**

A Cool Tool can be a big help in comfortably achieving full archwire engagement with thicker wires.

## 13.7 PREVENTING WIRE POKES

Low friction increases wire displacement. Ironically, the problems of unwanted wire displacement resulting from low friction are perhaps the most convincing and immediate clinical evidence that the low friction found in laboratory studies is readily apparent in vivo. Even with very irregular teeth, the very low friction with self-ligating brackets enables aligning archwires to slip through the brackets and an archwire end to protrude. This is clearly a potential nuisance.

In the past, a variety of methods were recommended for preventing this problem, but these have all been rendered obsolete by the availability of archwires which come pre-loaded with tube stops that can be moved to the desired positions and then crimped. If your favoured archwires are not available with pre-loaded tube stops, buy a packet of stops and slide them onto your archwires. It is better to have two diameters of these tubes, using smaller ones for the smaller diameter wires. This enables easier, tight crimping of the stops on all wire sizes. The larger interbracket spans in the upper arch require two stops to sufficiently limit archwire movement, whereas only one is need in the lower arch (Figure 13.10).

If rectangular archwires with soldered or crimped archwire hooks are in place, the hooks double as stops to prevent wire pokes.

**Figure 13.9**

(a) The Floss trick being used to fully engage a 0.33 mm (0.013 inch) wire in a bracket with a very small interbracket span between LL1 and LR1. (b) Archwire fully engaged in the LL1 and LR1 brackets.

**Figure 13.10**

Tube stops crimped on flexible archwires to prevent the wire sliding distally and causing wire pokes. Note the two stops crimped on the upper arch and the single stop in the lower arch.

**Pearl:** Always place the tube stop anterior to the crowded teeth so that the archwire is free to slide distally as the teeth align. Avoid placing a stop in an interbracket span where the wire needs to be very active, because the tube stop increases the rigidity of the wire at that site.

It is interesting to note that in the previous edition of this textbook (2004), all the same categories of clinical tips were mentioned in this section, but with very differing relative emphasis. In 2004, much of the content related to overcoming difficulties arising from imperfection of self-ligating bracket design. With the big advances in the availability of brackets which are very well designed and manufactured, the need for such tips has greatly reduced. What is currently necessary is the continuing explanation and appreciation of the changes in biomechanics for the clinician to reap the full benefits of self-ligation. These tips are made in the light of the much better evidence now available about the inherent performance of self-ligating brackets and in the expectation that both clinicians in their practice and researchers in clinical investigations will adopt and continue to improve them.

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# 14 ORTHODONTIC AUXILIARIES

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A major component of contemporary orthodontic mechanotherapy is based on the principles of prescription appliances where tip, torque, and rotation are incorporated into the brackets with archwires kept simple, requiring the minimum of bending.

> **Pearl:** Unfortunately, nature is not as uniform as are our appliances. Malocclusions are not all the same, and a competent orthodontist still needs to know how to bend wires, modify arches, and draw on components and auxiliaries that fall outside the realm of standard straight wire appliances.

As mentioned earlier (see Chapter 12), irrespective of which philosophy you follow, the versatility of your appliance can be greatly enhanced by using brackets that incorporate a vertical slot. A number of the auxiliaries described in this chapter are designed to be used in conjunction with brackets incorporating a vertical slot; however, some auxiliaries can be modified to facilitate usage with conventional brackets.

## 14.1 DISTAL MOVEMENT OF FIRST OR SECOND MOLARS

That molars can be moved distally is unquestioned. However, whether it is always desirable to move molars distally is sometimes debatable and is dependent on the treatment philosophy of each clinician.

Many appliances have been designed for the distal movement of molars. This section presents a few of these auxiliaries designed as adjuncts to conventional fixed appliances.

### *14.1.1 Sliding Jig*

There are occasions when a malocclusion presents with a unilateral cusp-to-cusp Class II molar relationship. The use of unilateral Class

II elastics to an intermaxillary hook, usually placed between the lateral incisor and canine tooth, may be effective for a very limited amount of unilateral correction of the canine and premolar teeth, but not for correction of the molar relationship.

**Pearl:** It is more efficient to direct the distal force generated by Class II elastic directly against the molar tooth using a sliding jig. This auxiliary may be used either on the first or second molar tooth.

The auxiliary should be constructed using a relatively stiff wire, such as 0.457 × 0.635 mm (0.018 × 0.025 inch) or round 0.508 mm (0.020 inch). The design will vary depending on the molar buccal attachment.

#### 14.1.1.1 Banded or Bonded Single Buccal Tube/Edgewise Bracket

In cases where buccal tubes are bonded to the first and second maxillary molars, use a large diameter tube, 0.914 mm (0.036 inch), to reduce friction and allow easy movement of the molars (Figure 14.1a,b).

##### *14.1.1.1.1 Construction*

- Bend an eyelet with a vertical post approximately 3 mm (0.12 inch) in height.
- Bend the horizontal arm at right angles to the plane of the eyelet.
- Place the eyelet hard up against the mesial of the molar tube or bracket with the horizontal arm extending mesially.
- Mark the horizontal arm at least 3 mm (0.12 inch) mesial to the canine bracket or as close to the distal of the lateral bracket as possible; remove from the mouth.
- At this point, bend the wire up at right angles to the horizontal section in the same direction (gingival) and plane as the vertical post of the eyelet.
- At a height of 3 mm (0.12 inch) bend the wire (towards the dental arch as opposed to the cheek) a full 180° to create a U-loop in the same plane as the eyelet with the long arm now extending incisally.

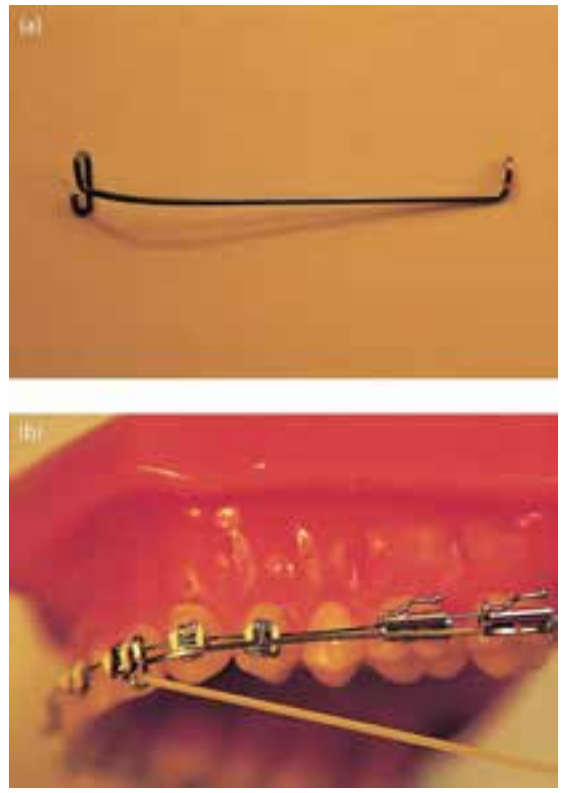

**Figure 14.1**

(a) Sliding jig with eyelet. (b) Sliding jig with eyelet; the main archwire is threaded through the eyelet and the distal force is transmitted directly to the buccal tube on the second molar.

- Measure approximately 4 mm (0.16 inch) on this descending arm then bend a mesially facing hook.

##### *14.1.1.1.2 Placement*

- Slip the distal end of the main archwire out of the buccal tube.
- Thread the distal end of the archwire through the eyelet of the sliding jig.
- Replace the distal end of the archwire into the buccal tube.
- From the gingival, slip the anterior hook of the sliding jig over the archwire in an incisal direction. In a few cases it may be necessary

to temporarily untie the lateral and canine brackets for this procedure.
- Once the anterior hook is in place, use a Howe or Weingart pliers to squeeze closed the gingival U-loop. This should prevent the hook from slipping up gingivally.
- The patient should now be able to attach a Class II elastic to the incisally and anteriorly facing hook.
- Check that the hook does not impinge on the cheek or gingiva.

#### 14.1.1.2 Banded or Bonded Double and/or Triple Buccal Tubes

##### *14.1.1.2.1 Construction*

- Bend a 3 mm (0.12 inch) vertical offset in an occlusal direction.
- Place the distal end into one of the tubes not occupied by the main arch.
- Slide the vertical offset up against the mesial of the buccal tube.
- Mark and construct the anterior section as described above (Figure 14.2a).

##### *14.1.1.2.2 Placement*

With this design it is not necessary to disengage the distal end of the main arch.

- Simply slide the distal end of the auxiliary into the free buccal tube.
- Slip the anterior section into place as described above.
- Make sure the distal extension of the jig is long enough to prevent the jig from sliding out of the molar tube (Figure 14.2b).

#### 14.1.1.3 Banded or Bonded Single Round Buccal Tube

The internal diameter of the buccal tube is 0.914 mm (0.036 inch) or greater.

The design and fitting is the same as for the double buccal tube. However, the sliding jig wire size must not be greater than 0.508 mm (0.020 inch) in order to fit into the tube together with a 0.406 mm (0.016 inch) main archwire. The combined size of the sliding jig and the main archwire cannot exceed 0.914 mm (0.036 inch).

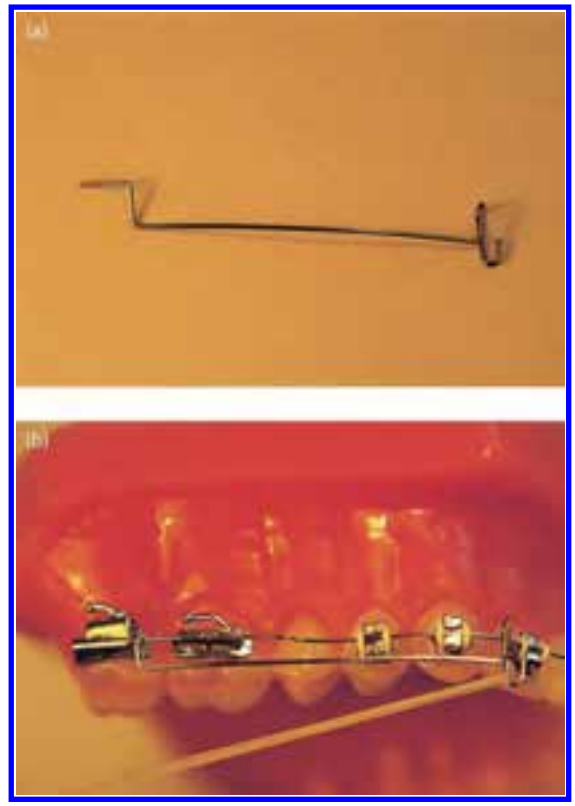

**Figure 14.2**

(a) Sliding jig with vertical offset. (b) Sliding jig with vertical offset; the vertical offset allows the horizontal arm to slide into the accessory buccal tube and the distal force is transmitted directly to the second molar.

#### 14.1.1.4 Banded or Bonded Buccal Tube with a Vertical Slot

##### *14.1.1.4.1 Construction*

- The wire size of the jig must match the size of the vertical slot of 0.457 mm (0.018 inch).
- Bend a 3 mm (0.12 inch) vertical post at right angles to the main section.
- Slip the post into the vertical slot.
- Mark and construct the anterior section as described above (Figure 14.3a).

##### *14.1.1.4.2 Placement*

- If the gingival margin of the band or tube is hard up against the gingival soft tissues or if

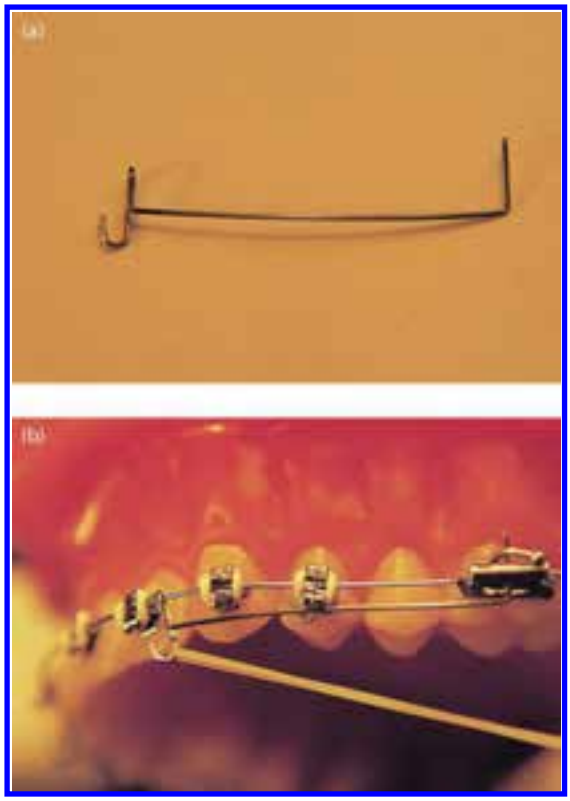

**Figure 14.3**

(a) Sliding jig with vertical post. (b) Sliding jig with vertical post; the post slides into the vertical slot of the buccal tube or any other buccal attachment incorporating a vertical slot (twin bracket).

there is gingival inflammation or hypertrophy, this design is unsuitable. However, provided there is adequate space between the gingival edge of the buccal tube and the soft tissue gingival margin, then from the occlusal aspect insert the vertical post of the sliding jig into the vertical slot of the buccal tube.
- With a 'bird beak' pliers grip the end of the post protruding through the vertical slot of the buccal and bend it horizontally.
- Slip the anterior section into place as described above (Figure 14.3b).

#### 14.1.1.5 Advantages of the Sliding Jig

- It can be easily constructed at the chair-side.
- It can be added to the current fixed appliance without having to remove or modify any component of the existing appliance.

#### 14.1.1.6 Disadvantage of the Sliding Jig

- It requires the use of Class II elastics, which are in turn, dependent on patient compliance and anchorage considerations.

### *14.1.2 Removable Appliances*

An upper removable appliance can be used in conjunction with conventional fixed appliances to assist in the distal movement of one or both maxillary molars. In the presence of a fixed labial archwire, it is possible to retain the removable appliance with ball clasps placed between the premolars. The retention can be further enhanced by the incorporation of an anterior bite plane. A palatal finger spring 0.66 or 0.711 mm (0.026 or 0.028 inch) active against the mesial surface of a molar will be effective in achieving the required distal movement.

The disadvantages of such an appliance are:

- The need to take an impression over an existing fixed appliance.
- In the presence of a tight contact it is essential for the finger spring to act first in a gingival direction in order to break through the contact point before it can be activated in a distal direction. In certain cases, the retention generated by the ball clasps will be insufficient to overcome the displacing effect of vertical activation of the finger spring.
- It needs to be constructed in a laboratory.
- The appliance may be uncomfortable.

### *14.1.3 Extra Oral Traction*

The use of headgear for the distal movement of maxillary molar teeth has probably been the most frequently used adjunct to fixed appliance therapy over the last 60 years. Headgear was originally described by pioneers such as Farrar, Goddard, and Kingsley and further modified by Angle in 1888.[1] The use of cervical headgear increased in the 1950s following the work of Kloehn.[2] It is still widely used today; however, there is a perception that when possible, clinicians today may be seeking and using other alternative options.

**Editor's Comment**
A brief (unscientific) enquiry around the international orthodontic fraternity indicates that due to compliance issues, there is a swing away from the use of headgear. However, it is still a recognized form of therapy which some orthodontists believe has unique features and is very useful for the correction of malocclusions that have their aetiology based in the maxilla. On this basis I have retained the following section on the headgear appliance.

## *14.1.4 Headgear (Rampton Headgear)*

Demetri Patrikios

The main reason for using an extraoral appliance, such as a headgear, is an attempt to find an area (a source of anchorage) from where we can exert a force to move teeth or prevent their movement, while the anchorage area itself does not undergo any adverse effect. Intraorally there is no area that can provide a comparable stable source of anchorage. In certain cases, implants may possibly be an answer and currently miniscrew implants and submucosal miniplates are being used more frequently (see Chapter 17).

The main thrust of this section is the Rampton headgear which I will describe in some detail. I will point out the advantages of the Rampton and thus wish only to very briefly mention the other common headgears used and why I rarely use them.

### 14.1.4.1 Cervical Headgear

This relies mainly on the posterior neck area as a stable base. The problems encountered here are

- The neck is flexible and therefore not as stable as one would like. By bending the neck in various ways the patient can change the force applied. To reduce the force children commonly increase the spinal lordosis when sleeping. This also leads to neck and muscle ache.
- The length of the outer bow of the facebow can be dangerous as it can easily hook on to articles of clothing. Also, patients find it difficult to lie on their sides when sleeping, not to mention the changes in force distribution that occur with movement of the head while sleeping.
- The direction of pull leads to the upper first molar crowns tipping distally with the apices of the roots moving mesially.

**Pearl:** If these teeth are left with this inclination at the end of treatment, despite the crowns appearing to be in a Class I relationship with their lower counterparts, a cusp-to-cusp situation will develop as the upper molars upright during and after retention.

- In addition to the above, the upper first molars are also subject to extrusion under the influence of this type of headgear. In most Class II cases it is not desirable to increase the mandibular plane angle as this drives the chin point down and back, increasing the lower face height. Naturally, there are some cases such as Class II division 2 malocclusions where we would like this to happen but these are in the minority.

### 14.1.4.2 Straight-Pull Headgear

This is similar to the Rampton headgear; however, I have found that the straps used are too narrow and too soft so that the force delivered is not as accurate or as constant as one would like it to be. Part of the headcap component fits around the neck, which is uncomfortable for the patient. Furthermore, the outer bow is generally still too long.

### 14.1.4.3 High-Pull Headgear

Two versions of this form of headgear are generally used.

- *Incorporating J-hooks*. This is generally used to intrude maxillary anterior teeth, the J-hooks engage hooks soldered to the anterior part of the archwire. The risk of root resorption here is increased and pulling upwards on the anterior portion of the arch while the archwire is tied in to all the posterior teeth does not seem mechanically correct. I can envisage the posterior maxillary

teeth having an eruptive force applied to them as the anterior teeth are depressed.
- *Incorporating a facebow*. The idea is good, but by using a facebow I feel it is difficult to avoid either mesial or distal crown tipping of the maxillary first molars. If you carefully examine the attitude and movement of the facebow under this type of high-pull force, you will soon appreciate the attributes and consequences of the force you are delivering to the maxillary molars. Again, I believe the facebow is too long.

#### 14.1.4.4 Rampton Headgear

This headgear is one of the most useful extraoral appliances I have used in my career as an orthodontist. In fact, it almost became the only extraoral appliance I relied on to enhance maxillary anchorage, distalize maxillary molars, and distalize whole buccal segments or even the entire maxillary arch. It is probably not as well known as, for example, the Kloehn-type cervical headgear and I only know of one company that markets it commercially (Oscar, Inc., USA).

What is it about the Rampton headgear that makes it, in my opinion, so superior to other headgear appliances? Let me list the advantages:

- The sources of anchorage are the occipital and superior cranial areas of the head. These are 'immovable' and provide a solid anchor from where to deliver the force required.
- The material I used to make the 'headcap' portion of the headgear is wider and stronger than the average available straight pull-type headgears and hence provides increased stability and anchorage.
- The outer bow of the facebow is much shorter than the usual facebows available and can be bent to closely follow the curvature of the cheeks (without touching them). This markedly reduces the chance of something hooking on to the facebow and injuring the patient. Also, when worn during sleeping, the patient can lie comfortably on their back or on either side without disturbing the appliance. The hook on the outerbow is adjusted to end at a point just mesial to the headgear molar tube (in the vertical plane). Under elastic traction this hook will come to be at the same level as the mesial opening of the molar headgear tube (Figure 14.4).

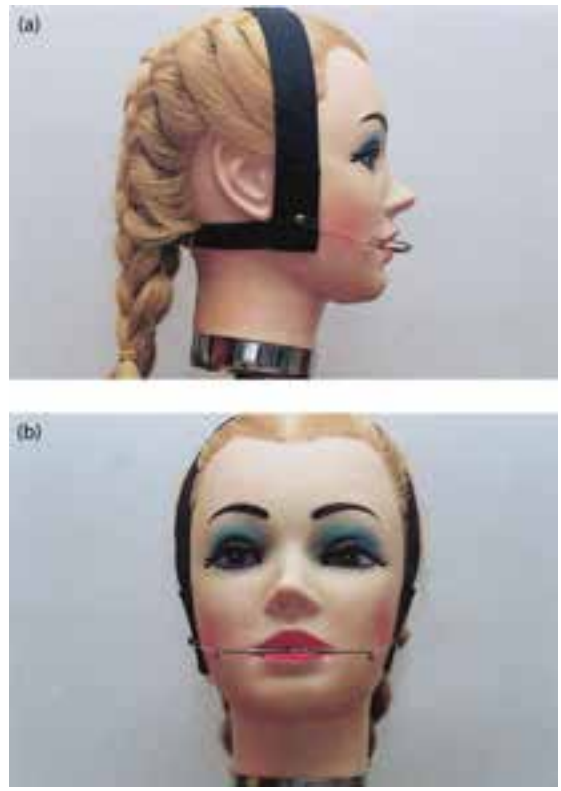


**Figure 14.4**

(a) The Rampton headgear showing the soldered joint lying passively between the lips. (b) The outer bow is short and the hooks lie parallel with the cheeks.

**Pearl:** The outer bow hook is bent to lie parallel to the face (instead of horizontal as is usual with all facebows) so that it does not interfere or hook onto the pillow when the patient is sleeping. Also, while the patient is active during the day, the hook is not sufficiently prominent to hook on to extraneous objects, such as items of clothing, etc.

- Patients who have worn a cervical traction headgear and later a Rampton headgear have all expressed their preference for the latter, certainly from a comfort point of view, thus increasing the likelihood of compliance. In cases that require headgear therapy, I believe that it is incumbent on the orthodontist to do all he or she can to motivate patients

to wear the headgear. As with other removable appliances, such as functional appliances, all too often, the operator gives up and blames the patient for not wearing the appliance. I think we ought to look at ourselves more closely and develop techniques to improve rapport between our patients and ourselves. This requires knowledge and understanding of the psychology of teenagers and the ethnic and social environment in which they find themselves. In most cases, a sympathetic, understanding operator will eventually be able to gain the confidence and cooperation of patients under his or her care. It is quite amazing how teeth move once cooperation is established!

**Pearl:** The direction of force delivery must be well controlled.

In my view this is the critical factor in successful headgear wear. In most instances we require the maxillary first permanent molars to move distally while maintaining an upright position. Therefore, the force applied must be directed through the centre of resistance of the molar in question. Inappropriate direction of force delivery will result in mesial or distal tipping of the tooth crown, and concomitant undesirable root movement of the molars.

It is very difficult to determine the exact position of the centre of resistance of a given tooth. In respect of the maxillary first permanent molar, convention has it that the centre of resistance is about where the bifurcation of the buccal roots occurs. When using the Rampton headgear, I have found it quite easy to arrange the outer bow and the boot hook on the headcap (as fitted in the custom-made version) in such a way as to have the distal force vector of the elastic traction passing through the centre of resistance. A practical method to achieve this configuration is as follows:

- Place the headcap on the patient (there is no boot hook on it at this stage).
- Fit the facebow in the usual way with the outer bow finishing just mesial to the corresponding headgear tube.
- Place headgear elastics on the facebow (e.g. Panther elastics supplied by Ormco, USA).
- Stand behind the patient, insert your index fingers into the elastics on both sides and pull distally, simulating the direction of pull that will be exerted by the headgear when fitted. At this stage the outer bow should be at the same vertical level as the inner bow. The anterior soldered joint of the facebow should rest passively between the lips so that upper or lower lips are not displaced vertically. By pulling on the elastic as above, the anterior portion of the facebow will either:
  - *Bend upwards* – This indicates that the direction of pull you are applying is too high and will lead to mesial crown tipping with distal root tipping of the maxillary molar.
  - *Or bend downwards* – This indicates that the direction of pull is too low and will lead to distal crown tipping with mesial root tipping.
  - *Or* – By varying the direction of pull so that the anterior portion of the facebow tips neither up nor down but remains neatly between the lips (i.e. a 'neutral' position), the correct direction of pull will be determined and hence the position of where to attach the elastic to the headcap (boot hook as fitted in the custom-made version) will have been determined.
- During treatment, this direction of pull must be checked at each visit. Variations can be made by adjusting the outer or inner bow accordingly, always looking for the 'neutral' position of the facebow as described. Sometimes, it may be necessary to change the position of the boot hook in order to vary the direction of the applied force.
- By placing two boot hooks on each side and stretching the elastic over both and hooking up to the outer bow, the elastic forms a triangle. If the force vector passes through the centre of resistance of the molars, these teeth can be driven both distally and intruded in an upright position with no tipping. This facility is extremely useful in treating moderate anterior openbite malocclusions of skeletal origin.
- When the headgear is finally fitted, it should be snug and comfortable. Twelve hours

wear (over a 24-hour period) should be sufficient to move the maxillary first permanent molars distally. Of course, the time needs to be adjusted according to the response of the individual patient to the applied force. If entire buccal segments are to be moved distally on sectional arches (from canines to second molars), 18 to 20 hours wear is required. The force required may be calculated on the basis of 71 g (2.5 ounces) per tooth involved.

**Pearl:** It is, of course, the wearing time that is the most important factor as opposed to the force applied.

#### 14.1.4.4.1 A Note on Safety

Currently, there is the tendency to incorporate break-away elements between the facebow and cervical strap as a safety measure. This feature is designed to disengage the facebow if it is intentionally or accidentally pulled forward. Such an incident would be a rare occurrence and the break-away would not necessarily prevent any accidents. The length of the outer bow and how far it is situated away from the cheeks presents a real problem as almost anything can get accidentally hooked on the outer bow. Where the outer bow ends, the hook is usually bent horizontally (as opposed to vertically with the Rampton facebow), almost inviting something to get hooked on to it, not to mention the problems of the pillow when the patient is sleeping on his or her side.

If the patient or parent reports that the facebow becomes disengaged during the night, it is important to ascertain if the patient is actively removing the facebow or if the break-away module is faulty.

I am much happier with the smaller Rampton facebow which fits close to the face and is positively held by strong rubber elastics to a strong well-fitting headcap and where the hooks on the outer bow are bent parallel to the facial skin rather than at right angles to it. The whole appliance fits so well that it is snug and comfortable and very difficult to displace.

For those orthodontists who feel that they must use a break-away mechanism, this can easily be incorporated on to the headcap. A headcap, with loops incorporated for the break-away mechanism, is commercially available (Oscar, Inc., USA).

Another protection mechanism is the plastic safety strap. This strap is simply placed around the neck and hooked on to the outer bow on both sides. This prevents the headgear from being accidentally removed.

Unfortunately, both the above mechanisms require the hooks on the outer bow to be bent out horizontally, thus increasing the chance that they can catch on something. It is all a question of what the orthodontist feels is the safest option. The patient and parents should be given to understand that they must accept the responsibility of ensuring the appliance is worn correctly and looked after with care.

#### 14.1.4.4.2 General Comments

At this stage I believe it is relevant to list some important points that experience has taught me over the years:

It is important to ensure that the parents, especially the mother, are in full agreement with you concerning the patient's wearing of the headgear. Some mothers get upset to see their child wearing a headgear. In these cases you have failed before you start because the mother's concerns are passed on to the patient (even though mother attempts to hide her feelings; children are adept in their ability to pick up on this) and the headgear will simply not be worn to prescription.

**Pearl:** Hence, convince the mother first (in private if necessary) before any treatment starts. In fact, I tell them at the very first visit that there is a high probability that a headgear will be required during treatment.

1. When discussing the diagnosis and treatment plan, mention all the appliances to be used including the headgear. This often raises the question of whether there is a technique to avoid using the headgear. This would mean using Class II elastics or a Herbst appliance or altering extraction patterns. I personally do not like to deviate from a chosen mechanical procedure that

has been worked out to give the optimal result with regard to the soft tissue profile and final occlusion. In addition, the above-mentioned alternatives have disadvantages of their own which may be undesirable.
2. Since we have the responsibility of providing the best result possible for the patient, it is a poor defence to say afterwards: 'You could have got a better result if only they allowed you to use a headgear.' In this situation, I offer to refer the patient elsewhere if I could not choose the appliances I wanted to use in a particular case. Most simply agreed and stayed with me.
3. However young a patient may be, I always spent adequate time explaining why we need to use a headgear in their particular case. I stress the *'we'* in such a way as to make the patient understand that they and I are in this *together as a team*. I provide the appliance and guidance, they provide the effort and dedication and we both achieve a result. I get paid for it and they get to have their teeth in the best possible position for the rest of their lives. This is between you and the patient, and a special rapport should be established. They must regard you as a friend, easily approachable, and not the autocratic, aloof doctor (see Chapter 11).
4. I make vigorous attempts to explain the mechanics involved, such as the matter of stable anchorage to move the teeth efficiently. A quick drawing or moving objects on a counter top does wonders for understanding the problems involved and creates an interest the patients like to follow.
5. I go through the wearing times very carefully and make sure the patient understands what 12 hours out of 24 hours really means. I check with them what they do during school hours, after school hours, homework time, and TV watching, I work out when and how they can achieve their goal, starting with just two hours on the first day and building this up to the desirable numbers of wear hours. A chart is given to the patient for recording the wearing time. The most suitable is a firm card approximately half an A4 page size with divisions to clearly record dates and wearing times. The chart should also include motivating sentences that are short and to the point and remind the patient what *we* have already discussed and what *we* are trying to achieve.
6. Place the headgear, elastics, and time chart in a special case that is then given to the patient. I use a bright soft plastic pencil case, which can still be used for other odds and ends after the headgear phase is completed. Exhort the patient to always keep the headgear, elastics, and time chart in the case and to bring it to every visit without fail.
7. At each visit, the rapport with the patient must be renewed. Check the headgear, its direction of pull (as previously described) and adjust as necessary. Check the time chart and comment as necessary. Show the patient what has been achieved, show your pleasure, and reinforce the commitment to achieving the desired tooth movements.

If any reader wishes to contact me in regard to this appliance or for detailed instructions on the fabrication of the headcap, I will be happy to provide the relevant information (see list of Contributors in Front Matter for address).

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### 14.1.5 Length of Outer Bow Arms in Headgear Therapy

Luc Dermaut

Translation of upper first molars by headgear therapy can be achieved by having the force application going through the centre of resistance of the first molar (trifurcation area). The length of the outer bow arms determines whether pure translation or tipping of the molars will occur.

To find the sagittal position (length of the outer bow) of the centre of resistance the following procedure may be adopted. By exerting a downward vertical force (with two fingers) on the outer bow arms starting from the connection between the inner and outer bow arms, the soldered joint will descend Figure 14.5.

By moving both fingers distally, at a certain point, the soldered joint will remain at the same vertical position as before exerting the force.

This is the sagittal level of the point of force application. By moving the fingers more distally,


**Figure 14.5**

Technique for determining the length of the outer bow so that the distal force is directed through the centre of resistance of the maxillary molar. (a) Using two fingers, press down on the outer facebow near the soldered joint. (b) Slide the fingers distally and continue pressing down. (c) When the soldered joint reaches a neutral position between the upper and lower lips, the position of the fingers on the outer facebow determines the correct length of the bow. (d) Further distal movement of the fingers will move the soldered joint up onto the upper lip.

the soldered joint will move in the opposite direction (upwards).

This procedure will assist the orthodontist to adapt the length of the outer bow arms to obtain the desired molar movement.

### *14.1.6 Headgear Safety – A Simple Solution*

Tom Weinberger

As far back as 1975, the American Association of Orthodontists issued a warning about the potential dangers of extraoral appliances (EOAs).[3] Since then a number of surveys,[4–7] and many case reports,[5,8] have confirmed that the use of EOAs does present a finite risk of damage which cannot be ignored. The potential for injury to the patient can be divided into two categories:

1. The first category concerns the accidental removal of the inner headgear bow from the tubes on the molar bands or, if a removable appliance is being used, removal from the tubes soldered to clasps. This is usually the result of a force applied from the outside by someone or something pulling the bow forward either as a prank or as the result of the outer wire bow getting caught up in an article of clothing. The elastic force of the neck strap or headcap pulls the wire bow backwards with considerable force and the exposed inner bow ends can cause penetrating injuries to the mouth, pharynx or, if the inner bow has come completely out of the mouth, to the face or eyes. The site of the

injury is determined by the direction of the external force, low-pull or high-pull, and the distance that the inner bow disengages from the tubes.

A number of safety devices have been designed to prevent such accidents from occurring. The most common, and effective, is the snap-away module attached to the neck strap or headcap. This disconnects when the force applied exceeds a preset limit, thereby nullifying any backward force on the inner bow and preventing penetrating injuries. The use of such modules must now be considered to be standard practice when EOAs are applied and failure to do so may be regarded as professional negligence even when no injury ensues. The break-away force limit of the module must be high enough to allow clinically meaningful forces to be applied to the teeth but not so high that it fails to disconnect before the inner bow leaves the molar tubes.

**Pearl:** It is vital for the orthodontist to ask the patient whether the EOA is removed at night and to make the appropriate note in the patient's records.

2. The second danger of EOA injury occurs when the wire bow comes out, or is taken out by the patient during the night. The exposed ends of the inner bow may now lie on the pillow and may scratch the patient's face or eye during movement. Any contact between the inner bow, which is contaminated by oral bacteria, and the eye is likely to cause a severe reaction, in excess of the physical damage caused by the scratch itself. This almost inevitably leads to blindness in the affected eye with the possibility of sympathetic ophthalmitis damaging the second eye unless immediate and effective treatment is carried out. The disconnection of the EOA at night may occur even when a break-away safety neck strap or headcap is used.

**Pearl:** The length of the inner bow wire, which is inserted into the molar tubes, is also significant, it should not be too short or disengagement from the tubes may occur before the modules disconnect.

To minimize the dangers of such an event occurring, the inner wire bow must be secured to the molar tubes in such a way that it is unlikely to come out at night even if the neck strap or headcap is disconnected. In 1996, Trayfoot described the use of small orthodontic elastics to secure the inner bow to the clasps of a removable appliance for use with headgear,[9] and in 1997, Samuels described a locking device, which prevents detachment of the inner bow.[10] Recurved facebows, which do not have sharp ends, and nonelastic neck bow straps, which prevent accidental dislodgment of the inner bow, have been designed and may offer some security. The catches, straps, and recurved facebows are effective but complicated to use as well as being expensive.

For a number of years I have been using a simple and very effective safety device, which has eliminated the risk of accidental dislodgment of the inner EOA bow either during the day or at night. I solder a 0.7 mm (0.028 inch) stainless steel wire to the anterior part of the inner bow on each side and bend it forward as a low profile hook (Figures 14.6 and 14.7).

**Pearl:** Connecting a small 4.762 mm (0.1875 inch) orthodontic elastic between this hook and the hook on the molar tube will secure the inner bow in the molar tubes even in the event that the neck strap or head cap is removed.

**Figure 14.6**

Modification to enhance headgear safety. Hooks soldered to the inner bow and bent mesially.

**Figure 14.7**

Headgear fitted with intraoral elastics to hold the inner bow in position.

Alternatively, it is possible to buy facebows with canine hooks that face distally, and very gently rotate the hooks through 180 degrees until they face forward. The importance of full-time use of the safety elastics should be explained to the patient and parents without scaring them too much. Since starting to use this simple safety device the incidence of night-time EOA disengagement has fallen to nil. Like all such devices, it only works when the patient uses it as instructed and this is, of course, its major drawback. Despite the comment in the *British Orthodontic Society News* that: 'small facebow retaining elastics are difficult for the patient to use,'[11] my experience has been quite the opposite. With the exception of a very small number of patients with marked manual dexterity problems, the idea and the use of these elastics is quickly assimilated.

The orthodontic specialty may have to accept that the use of any form of extraoral appliance carries with it a risk, but with the correct use of both extraoral and intraoral safety devices, this risk can be kept at an acceptably low level.

I have in the past been required to prepare an expert opinion for a plaintiff who lost an eye. Seeing a 15-year-old girl suffer such a loss made me determined to make every effort to teach, practise and advocate measures that contribute to the reduction in the incidence of such accidents.

### *14.1.7 Headgear Compliance*

Matie Grobler

Never give a neck pad with a cervical traction appliance until the patient complains that the elastic neck band hurts or irritates the skin around the neck and that they cannot wear the appliance. Given the neck pad, they now have no reason for not wearing it. Fewer than 5% ever need the neck pad.

**Editor's Comment**

The current literature is replete with alternatives to headgear therapy. This publication is not intended to provide a list of all the available alternatives, but as an example, a study by Santiago de Lima et al. showed that the effects of the Jasper Jumper and the activator-headgear combination followed by fixed appliances were similar in Class II malocclusion treatment.[12] Further examples of an alternative to headgear therapy are presented below.

## 14.2 FIXED FUNCTIONAL APPLIANCES: ADVANSYNC 2 CORRECTOR

Glenn Cooper

Functional appliances often used for the correction of Class II malocclusions may be either removable or fixed. For a number of years I have used both types and I have found that the main advantage of a fixed functional appliance is the improved compliance obtained by having an appliance cemented to the teeth.

**Pearl:** This improved compliance contributes to an increased success rate and a reduction in overall treatment time as the fixed appliances are fitted simultaneously with the fixed functional eliminating the need for two-phase treatment.

The AdvanSync2 (Ormco Corporation) fixed functional appliance originally developed by Doctor Terry and Bill Dischinger has since been modified to improve patient comfort and facilitate enhanced lateral jaw movement (Figure 14.8).

The telescopic arms are 50% shorter than those in traditional Herbst appliances reducing discomfort and cheek irritation. The arms also sit further back in the mouth for a more discreet appearance. Speech is unaffected unlike removable functional appliances.

The AdvanSync2 kit is supplied with upper and lower left and right first molar bands in four sizes with housings for attaching the telescopic rods. The four sizes should fit 95% of patients. In the kit are left and right telescopic rods with Hex screws to attach the rods to the housings, 1 mm and 2 mm spacers to advance the appliance as necessary, and Hex keys to tighten the screws securing the rods to the housings. There are also extenders in the kit to extend the housings buccally where the molars are in standing (rarely used) (Figure 14.9).

**Figure 14.8**

AdvanSync2 appliance – left side unit.

### 14.2.1 Step by Step Fitting

1. Place separators on all first molars.
2. One week later, bond upper and lower arches from second premolar to second premolar with fixed appliances. In the lower arch bond the premolars closer to the gingival margin to facilitate levelling as the buccal tube on the molar bands are placed low down close to the gingival margin. Select the best fitting bands to get a tight mechanical fit. The bands can be crimped to fit better (see Chapter 12). If the gingival tissues blanch excessively, the bands can be trimmed with a stone.
3. Remove the bands from the mouth and working outside the mouth, connect the telescopic rods to the *distal* hole on the upper bands. Dip the screw in Ceka Bond dental thread locker an anaerobic medical grade adhesive to secure the hex screws into the housings. (Preat Corporation 100 S. 4th Street Grover Beach, CA 93433 USA).
4. Place toothpaste in all the slots and tubes on the bands to prevent cement from blocking the slots and tubes.
5. Cement all the bands using dual-cure glass ionomer orthodontic band cement.
6. Lace the upper arch together from first molar to molar using an underwire ligature wire. This is to obtain a maximum orthopaedic effect and ensure the maxillary molars do not distalize as individual units.
7. Place the initial upper and lower aligning archwires into the slots and cut the distal ends.
8. Now, working intraorally connect the telescopic rods to the *mesial* hole of the lower band housing using fixing screws dipped in Ceka Bond.

### 14.2.2 Patient Instructions

In addition to the usual fixed appliance instructions, inform the patient that it will take


**Figure 14.9**

Standard kit supplied with prewelded attachments and all necessary components.

up to a week to adapt to the AdvanSync2. There may be some discomfort and some difficulty in eating; however, patients do adjust surprisingly well. There is also a risk of a screw coming loose at times. Patients need to be aware that this can occur. If this does happen the patient needs to return to the practice for reattaching the screw as soon as possible.

**Pearl:** At the start it is important to reduce the overbite by intruding the lower incisors to prevent a posterior open bite when the mandible is advanced to a Class III bite.

In a case with malaligned lower anterior teeth, place a 0.356 mm (0.014 inch) nickel-titanium wire sectional arch from lower left to right second premolars. In cases presenting with a deep overbite, it is necessary to reduce the overbite in order to allow the mandible to move forward under the influence of the AdvanSync2. The overbite is reduced by placing an 0.406 mm × 0.559 mm (0.016 × 0.022 inch) stainless steel overlay archwire with a 30 degree tip-back bend, into the molar tubes. The overlay archwire is tied to the anterior teeth using steel ligature ties between the canines and lateral incisors. To prevent the premolars from possibly tipping lingually, they can also be tied to the overlay archwire between the first and second premolars. The importance of reducing the overbite is particularly relevant in Class II division 2 malocclusions: the upper incisors need to be proclined and the lower arch levelled before placing the telescopic rods. If this is not done then the mandible cannot move forward and a vertical component of force is created resulting in intrusion of the molars and an increase in the Curve of Spee.

### 14.2.3 Appointment Scheduling

The orthodontic alignment and progression into larger wires is the same as normal treatment. In addition it is necessary to reactivate the telescopic rods by adding the 1 mm and 2 mm spacers every three months until a reverse overjet is achieved and overcorrection of any midline discrepancies is completed.

**Pearl:** The ability to add spacers selectively and unilaterally is a significant benefit as many Class II malocclusions present with slight asymmetries.

The spacers are cinched closed on the thinnest part of the telescopic rod using special pliers, made to cinch the spacers, which have circular cut-out to hold the spacers (Ormco Corporation).

Once overcorrections have been attained, leave the appliance in place for a further 3–4 months before removing the bands and functional appliance. Full correction should be achieved in six months.

### *14.2.4 Appliance Removal*

The bands cannot be removed with conventional band removers because of the rigidity of the band material and furthermore, the molars may be slightly mobile. It is advisable to cut through the bands with a high speed diamond burr on the mesiobuccal and distobuccal line angles and remove the band using Weingart pliers grasping the housing of the bands.

Clean off all excess cement and schedule another appointment one week later to bond conventional tubes on the first and second molars and continue the planned orthodontic treatment.

Like any form of appliance treatment, there is a learning curve for the clinician; however, it does not take long to become proficient in the insertion and maintenance of this appliance, and the results are highly satisfactory.

## 14.3 A TREATMENT METHOD FOR CLASS II DIVISION 1 PATIENTS WITH EXTRACTION OF PERMANENT MAXILLARY MOLARS

Hans Booij

Through the years a great variety of options for the treatment of Class II malocclusions have been presented, there are orthopedic, functional, nonextraction and extraction procedures. Of course as an orthodontist, your preference of choice depends on the character, the severity of the malocclusion, your background, and your training. Recent alternatives offered in the literature are miniscrew implants and sub-mucosal bone anchored miniplates (see Chapter 17). No doubt evidence-based studies will continue to produce opinions on the optimal treatment solutions for the individual patient.

Clearly it is outside the scope of this presentation to discuss the diagnosis and treatment planning aspect of Class II malocclusions. It is assumed that the case requires Class II correction and that one of the options would be the extraction of maxillary first molars.

The views presented in this presentation are based on my philosophy related to achieving tooth movement which to a large part is independent of patient cooperation and reduced concern with anchorage preservation by means of extraoral support or skeletal anchorage. For this form of treatment, low friction brackets and long molar tubes are a prerequisite.

**Pearl:** This approach involves extraction of upper first molars to facilitate the rearrangement of the dentition and the occlusion incorporating the natural tendency for mesial drift of the upper second molars and distal drift of the upper premolars.

Low orthodontic forces will do the job. So 'Mother Nature' is helping the orthodontist and of course this benefits the patient. As a prerequisite, the anatomy of the second molars must be acceptable and the upper wisdom teeth, the so called 'hidden molars', have to be present. In adolescents, these third molars will erupt earlier after extraction of the upper first molars, as described by Livas.[13]

**Pearl:** With the upper wisdom teeth in occlusion, the finished case looks like a nonextraction case showing an 'eight premolar smile' generally even more attractive than after premolar extraction.

At the start of treatment the second upper molars must be erupted; they have to be banded.

### 14.3.1 Treatment Protocol

Class II correction after upper first molar extraction is a so called 'low compliance treatment'. In most cases the boy or girl needs to change the horizontal elastics in the upper arch only once a week. After a short while the patient will see a decrease of the extraction space and a decrease of the overjet and overbite, this encourages, motivates and optimizes the treatment progress (Figures 14.10 through 14.12).

In case of a deep overbite, treatment is started with a bite plate in the upper jaw and fixed appliance in the lower. If necessary mild tooth stripping of the lower arch can be done generally between the lower canine and first premolar.

The initial archwire is a 0.36 mm (0.014 inch) Light Lower Accuform Medium Sentalloy (Dentsply). After about two months the second and last lower arch is placed. This is a custom-made 0.46 mm (0.018 inch) Australian special plus archwire (G&H Wire Company; Franklin, IN, USA). Minor corrections may be necessary with the placement of (small) horizontal and vertical offsets. Using the initial plaster models, the original arch form and dimensions are maintained as far as possible. Anchor bends mesial of the first molars and v-bends between the premolars and between the canines and first premolars will open the bite. The combination of the upper bite plate and fixed appliance in the lower arch will result in intrusion of the lower incisors and some extrusion in the lower buccal regions. The vertical position of the upper front teeth remains unchanged and often this is desirable.

In most cases the upper first molar extractions can be carried out after five months. Two to three weeks after the extractions, the bite plate is abandoned, the upper second molars are banded and the upper front teeth are bonded (Figure 14.13).

Upper premolars are only bonded after achieving a Class I premolar relation in order to minimize binding during the Class II correction phase. To make the treatment procedure clearer, we have divided it in three phases: the


**Figure 14.10**

(a) Pretreatment full face. (b) Pretreatment profile.

**Figure 14.11**

Pretreatment occlusion. (a) Right; (b) centre; (c) left.

**Figure 14.12**

Start of active treatment with a lower fixed appliance and upper removable incorporating an anterior bite plane. (a) Right view; (b) front view; (c) left view.

already mentioned Class II correction phase, the space closure and torque phase, and the detailing and finishing phase.[14]

Second molar control is enhanced by the use of a palatal bar and anchor bends placed ±5 mm mesial of the molar tubes.

In total only two maxillary archwires are required, the first is custom made 0.41 mm (0.016 inch) premium plus pull straightened Australian wire (G&H Wire Company). Circles bent into the archwire mesial of the canine brackets prevent the arch from excessive sliding. High hat lock pins (TP Orthodontics, Inc.) are placed in the upper canines with the gingival oriented hook bend to the mesial to host the light 8 mm (5/16 inch) horizontal elastics to the buccal ball end hooks on the second molars. The patient and the parents are instructed to replace the elastics once a week. It is important to instruct the patient not to use the circles to attach the elastics; only the canines must move/slide along the arch. In cases where the incisors

**Figure 14.13**

Following extraction of maxillary first molars, fixed appliances fitted to the maxillary teeth excluding the premolars. Intraoral elastics from maxillary molars to the canines. (a) Right view; (b) front view; (c) left view.

**Figure 14.14**

Brackets bonded to the maxillary premolars. Note the movement of the canines and premolars into a Class I relationship. Reduced overbite. Sectional Co-Ax wire to align the UR2. (a) Right view; (b) front view; (c) left view.

are malaligned, I use a sectional 0.41 mm (0.016 inch) Co-Ax wire canine to canine. (For example, see Figure 14.14a.) The incisors are tied to the main arch with steel ligatures. In this way the anchor bends in the main archwire can maintain good vertical control while the anterior teeth are being aligned and the elastics are active on the canines (Figure 14.14).

To accelerate the Class II correction the use of medium 8 mm (5/16 inch) Class II elastics can

be considered; in that case the patient is instructed to replace them every day. The Class II elastics are also placed from lower molar to the high hat pins on the canines. In case of an asymmetry the unilateral use of Class II elastic could be the solution. The patients are seen at seven to eight week intervals.

At the control visits the distal ends of the upper archwire have to be adjusted and the orthodontist has to analyse the treatment progress in a precise way. For example, partial grinding of the lower premolar brackets may be necessary to avoid occlusal interference and to facilitate distal drift of the upper premolars. It is fun to see the development of spontaneous spaces between the upper premolars; these teeth really want to move to the distal.

Generally after five months, a Class I premolar occlusion is established. Now time has come to bond the upper premolars and to adjust the upper archwire. Place v-bends and anchor bends to prevent deepening of the bite. So, look at the initial situation and judge how the teeth have reacted to the orthodontic therapy so far. Large individual variations are possible which may require some adjustments. In some cases spacing between the upper front teeth may need to be closed at this time using small elastics from the canine brackets to the circles in the archwire. The use of Class II elastics can be restricted to night use only or even be stopped.

The next visit can be scheduled in four weeks. Are the spaces between the upper front teeth closed? Yes, then the second phase, space closure and torque, is started (Figure 14.15). This is the second archwire. A custom-made 0.46 mm (0.018 inch) Australian special plus archwire is placed in combination with a 0.36 mm (0.014 inch) Australian regular wire two spur torque auxiliary and power chain in the buccal segments for closure of the remaining extraction spaces. Is this a straight archwire? No, again, as necessary small horizontal and vertical steps are bent in this second and last main arch. At this stage, the orthodontist really has to concentrate on all the details in the mouth. If indicated, uprighting springs (TP Orthodontics, Inc.), can be placed on the upper canines. Based on the orthodontist's evaluation of the anchorage situation, the palatal bar can be removed, to facilitate the mesial

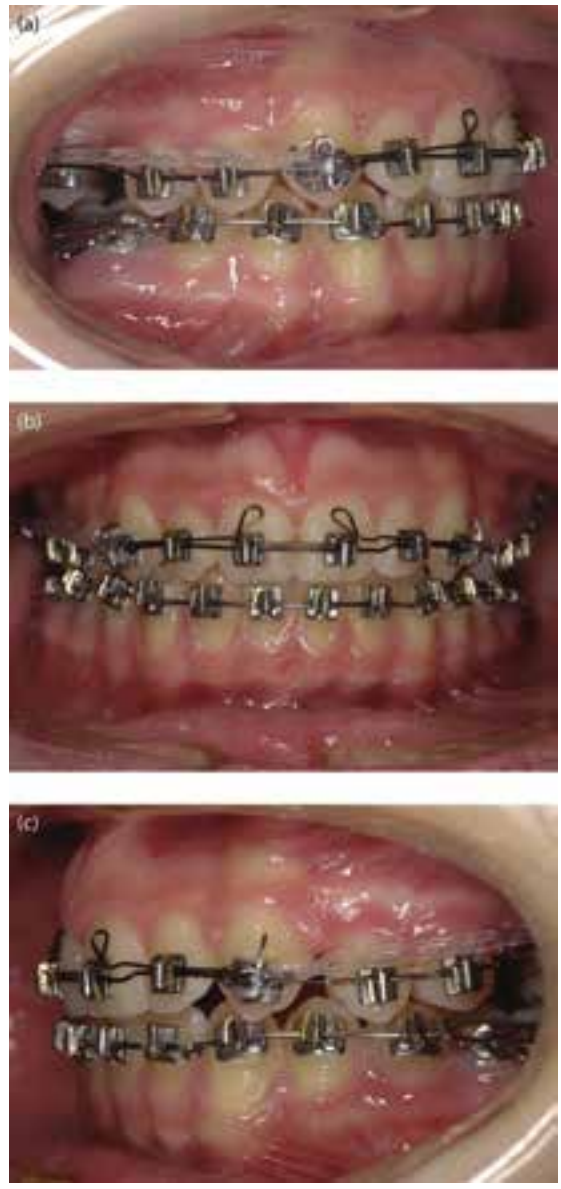


**Figure 14.15**

Note 0.46 mm (0.018 inch) Australian special plus archwire is placed in combination with a 0.36 mm (0.014 inch) Australian regular wire two spur torque auxiliary and power chain in the buccal segments for closure of the remaining extraction spaces. (a) Right view; (b) front view; (c) left view.

movement of the second molars. Again the orthodontist has to judge the necessity or otherwise for Class II elastics.

The seven to eight week intervals are back again. At these visits, the power chains are renewed and if an extraction space is totally closed, the distal end of the arch is tightly bend distal of the second molar tube. The beauty of this phase is the balance of torque forces and lateral space closure but, of course large individual differences can occur. In the last phase, the finishing phase, adjustments are made in the arch wires and if necessary the palatal bar can be adjusted to correct molar root torque. Check the degree of anterior root torque; the best way to do it is to request the patient to stand up and show the teeth, I favour the procedure and criteria for examining anterior aesthetics as described by Zachrisson (Figure 14.16).[15]

My method of choice for retention is the placement of bonded custom made retention wires from canine to canine in both arches. To prevent the over eruption of lower second molars check the contact between the distal ridge of the upper second molar and the mesial ridge of the lower second molar; if there is no contact, bond a piece of retention wire on the buccal surface of the lower first and second molars. This is removed after the generally early eruption of the upper wisdom teeth (Figure 14.17).

**Pearl:** I want to stress the simplicity of the materials needed for this treatment concept. Just two arches in both jaws, the brackets are simple and inexpensive and some bands and a palatal bar complete the instrumentation. I believe this treatment protocol could be of great help in areas of the orthodontic world where material costs are a factor, but orthodontic knowledge and manual skills are present.


**Figure 14.16**

Final occlusion, note the Class I occlusion of the maxillary second molar with the mandibular first molar and the reduced overbite. (a) Right view; (b) front view; (c) left view.

I am aware that there are many appliance systems (generally more expensive) that have been designed to simplify clinical treatment but in cases where first maxillary molar extractions are an option, the system I have described is capable of delivering excellent results. However, if the clinician wishes to translate this concept to other bracket systems, they need to ensure the use of minimal friction brackets and as an adjunct I would recommend using a Begg bracket (TP Orthodontics, Inc.; 256-Begg bracket bicuspid) for the upper canines. This makes use of optimal sliding effects and prevents vertical complications. After uprighting of the canine at the end of the

**Figure 14.17**

Two years post-treatment. Note the eruption of the maxillary third molars into occlusion with the mandibular second molars and the stability of the reduced overbite. (a) Right buccal occlussion, (b) front occlusion and (c) left buccal occlusion.

second phase, the bracket can be replaced by another bracket of personal choice.

This form of appliance therapy was first described by Williams in 1979[16] and fine-tuned by this author.[14] Stalpers et al.[17] reported a 90% improvement of the peer assessment rating index in a group of 100 Class II division 1 patients, thus demonstrating the efficacy of this approach. A number of studies have evaluated the cephalometric and clinical results obtained with first molar extraction cases Figure 14.18 and 14.19.[18,19]

## 14.4 LATERAL MOLAR EXPANSION

The desirability or the final stability of lateral molar expansion is dependent on establishing the correct diagnosis, treatment plan and appliance selection. There are many well-documented conventional fixed and removable expansion appliances, some will tip the teeth, some will move them bodily, and some will contribute to a limited degree of skeletal base expansion. Certain interesting useful variations are described in this section (Figure 14.20).

### *14.4.1 Overlay Arch*

The overlay or 'piggyback' arch is a useful adjunct for this procedure. This auxiliary requires double buccal tubes on the maxillary molars either bonded or preferably welded to conventional bands. The expanding arch is constructed from 0.914 mm (0.036 inch) stainless steel wire. Using the patient's maxillary study model, the wire is bent to conform approximately to the dental arch, and estimated to just touch the labial surface of the fixed brackets on the incisor teeth. Insert the arch into the headgear tubes and place a mark on the expanding arch at the mesial opening of the tubes. Remove the auxiliary from the mouth, bend a lingual molar offset, and cut the distal extensions so that the ends just protrude through the buccal tubes. This is a heavy gauge wire and not easy to bend; use heavy duty pliers and cutters. The arch should be widened and expanded in the molar region by approximately 13 mm (0.5 inch) on either side. The expanding arch will need to be firmly squeezed while being inserted into the headgear tubes on the maxillary molars. Once the activated arch has been placed in position,

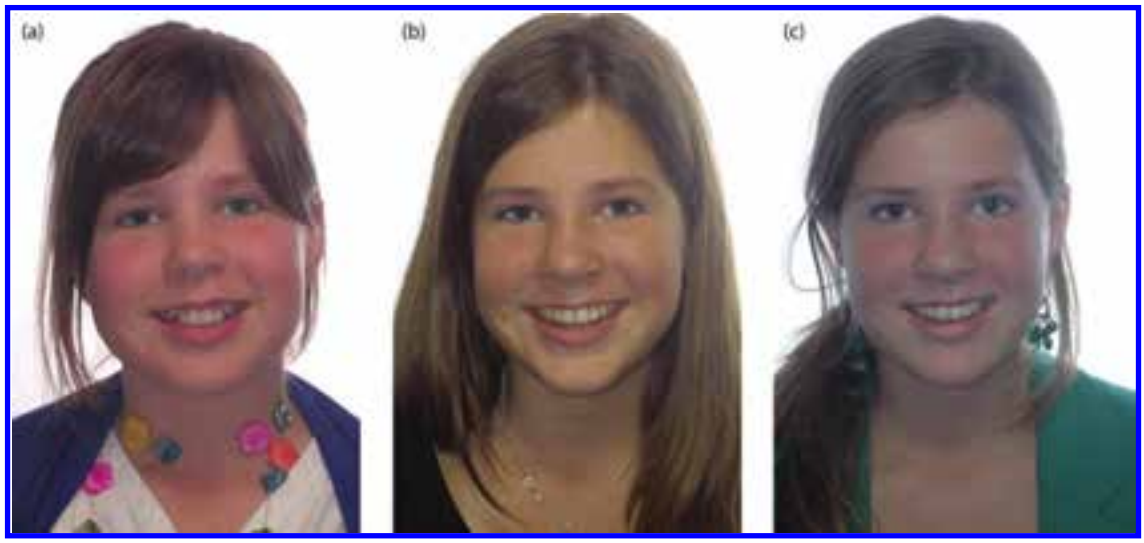


**Figure 14.18**

Full face images, note the broad smile. (a) Start of treatment (16/06/2009); (b) end of treatment (30/08/2011); (c) one year later (12/09/2012).


**Figure 14.19**

Profile images, note the favourable changes with treatment and maturation. (a) Start of treatment (16/06/2009); (b) end of treatment (30/08/2011); (c) one year later (12/09/2012).

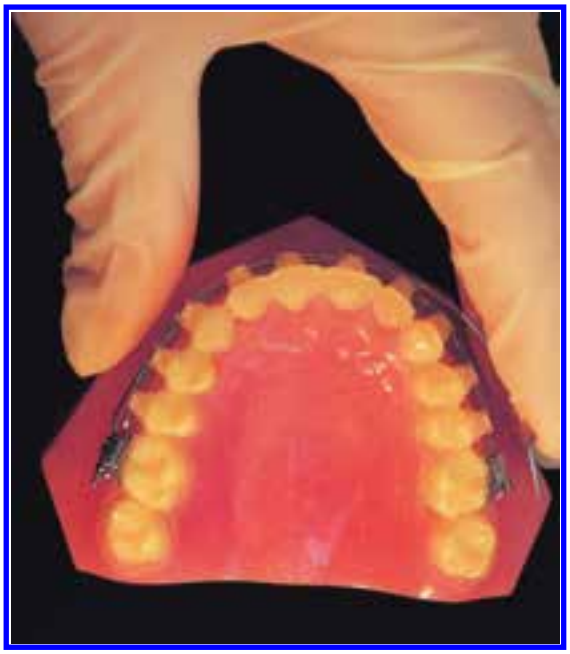

**Figure 14.20**

The overlay, 'piggyback' auxiliary expansion arch. The expanded arch is first placed into one buccal tube and then squeezed to engage the buccal tube on the other side.

to prevent dislodgement, it should be tied with ligature wire to the brackets and existing archwire in the buccal and anterior segments.

This expanding auxiliary may also be used in the mandibular arch provided the mandibular molar bands have double buccal tubes.

This appliance is very efficient and needs to be monitored regularly to prevent excessive molar expansion.

The advantages of this expanding auxiliary are

- The ease of construction
- Simple design
- Can be fitted and removed without interfering with any existing appliance
- Works efficiently
- It is not dependent on patient co-operation
- In contrast to crossbite elastics, it has no vertical component of force contributing to molar extrusion

As with a removable palatal expansion appliance or crossbite elastics, there will be a degree of buccal tipping of the molars. Depending on the requirements of the case, this tipping may either be desirable or not; if not, then molar buccal tipping may be counteracted by the incorporation of buccal root torque in the existing archwire.

## *14.4.2 Rapid Maxillary Expansion*

Brett Kerr

The concept, rationale for use, design, construction, and fitting of rapid maxillary expansion appliances have been well documented and discussed in the literature. Following completion of the expansion and the consolidation period of about three months, the cemented appliance is generally removed with conventional band-removing pliers. This may be an uncomfortable procedure particularly for young, sensitive patients. In order to make this procedure more comfortable, I have taken to weakening the bands prior to cementing the appliance (Figure 14.21).

**Pearl:** Use either a cutting disc or a diamond burr to cut a gingival vertical notch on the mesiobuccal surface of each band. Do not cut more than half the height of the band.

The cut should be placed on the mesiobuccal aspect to allow for easy access if you wish to use a band slitting pliers or a burr. I have never had a problem with the appliance becoming loose during treatment. The removal of such a weakened appliance is comfortable for the patient.

**Editor's comments**

When we contemplate the pros and cons of fitting a rapid maxillary expansion appliance, apart from the occlusal changes that we intend to achieve, I hope that we do not forget the significant increases in nasal cavity volume, nasopharynx volume, and the changes that will occur in facial height, palatal, and mandibular planes.[20–22]

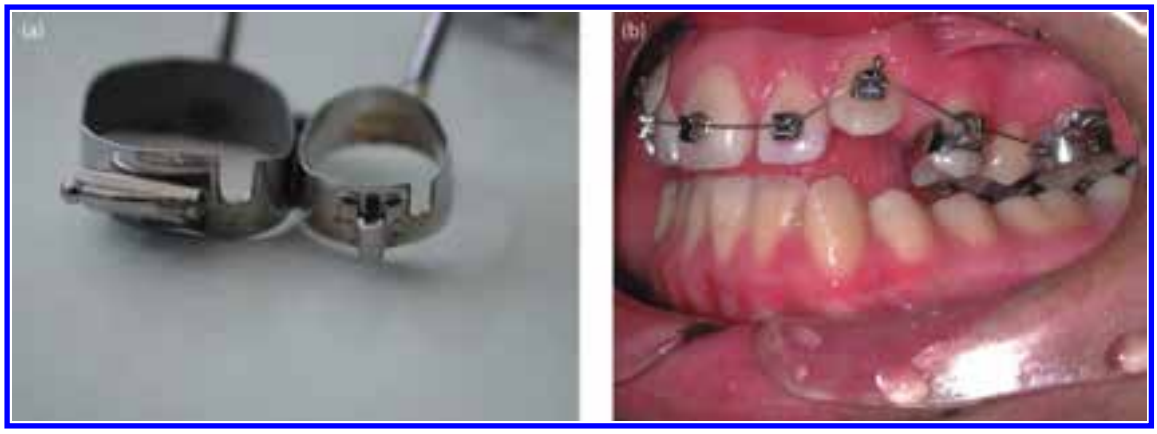

**Figure 14.21**

(a) Modified rapid maxillary expansion appliance weakened to facilitate removal. The molar and premolar bands are weakened by cutting a notch in the mesiobuccal region. (b) Rapid maxillary appliance *in situ* showing the position of gingival notches cut in the premolar and molar bands.

### *14.4.3 Stabilizing Molar Bands in an Impression*

Brian Nebbe

In the construction of certain appliances, such as lingual arches or rapid maxillary expansion appliances, impressions are taken over bands fitted to molar and/or premolar teeth. These bands are then placed in the impression prior to casting. Unless the casting is done very carefully, it is possible for these bands to become dislodged during the casting process. To assist in holding the band firmly in position in the impression, place a drop of superglue (cyanoacrylate) on the lingual aspect of the band in contact with the impression material. This glue will set rapidly when it comes into contact with moisture. This technique has also been reported by Lisenby and Bowman.[23]

## 14.5 ALIGNING DISPLACED SECOND MOLAR TEETH

Not infrequently, both maxillary and mandibular second molar teeth erupt during treatment, either displaced to the buccal or lingual, or rotated. Often, it is not possible to incorporate or engage these displaced teeth into the line of the main archwire. Under these circumstances using a sectional auxiliary is a useful adjunct.

Depending on the position of the tooth it is necessary to fit either a conventional band with a buccal tube and a lingual cleat, or to bond a buccal tube. In cases where only a small area of buccal, lingual, or occlusal enamel surface is available, it may not be possible to place a conventional band or molar tube. In such cases, it is usually possible to bond a small single molar tube or a conventional Begg light-wire bracket in a horizontal orientation rather than the conventional vertical orientation; this bracket acts as a small buccal tube. Depending on which auxiliary or what movement will be required, the archwire slot may face mesially or distally. The design of the auxiliary and the attachment on the second molar will be dictated by the position of the second molar and its relationship to the first molar.

### *14.5.1 Uprighting Second Molars*

#### 14.5.1.1 Separating Springs and Elastomerics

If the second molar is only mildly mesially tipped and engaging the distal cervical region

of the first molar, construct a separating spring from 0.711 mm (0.028 inch) wire and slip it between the contact points. The design of the spring is similar to the separating springs marketed by TP Orthodontics, Inc., USA (Figure 14.22).

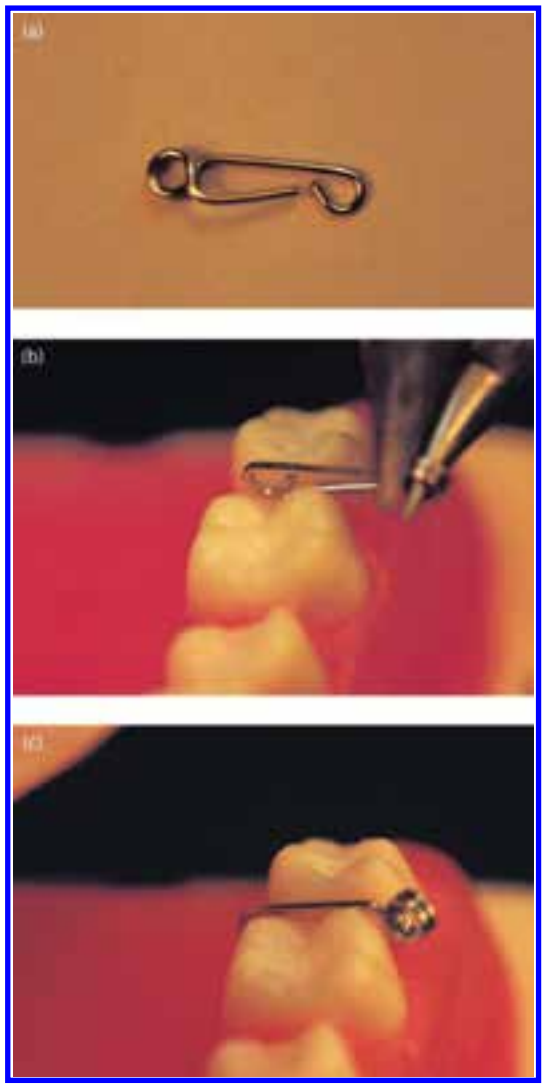

**Figure 14.22**

(a) Separating spring constructed from 0.7 mm (0.028 inch) stainless steel wire for reducing mild mesial second molar impaction. (b) Placing the separating spring, one arm above the contact point, the coil opened, and the other arm slipped below the contact point. (c) Separating spring in position.

The spring is fitted with the gingival arm slipping under the contact point; this procedure is sometimes a little difficult and initially uncomfortable for the patient. The spring should be left in place for about three weeks then removed, the area well irrigated with water, and if necessary replaced, and the procedure repeated until the second molar disengages from the distal surface of the first molar.

Still remaining with the concept of using separators, Cerny described a technique to resolve mild impaction using jumbo separators. Instead of using conventional elastomeric ring separators, he used commercial black 'O'-rings, 6 mm (0.24 inch) in diameter and 2 mm (0.08 inch) thick.[24] These are sterilized in a conventional manner, softened in hot water, and then gently stretched through the contact points using fine needle holders. Following conventional separators the use of jumbo separators can move teeth up to 2 mm (0.08 inch) apart.

#### 14.5.1.2 Sectional Arches and Jigs

Where the second molar is mesially tipped and it is still possible to bond a conventional buccal molar tube, then the simplest auxiliary comprises a straight section of 0.356 mm (0.014 inch) nickel-titanium wire slipped through the buccal tube on the first molar or tied to the bracket on the first molar and extended into the tube on the second molar. The mesial end of the sectional should be bent 90 degrees, leaving a vertical extension of 4 mm (0.16 inch); cut off the rest of the wire. The sectional arch is tied with ligature wire to either the canine or premolar teeth (overlying the main archwire). The presence of a vertical channel in the brackets makes this procedure much easier (see Chapter 12). From the gingival aspect, the vertical extension of the auxiliary is slipped into the vertical slot of the bracket and the excess protruding from the occlusal is firmly gripped with small pliers and bent over the bracket. It is essential to ensure that the sectional wire cannot slip or become dislodged in either a mesial or distal direction. As the tooth uprights, the sectional auxiliary can be changed to a 0.406 mm (0.016 inch) nickel-titanium or stainless steel wire and the wire size or stiffness increased until the tooth has aligned

sufficiently to allow engagement of the main archwire into the tube on the second molar tooth.

#### 14.5.1.3 Partial Eruption

If the second molar tooth is partially erupted and needs considerable active distal movement, the chances are that there is only a limited amount of buccal enamel exposed. Under these conditions, it is usually possible to bond a horizontally placed Begg bracket with the archwire slot facing mesially. The auxiliary is constructed from a straight length of 0.406 mm (0.016 inch) stainless steel wire (Figure 14.23).

Bend a 3 mm (0.12 inch) vertical offset at the distal end of the auxiliary – the distal horizontal section should not exceed approximately 3 mm (0.12 inch); this section is slipped into the horizontal Begg bracket and the vertical arm of the offset should lock into the archwire slot of the bracket. The anterior section extends mesially and is marked with a pencil opposite the canine area, removed from the mouth and an eyelet or mesially directed hook bent at the mesial end of the sectional. The sectional auxiliary is replaced in the mouth and tied with ligature wire to the first molar and canine tooth (overlying the main archwire). To create a distally directed force against the mesial end of the bracket on the second molar, an elastomeric chain, thread, or a nickel-titanium coil spring with eyelets is tied from the mesial hook on the first molar to the hook or eyelet at the mesial end of the sectional auxiliary. Be careful not to leave too much wire extending distally to the bracket on the second molar, as it will impinge on the soft tissues and lead to irritation and swelling of the soft tissues in a region where oral hygiene is a problem and gingival swelling interferes with access to the crown of the second molar. It is essential to monitor the movement of the second molar to ensure it is not driven too far distally into the soft tissues and bone of the ascending ramus of the mandible. It is assumed that the clinician will have assessed and taken into account the presence and position of the unerupted third molar. Once the tooth has moved distally sufficiently to relieve the mesial impaction, the force vector and auxiliary will need to be changed to encourage vertical eruption.

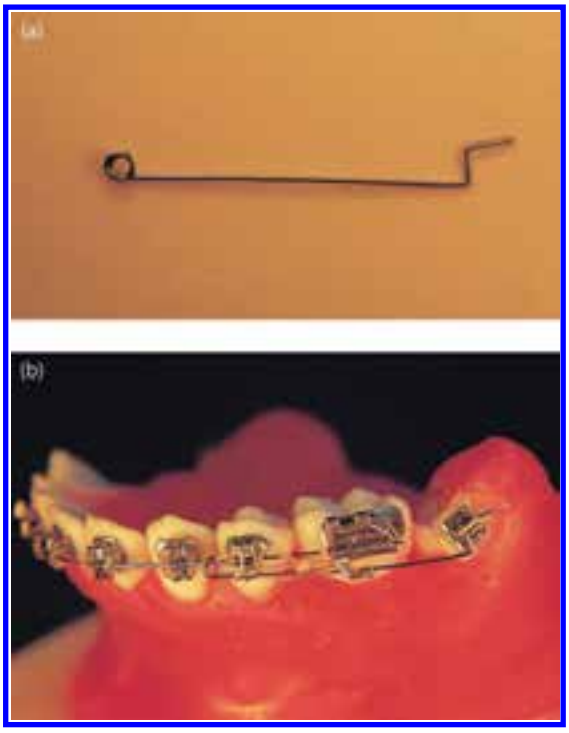


**Figure 14.23**

(a) Auxiliary for distal movement of a mesially impacted second molar, using elastic traction. (b) Auxiliary for distal movement of a mesially impacted second molar. Distal force generated by an elastic tie from the auxiliary eyelet to the first molar hook.

To assist the vertical eruption, it may be possible to place a horizontal high hat pin (TP Orthodontics, Inc., USA) through the bracket slot, bend the tail gingivally, and hook a vertical up-and-down elastic from the mandibular second molar to the maxillary first or second molar.

Santoro et al. approach the impacted mandibular second molar from the lingual aspect.[25] A palatal sheath is bonded to the lingual of the first molar tooth and a transpalatal arch from which one end has been cut off is bent to fit into the lingual sheath, and extended along the lingual of the alveolus to the distal of the second molar. The end is formed into a loop from where an elastomeric thread or chain is tied to a button bonded to the occlusal surface of the partially impacted second molar.

With a partially erupted second molar, Park recommends bonding a lingual button on the

partially exposed occlusal surface and a conventional band on the first molar.[26] He bends an uprighting spring from 0.356 mm (0.014 inch) high tensile stainless steel wire. At one end a hook is bent to engage the lingual button on the occlusal of the second molar and at the other end of the spring he places a stop which will rest against the distal opening of the buccal molar tube on the first molar. The spring is inserted into the distal opening of the buccal molar tube and the hook of the spring engaged on the lingual button. The degree of distal activation will depend on the position of the stop and can be adjusted as required. The wire projecting through the mesial opening of the molar tube is bent gingivally to prevent dislodgement.

#### 14.5.1.4 Dis-Impacting Mandibular Second Molar Teeth

Farah R Padhani

Bond a horizontally orientated Begg bracket to the exposed buccal surface of the second molar and bond a double buccal tube on the first molar. Construct the auxiliary from 0.406 mm (0.016 inch) stainless steel wire. At one end, bend a horizontal stop to engage the horizontal slot of the Begg bracket. As the wire extends mesially place a mark opposite the contact between the first and second premolar teeth and at this point bend a full helix with the free end extending back distally. This section passes through the auxiliary tube on the first molar and extends distally; anneal this section of wire. Replace the auxiliary in the mouth, grip the wire extending distal to the molar tube with pliers, pull distally and bend the extension so that it cannot retreat into the molar tube (cinch the auxiliary) (Figure 14.24).

This will have the effect of bowing the gingival section of the auxiliary and exerting a distally directed force on the second molar.

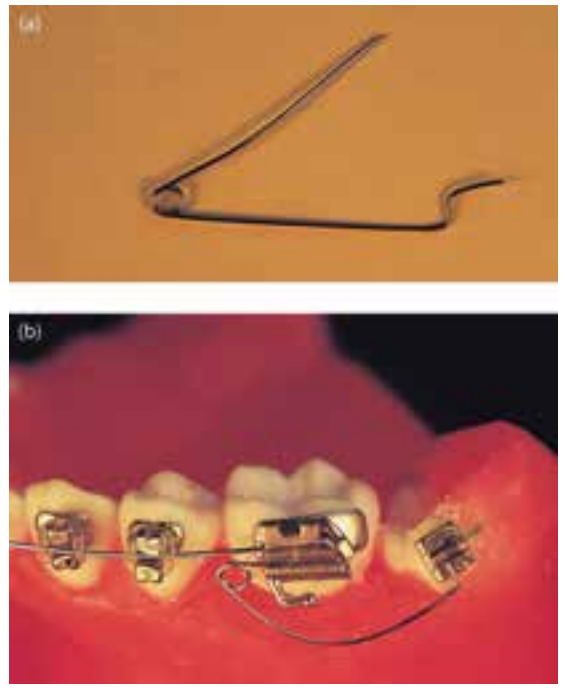


**Figure 14.24**

(a) Auxiliary for distal movement of a mesially impacted second molar; incorporating a helix. (b) Auxiliary for distal movement of a mesially impacted second molar. Distal force generated by cinching back the distal extension of the helix as it exits the buccal tube.

### *14.5.2 Horizontally Displaced Second Molar Teeth*

Once again, it is essential to band or bond a buccal tube or bracket on the displaced tooth. The design of the auxiliary will depend on the position and severity of the tooth displacement. On the assumption that the first molar tooth is in its correct position, it should be maintained in this position with the main archwire. The auxiliaries should move the displaced tooth and not the correctly placed first molar.

In the case of a mild displacement, then the simplest auxiliary comprises a straight section of 0.356 mm (0.014 inch) nickel-titanium wire slipped through the buccal tube on the first molar or tied to the bracket on the first molar and extended into the tube on the second molar. The mesial end of the sectional should be bent 90 degrees and tied with ligature wire to either the canine or premolar teeth (overlying the main archwire). As mentioned previously, make sure the auxiliary is well secured to prevent mesial or distal dislodgement.

**Figure 14.25**

Stainless steel sectional arch for palatal movement of a buccally displaced second molar.

### 14.5.2.1 Buccal Displacement

When a maxillary second molar erupts with a buccal displacement close to the end of treatment, Kirshon has developed a technique using a length of 0.547 × 0.635 mm (0.018 × 0.025 inch) stainless steel wire threaded through the first molar auxiliary archwire slot, the distal protruding section bent down at 45 degrees then pushed distally to lie on the buccal surface of the second molar.[27]

Where the second molar is excessively buccally displaced, it will not be possible to thread the auxiliary through the buccal tube on the first molar, as the exit from the tube will be blocked by the mesial surface of the second molar (Figure 14.25).

In such cases, use 0.356 mm (0.014 inch) stainless steel wire extending from the second molar to the canine tooth bypassing the first molar, and tie the sectional auxiliary with ligature wire to the buccal tube or bracket on the first molar. As the second molar moves into a more favourable position, it should be possible to replace the sectional arch with a more rigid steel sectional arch until such time as a new full arch incorporating the first and second molar teeth can be accommodated.

### 14.5.2.2 Palatal Displacement

Where the second molar is excessively palatally/lingually displaced, once again it is not possible to place a sectional arch through the tube on the first molar and then through the tube on the second molar (Figure 14.26).

In such a case, the distal end of a steel sectional arch should be bent back on itself 180 degrees and then slipped into the distal opening of the buccal tube of the second molar. The mesial segment of the sectional arch then overlies the buccal attachment on the first molar and ends at either the premolar or canine tooth. As described above, the sectional arch should be securely tied to the premolars to prevent any dislodgement. Once the tooth is more favourably placed, it becomes possible to gain access to the mesial end of the buccal tube and the auxiliary can be changed.

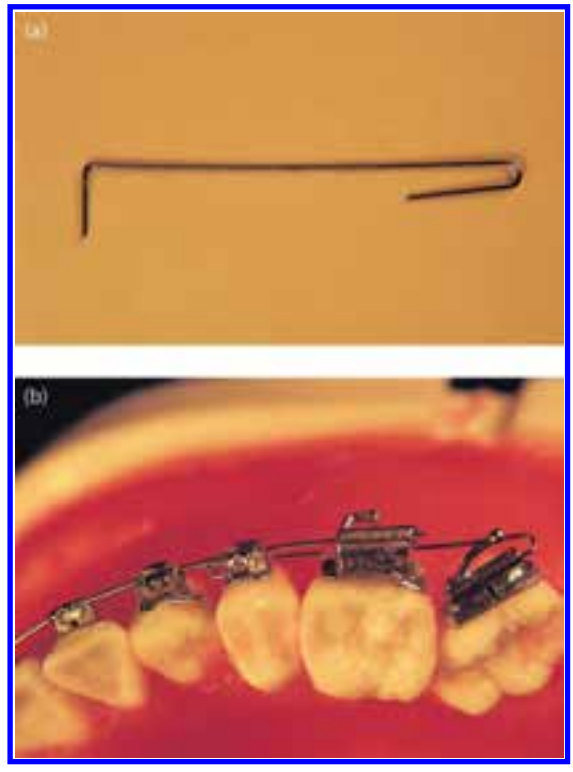


**Figure 14.26**

(a) Stainless steel sectional arch with a reverse back bend for buccal movement of a palatally displaced second molar. (b) Stainless steel sectional arch with a reverse back bend inserted into the distal opening of a buccal tube for buccal movement of a palatally displaced molar.

## 14.6 MANAGEMENT OF UNERUPTED IMPACTED TEETH (SEE CHAPTER 19)

This subject is large and complex. It encompasses careful diagnosis, surgical procedures, and the orthodontic mechanotherapy required to finally place the impacted tooth in good functional occlusion, and an aesthetically acceptable position within the dental arch. This topic is well presented and covered in a textbook by Becker.[28]

A glance at the literature reveals that there are many variations in the auxiliaries and springs that orthodontists use to assist in the eruption and movement of impacted teeth; the design is limited only by the imagination and ingenuity of the clinician. The task of the orthodontist can, in many cases, be greatly eased by the surgical uprighting of impacted mandibular second molars.[29]

A technique was shown to me many years ago by Reed Holdaway but which I have not seen in the literature. This involves the use of a temporary plastic crown, particularly for deeply embedded palatal canines. Request the surgeon to cement an oversized temporary plastic crown (the type used in restorative dentistry) over the crown of the impacted tooth. It does not have to fit accurately and the field of operation does not have to be dry, the temporary crown is loaded with glass ionomer cement, firmly placed into position over the crown of the impacted tooth and left to set. The advantages of this technique are

- The plastic temporary crown artificially lengthens the crown of the impacted tooth
- Prevents closure of the wound thus eliminating any time pressure on the clinician to bond a bracket to the impacted tooth
- Appears to act as a stimulus to encourage eruption of the impacted tooth
- Allows ease of bonding a bracket of your choice on the plastic surface of the artificial crown to apply traction

Once the elongated crown has reached the required position, the plastic crown can be removed with a scaler and any residual cement removed. The surrounding mucosa will be standing away from the enamel surface and a regular bracket may be bonded to the crown of the impacted tooth. Traction will continue until the impacted tooth reaches its final position.

The problems with this technique are

- Persuading the surgeon to acquire and keep a selection of temporary plastic crowns.
- Occasionally, the crown of the impacted tooth may be in too close contact with the root of an adjacent tooth and access to place a plastic crown over the crown of the impacted tooth may not be possible.

In cases where mandibular molars are unerupted, and the last standing teeth are premolars, it is not possible with conventional fixed appliances for an unsupported archwire to extend distally over the unerupted first and second molar teeth. As an alternative, Resch described a fixed lingual arch soldered to bands on the first and second premolars extending distally on the lingual aspect of the unerupted molar teeth.[30] The lingual arch was reinforced with an acrylic covering into which 0.508 mm (0.020 inch) extruding finger springs were embedded. The lingual arch extended to the molar band at the other end of the arch. Following conventional surgical exposure and bonding of a gold chain to the unerupted teeth, the chain was tied to the extruding spring, generating an occlusally directed eruptive force.

## 14.7 DISPLACED MAXILLARY LATERAL INCISOR TEETH

Palatally displaced maxillary lateral incisor teeth are frequently associated with malocclusions displaying varying degrees of dental crowding. In these types of cases, it is good practice to follow one of the basic principles in orthodontics:

> **Pearl:** First create space in the dental arch before moving a tooth into the arch.

This procedure is not difficult and there are many methods of creating space. However, a problem may arise when the lateral incisor is

in crossbite with a lower incisor; a labially bonded bracket will either traumatize the lower incisor (particularly when using porcelain brackets) or is repeatedly sheared off during function.

### 14.7.1 Palatally Displaced Lateral Incisor Teeth

Victor Lalieu

On upper lateral incisors in linguoversion, where a buccally placed bracket interferes with the bite and may thus be fractured; I often bond a Begg bracket on the palatal surface, and ligate this to a nickel-titanium 'piggyback' archwire. Once the tooth is across the bite I rebond on the labial surface with an edgewise bracket upside down to provide the necessary buccal root torque.

A variation on this technique has been described by Smith et al.[31]

### 14.7.2 Palatally Displaced Lateral Incisor Teeth

Farah R Padhani

With a displaced tooth, such as a lateral incisor, I like to bond a horizontally orientated Begg bracket. This acts as a mini-labial tube through which I thread a nickel-titanium 'piggyback' sectional archwire.

#### 14.7.2.1 Missing Lateral Incisor

In many cases where the space is being maintained for an artificial lateral incisor, it is aesthetically desirable to replace this tooth with a pontic during orthodontic treatment. Select a plastic tooth with the correct size, shape, and colour, and adjust it to fit passively in the space available. Bonding a bracket directly to an individual tooth is not easy. It is difficult to hold the tooth, and at the same time bond a bracket at the correct height and orientation. Instead, I prefer to tie an edgewise bracket to the rectangular archwire in the pontic area, place composite on the mesh base, and then move the plastic tooth into position from the lingual approach, with the tooth in the correct position the composite is light-cured.

Prior to moving an incisor tooth across the bite, the anterior overbite can be temporarily reduced by placing glass ionomer cement on the occlusal surface of first or second molar teeth. It is essential to ensure that the mandible occludes evenly on both left and right molars, the cement can be easily ground to achieve an evenly balanced occlusion. This procedure is uncomfortable and interferes with mastication, so the cement should be reduced or removed as soon as the anterior crossbite has been corrected.

The use of a temporary bite raising auxiliary has been described by Guray.[32] He bends a 1.02 mm (0.040 inch) stainless steel wire into a rectangle and the two terminal ends are bent to slide into the mesial and distal opening of the auxiliary buccal tube of the maxillary molar. The rectangle conforms to the occlusal surface of the molar and the palatal side of the rectangle is notched and tied to a palatal cleat or hook on the molar band. When the bite-raising auxiliary is no longer required, it can be removed easily.

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# 15 AUXILIARY SPRINGS FOR CROWN AND ROOT MOVEMENT

Eliakim Mizrahi, Ronald G Melville, Farah R Padhani and André O Hugo

CONTENTS



## 15.1 CORRECTING MESIODISTAL ANGULATIONS

### *15.1.1 Uprighting Auxiliary Springs*

Contemporary orthodontic brackets incorporate built-in tip designed to position the tooth at its correct inclination in the finished occlusion. The final expression of the built-in tip is dependent on careful and correct placement of the bracket in relation to the long axis of the tooth. Variations in the final tip do occur due to variations in manufacture, prescription, crown–root angulations, and placement of the bracket during bonding. The importance of correct final root angulations is highly relevant to achieving root paralleling following extractions and satisfactory aesthetics of the anterior teeth. Notwithstanding the use of prescription brackets, there are occasions when it is necessary or expedient to modify the tooth uprighting procedures with the use of auxiliary springs.

While I acknowledge that the Begg light-wire technique has been largely replaced by the Tip-Edge technique, many of the original principles and auxiliaries used in the Begg technique are still valid and useful adjuncts in contemporary orthodontics. The Tip-Edge technique is still widely used in certain countries.

Uprighting springs and sidewinder springs are used extensively in the Tip-Edge technique (Figure 15.1).

These springs are very effective small intraoral mechanical machines acting in the mesiodistal or sagittal plane; however, they can only be used in combination with a bracket incorporating a vertical slot. While they are most efficient in combination with the light-wire bracket or the Tip-Edge bracket, they can be used with any edgewise bracket provided there is a vertical slot (see Chapter 12).

To be effective with a standard edgewise bracket, the archwire size must allow for sufficient slack within the bracket slot to allow for uprighting of the tooth or the archwire must incorporate a second order bend, which will work in the same direction as the uprighting spring. While uprighting springs and sidewinder springs are commercially available (TP Orthodontics, Inc., USA), there are occasions where it is necessary to bend-up individual

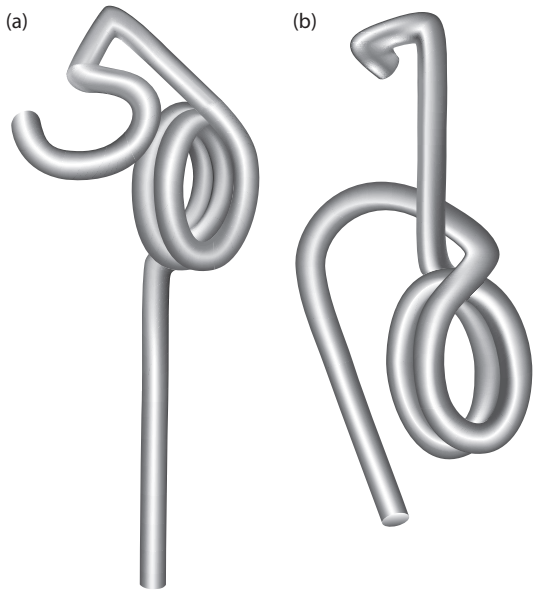


**Figure 15.1**

(a) Uprighting spring for use with a Tip-Edge bracket or any bracket incorporating a vertical slot. (b) Sidewinder spring for use with a Tip-Edge bracket. This spring has been modified from the original design to allow the hook arm to overlie the main archwire, making it less visible. (Photographs courtesy of TP Orthodontics, Inc., USA.)

uprighting springs to suit a specific situation. Variations that may be introduced into an individually constructed spring include different size wires ranging from 0.305 mm (0.012 inch) for mini-springs to 0.356 mm (0.014 inch) for conventional springs and variations in the size of the stem or hook arm of the spring. These may be bent freehand with fine 'bird beak' pliers or by using a jig incorporating three vertical steel posts.

Whenever these springs are used, it is essential to tie the relevant tooth to the main archwire with a steel ligature to prevent unwanted tooth displacement. Furthermore, ensure that the ligature tie does not impede the uprighting action of the spring. It is important to select the correct spring for the desired tooth movement. Clockwise or counter-clockwise uprighting springs are conventionally inserted from the gingival aspect, and the tooth crown will move in the *opposite* direction to the hook arm of the spring. In certain cases it may be expedient to insert the spring from the occlusal direction (as are sidewinder springs). In such cases the tooth crown will move in the *same* direction as the hook arm of the spring.

Uprighting springs constructed from 0.406 mm (0.016 inch) wire and with longer hook arms, can also be used for uprighting molar teeth, provided the buccal tubes incorporate a vertical slot (TP Orthodontics, Inc.). Once again, the main archwire must incorporate a second order bend to work in the same direction as the uprighting spring.

## 15.2 CORRECTING ROTATIONS

### *15.2.1 Rotating Springs*

In contrast to uprighting springs, rotating springs work in the horizontal plane. Selection of either clockwise or counterclockwise springs will produce mesiolabial or mesiopalatal rotations (Figures 15.2 and 15.3).

Once again, these springs are designed to work with brackets incorporating a vertical slot (see Chapter 12). They are equally effective with Begg, Tip-Edge (TP Orthodontics, Inc.), or edgewise brackets, such as Damon self-ligating bracket (Ormco, Inc.), the Butterfly system bracket, and the Stealth bracket (American Orthodontics). In certain twin edgewise brackets that do not incorporate a vertical slot, it may be possible to slip the vertical arm of the spring lingual to the main archwire between the mesial and distal tie-wing elements.

These rotating springs are commercially available (TP Orthodontics, Inc.) and if necessary they can be individually constructed from 0.356 or 0.406 mm (0.014 or 0.016 inch) stainless steel wire. Clinically, they are a very useful adjunct irrespective of which technique is used as there are occasions when it is desirable to rotate a tooth just that little bit extra; in such cases it is possible to place a rotating spring to achieve the desired tooth movement without having to remove the entire archwire. These springs will work on flat-surfaced incisors as well as on curved labial surfaces of canines and premolars.

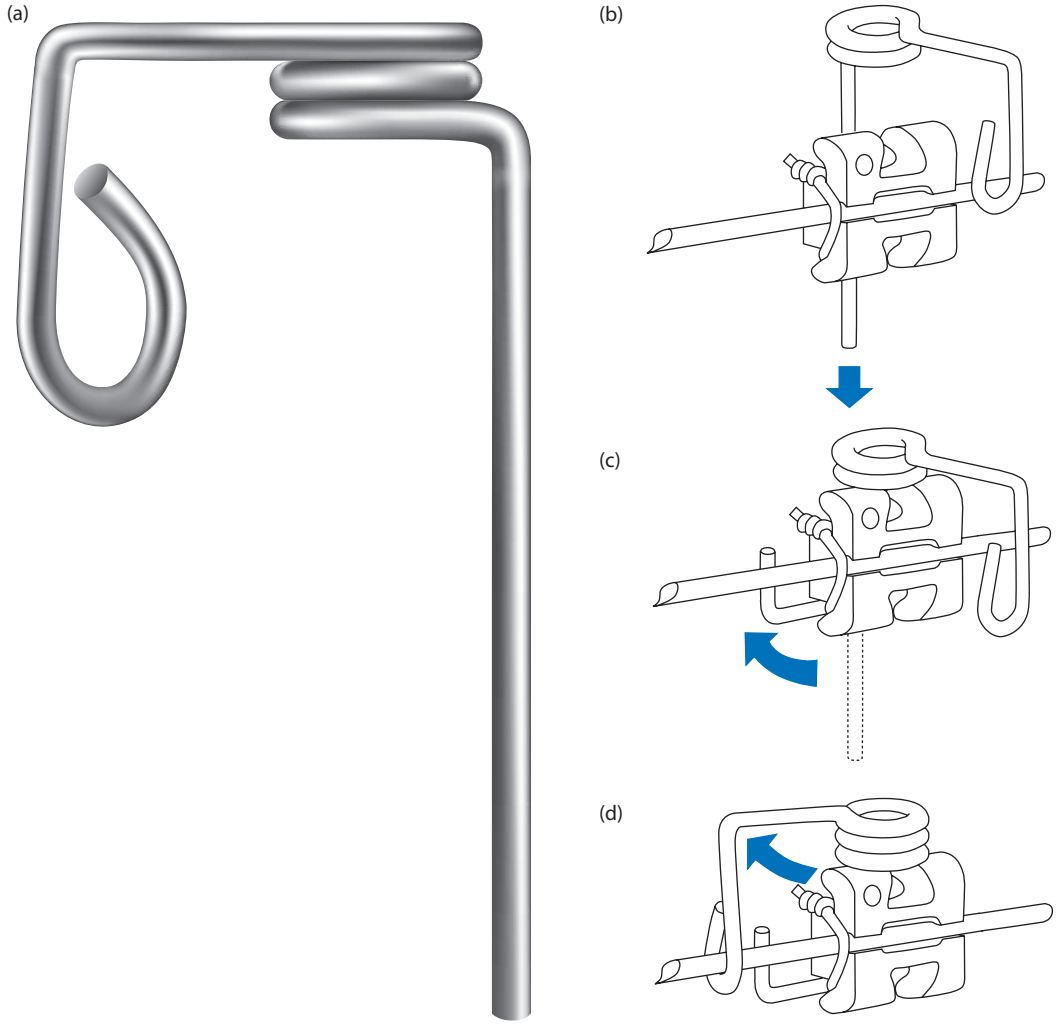


**Figure 15.2**

(a) Counter-clockwise rotating spring. (b) The vertical arm is placed into the vertical slot from the gingival aspect. (c) With the hook arm lying perpendicular to the tooth surface, turn the protruding section of the vertical arm 90° to lie parallel to the tooth surface. (d) The spring is activated by engaging the hook arm on to the main archwire. (Photograph courtesy of TP Orthodontics, Inc., USA.)

**Pearl:** Bonding a lingual button and tying an elastomeric thread to complement the clockwise or counterclockwise movement of the tooth can enhance the rotating action of the spring.

### *15.2.2 Rotation Wedges*

Rotation wedges are more efficient on teeth with flat labial surfaces than on curved canines and premolars. While they are effective, their action is slower than that of rotating springs. They are useful for maintaining a corrected or mildly over-corrected rotation.

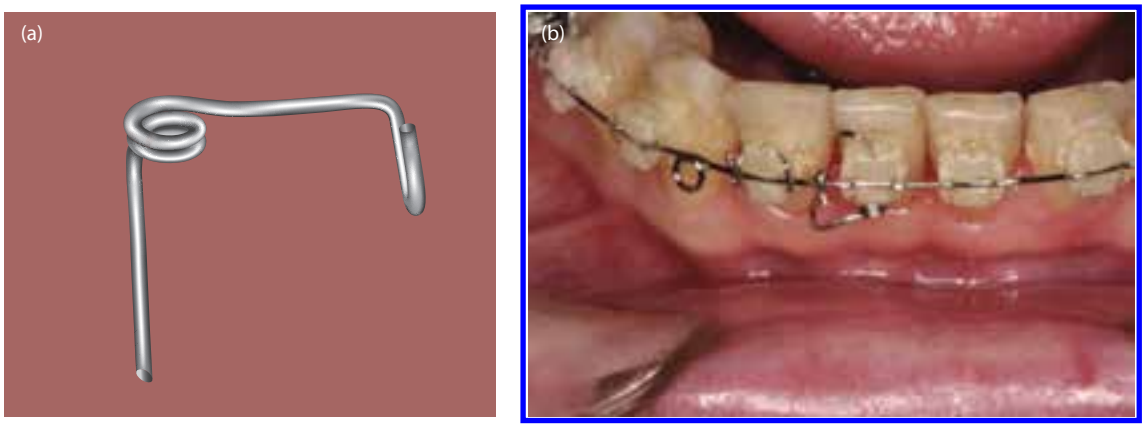


**Figure 15.3**

(a) Individual rotating spring. (b) Rotating spring placed to rotate LR1 mesiolabially (or distolingually).

### *15.2.3 Bracket Offset*

Prior to bonding, a stainless steel bracket can be offset to correct and maintain a mild over correction of a rotation. To offset a bracket, a small section of 0.356 or 0.406 mm (0.014 or 0.016 inch) stainless steel wire is spot-welded to the mesial or distal edge of the mesh base.

Using aesthetic porcelain brackets, Schneeweiss describes a technique to offset the archwire within the bracket slot.[1] One side of the slot is blocked out with a small amount of light-cured composite, the archwire is ligated only to the opposite wing and the resulting pressure from the archwire will rotate the tooth. This technique can also be used effectively with standard stainless steel edgewise brackets. It works more efficiently when used in conjunction with a 0.356 or 0.406 mm (0.014 or 0.016 inch) nickel-titanium archwire (Figure 15.4a–c).

## 15.3 TORQUING AUXILIARIES

Contemporary orthodontic techniques incorporating prescription brackets with built-in torque have, in most cases, simplified and standardized the establishment of the correct torque in the final finished occlusion. However, different manufacturers have varying prescriptions for torque and different skeletal jaw relationships may also require variations in torque not catered for in the original prescription bracket. Variations in crown morphology and crown root angle will also affect the expression of built in prescription torque. It is essential for the orthodontist to be able to clinically introduce varying degrees of torque or countertorque into his or her selected appliance.

Torque may be actively varied or incorporated into an appliance in a number of ways:

1. Incorporating torque into a segment of the main rectangular archwire by holding the wire firmly with two pliers (Tweed arch adjusting pliers) closely adjacent to each other and placing a twist in the wire. Clearly, the twist must be in the direction required to produce the necessary torque and the twist must be counteracted at the other end of the relevant archwire segment.
2. Varying the archwire size in relation to the bracket slot size. To fully express the built-in torque, the wire size must match the bracket slot size and must be fully engaged into the bracket slot. By contrast, to under or not fully express the prescription torque, the archwire size must be reduced.
3. The adjunctive use of torquing auxiliaries. These auxiliaries are available in many different formats; some are commercially available (TP Orthodontics, Inc.) while others need to be individually constructed to suit a specific requirement. Historically, these auxiliaries have been associated with the Begg light-wire technique, however, they can be adapted for use with any edgewise technique

**Figure 15.4**

(a) Flowable composite placed at the distal end of a Tip-Edge bracket. (b) 0.356 mm (0.014 inch) nickel-titanium arch tied in to rotate UL2 disto-palatally. (c) Flowable composite placed at the distal ends of edgewise brackets for disto-lingual rotation of LL1 and LR1 using an 0.356 mm (0.014 inch) nickel-titanium arch.

or bracket. When used with an edgewise bracket it is advisable to use the auxiliary in combination with a round archwire. If used with a rectangular archwire, then the archwire should be expressing torque in the same direction as the torquing auxiliary. Whether a round or rectangular archwire is used, it should be rigid enough to resist any undesired side effects of the auxiliary, such as expansion of the molar teeth.

## *15.3.1 Torquing Auxiliary Design*

### 15.3.1.1 Two-Spur Torquing Auxiliary

This has been used as a standard auxiliary with the Begg light-wire technique for many years. It can be added to an edgewise appliance by first placing the auxiliary into the bracket slot and then tying the main archwire over the auxiliary. The active spurs may be constructed to act either mesial or distal of the bracket. The auxiliary must be modified to avoid impingement with the tie wings of the edgewise bracket. If the spurs are acting mesial to the bracket, it is necessary to tie the two central incisors together to avoid the development of a diastema, if the spurs are positioned distal to the central incisor brackets, a diastema should not develop (Figure 15.5).

### 15.3.1.2 Udder Torquing Auxiliary

This auxiliary may look intimidating and complicated, but in reality it is very simple and very useful. It may be purchased commercially (TP Orthodontics, Inc.) or it can be preformed and kept in stock. Variations occur in the size

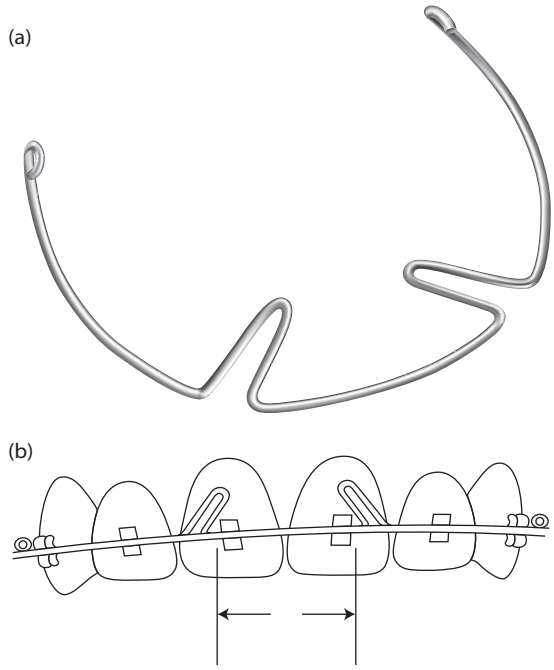


**Figure 15.5**

(a) Two-spur torquing auxiliary. (b) Diagrammatic representation showing the torquing auxiliary in position. This can be used with any bracket provided the auxiliary is adjusted to avoid interference of the torque spurs with the brackets. (Photograph courtesy of TP Orthodontics, Inc., USA.)

of the trapeze for the central and lateral maxillary incisors; for the four mandibular incisors there is no variation in the size of the trapeze. Its main advantage is that it can be inserted and removed without having to remove or modify the existing main archwire. It can be used in the upper and the lower arch, and the same auxiliary can be used for palatal root torque (labial crown torque) when inserted from the gingival aspect and for labial root torque (lingual crown torque) when inserted from the incisal aspect (Figure 15.6).

**Pearl:** This auxiliary is useful in the early stages of bimaxillary protrusion cases. When placed to produce palatal/lingual crown torque in the presence of archwires that are free to slide distally, it is possible to achieve a reduction in protrusion without taxing anchorage.

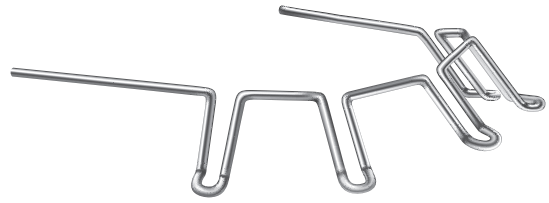

**Figure 15.6**

Udder torquing auxiliary. (Photograph courtesy of TP Orthodontics, Inc., USA.)

If there is anchorage to burn, this action can be enhanced with the use of intramaxillary elastics.

When using any form of palatal root torquing auxiliary on maxillary incisors, it is essential to determine where you wish to place the maxillary incisal edges at the end of treatment. A reciprocal labial movement of the crown invariably accompanies palatal root torque. If you do not wish the crowns to move forward, then it is essential to either tie-back the arch or to counteract the labial movement with Class II elastics.

### 15.3.1.3 Torque Bar

Tip-Edge brackets for maxillary central and lateral incisors have an optional deep groove; this allows for the placement of a 0.457 to 0.559 mm (0.018 to 0.022 inch) nickel-titanium torque bar to be placed palatal (deep) to the main archwire (Figure 15.7).

### 15.3.1.4 Reciprocal Root Torquing Auxiliary

Moving the crown of a palatally displaced lateral incisor tooth into alignment with the rest of the dental arch is not difficult. However, in most cases, the root apex of this tooth will remain more palatally placed than the crown. To complete such a case successfully, it is essential that adequate labial root torque of the lateral incisor tooth be carried out. There are a number of ways to perform this procedure.

- If a prescription bracket is used with built-in palatal root torque, this bracket may be inverted (placed upside down) provided there is no conflict with the prescription

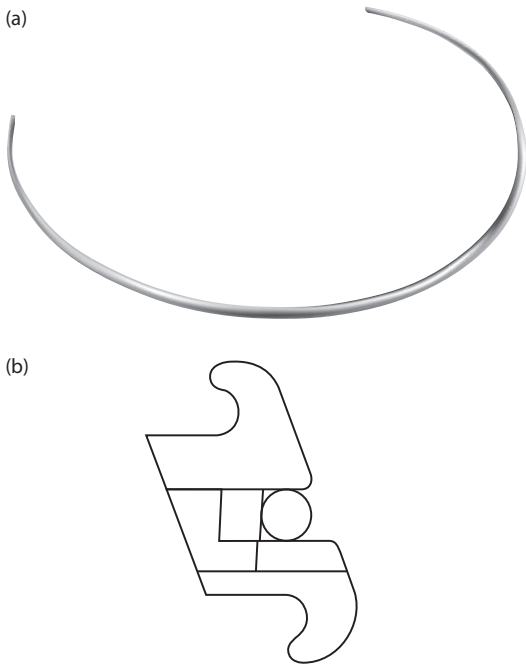


**Figure 15.7**

(a) Preformed nickel-titanium palatal torque bar. (b) Nickel-titanium torque bar placed in the deep groove of a Tip-Edge bracket under the main archwire. (Photograph courtesy of TP Orthodontics, Inc., USA.)

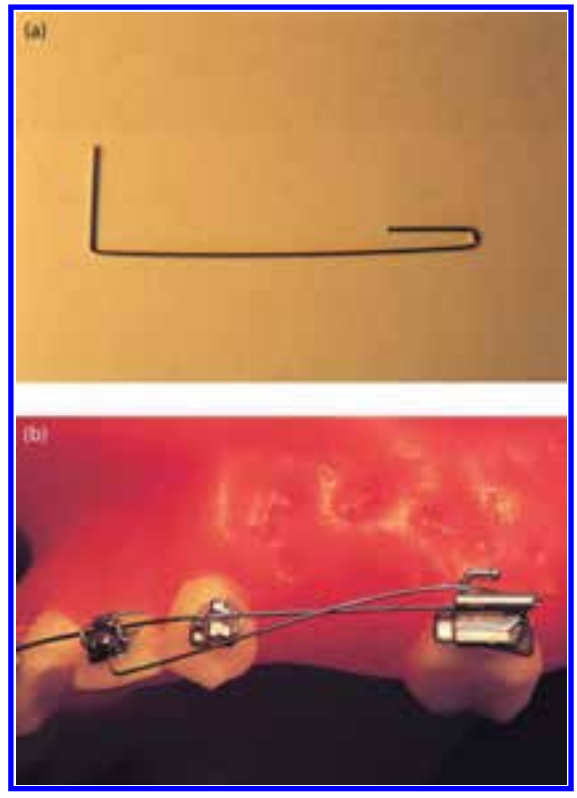


**Figure 15.8**

(a) Wind-up single tooth torquing auxiliary. (b) Wind-up single tooth torquing auxiliary; the distal end is bent back on itself 180° and inserted into the distal opening of the buccal tube. Depending on the torque required, the mesial post is wound either clockwise or counter-clockwise and inserted into the vertical slot of the relevant bracket.

built-in tip. The correct rectangular archwire placed in such a bracket will induce labial root torque.

- Labial root torque for the lateral incisor may be bent into the main rectangular archwire.
- If a bracket with a vertical slot is used (see Chapter 12), it is possible to place a preformed individual tooth torquing auxiliary (TP Orthodontics, Inc.) to produce either labial or palatal root torque.
- In conjunction with a bracket incorporating a vertical slot, a very simple and efficient root torquing auxiliary can be easily fabricated at the chairside and is quick to place. One end of a length of 0.356 mm (0.014 inch) high tensile stainless steel wire (Wilcock, Australia or TP Orthodontics, Inc.) is bent back on itself 180° (Figure 15.8).

Cut the short end to a length of 8 mm (0.32 inch) and slip this short end into the distal opening of the auxiliary tube (headgear tube) on the first molar; it should just protrude through the mesial opening of the tube. Pull firmly on the long section extending mesially, mark the wire at the lateral incisor bracket, remove the auxiliary, and create a vertical post by placing a right-angle bend at the mark. Leaving 6 mm (0.24 inch) after the bend, cut off the rest. Replace the auxiliary into the molar tube as before; the right-angle bend (vertical post) should lie opposite the lateral incisor. For *labial* root torque of a maxillary left lateral incisor tooth, hold this postsection with Howe pliers and turn (wind) it *counter-clockwise* 180° and without letting go, slip the post into the incisal opening of the vertical slot of the lateral incisor bracket. Push it right

through the bracket then with fine 'bird beak' pliers, turn the gingivally protruding end either mesially or distally to prevent dislodgement. To stabilize the buccal section of the auxiliary, loosely tie it to the canine or premolar teeth. Be aware that *if* the active end of the auxiliary is turned *clockwise*, it will deliver a *palatal* root torquing action. For the maxillary right lateral incisor tooth, winding the auxiliary counterclockwise will deliver a *palatal* root torquing action and clockwise a *labial* root torquing action. This auxiliary takes its anchorage from the molar tooth; labial root torque on the lateral incisor will produce palatal root torque on the molar tooth. However, the root surface areas of the molar is so much larger than that of the lateral incisor that the action on the lateral will have been completed before the molar starts to move adversely.

- If bilateral labial root torque is required, then the reciprocal torquing auxiliary, which delivers palatal root torque for the central incisors and labial root torque for the lateral incisors, is a very useful auxiliary (TP Orthodontics, Inc.).

Palatal and buccal root torquing auxiliaries soldered to the main archwire have been described by Reyenders and Massaro.[2]

### 15.3.1.5 Molar Root Torque Auxiliary

In certain cases it may be necessary to increase or decrease buccal or palatal molar root torque. If you are using a round main archwire with double buccal molar tubes, the torquing auxiliary may be placed without removing the archwire. If you are using a rectangular archwire, ensure that the torque bent into the archwire is working in the same direction as the auxiliary. The auxiliary is constructed from high tensile 0.406 mm (0.016 inch) stainless steel wire (Figure 15.9).

#### *15.3.1.5.1 Construction*

- Curve the wire to conform to the general arch shape.
- Place the auxiliary on the maxillary model or working directly in the mouth mark the wire at the distal end of the relevant molar buccal tube.

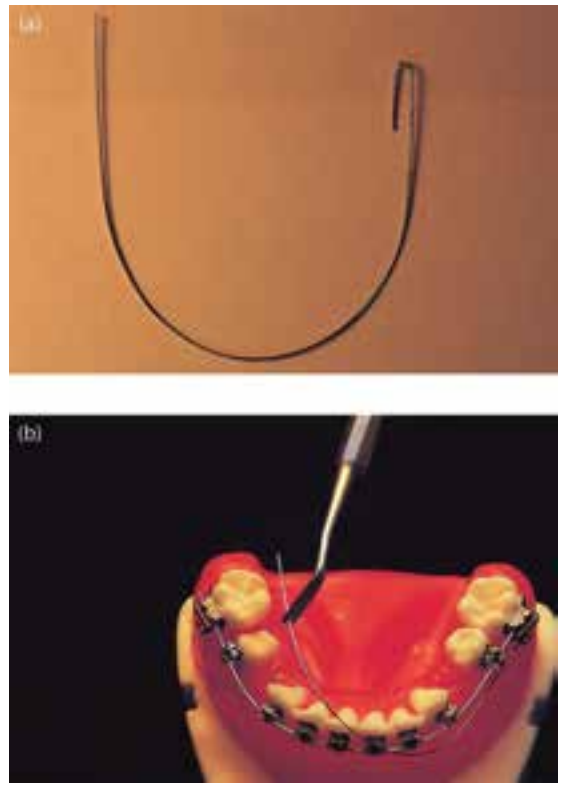


**Figure 15.9**

(a) Wind-up molar tooth torquing auxiliary curved to conform with the dental arch. (b) Wind-up molar tooth torquing auxiliary; the distal end is bent back on itself 180°. Depending on the torque required, the curved auxiliary is wound either clockwise or counterclockwise and the free end is tied or slipped into the buccal tube of the molar on the opposite side.

- Bend the wire back on itself 180° and cut off leaving a section of 6 mm (0.24 inch). The double back should be in the same flat horizontal plane as the curved section of the auxiliary.

#### *15.3.1.5.2 Placement*

As an example, if you required buccal root torque of the left maxillary molar, then insert the doubled back section into the distal opening of auxiliary or headgear tube of the left maxillary molar, the auxiliary torque arch is now turned clockwise a full 360°, and the free end is slipped into the second buccal tube of

the right maxillary molar. The auxiliary overlies the main archwire and should be tied with ligature wire as an overlay arch in the buccal and anterior segments. The main archwire should be rigid enough to prevent any arch shape distortion. It is unlikely that the occlusal plane level will alter over a period of approximately three months; however, the level should be monitored regularly. For palatal root torque, the auxiliary must be turned counterclockwise. The same auxiliary and the same principles can be used in the mandibular arch.

If the buccal tube has a vertical slot, then instead of a double back bend, a post is created by bending a 90° bend in the same flat horizontal plane; this post is inserted into the vertical slot either from the occlusal or gingival aspects, depending on access. To activate, the auxiliary is turned either clockwise or counterclockwise and tied to the main archwire.

## 15.4 COIL SPRINGS

Coil springs are very useful auxiliaries; they may be used either as push springs to expand or as pull springs to close spaces. Historically, coil springs have been manufactured from stainless steel wire; currently, they are also manufactured in nickel-titanium wire. These coil springs may be purchased in different lengths and sizes either on a coil or as individual springs with pre-formed eyelets at either end. Nickel-titanium springs retain their activity more efficiently than conventional stainless steel springs.

Measured cut lengths are threaded on the archwire prior to placement in the mouth. To assist in the placement of an active coil spring, Binder describes a technique to render the coil spring passive by threading a length of ligature wire through the coil spring and compressing the spring by tying the ends of the ligature wire in a 'pigtail'.[3] Once the archwire and coil spring are in position in the mouth, cut the ligature wire and the coil spring will return to its active state. During treatment, coil springs may be activated in a number of ways. With two notched flat plastic instruments placed over a section of coil spring, it is possible to overstretch a section and thus increase overall activation. Squeezing the tips of light wire pliers between adjacent helices of the coil spring will also result in an effective increase in the resting length of the spring.[4]

### *15.4.1 Activating Coil Springs*

Ronald G Melville

Open push coils used to expand space between two teeth will lose activation as the teeth move and the space gets larger. It is possible to activate the coil spring with a short length of stainless steel tubing 0.762 mm (0.030 inch), which has been split longitudinally and crimped on to the archwire. The length of tubing used will depend on the amount of activation required, usually 2–3 mm (0.04–0.08 inch). The tubing is split longitudinally with a cutting disc and then at the required length, the tube is cut across but not fully; the small section should still remain attached to the main length. To reactivate the coil spring, compress it with a notched flat plastic instrument, then using the main length of stainless steel tubing as a handle, slip the small split section over the archwire, crimp it in position, then break off the main length by twisting it (Figure 15.10).

### *15.4.2 Activating Coil Springs*

Farah R Padhani

In anticipation of the need to reactivate push coil springs as adjacent teeth move, at the time of placement of the active spring, passive pieces of closed coil spring are threaded on the archwire and left in the adjacent interdental areas. When the need arises to activate the main coil spring, the adjacent tooth is untied, and the passive section of coil spring is moved across and compressed up against the main coil spring. The tooth is retied. This has the effect of lengthening the coil spring and rendering it more active, a technique also described by Binder.[3]

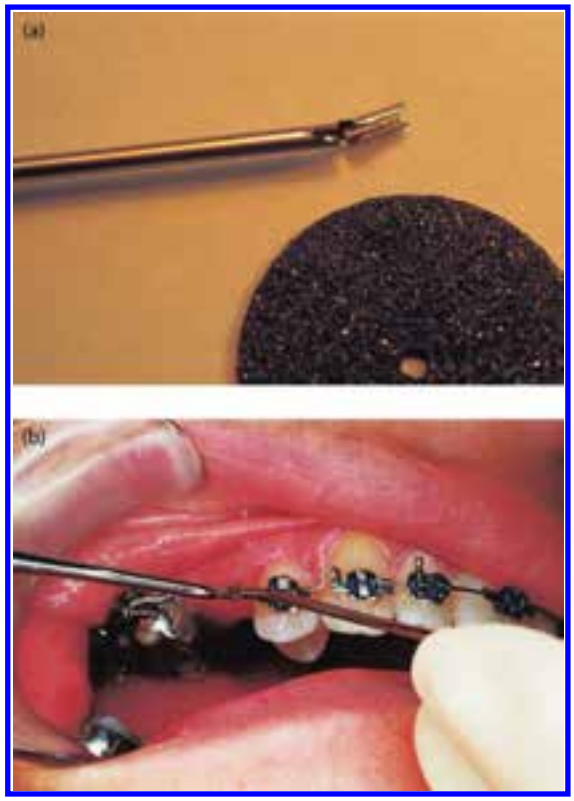

**Figure 15.10**

(a) Stainless steel tube stop for coil spring activation. Slit the tubing lengthwise. Cut the tubing across almost completely at the desired length. (b) Compress the coil spring with a notched flat plastic instrument, holding the long section of the stainless steel tubing, place the slit section on the archwire, break by twisting the stainless steel tubing then crimp the remaining cut section on the archwire.

## 15.5 PLASTIC TUBING

Plastic or elastomeric tubing slipped over an archwire contributes to patient comfort. This is particularly relevant in cases where the archwire rubs against the inner surface of the cheek, and in lingual orthodontics to reduce archwire irritation of the tongue. The tubing is cut to size and the archwire slipped into the tubing prior to placing it in the mouth. In certain cases it is possible to place the tubing over the archwire in situ. Cureton describes a technique whereby the tubing is split lengthwise by threading a ligature wire through the tubing and using the ligature wire to slice through the wall of the tubing.[5] The split tubing is placed over the relevant section of archwire and the heated tip of an instrument is used to fuse the plastic seam.

In cases requiring mild expansion, an overextended length of plastic tubing compressed between two adjacent teeth can act as an expansion auxiliary.

## 15.6 AUXILIARIES IN ORTHODONTICS

*André O Hugo*

Numerous auxiliaries have been developed for use with labial and lingual appliances with and without vertical slots (V-Slots).[6] Some of these auxiliaries can be used to create space, others for root movements, and some for a combination of both. Furthermore, a certain number of these auxiliaries are used only with labial appliances, others only for lingual appliances, and some are for both. Since the majority of our lingual cases have lower labial appliances, I have decided to include both labial and lingual auxiliaries in this discussion and have divided them into two categories:

1. Auxiliaries for labial and lingual appliances using brackets *incorporating* a vertical slot.
2. Auxiliaries for labial and lingual appliances using brackets *without* a vertical slot.

**Pearl:** To achieve and maintain adequate activation, unless otherwise stated, all auxiliaries are constructed from high tensile stainless steel wire, manufactured by Wilcock, Australia or TP Orthodontics, Inc., USA.

### *15.6.1 Auxiliaries for Labial and Lingual Appliances Plus Vertical Slot*

These are in the following categories:

- Hugo tipping, torquing, rotating and spacing auxiliary (TTRS)
- Hugo lingual reciprocal torquing auxiliary
- Hugo staple auxiliary
- Supermini occlusal uprighting spring
- Hugo rotating/uprighting spring

#### 15.6.1.1 Hugo Tipping, Torquing, Rotating and Spacing

*T* – *Tipping*: For correcting and maintaining mesiodistal angulation (limited control if no vertical slot exists)
*T* – *Torquing*: For reciprocal labiolingual torquing of the anchor teeth (limited if there is no vertical slot)
*R* – *Rotating*: For correcting axial rotations (most effective with a vertical slot)
*S* – *Spacing*: Mesiodistal expansion within the arch

This sectional auxiliary may be used in conjunction with either the labial or lingual appliances and has been designed to create intra-arch space whilst simultaneously having the capability for tipping, torquing, and rotating the anchor teeth as desired, hence the name: TTRS (Figure 15.11).

##### *15.6.1.1.1 Construction*

The auxiliary may be constructed either directly in the mouth or indirectly on the patient's study models. A length of high tensile stainless steel wire either 0.356 mm (0.014 inch) or 0.406 mm (0.016 inch) is bent with vertical arms engaging the two anchor teeth which are to be reciprocally tipped, torqued, rotated, or spaced. Such teeth may be adjacent to each other, or with any number of intervening teeth. To create space one or more vertical loops are incorporated; this also facilitates the alignment of the intervening teeth. The vertical loops are activated to varying degrees depending on the degree of crowding that has to be overcome, and the *enface* root surface of the engaged teeth. Depending on the angle at which the vertical end posts are bent, it is possible to also tip, torque, and rotate the anchor teeth.

##### *15.6.1.1.2 Placement*

All teeth are ligated to the main archwire. The vertical arms of the auxiliary are inserted into the vertical slots of the brackets on the anchor teeth and the vertical loops are slipped behind the main archwire. The 0.356 mm (0.014 inch) TTRS auxiliary is typically adjusted to produce approximately 2–3 mm (0.08–0.12 inch) of activation, which in turn generates a force of about 140–170 g (5–6 ounces). Once fully inserted, the protruding ends of the vertical posts are bent over to prevent dislodgement of the auxiliary.

The *enface* root surfaces of an upper central incisor (50 $mm^2$) and an upper lateral (40 $mm^2$)

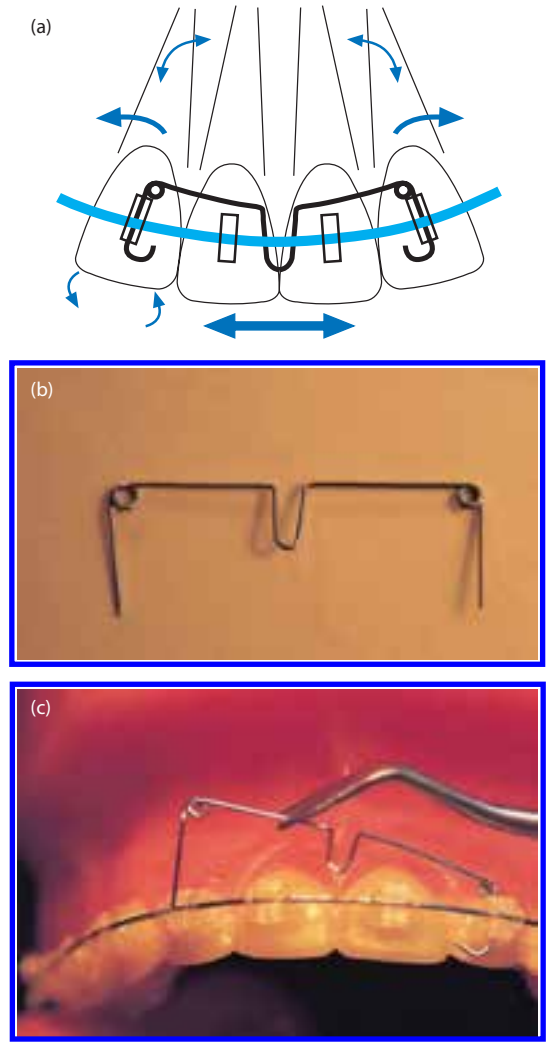


**Figure 15.11**

(a) Diagram of the Hugo TTRS (tip, torque, rotate, spacer) auxiliary. The vertical arms can alter the angulations and torque of the lateral incisors. The horizontal arm on the lateral incisors can correct rotations and the vertical loop between the central incisors can produce either expansion or space closure. (b) Wire example of a TTRS auxiliary fabricated from high tensile stainless steel. (c) Auxiliary designed for mesiolingual rotation of the 22 and labial root torque of the 12.

are often pitted against the *enface* root surface of an upper first premolar (75 mm$^2$) in the process of creating space for the eruption of an upper canine. The 140–170 g (5–7 ounces) of force generated by the typical clinical activation of the TTRS by 2–3 mm (0.08–0.12 inch) approximates the ideal force level of 1 g/mm$^2$ of *enface* root surface (considering purely mesiodistal movement).

The advantages of this method of expansion (without even considering that in addition, desired angulations, torquing, and rotations may simultaneously be achieved) are as follows:

- Greatly improved oral hygiene compared to coil springs
- Simplicity of construction
- The ability to insert and remove the auxiliary without the need to remove or adjust the main archwire
- Cost-effectiveness
- Partial prefabrication

### 15.6.1.2 Hugo Lingual Reciprocal Torquing Auxiliary

Sometimes, maxillary lateral incisors require labial root torque while the central incisors need palatal root torque. With the vertical arms activated correctly and inserted into the vertical slot of the lateral incisors, simultaneous uprighting and de-torquing of the laterals can be achieved (Figure 15.12).

#### *15.6.1.2.1 Construction*

This lingual reciprocal torquing auxiliary is made from high tensile 0.356 mm (0.014 inch) stainless steel wire. Vertical loops are incorporated to create the trapeze (horizontal section), which will act on the lingual or labial surface of the tooth in an opposite direction to the activation incorporated into the vertical post of the auxiliary that will be inserted into the vertical slot of the anchor teeth (lateral incisors). As with the previous auxiliary, it is also possible to incorporate a degree of tipping action on the anchor teeth depending on the angle at which the terminal posts of the auxiliary are bent.

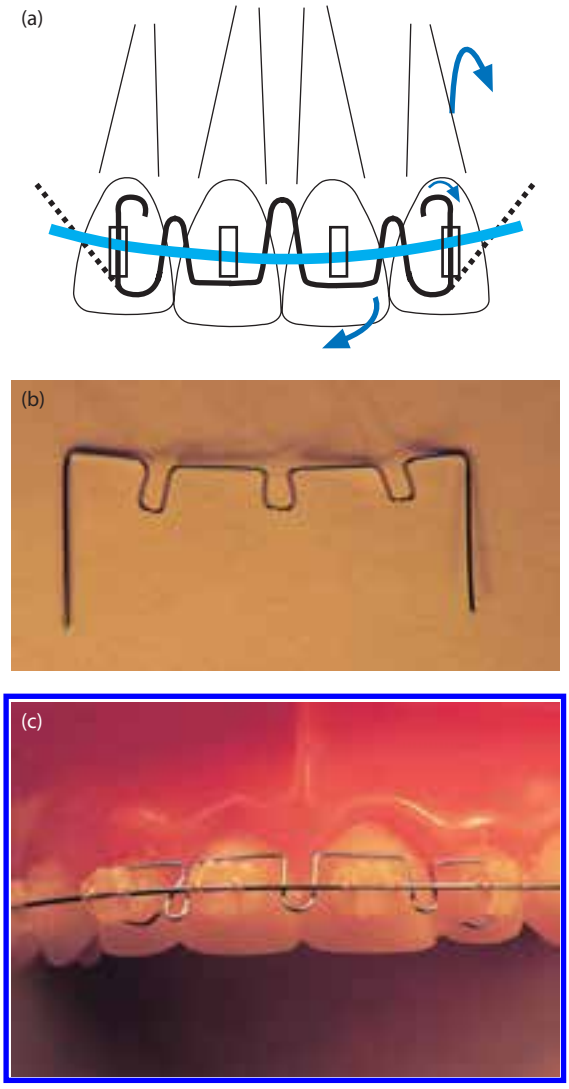


**Figure 15.12**

(a) Diagram of the lingual and labial reciprocal torquing auxiliary. The horizontal trapeze on the central incisors produce lingual crown torque (labial root torque) and the vertical arms on the laterals can produce labial crown torque (or vice versa). It is also possible to alter the angulations of the lateral incisors. The vertical loops behind the main archwire can create expansion or space closure. (b) Wire example of an auxiliary fabricated from high tensile stainless steel. (c) Auxiliary designed for labial crown torque of the central incisors and reciprocal lingual crown torque of the lateral incisors.

#### *15.6.1.2.2 Placement*

All teeth are ligated to the archwire, the vertical loops are slipped behind the main archwire and the vertical posts of the auxiliary are inserted into the vertical slots of the anchor teeth. On the assumption that the main archwire is round, these auxiliaries will continue to work until all the activation is dissipated; it is essential to continually monitor the progress of the root movements to avoid excessive overcorrection. If the main archwire is rectangular, then either it should be reduced in size to allow corrective movement of the relevant teeth, or the correct torque should be bent into the arch to assist in the torquing action of the auxiliary.

### 15.6.1.3 Hugo Staple Auxiliary

The staple auxiliary is very useful for correcting the differential torque of two adjacent teeth. To use the lateral incisor as an example, it is often clinically possible to feel the palatal displacement of the lateral incisor root and the prominence of the adjacent canine root (Figure 15.13).

#### *15.6.1.3.1 Construction*

The auxiliary is made from 0.356 or 0.406 mm (0.014 or 0.016 inch) high tensile stainless steel wire. Vertical posts are bent at each end, then in the horizontal plane, the posts are bent in opposite directions to generate reciprocal root torquing actions on the lateral and canine teeth.

#### *15.6.1.3.2 Placement*

This auxiliary can be used with any bracket incorporating a vertical slot. The staple is inserted usually from the gingival into the vertical slots of the brackets and the protruding ends of the vertical posts are bent over to prevent accidental displacement of the staple. The correction can be exaggerated or over-corrected by further bending the posts of the staple in the direction designed to correct the original torque differential. The vertical arms also parallel the angulation of adjacent teeth.

This auxiliary is small, neat, can be used on any maxillary or mandibular teeth, and can be inserted and removed without disturbing the main archwire.

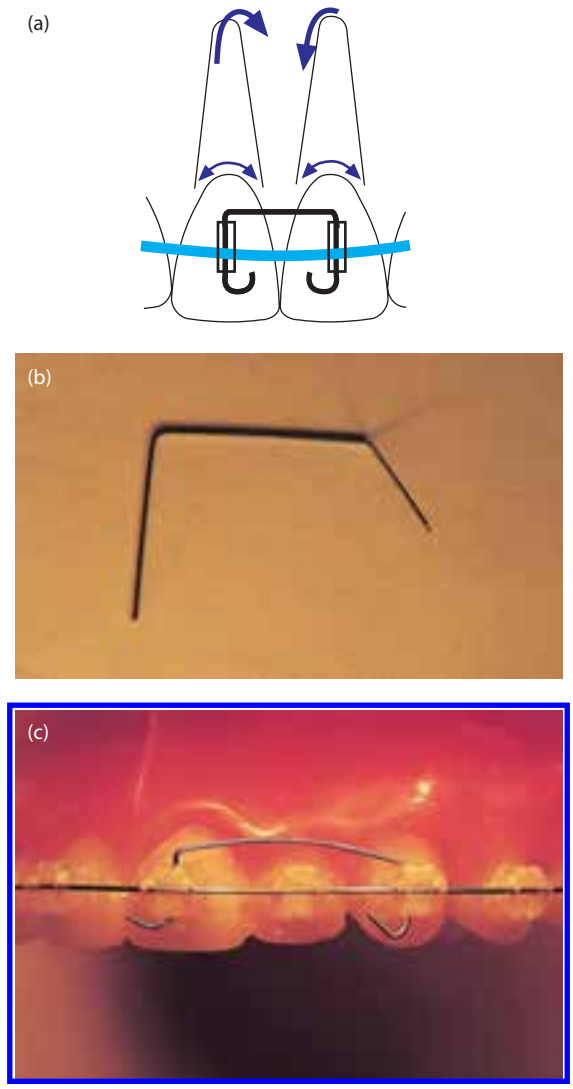


**Figure 15.13**

(a) Diagram of the Hugo staple auxiliary. The vertical arms are adjusted to parallel the torque of adjacent teeth. The vertical arms can be adjusted to parallel or change the angulation of adjacent teeth. (b) Wire example of a staple designed for palatal root torque of a maxillary canine and labial root torque of a central incisor. (c) Auxiliary placed on a model.

### 15.6.1.4 Supermini Occlusal Uprighting Spring

This spring was designed to overcome some of the problems encountered with the use of the conventional Begg uprighting spring. The

conventional spring generally inserted from the gingival aspect has certain disadvantages:

- An extrusive effect as a result of the contact of the spring helix with the gingival part of the bracket
- A tendency to rotate the tooth being uprighted
- A food-trapping effect as a result of the 'box' formed between the horizontal hook arm and the main archwire
- It cannot be inserted from the occlusal aspect without generating occlusal interference

The ability to insert an uprighting spring from the occlusal aspect is advantageous in situations where competition for space on the archwire is a factor and in situations where the gingival tissue limits access for placement or cleaning.

The modified (Hugo and Weber) supermini occlusal uprighting spring has the following advantages (Figure 15.14):

- It can be inserted from the occlusal without interfering with the occlusion.
- The spring helix (circle) lies adjacent to the bracket and has no intrusive or extrusive action on the tooth.
- There is reduced food-trapping because the horizontal hook arm lies adjacent to the main archwire.

Unfortunately, if the supermini uprighting spring is inserted from a gingival aspect, the masticatory forces sometimes impinge on the helix (circle) and tend to unseat the spring.

This spring can be used with any bracket that incorporates a vertical slot. It is especially useful in lingual orthodontics using the light wire bracket.

#### *15.6.1.4.1 Construction*

This mini uprighting spring is totally prefabricated by the practitioner or his staff from 0.035 mm (0.012 inch) high tensile stainless steel wire. It has a vertical shaft of 3 mm (0.12 inch), and a horizontal offset of 1 mm (0.04 inch) as it emerges from the bracket's vertical slot. The helix (circle) of 1 mm (0.04 inch) diameter is then bent so that the circle lies adjacent and not occlusal or gingival to the bracket. The horizontal hook arm of 3 mm

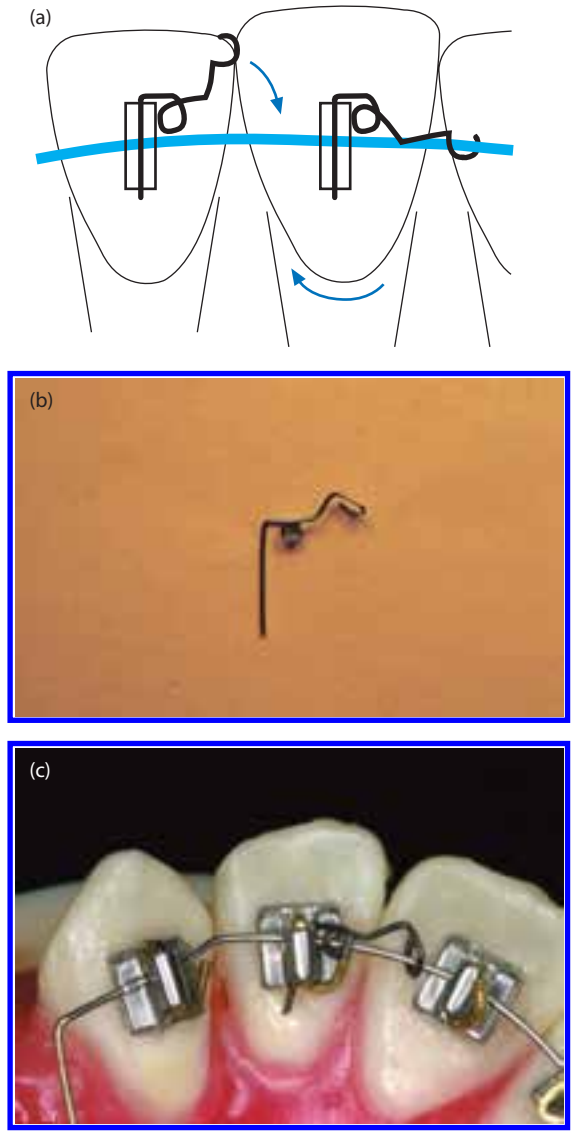


**Figure 15.14**

(a) Diagram of the Hugo and Weber modified supermini occlusal uprighting spring inserted from the occlusal. (b) Wire example. (c) Supermini occlusal uprighting spring placed on a model (Lingual Appliance).

(0.12 inch) has a shallow V-bend so as the tooth uprights and the spring becomes less active, the horizontal arm will bend towards and not away from the main archwire.

The tips of commercially available 'bird-beak' pliers are not fine enough to handle these

small uprighting springs, it is necessary to trim the round beak of small 'bird-beak' pliers to a smaller dimension using either sandpaper discs or a diamond burr in a high speed turbine (No. 105G, Dentronix, Inc., USA).

#### *15.6.1.4.2 Placement*

The teeth should first be ligated to the main archwire. Using fine 'bird-beak' pliers, the stem is inserted into the vertical slot from the occlusal aspect and with a notched flat plastic instrument, the spring is activated by engaging the hook on to the main archwire.

### 15.6.1.5 Hugo Rotating/Uprighting Spring

This spring was designed as an alternative to the conventional Begg rotating spring and it can be used in conjunction with both labial and lingual appliances (Figure 15.15).

It has the following advantages:

- It is self-retained and is therefore particularly useful when used in conjunction with the mandibular lingual appliance where limited access makes it difficult to bend over the protruding end of the vertical shaft of a conventional rotation spring. When the conventional rotating spring is activated, it is this crucial horizontal bend that applies the rotating force to the crown of the tooth.
- It can be inserted from the occlusal aspect (essential with lingual appliances) since it can be adjusted so as not to interfere with the occlusion.
- It is the only spring that can simultaneously effect distolingual/palatal rotation and distal root tip to upper canine teeth when used with the light-wire bracket lingual appliance (Begg). When used only as a *rotating spring*, the horizontal arm is deflected in a horizontal direction only, with no vertical deflection. When used as an *uprighting spring*, the horizontal arm is deflected vertically. If simultaneous rotation is desired then the arm may also be deflected horizontally.

#### *15.6.1.5.1 Construction*

The spring is made from 0.356 mm (0.014 inch) high tensile stainless steel wire. As with most auxiliaries described in this section, a vertical post is bent at 90°, to fit into the vertical slot of the bracket. Adjacent to the vertical post, bend a vertical loop – it is this loop, which will produce the rotating force when the spring is activated. The horizontal arm incorporating a terminal hook is bent after the vertical loop at an angle to the vertical loop; this angle will determine the degree of activation and will also determine whether a purely rotational or a rotational plus combined tipping force will be delivered to the relevant tooth. The length of the hook arm will be dependent on the space available on the main archwire to engage the retaining hook. It is possible to bypass one or more adjacent teeth.

#### *15.6.1.5.2 Placement*

All the teeth are ligated to the main archwire. The vertical arm of the auxiliary is inserted into the vertical slot of the tooth, ensuring that the vertical loop is positioned behind the main archwire in contact with the tooth surface (lingual or labial). The hook arm will be projecting away from the main arch in a horizontal direction for pure rotation; activate the spring by engaging this hook arm on to the archwire. If a degree of tipping is required, the hook arm will have a horizontal and a vertical deflection prior to engagement with the archwire.

As with the other auxiliaries, this rotating spring can be inserted and removed without disturbing the main archwire.

## *15.6.2 Auxiliaries for Labial and Lingual Appliances Plus Those without a Vertical Slot*

The first two are essentially crown-moving auxiliaries and the second two are root-moving auxiliaries.

- Hugo space bar
- Overlay expander
- Hugo lingual torquing auxiliary
- Hugo detorquing bar

### 15.6.2.1 Hugo Space Bar

This is a space-creating auxiliary for any labial or lingual appliance irrespective of the bracket used. It is easier to make than the Hugo TTRS sectional auxiliary but does not provide the ability to tip, torque, or rotate teeth. The

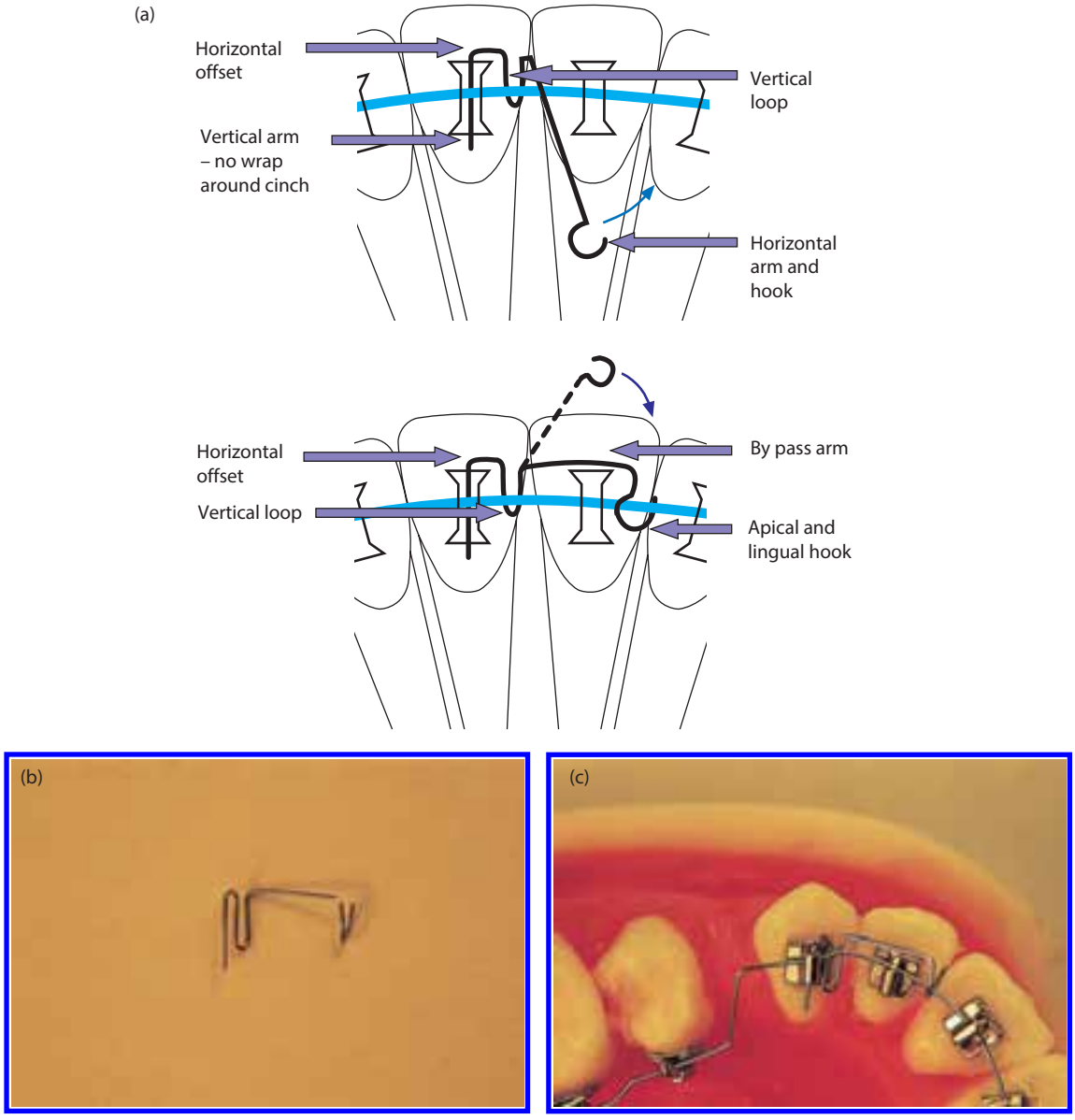


**Figure 15.15**

(a) Diagram of the Hugo self-seating lingual rotating spring. (Top) When used as a rotating spring, the horizontal arm is deflected and activated in a horizontal direction only. (Bottom) When used as an uprighting spring the arm is deflected and activated in a vertical direction only. By varying the deflection a combination of uprighting and rotation can be achieved. (b) Wire example. (c) Auxiliary designed for mesiolabial rotation of a maxillary canine, placed on a model.

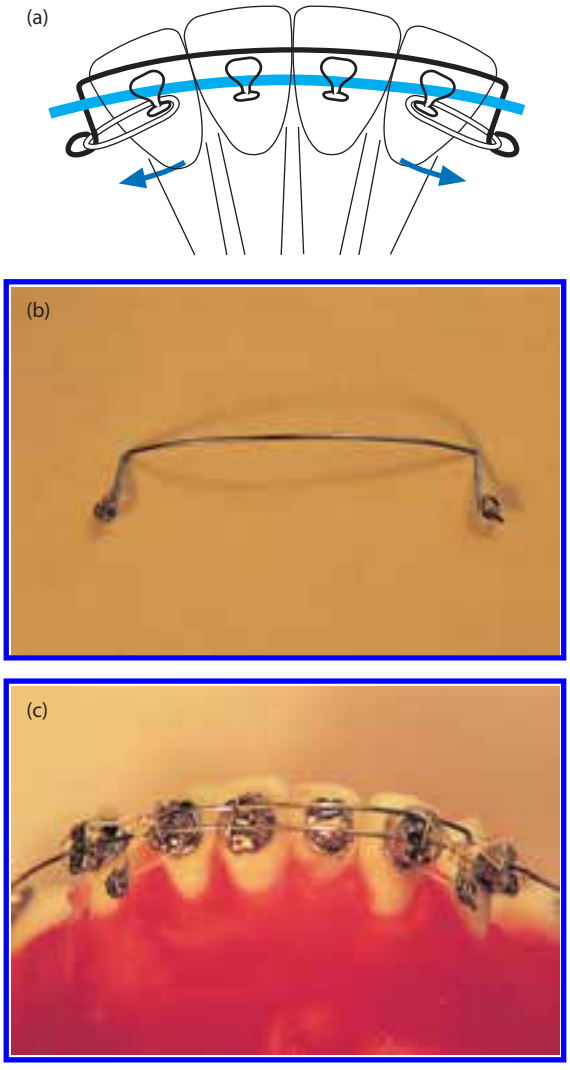


**Figure 15.16**

(a) Diagram of a Hugo space bar designed to create space using either labial or lingual techniques. The central portion needs to ligated to the main archwire. (b) Wire example. (c) Space bar auxiliary designed to create space for mandibular incisors. Elastomeric thread tied from the lateral incisors to the circles of the auxiliary.

expansion force is derived from elastomeric rings or thread and not directly from the wire base (Figure 15.16).

#### *15.6.2.1.1 Construction*

The space bar is constructed from a length of 0.406 or 0.457 mm (0.016 or 0.018 inch) high tensile stainless steel wire with short vertical arms (2 mm or 0.08 inch) the ends of which are bent into small circles or hooks. The transverse length of the space bar is made 2–3 mm (0.09–0.12 inches) longer than the mesiodistal distance of the teeth to be reciprocally spaced.

#### *15.6.2.1.2 Placement*

The auxiliary is inserted from the incisal aspect with the two vertical legs sliding behind the main archwire and positioned distal to the teeth at each end of the dental segment requiring expansion. Elastomeric rings (doughnuts) are hooked over the brackets (e.g. the palatal hook of the Ormco lingual appliance or over a high hat pin on the Begg appliance or the vertical post available on certain edgewise brackets) of the teeth adjacent to the circles or hooks of the space bar and stretched to engage the circle or hook of the space bar. The elastic force moves the respective teeth closer to the hooks of the space bar and so creates space. The central portion of the space bar is tied to the main archwire to prevent it from being displaced. It should follow the contour and offsets (if any) of the main archwire.

As with the other auxiliaries, this expansion auxiliary can be inserted and removed without disturbing the main archwire.

### 15.6.2.2 Overlay Expander

In certain cases, it is expedient to create a degree of buccal expansion during treatment. It is possible to remove the main archwire, and replace it with an expanded heavier archwire. However, this expanding auxiliary provides the facility to achieve buccal expansion at any stage during treatment without having to disturb or adjust the main archwire. As this auxiliary is of a larger gauge than the light main archwire used in the early stages of treatment, this overlay arch will expand a constricted arch while the main archwire continues to align the teeth (Figure 15.17).

#### *15.6.2.2.1 Construction*

The overlay expander follows the expanded contour of a labial or lingual archwire. This auxiliary is constructed from a length of 0.406, 0.457, or even 0.508 mm (0.016, 0.018 or even 0.020 inches) high tensile stainless steel wire.

The terminal ends of the overlay expander can have any of the following:

- Straight ends that simply slide into the extra buccal tubes on the molar teeth
- Hooks that can be crimped onto the main archwire in the bicuspid or molar region
- Right angle bends which can be inserted in the vertical slots of the molar tubes for buccal root torque if desired

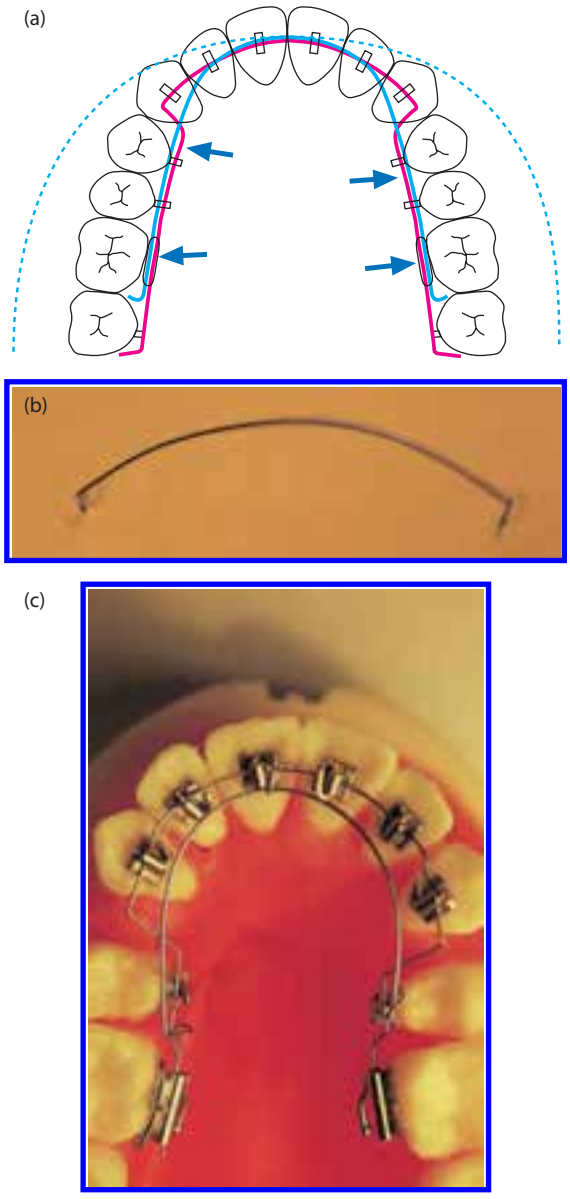


**Figure 15.17**

(a) Diagram of the lingual overlay expander. The auxiliary is usually only pinned or tied to the central incisors and pre-molar teeth. (b) Wire example. (c) Auxiliary designed for lingual maxillary expansion placed on a model.

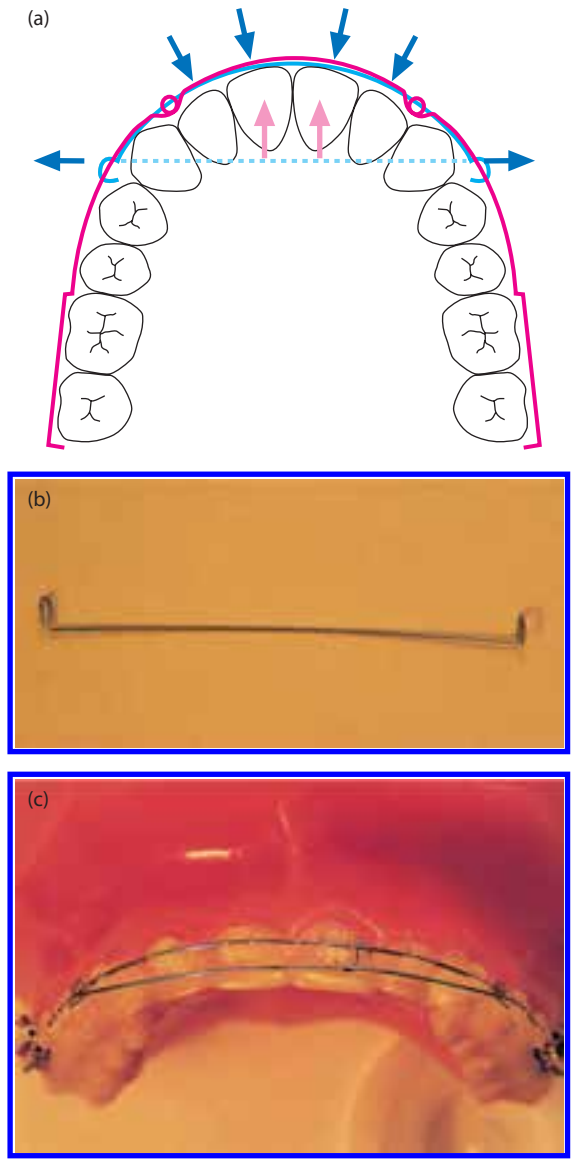


**Figure 15.18**

(a) Diagram of the Hugo detorquing bar. Effective in the lower labial segment to upright proclined lower incisors. (b) Wire example. (c) Detorquing auxiliary for lingual crown torque of maxillary incisor teeth placed on a model.

Depending on the gauge of wire selected, in its passive state, the auxiliary should have approximately 1 to 2 cm (0.4 to 0.8 inches) buccal expansion in the molar region.

#### *15.6.2.2.2 Placement*

When used with a labial appliance, the two distal ends are squeezed closer and slipped into the extra buccal molar tube or tied to the molar brackets. When used with a lingual appliance, the arch is similarly squeezed and hooked to the palatal arch generally between the second premolar and first molar teeth. In all cases the auxiliary should be tied to the anterior and buccal teeth to prevent any dislodgement (Figure 15.17).

### 15.6.2.3 Hugo Detorquing Bar

This auxiliary is very useful for uprighting excessively tipped lower or upper incisor teeth and is used in combination with a lower or upper labial appliance (Figure 15.18).

#### *15.6.2.3.1 Construction*

It is constructed from a *straight* piece of 0.406 mm (0.016 inch) high tensile stainless steel with small terminal hooks. The length of the auxiliary should be measured to finish with the terminal hooks fitting between the canine and first premolar teeth.

#### *15.6.2.3.2 Placement*

The auxiliary is placed incisal to the brackets of proclined incisors and the terminal hooks are crimped on to the main archwire between the canine and first premolar each side. Since this straight wire is curved around the anterior arch, it exerts a lingual force on the incisal part of the crown thereby effecting lingual crown torque. Clearly, some expansion of the buccal segments will tend to occur. However, if this side effect is not desired then the main arch should be constricted in this area to counter this action, or as an alternative a more rigid main archwire fitted.

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# 16 DIGITAL TECHNOLOGY FOR ORTHODONTICS: FEATURES AND BENEFITS

Rohit CL Sachdeva and Nikita Sachdeva

CONTENTS



**Editor's Comments**
Digital technology has influenced and continues to influence science, art, and the lifestyle for population groups throughout the world. There is no longer any doubt that this technology will drive our civilization through the twenty-first century. Within our comparatively limited sphere of clinical orthodontics, its influence has already been experienced in the fields of photography, radiology, and, more recently, clinical treatment.

It is not the intention for this publication to promote, endorse, or favour any product or technique mentioned or described in the text. However, as so many products and procedures are linked to commercial products and technologies, it is inevitable that in the process of educating and bringing the latest technology to the readership, certain products will be used as a vehicle to illustrate what is available to our profession.

## 16.1 INTRODUCTION

SureSmile technology is a total, digital orthodontic patient care system.[1] It enables orthodontists to provide personalized care for patients using the latest system based on the proper application of decision support and planning software to drive robotic manufacturing of customized archwires.

> **Pearl:** SureSmile technology is enabling in nature; it does not replace the fundamental skills and role of the clinician. The clinician's knowledge and input entirely control the output of the SureSmile system.

The purpose of this article is to describe the system, its functional components, its application, and research on its effectiveness and efficiency.

## 16.2 SURESMILE TECHNOLOGY

The technology is based on a comprehensive, cloud-based platform integrating four functional elements: (1) the OraScanner, (2) the SureSmile computer-aided design (CAD) software, (3) the SureSmile robotic manufacturing system and (4) the patient management system (Figure 16.1).

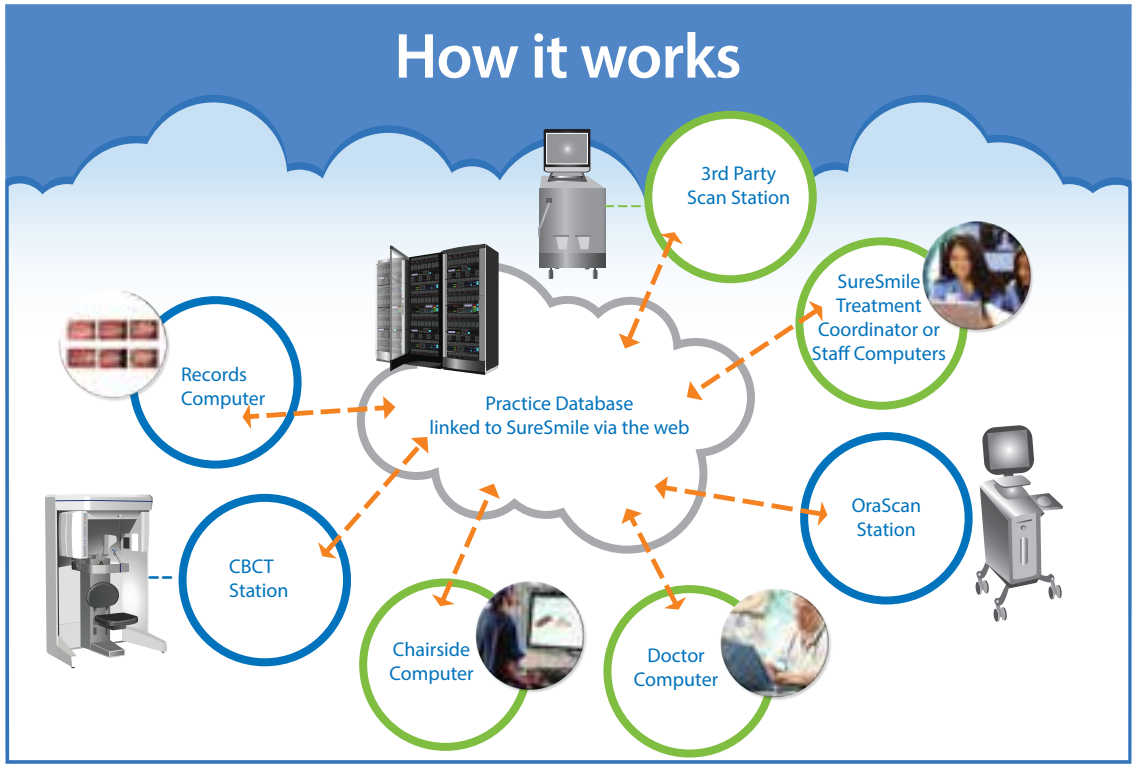


**Figure 16.1**

Schematic representation of 'How it works' showing the interrelationships between the clinician, SureSmile, and any third party supplier of records.

### 16.2.1 The OraScanner

The OraScanner is a proprietary scanner that may be used to capture 3D images. SureSmile has also certified other 3D imaging systems for use, including the iTero scanner, Carestream cs 3500 and Trios, please note Sure Smile have only certified the following CBCT machines. All i.cat CBCT machines and both the 9300 and 9500 Carestream CBCT machines. 3D images of the crown, roots, and/or the skeletal structure may be captured depending upon the system used (Figure 16.2).

The clinician determines which scanner technology to use based upon the patients' needs (Table 16.1).

The digital laboratory merges 2D cephalometric radiographs and 2D photographic images with any of the captured 3D intraoral images. As an additional service, the digital laboratory can paste images of gingival tissue captured with the above mentioned scanners into the CBCT scan to create a composite image of the entire craniofacial structure of the patient (Figure 16.3a–c).

### 16.2.2 SureSmile CAD Software

The software is compatible with images captured by the aforementioned 3D imaging systems. The 3D image outputs are used for different purposes in the management of patient care:

1. *The diagnostic model* is a 3D scan taken prior to the onset of treatment. It is used for (a) diagnosis, (b) decision support and (c) communication (Figure 16.4).

**Figure 16.2**

OraScanner with scanned image of the dentition appearing on the monitor as the scanning is progressing.

**Table 16.1**

Imaging Systems

| | OraScanner II[a] | iTero Scanner[b] | CBCT Scanners[c] |
|---|---|---|---|
| Scanning Technology | Light-based, noninvasive | Light-based, noninvasive | X-ray, invasive |
| 3D Image Output | Crowns and gingival tissue only | Crowns and gingival tissue only | Crowns, roots, and bone only |
| Portable | Yes | No | No |

[a] OraScanner II is a product of OraMetrix, Inc.
[b] iTero scanner is a product of CADENT.
[c] These are the certified CBCT scanners: Kodak 9300, 9500 and i-CAT systems.

**Pearl:** It provides the clinician with the ability to view on the screen, within the confines of his/her practice, a 3D virtual image of the extraoral hard and soft tissues incorporating the complete intraoral dental complex.

a. Diagnosis in 3D of the various craniofacial components is a feature of the software.
b. Decision support is a process by which the clinician can validate his/her mental concept of the proposed treatment plan through a visual interface using simulations. The software allows the clinician to simulate multiple treatment scenarios and choose the best approach based upon the patients' needs. Simulations for decision support can also be performed on CBCT process scans. Furthermore, the software allows the clinician to plan restorative and surgical care for patients (Figure. 16.5a and b).

   Decision support promotes a *proactive* approach to planning orthodontic care for patients.
c. The software allows the clinician to visualize, communicate, and refine a treatment plan with patients, the clinical team, and colleagues in a collaborative environment. This process promotes an *interactive* approach to planning and managing care for patients. In addition, the software generates diagnostic reports to facilitate communication and presentation both locally and via the internet.

2. The *therapeutic model* is a 3D scan taken at any stage of treatment (Figure 16.6a and b). It is used for designing the dental setup, which drives the design and manufacture of the customized appliance.

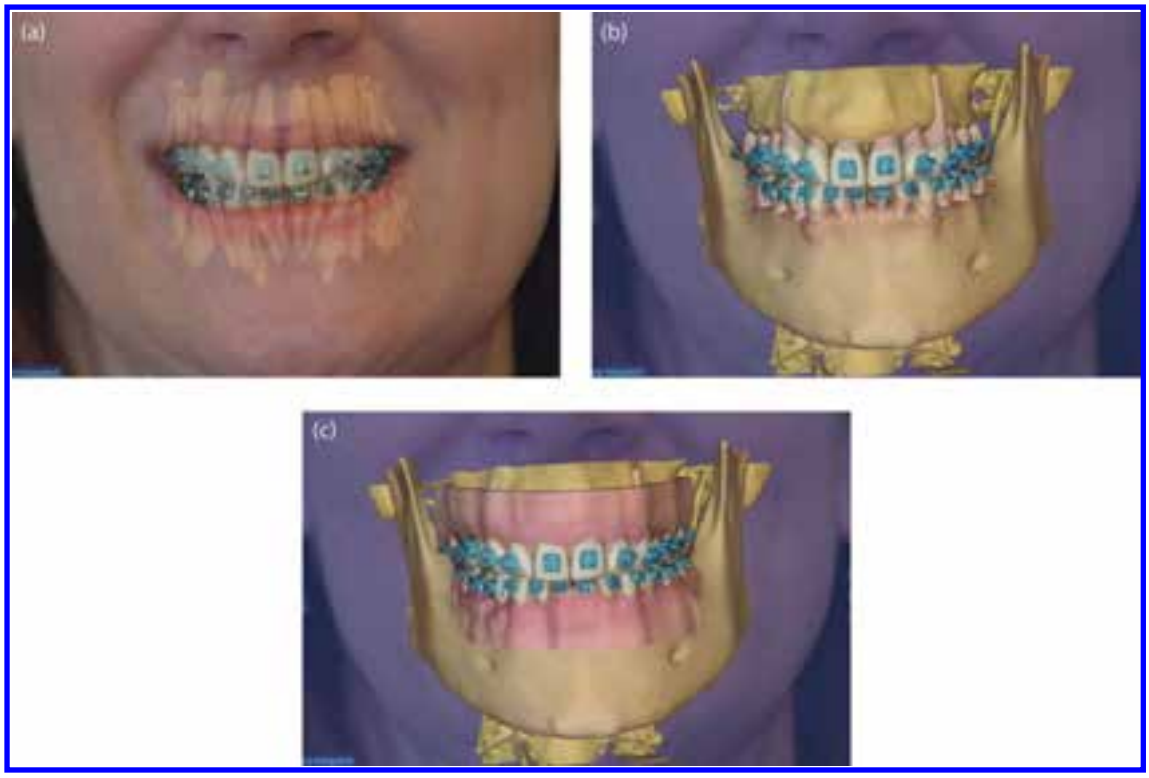


**Figure 16.3**

(a) CBCT 3D scanned image of the dentition and roots merged with the 2D facial photograph. (b) Intraoral scanned image of the dentition merged with 3D image of the facial skeletal components. (c) Merged image with superimposed gingival tissues.

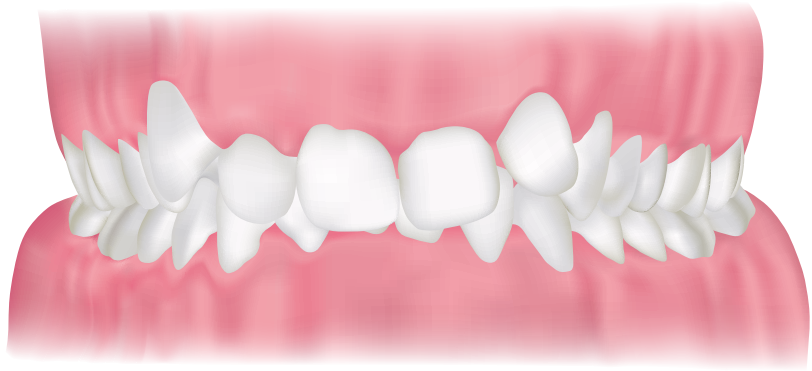

**Figure 16.4**

Virtual model of the malocclusion produced from the initial scan. Scan transmitted from an orthodontic practice.

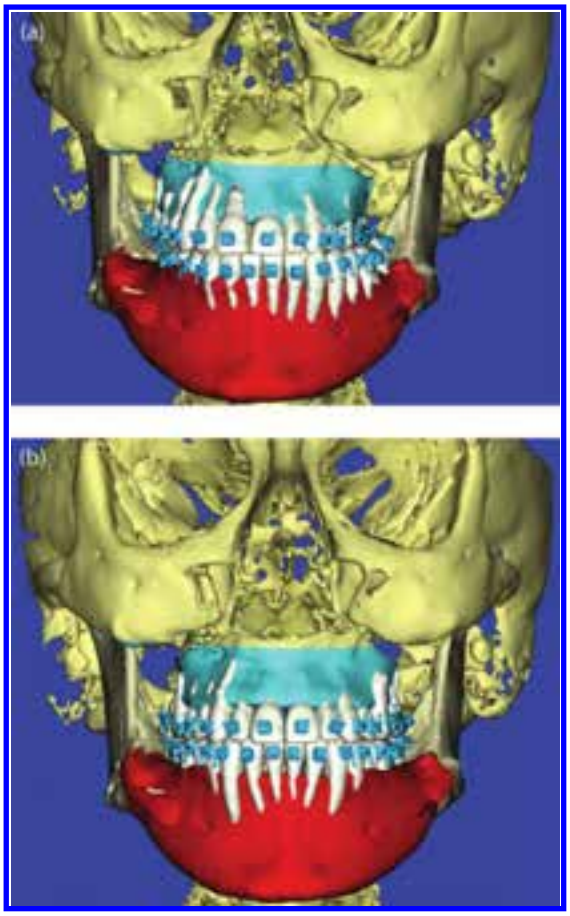


**Figure 16.5**

(a) Merged scan of the dentition and the skeletal components of the orofacial complex. Note the maxillary deviation to the right and the posterior crossbite. (b) A virtual projection of the planned surgical/orthodontic correction.

a. *Stage I: Design*. When designing customized archwires, the therapeutic scan is taken with the brackets *in situ* (Figure 16.7a and b).

   SureSmile software has an extensive library of electronic brackets and their respective prescriptions. These prescriptions are taken into account to design the final customized archwire. The therapeutic model can be compared against the diagnostic model to evaluate treatment progress at this point in care.

b. *Stage II: Prescription*. The clinician may send via the Internet a prescription in the form of either simulations and/or annotations to the digital laboratory in Richardson, Texas, USA. The clinician's prescription provides the laboratory technologists instructions for the fabrication of the setup.

c. *Stage III: Setup Evaluation*. The laboratory technologists send the clinician a setup based upon the clinician's prescription. Then, on his/her office computer, the clinician uses a guided checklist, which is built into the software, to refine, and to evaluate the setup. The clinician may also use automated toolsets to evaluate the quality of the setup.

d. *Stage IV: Customized Appliance Design*.

   i. *Customized Archwire Design*. The clinician has the ability to select the material and cross-section of the customized archwire (for labial and lingual orthodontics). Additionally, the clinician may stage and/or alter the shape of the customized archwire by digitally placing additive or subtractive bends (Tables 16.2 and 16.3).

**Pearl:** In this way, the software acts as a virtual plier. As treatment progresses, the clinician can modify the prescription and adapt the customized archwire to the needs of the prevailing clinical situation.

   ii. *Other Customized Appliance Designs*. Currently, the clinician may design staged aligners using SureSmile software. In the near future, the clinician will also be able design indirect bonding jigs or trays using the diagnostic model.

3. The *final model* is an optional 3D scan taken at the end of treatment to evaluate treatment outcomes. The model can be superimposed against both the diagnostic and therapeutic models, and the target setup in order to quantitatively and qualitatively evaluate treatment outcomes.

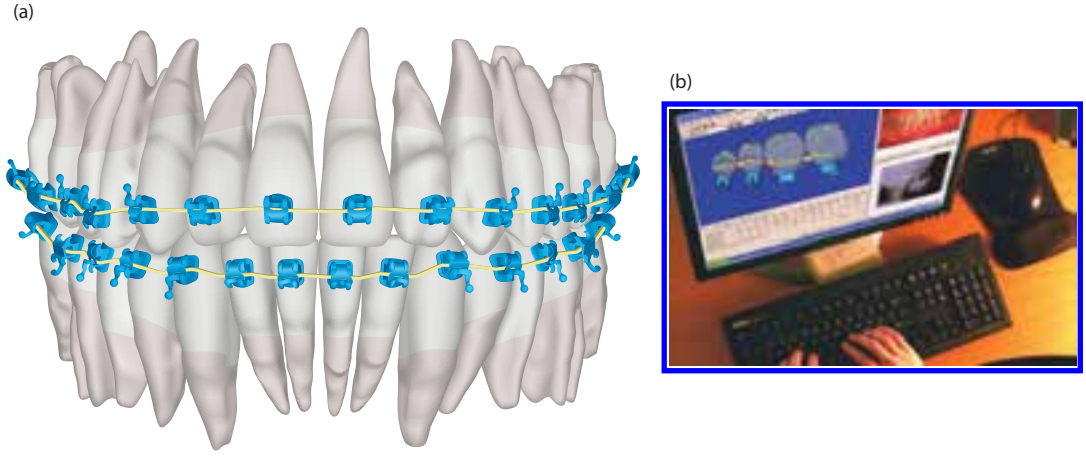


**Figure 16.6**

(a) 3D scan taken of the dentition at any stage of treatment. (b) SureSmile technician executing the tooth movements as prescribed for the treatment.

### *16.2.3 SureSmile Robotic Manufacturing System*

The robotic system resides in the SureSmile manufacturing facilities in Richardson, Texas, USA and Berlin, Germany.

**Pearl:** The robots can bend customized archwires to a precision of 0.1 mm for translation bends and 1° for angular bends in all three planes of space. In the near future, the robots will also be able to bend loops in the customized archwire (Figure 16.8 and Video 16.1).

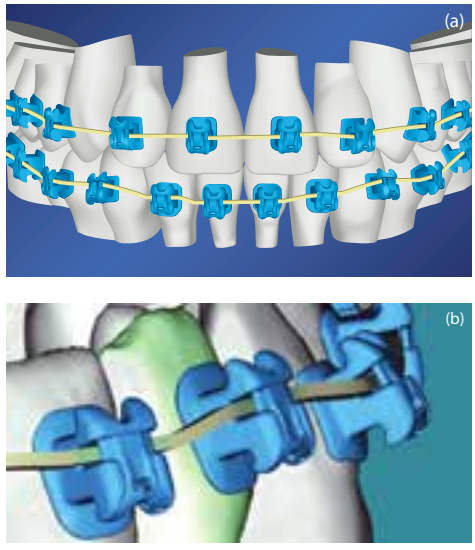


**Figure 16.7**

(a) Scan with brackets *in situ*. (b) Damon bracket drawn from the library of electronic brackets.

Tables 16.2 and 16.3 summarize the various design features that can be incorporated in the design of the archwire.

The clinician can select any permutation of the material and cross-section characteristics listed above. The clinician may order as many archwires as desired (Figure 16.9a–f).

**Table 16.2**

Selection of SureSmile Archwire Features

| Material | Cross-section |
|---|---|
| Superelastic NiTi | 0.406 mm (0.016 inches) round |
| Beta-titanium | 0.406 × 0.406 mm (0.016 × 0.16 inches) square |
| Elgiloy | 0.432 × 0.635 mm (0.017 × 0.025 inches) rectangular |
| Azurloy | 0.483 mm × 0.635 mm (0.0190 × 0.025 inches) rectangular |

**Table 16.3**

Summary of SureSmile Archwire Design, Modifications, and Appliances

*Standard active customized archwires*
- Description: the design of this archwire is based upon the target setup and has no modifications
- Use case: may be used at any stage in treatment

*Passive archwires*
- Description: can be designed for the entire arch or any particular segment
- Use case: surgical archwires, stabilizing peridontally compromised teeth, stabilizing arches against reactive forces (e.g. when using Forsus appliance), fabricating fixed lingual retainer

*Hybrid archwires*
- Description: consists of both active and passive bends
- Use case: to control reactive segments when dealing with inconsistent force systems

*Staged archwires*
- Description: expression can be changed from 0% to 100% for each tooth, segment, or the entire arch
- Use case: to preferentially affect the amount of tooth displacement

*Overcorrection (torque or any other bend)*
- Description: can be built into the wire
- Use case: to account for slop in the bracket

*Slide*
- Description: segments of the archwire can be preferentially straightened along or at any point in the arch
- Use case: to facilitate sliding mechanics during space closure

*Special shapes*
- Reverse curve or Curve of Spee
- Use case: for closing bites or leveling bites
- Expansion
- Constriction

*Lingual Fixed Appliance (Archwires)*
*Aligners*
*Jigs/Trays for indirect bonding*

Table 16.3 shows a list of design modifications that can be incorporated into the base archwire (derived from the setup).

As previously mentioned, OraMetrix does not currently manufacture aligners in house; rather, the software allows for the design of staged aligners, it provides clinicians with exportable Stereolithography (STL) files of the designed staged aligners. Clinicians can use said STL files as input to print hard models in house using 3D stereolithography printers. The aligners are then thermoformed from the hard models using well-known techniques. Clinicians may also outsource the STL model fabrication to other vendors. In the near future, OraMetrix plans to manufacture jigs for indirect bonding.

**Figure 16.8**

Wire bending robot.

### 16.2.4 SureSmile Patient Management System

The software is integrated with orthodontic practice management software, such as Dolphin and Ortho2 to facilitate the transfer of patient records. It also offers a suite of software utilities that ensure timely management of the process flow for each individual SureSmile patient over the entire patient care cycle. In

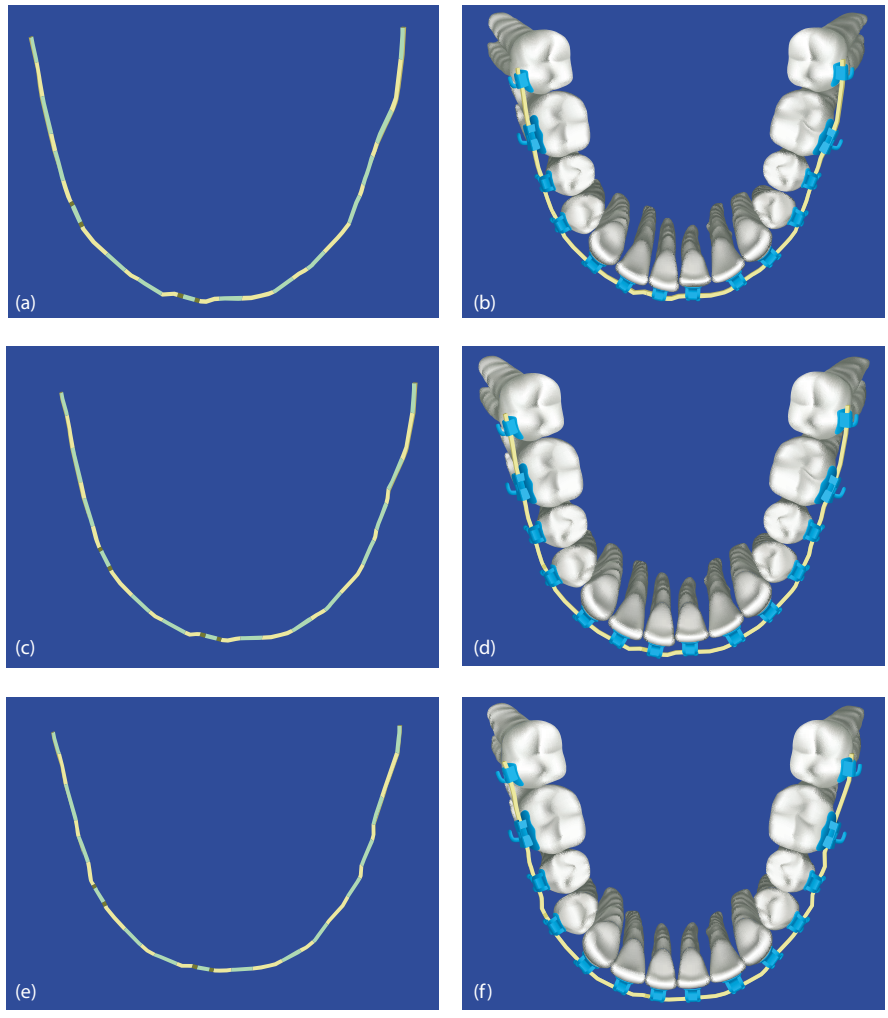


**Figure 16.9**

An example of archwire design by staging incremental expression. (a) Initial archwire design. (b) Digital model showing 25% tooth movement. (c) Subsequent 75% expression archwire (d), Digital model showing 75% tooth movement. (e) Final archwire. (f) Digital model showing final target with 100% archwire expression.

addition, it provides for a query-based database that allows for the retrieval of patient or population-specific information.

## 16.3 RESEARCH STUDIES ON SURESMILE

Most studies show that SureSmile provides greater efficiency in orthodontic care (in terms of average treatment time in months) and is more effective in terms of treatment outcome using Cast-Radiograph Evaluation (CRE) and ABO's Objective Grading System (ABO-OGS) scoring criteria.

On average, patients treated with SureSmile demonstrate 25%–40% shorter treatment times than patients treated with conventional orthodontics. The outcome of this treatment protocol is generally 10%–18% better than or equivalent to conventional treatment. Table 16.4–16.6

**Table 16.4**

Summary of Studies on SureSmile – Sample Characteristics

| | Population Sample Size, Discrepancy Index | | | |
|---|---|---|---|---|
| **Study** | **SureSmile** | | **Conventional** | |
| Sachdeva et al.[2] | $n = 9350$ | DI = N/A | $n = 2945$ | DI = N/A |
| Alford et al.[3] | $n = 69$ | DI = 13.2 | $n = 63$ | DI = 15.8 |
| Saxe et al.[4] | $n = 38$ | DI = 9.2 | $n = 24$ | DI = 11.0 |
| Rangwala[5] | $n = 33$ | DI = 18.7 | $n = 33$ | DI = 19.3 |
| Groth[6] | $n = 89$ | DI = 7.7 | $n = 89$ | DI = 7.8 |

DI = Discrepancy Index.

**Table 16.5**

Summary of Studies on Efficiency of SureSmile

| | Average Treatment Time (Months) | |
|---|---|---|
| **Study** | **SureSmile** | **Conventional** |
| Sachdeva et al.[2] | 16 | 24 |
| Alford et al.[3] | 22.7 | 32 |
| Saxe et al.[4] | 14.7 | 20 |
| Rangwala[5] | 18.1 | 29.6 |
| Groth[6] | 13.4 | 22.4 |

**Table 16.6**

Summary of Studies on Effectiveness of SureSmile

| | CRE and ABO-OGS Scores | |
|---|---|---|
| **Study** | **SureSmile** | **Conventional** |
| Sachdeva et al.[2] | N/A | N/A |
| Alford et al.[3] | 18.1 (CRE) | 20.8 (CRE) |
| Saxe et al.[4] | 26.3 (ABO-OGS) | 30.7 (ABO-OGS) |
| Rangwala[5] | 17 (CRE) | 21.6 (CRE) |
| Groth[6] | 24.1 (CRE) | 23.4 (CRE) |

summarize the findings of major studies on the efficiency and effectiveness of SureSmile treatment.

In a recent study on the accuracy of dental measurements using e-models produced by different technologies, the SureSmile models provided the best combination of accuracy, reproducibility, and time efficiency of measurement.[7,8]

## 16.4 CONCLUSION

SureSmile technology is a binding force for the orthodontic enterprise, placing patients at the epicentre. It allows orthodontists complete control of end-to-end processes – from clinical diagnosis to the manufacture of a customized appliance. As an integrated platform, it is a one-stop design and manufacturing hub for clinicians.

The greatest challenge the orthodontic profession faces in this digital age is whether orthodontists are committed to a cycle of

1. Unlearning the *reactive* care model
2. Embracing the *proactive* care model
3. Shifting to a culture of patient safety through high-reliability organization and lifelong learning
4. Managing patients both *in vivo* and *in silico*
5. Participating in a collaborate, convergent, and connected environment

**Pearl:** Mental dexterity supersedes manual dexterity as a functional skill requirement of the digital clinician. The application of digital technology to orthodontics renders 'high touch, high tech' care possible. However, clinicians must maintain their primary responsibility of 'high touch', championing the philosophy of *aeger primo* (patient first).

6. Establishing accountable care practices in the spirit of authenticity and transparency by divulging personal performance statistics

Clearly as with any new technology, there is a learning curve. Orthodontists must be willing, able, and prepared to embrace some failure in order to achieve the above objectives.

In a recent interview to the British *Sunday Times* (16 March 2014), the man behind Apple, Jonathan Ives, stated, 'When you think about technology and what it has enabled us to do so far, we're not even close to any kind of limit. It is still so, so new'.

## VIDEOS

16.1 Wire bending robot. © Orametrix, by permission. (Available at http://goo.gl/kQ8nBi)

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# 17 TEMPORARY ANCHORAGE DEVICES

Eliakim Mizrahi and Antony GH McCollum

CONTENTS



**Editor's comments**
The choice of using either miniscrews or miniplates is a clinical decision based on the requirements for each specific case. For many cases the decision is clear cut; however, in some cases either treatment modality would be acceptable. A Point-Counterpoint presentation by Baumgaertel and Sugawara presents the reader with a comprehensive discussion on arguments for and against miniscrews and miniplates.[1]

## 17.1 THE USE OF MINISCREWS IN CLINICAL ORTHODONTICS

Eliakim Mizrahi

### *17.1.1 Introduction*

Temporary anchorage devices (TADs) refer to a group of appliances designed to provide a source of bone-based anchorage, they include miniscrews and miniplates. This form of anchorage has been widely accepted by the profession and has provided a facility for orthodontists to widen their clinical scope of intraoral appliance therapy.

This chapter is not intended as an in-depth presentation on miniscrews. However, in view of the increasing acceptance of this treatment modality, I believe it warrants an abbreviated presentation highlighting important aspects related to this subject.

A brief review of the literature is interesting as it shows how this procedure has evolved over the years. From the original publication by Gainsforth and Higley in 1945,[2] a period of 38 years elapsed before we see the next article by Creekmore and Eklund in 1983,[3] and a further 14 years before Kanomi in 1997,[4] published his article in which, for the first time the term 'Mini implant' is included in the title. Then the momentum picks up dramatically. A group of orthodontists in Korea developed and reported on the Absoanchor Orthodontic microimplant in 1999;[5] a Scandinavian group developed the Aarhus Anchorage System in 2000;[6] and an Italian group developed the Spider screw in 2003,[7] which I continue to use for all clinical cases (Orthocare UK).

Following these publications, there has been an avalanche of papers, books, courses, and lectures at almost every orthodontic congress and meeting. Keeping up with these developments, the manufacturers have also flooded the market with a wide range of miniscrews, each extolling the benefits of their design.

Initially many of the publications were essentially case reports with little experimental or scientific backup; however, over the last few years the emphasis has changed and currently many of the published articles are based on a wide field of research related to technique, stability, bone and soft tissue reactions, as well as appliance designs adapted for the efficient use of miniscrews.

**Pearl:** In spite of all the advances, the original rationale for the use of miniscrews remains the same; it is intended as a source of bone supported anchorage either as a standalone source or as reinforcing anchorage.

Conventional osseointegrated implants used extensively in general dentistry have also been used as a source of bone-supported anchorage in adult orthodontics, although, in general, their application in orthodontics is limited.

## *17.1.2 Features of Miniscrews*

1. These implants are placed in the bone to provide immediate bony anchorage specifically for orthodontic treatment.
2. With caution they can be used in patients from as young as 12–13 years of age.
3. Their effectiveness is not entirely dependent on patient compliance.
4. They are comparatively easy to place.
5. They can be placed in many different parts of the mouth selected specifically for a particular malocclusion.
6. As opposed to conventional osseointegrated implants, miniscrews do not need edentulous regions for placement.
7. There is no major time delay, as they can be loaded immediately.[6]
8. They can be easily removed.
9. The cost factor is not a major issue.

### 17.1.2.1 Structural Features

The majority of miniscrews are made from nickel titanium; however, some are made from stainless steel. The physical characteristics of miniscrews vary with the different manufacturers.

*Length*: The length of the threaded component can range from 5 to 12 mm. The length selected for a clinical procedure is limited by anatomical considerations. An average length to keep in stock is 8 mm.[8]

*Diameter*: The width (diameter) can range from 1.2 to 2 mm. Once again the width is limited by anatomical considerations. Screws placed in an interradicular site can rarely exceed 2 mm. Screws less that 1.2 mm are weak and they can break easily. An average size for stock is 1.5 mm. It has been shown that the diameter of the miniscrew does not affect the amount of linear microdamage to bone adjacent to the miniscrew.[9]

*Head*: The head size and configuration allows for further variation; essentially, they are designed to only accept the driving head supplied by the manufacturer of that specific miniscrew. The miniscrews may be machine or hand driven. As a basic requirement, they should all have a hole for ligature wire or elastic thread, a collar to attach elastomeric thread, power chain or coils springs, and a neck which may vary in size to accommodate the varying thickness of mucosa. The head may have the shape of a post or a flat top with a slot designed to accept an archwire if necessary. Depending on the position of the screw, the flat top is probably more comfortable for the patient.

## *17.1.3 Site Selection*

Three major factors govern the site selection.

1. The anchorage requirement as dictated by the malocclusion; in other words, where exactly do you want the source of anchorage in relation to the required tooth movements?
2. The quality and quantity of suitable bone will influence where the screw can be placed.[10]
   *Maxilla:*
   - Buccal bone; thickest between 1st and 2nd molars
   - Interdental space; widest palatally between 2nd premolar and 1st molar

*Mandible:*
Buccal bone; thickest between 1st and 2nd molars
Interdental space; widest between 1st and 2nd premolar

**Pearl:** A stable screw requires good quality and adequate thickness, 1–2 mm, of cortical bone.[11]

3. The position of the roots of adjacent teeth will influence the position of the miniscrew.

### 17.1.4 Screw Placement Technique

This text is not intended as a course summary; it is advisable for any clinician planning to use miniscrews to attend a lecture or practical course on this topic. However, below I have listed some of the important features you need to bear in mind.

**Pearl:** Because miniscrews are not perceived as conventional orthodontics by most patients, it is essential that the procedure should be carefully explained to the patient/parent, and a relevant consent form signed prior to starting the procedure (see Appendix B).

- Keep the procedure simple.
- Select either a self-tapping screw placed in a predrilled pilot hole, or use a self-drilling self-tapping screw. Consider using a predrilled pilot hole when placing a miniscrew in a patient with a large heavy-bodied mandible; the cortical bone in these cases can be very dense and it will be difficult to place a self-drilling self-tapping miniscrew.
- Be gentle and use a slow speed reducing handpiece. When placing the miniscrew either with a manual driver or a reducing handpiece (use an electric motor which allows accurate speed control) turn very slowly; be aware that as the screw forces its way into the bone, the bone at the site is compressed, crushed, and micro cracks are formed.[12]

**Pearl:** Turning the miniscrew too fast or exerting excessive pressure will generate heat which will in turn contribute to bone necrosis and failure.

- Do not over torque the screw once primary stability has been achieved.
- The head should protrude through attached mucosa and not unattached mucosa.
- If the head is in the unattached mucosa, the soft tissues will become irritated, inflamed, and grow over the head.
- If the intention is to place the minscrew high up in the sulcus or to make use of the zygomatic buttress, then it is necessary to raise a flap and use specially designed miniplates. It should be pointed out at this stage that miniplates placed submucosally either in the maxilla, zygomatic buttress, or the body of the mandible, offer more stable sources of bony anchorage than miniscrews. (See Section 17.2) Using miniplates, a number of workers have achieved remarkable results particularly in the treatment of Class III malocclusions.[13–15]

### 17.1.5 Site of Anchorage Dictated by the Malocclusion

#### 17.1.5.1 Distal Movement of Buccal and or Anterior Teeth

When placing the miniscrews in the maxillary buccal region, they need to be inclined apically 40° to 45° and distally about 10° to 20° and placed 0.5 to 2.7 mm distal to the contact point to minimize root contact.[16]

Varying the angle of insertion in relation to the applied force can alter the stress distribution in the bone surrounding the screw thread.[17]

Moving molars distally is something clinicians have been doing successfully for many years using different forms of intraoral appliances. A recent meta-analysis study showed that both conventional anchorage systems and skeletal anchorage systems were equally effective; however, with skeletal anchorage there was no anchorage loss.[18]

**Figure 17.1**

Elastomeric thread for traction from the miniscrew directly to the canine.

Buccal placement: Preferably between the first molar and second premolar.

Palatal placement: Preferably between the first and second molar.

Retromolar placement: If access permits, miniscrews can be placed in the retromolar region distal to the last standing tooth. In the maxilla, this site does not offer good dense cortical bone.

Using direct anchorage: For teeth anterior to the miniscrew, an elastomeric thread, chain, or coil spring can be placed between the miniscrew and the relevant tooth or for en-masse retraction of the anterior teeth the traction can be applied directly to a hook attached to the archwire (Figure 17.1).

Using indirect anchorage: For teeth distal to the miniscrew, the anterior dentition, either via the archwire or the canine tooth can be tied to the miniscrew with ligature wire thus preventing any mesial movement while the molars are moved distally either with an expanding coil spring or an expanding loop. Clinically placing a coil spring between the first and second molars is a difficult procedure (Figure 17.2).

To move either the first or second molar distally when the miniscrew is actually positioned mesial to these teeth, the option of using an auxiliary is recommended. The advantage of an auxiliary is the facility to place or remove it easily without major adjustment of the main archwire.

**Pearl:** If the second molar is present, it is advisable to first move this tooth distally to the required position and then retract the first molar into contact with the second molar.

**Figure 17.2**

Reinforced anchorage of the anterior dentition allowing distal movement of second molar using a coil spring.

The auxiliary is constructed using 0.457 × 0.635 mm (0.018 × 0.025 inch) or 0.508 mm (0.020 inch) round stainless steel wire using a similar technique described for the construction of sliding jigs (Figure 17.3a–d) (see Chapter 14).

The distal end of the archwire is threaded through the eyelet of the auxiliary before the archwire is placed into the tube on the second

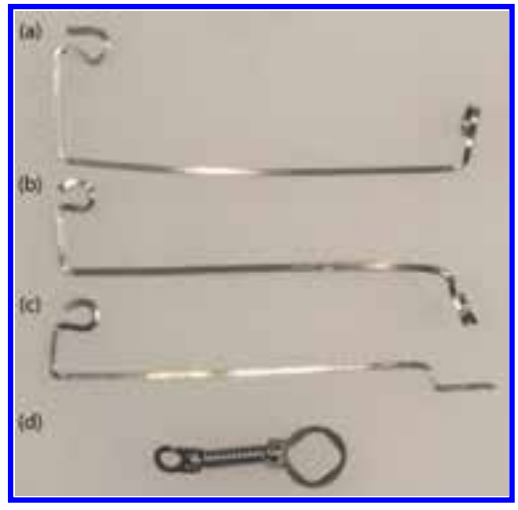


**Figure 17.3**

Auxiliaries for distal movement of second molars. (a) For single buccal tube, auxiliary tied to occlusal of the premolar brackets. (b) For single buccal tube, auxiliary tied to gingival of the premolar brackets. (c) For double buccal tube, auxiliary tied to gingival of the premolar brackets. (d) Nickel-titanium coil spring with attachment to fit miniscrew.

**Figure 17.4**

Auxiliary for single buccal tube on the second molar, tied to the gingival of the premolar brackets.

molar. The auxiliary may be tied to either the gingival or occlusal of the brackets (Figures 17.4 and 17.5).

If a double tube is bonded to the second molar, then use the auxiliary with the stepped distal end placing it into the gingival or occlusal tube. This is an easier auxiliary to place and remove (Figure 17.6).

The auxiliaries bypass the first molar and are lightly tied to the outside of the brackets of the first and second premolar teeth. A traction force is applied from the miniscrew head to the hook on the auxiliary using either an elastomeric thread, power chain, or coil spring. Once the second molar has moved distally to the required position, hold it in position by

**Figure 17.5**

Auxiliary for single buccal tube on the second molar, tied to the occlusal of the premolar brackets.

**Figure 17.6**

Stepped auxiliary for double buccal tube placed into the gingival tube on a second molar and tied to the gingival of the premolar brackets.

retaining the traction from the miniscrew to the auxiliary and then use an elastic thread from the second molar to the first molar to move it distally (Figure 17.7a and b).

While maintaining the position of the molars, the premolars can be moved distally using the same mechanics. As the premolar moves distally, make sure the root of the premolar does not move against the miniscrew; it may be necessary to relocate the miniscrew.

**Pearl:** When using sliding mechanics as described above, friction between a rectangular archwire and a rectangular bracket/tube will inhibit tooth movement. Friction should be reduced to a minimum by using a round 0.406 mm or 0.457 mm (0.016 inch or 0.018 inch) archwire. Check for free sliding of the archwire in the brackets and tubes.

As the miniscrew head is generally above or below the level of the archwire, traction directed to the tooth or archwire will invariably be at an angle, this may or may not be desirable. When it is necessary to apply traction in a direction parallel to the archwire, it is essential to use a power arm. Constructing a multipurpose power arm at the chairside is well illustrated in an article by Prabhat et al.[19] Further examples of power arms fitted to a lower molar tube incorporating a vertical slot

**Figure 17.7**

(a) Crowded lateral incisor, space created by moving second molar distally using miniscrew, nickel-titanium coil spring and auxiliary. First molar moved distally using elastomeric thread from the distalized second molar. (b) Occlusal view showing space created between the first molar and second premolar.

is shown in Figure 17.8a–c and into a double molar tube in Figure 17.9a and b.

If the power arm in unstable, it can be fixed in position with flowable composite (Figure 17.10a and b).

Palatal miniscrews placed bilaterally between the first molar and second premolar teeth, can be used to retract the anterior teeth by tying elastomeric thread from the miniscrew head, through the contact points between the lateral incisors and canines to the labial archwire. This procedure is very useful in the absence of posterior anchorage; it works well for both lingual orthodontics and conventional labial techniques (Figure 17.11a–c).

### 17.1.5.2 Mesial Movement of Buccal Teeth

Molar and premolar teeth can be moved mesially, using direct traction from the relevant tooth to the miniscrew.

**Pearl:** The miniscrew should be placed just distal and not mesial to the root of the canine tooth. If it is placed mesial to the root of the canine, then traction from a molar or premolar to the miniscrew will need to traverse the canine eminence resulting in gingival irritation.

For Class III correction, the same principles apply; the screw can be placed in the mandible between the first molar and the second premolar and direct anchorage used to retract mandibular incisors.

Miniscrews may also be used directly as a source for Class II and Class III intraoral elastics.

### 17.1.5.3 Intrusion

Intrusion of buccal quadrants either unilaterally or bilaterally is a difficult procedure when using conventional orthodontic techniques. However, correctly placed buccal and palatal miniscrews used in tandem have greatly facilitated this procedure. Using elastomeric thread, the mechanics are remarkably simple but be aware intrusion is a slow procedure (Figure 17.12a–c).


**Figure 17.8**

(a) Buccal tube with vertical slot. Power arm 0.508 mm (0.020 inch) wire annealed at the end of the vertical post. (b) Power arm inserted into the vertical slot of the tube from the gingival aspect. (c) Annealed end of vertical post bent over.

If palatal or buccal miniscrews are used individually on their own for intrusion, then it is essential to use a transpalatal arch to prevent the molar teeth from tipping either palatally or buccally.[20] To intrude anterior teeth use labially placed miniscrews. In the maxilla, these are generally placed between the roots of lateral and canine teeth. In the mandible, they are also placed between the lateral incisors and canines, there may be a problem due to the limited height of the attached mucosa and the limited interradicular space. Occasionally one miniscrew placed in the midline between the central incisors may suffice.

**Pearl:** When intruding anterior teeth, don't fight against the archwire; the archwire must be adjusted to work with the intrusion force of the elastomeric thread. The intrusive force must be gentle, as there is a risk of root resorption. This procedure must not be carried out in the presence of any gingival or periodontal disease.

Preprosthetic tooth movement with particular reference to intrusion of overerupted teeth used to be a very difficult procedure using conventional fixed appliances. Now, this procedure

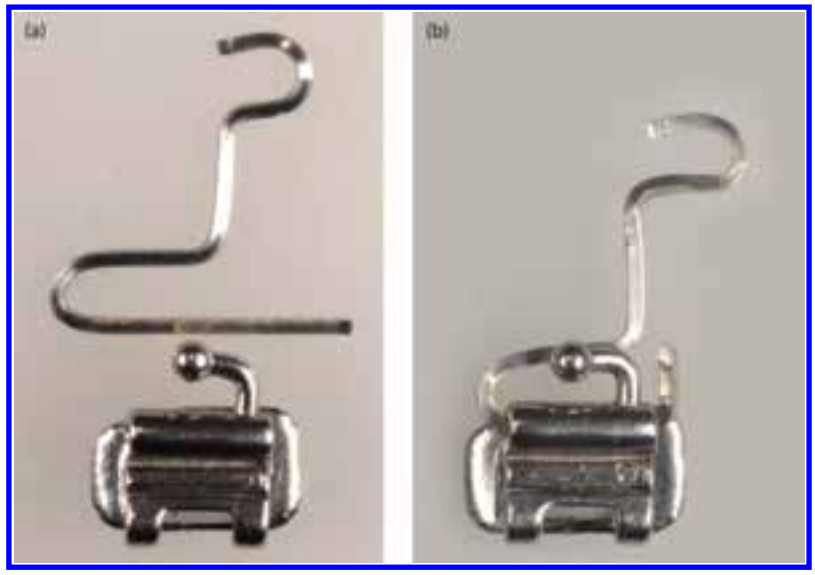

**Figure 17.9**

(a) Power arm 0.457 × 0.635 mm (0.018 × 0.025 inch) for double molar tube. (b) Power arm inserted into gingival tube and the free end bent over to lock.

**Figure 17.10**

(a) Mesial traction from a miniscrew to the maxillary first molar showing unfavourable angle of traction. (b) Power arm placed into the gingival tube and sealed with flowable composite. Note more favourable angle of traction.

has become much simpler and more efficient with the use of miniscrews. Uprighting tipped molars is also greatly facilitated by incorporating the use of miniscrews (see Chapter 18). This is further illustrated in an article by Nienkemper et al.[21]

Altering the occlusal plane by posterior maxillary intrusion can also alter the degree and site of orthognathic surgery.[20]

### 17.1.5.4 Midline Palatal Miniscrews

The bone density of the cortical palatal bone particularly in the midpalatal region favours this site as a source of anchorage. The Onplant described by Block in 1995 was placed under the palatal mucosa,[22] and Wehrbein et al. described a large diameter midpalatal screw;[23] neither of these have been widely accepted.

**Figure 17.11**

(a) Bilateral palatal miniscrews for retracting anterior teeth. (b) Bilateral palatal miniscrews used to retract anterior teeth. Maxillary right molar periodontally compromised, left molar extracted.

**Figure 17.12**

(a) Overerupted left maxillary buccal segment. (b) Buccal miniscrew with elastomeric thread to intrude molar teeth. Balancing palatal miniscrew placed to intrude molars without buccal tipping. (c) Occlusal plane levelled, enabling implant replacement of absent mandibular dentition.

**Pearl:** As miniscrews in the midpalatal region are not in line with the dental arches, the designs of the appliances required for delivering the necessary forces to the dentition are more complicated and usually require the services of a laboratory technician.

Dr Ludwig and co-workers have focused their attention on palatal miniscrews and have developed many designs using two palatal miniscrews generally in tandem to execute a number of orthodontic procedures;[24–29] their overall survival rate is impressive at 97.9%.[30]

### *17.1.6 Stability*

It has been well established that miniscrews can be loaded immediately after placement;[6,31] furthermore, recent studies indicate that immediate loading appears to encourage an increase in bone hardness surrounding the miniscrew.[11]

A systematic review of the literature by Schätzle et al. showed a 16.4% failure rate for miniscrews and 7.3% for miniplates.[32]

#### 17.1.6.1 Why and When Do Miniscrews Fail?

A study by Lee et al. showed that the risk of failure is highest soon after placement, and then decreases to zero after about 100 weeks; this suggests a gradual osseointegration of the miniscrews. They also showed that age was the only variable associated with failure. Caution is advised when placing miniscrews in young patients; failure rate of 17.6% below the age of 20 and 6.2% for over 20-year-old patients have been recorded in their study.[33]

Studies by Al Maaitah et al. showed that below the age of 20 years, male subjects have a significantly higher bone density than female patients; furthermore, they showed that there is an increase in bone density after 3 months following insertion.[34]

**Pearl:** Expect a higher failure rate for miniscrews placed in female patients below the age of 15.[35]

#### 17.1.6.2 Poor Quality Cortical Bone

Miniscrews rely purely on mechanical retention of the threaded component (5–6 mm) of the miniscrew in the cortical bone.

*Overloading the miniscrew*: Clinicians need to exercise common sense when loading a miniscrew. Clinically, the load applied to a miniscrew head is generally at right angles to the body of the miniscrew (Figure 17.13). This creates a moment of force with the fulcrum located at the surface of the cortical bone. The significance of this arrangement is that for the same applied load, the stress at the fulcrum will increase as the point of application moves

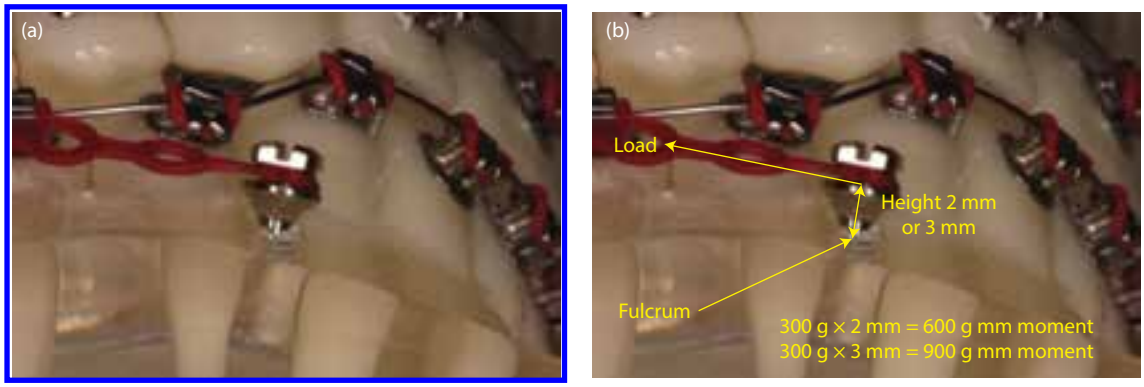


**Figure 17.13**

(a) Traction to miniscrew creating a moment of force. (b) For a load of 300 g, at a miniscrew height of 2 mm the moment at the bone surface is 600 g mm. For the same load, at a miniscrew height of 3 mm, the moment increases to 900 g mm.

further away from the bone surface. For example, if a 300 g load is applied to the miniscrew head at 2 mm from the bone surface, the moment at the fulcrum will be 600 g mm; however, if the head of the miniscrew protrudes 3 mm from the bone surface, for the same load of 300 g, the moment developed will be 900 g mm. Once these force levels are reached, the clinician will start to invite failure. Research by Buchter et al.[36] showed that for their experimental animal subject, the upper limit of force application was 900 cN mm (centinewton millimetre) equivalent to 917 g mm.

**Pearl:** Make sure the head of the miniscrew is inserted as close to the cortical bone surface as the mucosal thickness will allow. Buccal mucosa thickness is approximately 1 mm and palatal mucosa thickness 2–5 mm.[37]

Elastomeric chains need to be used with caution. In anticipation of the degradation of elastomeric materials, clinicians tend to overstretch the elastomeric chain. For conventional space closure where the load is spread over a number of teeth, this is not a problem. However, when such an overload is placed on a miniscrew, this may lead to failure. Nickel-titanium coil springs give a more constant and more controllable strain to load ratio.

#### 17.1.6.3 Failure to Achieve Good Primary Stability

**Pearl:** If primary stability is not achieved at insertion, the miniscrew will fail. Do not over torque the miniscrew at insertion.

A study by Inaba showed that in clinical practice, implants that are inclined to the bone surface had an increased primary stability.[38]

#### 17.1.6.4 Root Impingement

If the miniscrew impinges on a tooth root, the constant movement of the tooth during mastication will, firstly, be painful, and, secondly, will contribute to the loosening of the miniscrew.[39] It is essential that good quality intraoral radiographs are taken pre- and postoperatively to determine the space available prior to placement and to evaluate possible root contact after placement. Unfortunately, due to two-dimensional limitations of conventional radiographs, the relative positions of the miniscrew and the adjacent tooth root are not always clearly represented. Cone beam computed tomography may provide a different scenario. Work by Shinohara revealed 20% of 147 implants to be in contact with a root.[40] This finding is higher than clinical experience would indicate, so either we have been under a misapprehension as to the sensitivity of the patient to detect root contact or the significance of root contact may be over emphasized.

#### 17.1.6.5 Root Damage

Clearly, clinicians must be concerned regarding the implications of screw impingement on the adjacent tooth roots. Early studies particularly in relation to maxillofacial transalveolar screws showed that the incidence of any significant damage to be very low.[41–43]

Root damage can occur during placement due to selecting the incorrect initial point of insertion, incorrect path of insertion, anatomical variation in root morphology, and subsequent tooth movement. The use of minimal local anaesthetic retains the sensitivity of the periodontal ligament allowing the patient to be aware and able to feel pain as the miniscrew gets close to the periodontal ligament. Current research has shown that if there is some root contact, removal of the miniscrew is followed by good repair of the cementum within three months.[44–46]

#### 17.1.6.6 Poor Oral Hygiene

Accumulated plaque around the head of a miniscrew will initiate mucosal inflammation which, will in turn affect the integrity of the underlying cortical bone and subsequently lead to loosening and failure. Gentle and frequent brushing will keep the area around the miniscrew head clean and free of food debris.

### *17.1.7 Conclusion*

Like any new clinical procedure, each clinician will go through a learning curve; for some this

may be brief and they become fast and efficient in a short time, while for others the learning curve may be a little longer. Essentially, each clinician first needs to accept that the procedure is safe, has a valid clinical basis, and that it will enhance the scope of his/her orthodontic practice; once this premise has been accepted, the rest will come with time.

## 17.2 RETRACTION OF MAXILLARY BUCCAL SEGMENTS USING ZYGOMATIC ANCHOR PLATES

Antony GH McCollum

Orthodontists are confronted daily by the need to retract the maxillary buccal segments in order to relieve anterior crowding, correct Class II malocclusions, or treat dental asymmetries. Extraoral devices, such as headgears, are not well tolerated by the nongrowing patient. Innumerable temporary appliances have been developed in the effort to achieve the treatment objectives when poor compliance with conventional approaches is jeopardizing progress.

Anchor plates are temporary anchorage devices that fall within the broad concept of orthodontic bone anchors,[47] a classification which includes onplants and screw-type anchor units. These are described variously as miniimplants, microimplants, microscrew implants and miniscrews. It would appear that Jenner et al.[48] in 1985 was the first to use maxillofacial fixation plates for orthodontic anchorage. Later, in 1999, Umemori et al.[49] employed L-shaped miniplates in the mandible to intrude molar teeth in order to correct an anterior open bite introducing their skeletal anchorage system (SAS). Sherwood et al.[50] successfully used the skeletal anchorage system to intrude molar teeth in the maxilla to reduce anterior open bites. These flat miniplates are produced in a variety of designs and lengths to suit individual morphological and mechanical requirements (Figure 17.14) (www.Jeilmed.co.kr; www.biometmicrofixation.com; www.klsmartin.com; www.synthes.com/lit; www.dentsply-sankin.com).

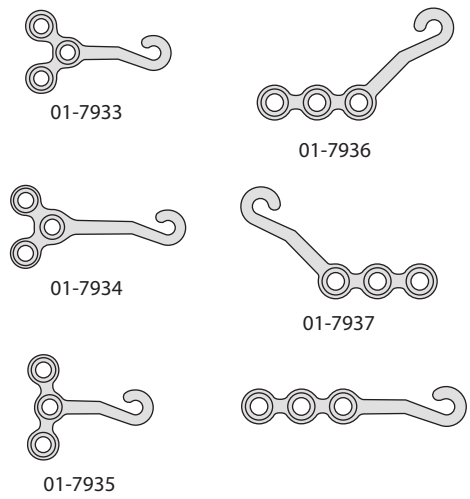


**Figure 17.14**

Flat miniplates produced in a variety of designs and lengths to suit individual morphological and mechanical requirements.

The Bollard miniplate, a development of the flat miniplate, was first introduced by De Clerck et al. in 2002 when they described the zygoma anchorage system (Figure 17.15).[51] This consists of a titanium plate extending into a round bar to which a cylinder is attached forming a bollard. The cylinder has a rectangular hole in the vertical plane measuring $0.813 \times 0.813$ mm ($0.032 \times 0.032$ inch) through which orthodontic hooks, springs, or other appliances can be fitted. At the open end of the cylinder is a locking screw which may be used to secure these auxiliaries (www.surgitek.eu). The mini plates are secured to the zygomaticomaxillary buttress by means of two or three self-tapping titanium miniscrews which are uncoated, sand blasted, or etched.

The biomechanics of using the zygomatic anchorage system for the treatment of Class II extraction and nonextraction treatment of Class II cases were excellently described by Cornelis and De Clerck[52] and De Clerck and Cornelis.[53] They demonstrated how auxiliaries such as hooks and springs that are secured to the Bollard acting as a source of anchorage for retraction of the upper buccal segments, the canines, and incisor teeth. Patient cooperation is, however, required in attaching any necessary elastics. The retraction of the canine teeth into a Class I

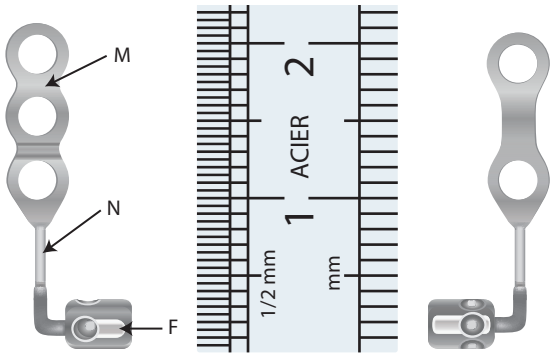


**Figure 17.15**

The Bollard miniplate: a development of the flat miniplate.

relationship with the lower arch before retraction of the incisors allows visualization of crowding relief and partially reduces the overjet through the reaction of the transseptal fibres. These effects result in considerable reduction of anchorage strain when the incisor teeth are finally retracted.

Sugawara et al.[54] measured the effectiveness of retraction of upper molar teeth using anchor plates for skeletal anchorage. The average amount of distal movement of the crowns was 3.78 mm and of the root apices, 3.2 mm, that is there was minimal distal crown tipping. These movements were significantly correlated with the average value of the treatment goal of 3.6 mm. This was achieved irrespective of age or the extraction of second or third molar teeth. Cornelis and De Klerck[55] in a prospective study recorded a mean distal movement of the molar teeth of 3.3 mm (±1.8 mm) over a period of seven months.

A study by Kaya et al. compared the molar distalization of maxillary buccal segments using zygomatic plate anchorage and a palatal miniscrew implant supported pendulum appliance. They reported that both systems could be used as alternatives to headgear traction but the skeletal and soft tissue outcome as well as distalization was greater with the zygoma plate anchorage system.[56]

Failures in the stability of miniplate temporary anchorage devices were found by Choi et al.[57] to occur only in the mandible.

**Pearl:** Cornelis et al.[58] determined that the success rate of miniplates was 92.5%, with any failures recorded mainly in growing patients. The plates were well tolerated and all of the orthodontists involved in the study confirmed that treatment was simplified by miniplates and that they would use them again.

## *17.2.1 Clinical Procedures*

### 17.2.1.1 Orthodontic Preparation

Whilst the orthodontic method described in this paper relies upon 0.457 × 0.635 mm (0.018 × 0.025 inch) mini Lang single wing brackets, the biomechanical principles apply to any bracket system.

The molar teeth are banded and brackets bonded to the remaining teeth. It is imperative that upper second molar teeth are banded or bonded to enable first and second molar distalization while maintaining their alignment and inhibiting crown tipping. Levelling, aligning, and derotation, when required, is accomplished with nickel-titanium archwires. A 0.406 mm (0.016 inch) Australian (AJ Wilcox, www.ghwire) wire with a stop crimped in the midline is placed in the upper arch. The mesial wings of the mini Lang central incisor brackets are bent labially to contact the archwire and, together with the stop, prevent archwire sliding. The ends are free which allows distal sliding of the teeth of the upper buccal segments.

The patient is now ready to be referred for the surgical placement of the miniplates.

### 17.2.1.2 Surgical Placement of Miniplates

**Pearl:** The surgical placement of the miniplates, ideally, should only take place once the teeth in the upper buccal segments have been orthodontically levelled. This allows for a more accurate relationship between the miniplate and the molar teeth.

The patient is admitted for either a general or local anaesthetic, the latter, normally being quite adequate, especially when combined with intravenous sedation. General anaesthesia is

indicated if the patient is particularly nervous or if the cheek tissue is inflexible and tight, when greater pressure than normal may be required in gaining access to the operative site.

The zygomatic buttress is an excellent site in which to place temporary anchor screws. It offers reasonable screw retention as the bone in this area is classified as D3 by Misch,[59] and described as porous cortical plate at least 1 mm thick. De Clerck and Cornelis,[53] showed that the bone was in fact 2–5 mm thick which they declared was more than adequate to provide good anchorage. In their studies no signs of sinus perforation or infections due to the screws have been observed.

As this procedure is generally carried out by an oral surgeon, the surgical details fall outside the scope of this publication, suffice to mention that at the conclusion of surgery, the flat miniplate emerges in a vertical position with the hooks facing distally. The cylinder of the Bollard miniplate will emerge at a right angle to its point of contact with the maxillary alveolar process with the screw of the cylinder facing mesially (Figure 17.16).

The wound is closed with resorbable sutures and cold presses are applied to the cheeks in the malar area to control any oedema. If necessary, paracetamol is prescribed but in most cases very little pain is experienced. Antibiotic cover is provided at the discretion of the maxillofacial surgeon. It is possible to load the temporary implant immediately but it is probably prudent to wait for three weeks until all swelling is resolved and the patient is accustomed to the appliance.

**Figure 17.16**

The cylinder of the Bollard miniplate emerging at a right angle to its point of contact with the maxillary alveolar process with the screw of the cylinder facing mesially.

On completion of the orthodontic treatment or when there is no longer a need for the miniplates, they are surgically exposed and easily removed under local anaesthetic. The Bollard miniplate screws require a special screwdriver that fits into the outer pentagonal holes. It has been occasionally recorded that appositional bone growth can occur over the miniplate thus complicating their removal.[52]

#### 17.2.1.3 Oral Hygiene and Infection Control

Immediately following the surgery the patient is instructed on oral hygiene techniques. They are advised to apply cotton wool ear buds impregnated with Corsodyl, a 2% chlorhexidine solution, once a day to the gingival tissue in the vicinity of the emergence of the implant. This is really helpful in preventing infection whilst mouth washes such as Dentyl are an added benefit. These oral hygiene techniques are vital throughout the orthodontic treatment.

#### 17.2.1.4 Post Surgical Orthodontics

After a three week recuperation period following the surgery, the brackets on the upper second premolar teeth are removed (Figure 17.17a).

This provides a large interbracket space which allows for an increased range of activation of the coil spring. The upper first premolar teeth are tied firmly to the zygomatic plates thus providing rigid skeletal anchorage for the distalization of the molar teeth.

The 0.406 mm (0.016 inch) archwire is removed and 0.254 mm × 1.016 mm (0.010 × 0.040 inch) nickel-titanium open coil springs cut to two lengths of approximately 18 mm (0.7 inch) each and fed onto the 0.406 mm (0.016 inch) main archwire. This archwire is then retied into position so that the coil springs are active between the upper first molar tubes and the distal aspect of the upper first premolar brackets on the left and right sides. The force produced is *circa* 300 g; Cornelis and De Clerck[55] successfully applied 150 g. Janssen et al.[60] reported that forces between 100 g to

**Figure 17.17**

(a) Three weeks following surgery, the brackets on the upper second premolar teeth are removed, providing increased interbracket space for activation of the coil spring. The upper first premolar teeth are tied firmly to the zygomatic plates. (b) Note the distal movement of the maxillary first and second molar and the space developed mesial and distal to the maxillary second premolar.

400 g can safely be applied without loosening of the miniplate. No jigs or patient cooperation is required. In most cases the molar teeth retract at a rate of approximately 1 mm per month. In general, some 3–5 mm of movement can be expected in younger individuals over a four to six months period, but this will require up to nine months or longer in older adults and euryprosopic (broad face) facial types with their heavy musculature (Figure 17.17b).

Once the molar teeth have been repositioned, they are anchored together using figure of eight ligatures and tied to the zygomatic plate. New brackets are bonded to the upper second premolar teeth and ligated to the 0.022 mm (0.016 inch) archwire for levelling. They are then retracted to contact the upper first molar teeth using chain elastics attached to the anchored molar teeth or light nickel-titanium coil springs attached to the zygomatic anchor plates. Alternatively, like molar retraction, the first premolars remain anchored to the miniplate and a compressed nickel-titanium coil spring will efficiently retract the upper second premolar teeth to contact the upper first molars.

The upper second premolar teeth are then coupled to the molar teeth with a figure of eight ligature and tied to the anchor plate. Now, in sequence the upper first premolar teeth are retracted in similar manner to contact the upper second premolar teeth. Distal *en masse* movement of the premolars and molar teeth is also possible where the retraction coils springs $0.254 \times 1.016$ mm ($0.010 \times 0.040$ inch) are attached to the anchor plates and to the hooks of the brackets of the upper first premolar teeth or the canines (Figure 17.18).

This *en masse* movement is not always reliable due to the development of greater frictional forces and or the heavy musculature associated with euryprosopic facial types and older adults.

The upper canine teeth are retracted into a Class I relationship with the lower arch using chain elastics or light coil springs

**Figure 17.18**

The retraction coils springs 0.254 mm × 1.016 mm ($0.010 \times 0.040$ inch) are attached from the anchor plates and to the hooks of the brackets of the upper first premolar teeth or the canines for *en masse* retraction.

attached to the premolars and molar teeth which remain anchored to the zygomatic plates. Alternatively the patient may at that stage comply by wearing intraoral elastics attached to the upper canine hooks and to the zygomatic plates.

The upper incisor teeth will often be partially retracted and spaced, due to tension on the transseptal fibres when the buccal segments and canine teeth are distalized. Closing loop arches resolve the overjet and reduce the residual spaces in combination with rigid anchorage provided by the ligature tie back from the upper canine teeth to the zygomatic anchor plates.

### *17.2.2 Conclusions*

Of the 85 plates fitted to my patients only three failures occurred, two of which were caused by infection and the other was due to the surgeon making the pilot holes too large.

The surgery required to place miniplates is invasive but patients suffer little discomfort and accept it as a necessary event. Miniscrews which likewise provide good anchorage are less invasive to place but can be associated with root damage if placed on the buccal aspect.

**Pearl:** Miniplates fixated to the infrazygomatic crest offer excellent anchorage possibilities. They are safe without jeopardizing any teeth and are well tolerated by the patients. Orthodontists have found them convenient and efficient anchor units especially for the noncompliant nongrowing patient.

Figure 17.19a and b shows the results achieved in the case of a noncompliant patient. Following the start of traction from the miniplates, the buccal segments were in a Class I relationship after six months. The case took 13 months to complete and the final occlusion after three years remained stable. This example illustrates the potential of the miniplate anchorage system.


**Figure 17.19**

(a) Noncompliant patient presenting with a Class II malocclusion – pretreatment. (b) Final result achieved using zygomatic miniplates.

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# 18 INTERDISCIPLINARY TREATMENT

Eliakim Mizrahi, W Aubrey Soskolne, Ayala Stabholz and Antony GH McCollum

CONTENTS



## 18.1 THE ORTHODONTIC/ RESTORATIVE INTERFACE

Eliakim Mizrahi

### *18.1.1 Introduction*

A beautiful smile, white teeth, aesthetic dentistry, implants, digital procedures, interdisciplinary dentistry – these are the terms and fields that will drive general dentistry into the 21st century. As orthodontists this is not new for us, we have been concerned with facial aesthetics since the days of Edward Angle in the early 1920s.[1]

From the orthodontist's point of view, there are some basic principles that need to be borne in mind which, sometimes clinicians appear to be unaware of or have forgotten. I am placing these at the start rather than the end so that the reader should keep them in mind before getting lost in the details of the chapter.

**Pearl:** The majority of adult patients do not enjoy wearing an orthodontic appliance.

- Whether the appliance is removable, vacuum-formed thermoplastic, fixed, steel, porcelain, or lingual, once the appliances are fitted it will not be too long before the patient starts asking, 'When are they coming off?' With time, this continual request does put the clinician under pressure.
- The team is generally led by the restorative dentist. Often the required tooth movement is minimal; moving one or two teeth a few millimetres is fine. However, sometimes when the restorative dentist asks for excessive tooth movement, remember, 'Don't try being a hero.' Conventionally, in orthodontic practice, we are dealing with young patients and for orthodontists, moving teeth the width of a premolar is something we do on a daily basis, but with adults we are dealing with a group of patients ranging from young adults to middle age adults to old adults.

**Pearl:** We need to remember some basic physiology: the older the patient the less vascular is the bone, the narrower the periodontal membrane, the slower the tooth movement, the greater the chance of both root resorption and alveolar bone loss.

Working with restorative dentists on a multidisciplinary basis, we often come across mutilated cases and compromised dentitions with gingival and periodontal problems. In these cases, it is very important that either the restorative dentist has a good working

knowledge of periodontics or we include a periodontist in the multidisciplinary team (see Section 2).

In spite of the above reservations, these types of cases are interesting, challenging, and difficult but very rewarding to treat.

Within the context of interdisciplinary treatment, the restorative-orthodontic interface is probably the most frequently practiced. The interface may be with a specialist prosthodontist or a general dental practitioner and this mutually beneficial collaboration may cover a wide range of clinical cases ranging from simple minor aesthetic bonding to single and multiple tooth replacement extending to multifaceted, mutilated complex cases.

One of the most experienced interdisciplinary teams was that of Frank Spear (Prosthodontist) Vincent Kokich (Orthodontist, very sadly, recently deceased), and David Mathews (Periodontist). For many years, these clinicians, based in Seattle, have taught, published, and lectured widely on this subject and I recommend a visit to www.kokichorthodontics.com where any reader will have access to a wealth of contemporary information on this subject.

Clearly this chapter is not designed as an in-depth study on this subject; my intention is to highlight some important and relevant issues.

## *18.1.2 Anterior Aesthetics*

**Pearl:** In order to optimize the aesthetic outcome, the planning sequence preferred by the Seattle team starts with aesthetics and proceeds to function, structure and finally biology.[2]

It is assumed that as a prerequisite for any case assessment a full set of orthodontic records will have been taken.

Optimizing anterior aesthetics involves evaluation of the following issues:

- Maxillary incisor display
- Centre line discrepancies
- Incisor inclination
- Relationship of the maxillary incisal edges to the occlusal plane
- Determination of the correct gingival margin levels
- Alignment, contour, and shade
- Developing a plan for the mandibular teeth
- Planning for retention

### 18.1.2.1 Maxillary Incisor Display

This is assessed in relation to the upper lip held in the rest position. This should be measured and recorded and a decision taken as to whether the current position is acceptable or unacceptable. Apart from the local factors that influence this assessment, the patient's age also needs to be considered.

**Pearl:** An incisal display of 3 mm is acceptable in a 30-year-old patient, whereas for a 60-year-old patient, a 1 mm incisal display is more appropriate.

If the incisal display is judged to be inadequate or excessive, the maxillary incisal crowns may be lengthened or reduced either by restorative procedures, orthodontic tooth movement, orthognathic surgery, or a combination of the above. The decision taken by the team will be influenced by the patient's existing anterior occlusion in relation to overbite and overjet, and facial proportions related to the length and width of the face.

In cases of real vertical maxillary excess, clearly restorative treatment or orthodontic treatment on their own is not an option; such a case needs surgical intervention (Figure 18.1a–d).

Once the incisor display is viewed with the lips in the smiling position, the gingival contours and levels will also need to be assessed.

The next case shows the other extreme, inadequate display of the maxillary incisors in spite of a short upper lip. This type of case can be significantly improved by a combination of orthodontic treatment and restorative incisal crown lengthening (Figure 18.2a–c).

Excess incisal edge wear also affects incisor display. Clearly, this is a restorative procedure;


**Figure 18.1**

(a) Maxillary incisor display; lips at rest. (b) Incisor display; smiling. (c) Incisor display; lips at rest postsurgery. (d) Incisor display; smiling postsurgery.

however, where it is associated with an incorrect incisor relationship, such as an edge to edge bite, it is best treated with a combination of orthodontics first to correct the incisor relationship, in this case to create a positive overjet, followed by restorative replacement of the lost incisal material (Figure 18.3a–c).

In cases showing an increased overbite, restorative options are generally limited to posterior occlusal onlay build up; unfortunately, while this may reduce the overbite, it alters the incisal relationship and may eliminate incisal guidance. With the assistance of orthodontic treatment, a corrected occlusion may be developed allowing the restorative procedures to be carried out in a more favourable occlusal environment. This feature is demonstrated by the following case which shows excessive overeruption of both maxillary and mandibular incisors associated with a deep overbite and destruction of labial enamel of the lower incisors. Restorative treatment on its own cannot achieve a satisfactory result; however, orthodontic treatment can correct the malocclusion, with particular reference to the interincisal relationship, incisal guidance, and placing the incisors in a position more suitable for restorative replacement of the lost labial enamel (Figure 18.4a–c).


**Figure 18.2**

(a) Reduced lower facial height, short upper lip, no incisal display; lips at rest. (b) Reduced lower facial height, short upper lip, smiling with effort, minimal incisal display. (c) To assist with the correct incisor positioning, temporary incisor crown lengthening can be carried out with flowable composite during orthodontic treatment.

### 18.1.2.2 Maxillary Centre Line

If the maxillary/mandibular centre line discrepancy is limited to 3 to 4 mm, this is unlikely to be perceived as unaesthetic by the average individual, provided the long axis of the incisors are parallel with the long axis of the face.[3,4] However, if the incisors are inclined 2 mm to the right or left this may be regarded as unaesthetic by the lay person.[5] Canted maxillary incisors can be corrected either with orthodontic treatment, restorative procedures, or in combination. However, if the dental centre lines deviate from the facial centre, then depending on the degree of deviation, there may be a skeletal component to the aetiology which, in turn may require surgical correction.

**Pearl:** If the restorative dentist requests orthodontic correction of the centre line; be aware, the incisors will probably need to be moved bodily, it will take time, it will require space management, and there may be anchorage considerations.

The following case shows an absent maxillary right lateral and a large midline diastema. Clearly the restorative dentist requested the mesial movement of the right central incisor to prepare for the replacement of the missing lateral with an osseointegrated implant. The patient and the restorative dentist must be aware that moving the central incisor bodily and creating adequate space for the implant does take time (Figure 18.5a and b).

**Figure 18.3**

(a) Edge-to-edge bite with excess incisal wear and interdental spacing. (b) Postorthodontics, positive overjet with temporary flowable composite incisal crown lengthening. (c) Postorthodontic smile, patient referred back to the restorative dentist for permanent definitive restorations.

#### 18.1.2.3 Maxillary Incisor Inclination

Having established the most desirable incisal length and midline relationships, the next step is to evaluate the labiolingual inclination of the maxillary incisors. Apart from cephalometric evaluation, a clinical guide requires that the labial surface of the maxillary incisors should be at right angles to the maxillary posterior occlusal plane. This provides the most ideal angle for correct light reflection.

**Pearl:** To assist with this evaluation, the clinician needs to hold a mirror handle or a flat wooden tongue depressor on the posterior maxillary teeth. The labial surface of the incisors can then be evaluated in relation to the anteriorly projecting instrument.

Once again, the incisor inclination can be corrected with either orthodontics or restorative procedures depending on other aspects of treatment. Unfortunately, the degree of restorative correction for proclined or retroclined anterior teeth is limited. For retroclined incisors, excess labial build up results in unsightly thick incisors, while restorative correction of proclined incisors may require pulp exposure and endodontic procedures. Orthodontic correction of incisor angulation is not a difficult procedure and can place these teeth in an ideal position for the restorative dentist.

#### 18.1.2.4 Relationship of the Maxillary Incisal Edges to the Occlusal Plane

The fourth factor to consider is the relationship of the maxillary incisal edges to the

**Figure 18.4**

(a) Maxillary and mandibular incisor over eruption creating an excessively deep overbite. (b) Excess wear of the labial enamel on the lower incisors. (c) Postorthodontic treatment with a reduced overbite and a corrected incisor relationship. Patient referred back to the restorative dentist.

**Figure 18.5**

(a) Large midline diastema associated with absent right lateral incisor. (b) Right central incisor moved mesially, absent right lateral incisor replaced with an osseointegrated implant and crown. Centre lines coincident.

posterior occlusal plane; ideally they should be on the same plane. Once the correct position of the maxillary incisal edges has been established, correction of the posterior occlusal plane may be accomplished by orthodontic treatment, restorative procedures, or orthognathic surgery.

In the past, intrusion of posterior teeth has always been a difficult tooth movement to achieve with intra oral fixed appliances; however, since the introduction of temporary anchorage devices, this procedure has been greatly facilitated by the use of miniscrews and miniplates (see Chapter 17). The following mutilated dentition was restored with a combination of orthodontics and restorative dentistry using miniscrews to level the occlusal plane on the right and retract buccal teeth on the left (Figures 18.6 through 18.8).

Changes to the posterior occlusal plane will be influenced by the degree of occlusal tooth loss, the patient's vertical proportions and the position of the alveolar bone. Once the position of the maxillary incisors has been determined and the posterior occlusal plane established, then the incisal edges of the laterals, and cusp tips of the canines and premolars can be determined. Generally to achieve the best aesthetic result, these teeth are placed to conform to the contour of the lower lip when smiling (Figure 18.9).[6]

A study by Machado et al. confirmed the clinical assumption that symmetry between the maxillary incisors is a paramount goal for aesthetic treatment of the anterior dentition.[7]

**Figure 18.6**

(a) Overerupted maxillary right buccal quadrant. Absent mandibular right molars and premolars. (b) Anterior occlusion, increased overbite, absent UL2, poor temporary crown on a partially erupted UL3. (c) Maxillary left buccal quadrant mesially displaced. Absent mandibular left second premolar and first molar with associated drifting of adjacent teeth, and a mutilated occlusal plane.

**Figure 18.7**

(a) Buccal and palatal miniscrews for intrusion of the maxillary first molar. 0.016 nickel-titanium upper arch to level maxillary occlusal plane. Mandibular buccal osseointegrated implants with temporary crowns. (b) Maxillary left retromolar miniscrew with retracting elastomeric thread to buccal and palatal attachments on UL6. (c) Occlusal view showing retracted left maxillary buccal segment. Space now available for retraction of UL3 in preparation for replacement of absent UL2. Space taken up between UL6 and retromolar miniscrew. Palatal miniscrew placed between UR7 and UR5 for intrusion of buccal quadrant.

### 18.1.2.5 Determination of the Correct Gingival Margin Levels

**Pearl:** It is important to determine the correct gingival levels and tooth size only after the positions of the projected incisal edges have been determined.

At this stage due consideration must be given to the correct width-to-length ratio (width 75%–80% of height) of the maxillary anterior teeth,[8] the desired amount of gingival display and symmetry between right and left sides of the arch. Adjusting the gingival margin levels can be carried out by either gingival or osseous surgery and, to a limited extent, orthodontic intrusion or extrusion together with crown restoration. This should be a team decision, taking into account sulcus depth, the position of the cementoenamel junction relative to the bone level, the amount of tooth structure, the root to crown ratio, and the shape of the root.

**Figure 18.8**

(a) Right buccal occlusion with corrected occlusal plane, restored with crowns and implants. (b) Anterior teeth restored with crowns and a bridge to replace left lateral incisor. (c) Left buccal occlusion restored with crowns and implants. (Posttreatment photographs by courtesy of Dr B Mizrahi, Prosthodontist.)

**Figure 18.9**

Aesthetically pleasing smile; maxillary teeth following the contour of the lower lip.

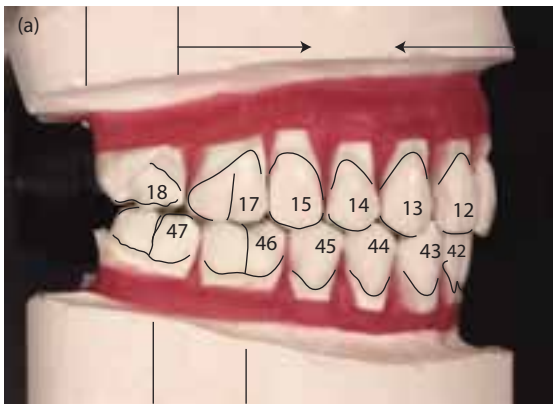
Due consideration also needs to be given to the position of the papilla, bearing in mind the position of the contact point. Changes in these parameters are generally carried out by a periodontist and to a limited degree; orthodontists can assist by slight changes to the mesiodistal angulation of the incisor teeth.

### 18.1.2.6 Alignment, Contour and Shade

At this stage, consideration needs to be given to the alignment of the teeth and the contours and shades of the final restorations. Once again this probably involves a joint discussion and decision by the team. A prerequisite for such planning and discussion is the creation of a diagnostic set-up of the dentition using either plaster models or virtual digital models[11] (see Chapter 16). You will often hear or read that orthodontics is a combination of 'Art and

Science'. Well, artists, particularly sculptors create an initial 'maquette' (a small model) to visualize and test shapes and ideas before proceeding with the final creation. So it should be for us, the diagnostic set-up allows us to visualize the final dentition, it allows us to test different treatment approaches, test shapes, sizes, and even colours. It is a very important and useful tool (Figure 18.10a and b).

It is essential to take into consideration the individual patient's desires and any specific request they may have. Balancing the patient's expectations with a clinically realistic expectation is an important consideration in evaluating a treatment plan.



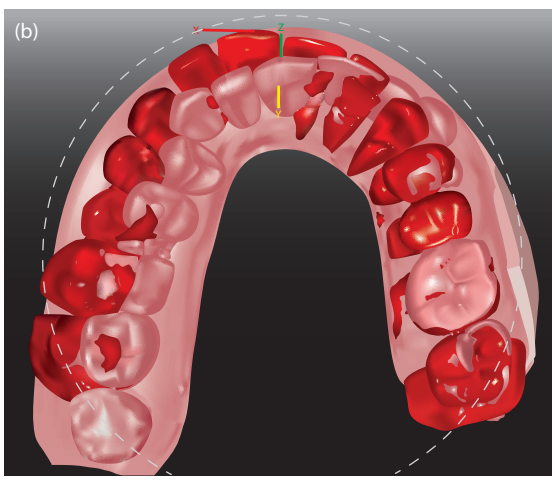




**Figure 18.10**

(a) Manually created diagnostic model set-up. (b) Computer generated virtual models allowing simulated tooth movements in all planes of space.

**Pearl:** Kokich warns that 'the more alterations one makes, in these parameters, the more teeth one will be treating and the more involved the treatment plan will become'.[9]

A common request from restorative dentists is for the correction of anterior crowding. While this is not generally a difficult procedure, there is a specific issue that needs to be brought to the attention of both the referring dentist and the patient. When incisor crowding is present and the teeth are overlapping, this is usually associated with reduced papillary tissue between the overlapping teeth. Therefore, following unravelling and aligning of these teeth the reduced papillary height will contribute to the development of a space between the apex of the shortened papilla and the tooth contact point, often referred to as a 'black triangle'. Patients with a high lip line or gummy smile may be very disturbed with this development.

With careful interproximal enamel reduction, the contact point can be changed to a contact surface which in turn contributes to a reduction in size of the black triangle. Careful aesthetic bonding by the restorative dentist on the mesial and distal interproximal surfaces of adjacent teeth also helps to reduce this space. It is difficult to eliminate it completely (Figure 18.11a–c).

### *18.1.3 Mandibular Dentition*

Once the position of the maxillary dentition has been established, the position of the mandibular incisors and posterior teeth need to be evaluated in relation to the maxillary dentition following the same steps as outlined for the maxillary teeth. It is crucial for the team to understand and appreciate that altering the position of the mandibular dentition is limited by the alveolar bone, the periogingival condition, the skeletal jaw relationships, and the surrounding soft tissue environment. The means of achieving the best position for the mandibular dentition will generally involve orthodontics, restorative procedures, or a combination of the two. In certain cases orthognathic surgery may also be required.

**Figure 18.11**

(a) Adult patient with crowded maxillary incisors. (b) Following orthodontic alignment interdental spaces develop at the gingival margins between the right lateral and central incisors 'black triangles'. (c) The interdental spaces have been reduced with composite bonding by the restorative dentist.

### *18.1.4 Site Preparation for Implants*

Remember when preparing the site for implant placement to tip the roots of the adjacent teeth away from the implant site. This is particularly relevant where implant replacement is planned for missing maxillary lateral incisors.

**Pearl:** In certain cases, the restorative dentist will request that a tooth be moved into an edentulous ridge area in preparation for implant placement. Be aware that depending on the width of the alveolar process, this can be a slow procedure and a study by Lindskog-Stokland has shown that while there may be dimensional changes to the edentulous ridge, lateral root resorption is an inevitable side effect.[10]

### *18.1.5 Planning for Retention (See Chapter 24)*

It is important to convey the implications of retention to the restorative dentist and the patient. The principle of retention as applied to conventional orthodontics still holds whether the orthodontic treatment was minor or major, whether the teeth were moved with fixed appliances or vacuum-formed thermoplastic appliances, the affected teeth will tend to move following removal of appliances.

Discuss with the restorative dentist:

- Will the final restorations contribute to retention, for example a bridge?
- Will a proposed implant contribute to retention?

- If crowns are planned for teeth that have been moved, will they be splinted, will they need fixed retention?
- Will the final overjet and overbite allow space for fixed retention?
- Will there be an option of metal-backed or full porcelain crowns? Bonding to metal-backed crowns has a poor prognosis.
- Together with the restorative dentist, plan how the restorative procedures following orthodontics will be carried out in relation to either fixed or removable retainers.

### *18.1.6 Case Discussion*

A meeting of the team members is essential to determine the final treatment plan and sequencing the treatment options. This stage should be followed by a case discussion with the patient. Accepting that the restorative dentist may be leading the team, the orthodontist should still ensure that he/she has their own case discussion with the patient at which time all aspects of orthodontic treatment are fully discussed, explained, and written consent obtained.

### *18.1.7 Treatment Sequencing*

#### 18.1.7.1 Pre-Orthodontics

1. Complete any urgent restorative procedures. In anticipation of bonding a fixed appliance, particularly when full crown coverage of certain teeth may be required, these crowns should be taken to the temporary stage only, either with composite or acrylic materials. Make sure they are cemented with durable cement, for example polycarboxalate cement (*not* TempBond), as they must not come loose during orthodontic treatment.
2. If osseointegrated implants are proposed, these may be useful and important sources of anchorage. The positioning and timing of implant placement is important in the light of anticipated tooth movements. This technique is well described by Ward Smalley.[11] Once again the crown on any implant should only be taken to the temporary stage.
3. If any periodontal treatment is indicated, this should be undertaken prior to the start of orthodontics and maintenance continued throughout orthodontic treatment (see Chapter 18, Section 2).
4. If the treatment plan calls for restorative incisor crown lengthening, this should be done prior to orthodontic treatment. Trying to establish the correct overjet and overbite with incorrect crown length is not a good option.
5. If the crown width needs to be reduced or increased, this also should be done prior to orthodontic treatment.

#### 18.1.7.2 Orthodontic Treatment

1. Throughout the treatment, the orthodontist should refer back to the original model set-up, check with the original photographs, measure planned space maintenance for example for any missing teeth, and consult periodically with the restorative dentist.
2. If implants are planned, ensure that the brackets bonded to the adjacent teeth are positioned to assist in diverging their roots away from the implant site. This is important particularly where space is limited as in the case of missing lateral incisors.
3. Once orthodontic treatment is completed, the case is referred back to the restorative dentist for completion of the final restorations. It is important to liaise with the dentist with regard to timing and sequence of retainer placement.

### *18.1.8 Orthodontic Appliance Options*

Currently, orthodontists have a wide range of appliances to offer their patients. A detailed discussion on appliance options falls outside the scope of this section. Suffice to mention that in view of the aesthetic consideration of adult patients, the increasing popularity of lingual appliances (see Chapter 20) and Invisalign type appliances invariably form part of the patient's question list. Clearly each clinician will select appliances with which he/she is familiar with and competent to use.

**Pearl:** Pressure from adult patients for aesthetically acceptable appliances must be balanced with an understanding of the limitations of each appliance.

While Invisalign type appliances are aesthetically excellent and efficient in tooth alignment, they are not so efficient for vertical or bodily tooth movements. Patients also need to understand the level of cooperation that is required for these removable types of appliances to work. They should be informed that cases treated with these aesthetically superior appliances also need to be retained.

### 18.1.9 Objectives

Clearly the objective of a multidisciplinary approach to treatment is to achieve the best possible aesthetic and functional occlusion to suit the individual patient's face. However, bearing in mind that for an adult patient, growth modification is not available and orthognathic surgery is not always an option, in some cases accepting a realistic as opposed to an ideal end result may be the best option. This needs to be explained together with valid reasons to both the restorative dentist and the patient.

## 18.2 ORTHODONTICS AND PERIODONTICS: AN INTERDISCIPLINARY APPROACH

W Aubrey Soskolne and Ayala Stabholz

In current clinical practice the concept of a multidisciplinary approach has been widely endorsed and accepted. Clearly there is an important interrelationship between orthodontic treatment and periodontal disease that is important to both specialties. Before either specialist starts a course of therapy he/she needs to be aware and to consider the interactions that may influence their approach to treatment. The periodontal considerations that the orthodontist needs to relate to can conveniently be listed under the three following headings:

1. Plaque induced gingivitis
2. Periodontitis
3. Gingival recessions

### 18.2.1 Plaque Induced Gingivitis

Plaque induced gingivitis is a painless inflammation of the marginal gingiva resulting from the accumulation of dental plaque/biofilm at the dental-gingival margins. It is characterized by redness, swelling, and bleeding (Figure 18.12).

Gingivitis is very common, affecting most of the population to different degrees of severity.

**Pearl:** The treatment of gingivitis involves the effective and efficient daily removal of bacterial plaque from the dentogingival junction (gingival margins).

Its importance for the orthodontist is that during orthodontic treatment with fixed appliances, efficient oral hygiene is difficult to achieve due to restricted access to the gingival margins for plaque elimination. The cemented

**Figure 18.12**

Plaque induced gingivitis.

**Figure 18.13**

Plaque induced gingivitis in a 14-year-old undergoing orthodontic treatment.

brackets create overhangs at the gingival margins and the arch wires interfere with access to the interdental spaces. The resultant erythema and swelling of the gums makes manipulation of the orthodontic arch wires and brackets by the clinician, much more difficult and furthermore it is painful for the patient and aesthetically undesirable (Figure 18.13).

Clearly, a related concern for the orthodontist is the increased risk of enamel decalcification in areas of plaque accumulation (see Chapter 12). For adults with a tendency to periodontitis, gingivitis increases the risk of initiating or reactivating periodontitis (Figure 18.14).

**Figure 18.14**

Adult periodontitis showing poor oral hygiene, accumulation of plaque and calculus, associated gingival swelling, redness and gingival recession.

It is therefore imperative that the orthodontist works closely with an oral hygiene therapist who is experienced in teaching and assessing the effectiveness of oral hygiene techniques. Berating a patient who has not been adequately instructed is neither fair nor helpful.

**Pearl:** The techniques should be specifically directed at accessing the gingival margins of teeth with orthodontic appliances.

Getting children to comply with the oral hygiene instructions is notoriously difficult. There are a few simple techniques which are helpful and if carried out will increase compliance and provide improved oral hygiene and gingival health. Improved gingival health leads to reduced oedema and gingival hyperplasia. The best recommendation is to teach a combined Bass and Charter's brushing technique. The Bass technique directs the bristles apically accessing the gingival sulcus as well as the incisal/occlusal aspects of the brackets and archwire while the Charter's technique directs the bristles coronally providing access to the apical/gingival aspects of the brackets and archwire as well as the underaspects of the contact points. This can also be achieved using the Bass technique together with a single tufted brush; however, the need for two brushes reduces compliance.

### *18.2.2 Periodontitis*

Periodontitis, which is caused by bacterial plaque, results in the loss of the supporting structures of the dentition and if untreated, leads to tooth loss. Orthodontic treatment of a periodontally involved dentition often results in increased rate of progression of alveolar bone loss due to two reasons:

1. Orthodontic appliances make effective oral hygiene more difficult; the periodontium is exposed to more inaccessible bacterial plaque.
2. The resultant mobility of the teeth during orthodontic treatment facilitates the progression of plaque induced periodontitis similar to what happens in the presence of occlusal trauma.

**Pearl:** It is of utmost importance to recognize if periodontitis is present before starting orthodontic tooth movement as well as recognizing whether periodontitis develops during treatment.

Periodontal disease is by and large a disease affecting the adult population. However, aggressive forms of periodontitis are known to occur even before the age of 13. These aggressive forms of the disease, although relatively rare among Caucasians (0.1%–0.3%),[12,13] are much more common in other populations (>5%).[14,15] Clinicians need to be aware that due to the extent of current population exchanges that are occurring all over the world, they can no longer base their decisions purely on the assumption that the ethnicity of the population is the same as it was in years gone by. Therefore, populations that were mainly Caucasian in the past, having a low incidence of aggressive forms of periodontitis, are likely to have an increased incidence of these diseases because of ethnic heterogeneity resulting from population migration.

Although orthodontists have been mainly involved in the treatment of teenagers, adult orthodontics is becoming more and more a part of everyday orthodontic practice.

**Pearl:** It is imperative that the orthodontist carries out a thorough periodontal examination prior to, as well as during, the orthodontic treatment (including the concluding visit).

The periodontal examination carried out by the orthodontist should include:

1. Visual examination of the periodontal soft tissues including an assessment of gingival colour, swelling, loss of papillae, tooth migration, etc.
2. Measuring and recording of pocket depths of the entire dentition. In adolescents this should be limited to the first molars and incisors. This means that orthodontists should have periodontal probes available in their offices and know how to use the probes and interpret the findings (Figure 18.15).

   We are aware that periodontal probing can be uncomfortable, particularly for young patients, and therefore orthodontists are sometimes hesitant to carry out the procedure. A set of four vertical bitewing radiographs can serve as an alternative although the risk/benefit must be considered if choosing this alternative.
3. Recording of tooth mobility prior to the commencement of orthodontic treatment. Tooth mobility resulting from orthodontic tooth movement as evidenced by the absence of periodontal pocketing and the presence of radiographic widening of the periodontal ligament. This occurs normally during orthodontic tooth movement and should be clearly differentiated from mobility resulting from periodontitis with its associated pocketing and loss of supporting bone.
4. In addition to the traditional panoramic and cephalometric views, a set of full mouth periapical radiographs using a paralleling technique should be done. In adolescents, periapical radiographs of the incisors and vertical bite-wing radiographs of the molar teeth can suffice. Panoramic views alone are not adequate for the definitive diagnosis of bone loss resulting from periodontal disease. If at initial examination, a decision has been taken to refer the patient to a periodontist, all radiographic records should be made available to the periodontist.

**Figure 18.15**

Adult periodontitis with periodontal probe inserted into a 5 mm pocket.

Since periodontitis (both chronic and aggressive) aggregates in families,[16,17] a thorough

periodontal examination is indicated in all patients with a history of periodontitis in their family.

In the event of any sign of periodontitis the patient should be referred to a periodontist for a consultation. The indications for referral are at least one of the following: probing pocket depth of 5 mm or more, radiographic evidence of more than 2–3 mm of bone loss measured from the cementoenamel junction (CEJ), and any tooth mobility present before commencing orthodontic treatment.

**Pearl:** In all patients with any form of periodontal disease, the periodontal treatment should precede any attempt to move teeth orthodontically.

Patients with residual periodontal pockets after initial anti-infective therapy should at least be subjected to open flap debridement in order to ensure that all bacterial deposits on the root surfaces are completely removed before commencing any tooth movement. These patients should also be under regular periodontal maintenance by the periodontist.

### *18.2.3 Gingival Recession*

Gingival recession is the displacement of the gingival margin apical to the CEJ with exposure of the root surface. In order to make the diagnosis of 'gingival recession' the CEJ has to be identified clinically. Often a tooth is mistakenly diagnosed as having recession even though the gingival margin is at the CEJ. This is because the gingival margins of the adjacent teeth have not yet completed their passive eruption with coronally positioned gingival margins relative to the fully erupted tooth. Gingival recessions present as problems to the patient when they result in increased dentinal hypersensitivity, unacceptable aesthetics, and increased risk for caries and gingival inflammation.

**Pearl:** Superimposed gingival inflammation related to plaque accumulation may lead to further progression of the recession.

The predominant causative factors for the development of recessions are: traumatic tooth brushing, periodontitis, and orthodontic tooth movement. The major predisposing factor is a thin or absent buccal bony plate which has been shown to be prevalent in a high percentage (10%)[18] of individuals who have undergone orthodontic treatment. Most postorthodontic gingival recessions occur in the lower anterior teeth. This fact should be borne in mind by all clinicians carrying out orthodontic treatment, and an attempt should be made to assess whether dehiscence may be present before the start of tooth movement or whether the proposed treatment plan might result in a dehiscence. Indications that dehiscence may be present include: a thin biotype (thin, delicate gingiva) accompanied by palpable root prominences (washboard effect) (Figure 18.16a and b).

Over the last few years there has been a trend to a reduction in the frequency of extractions and a preference for arch expansion. Orthodontists must be aware that moving teeth out of the bony envelope, whether due to tilting of the teeth or bodily movement, raises the risk of bony dehiscence and recession. One way of reducing this risk is to thicken the overlying gingiva using an autogenous or allogeneic connective tissue graft prior to starting the orthodontic treatment. The ideal solution to this dilemma would be to increase the thickness of the buccal bony plate before starting the treatment. The periodontally accelerated orthodontic technique,[19] purports to solve this problem by applying demineralized bone to the buccal aspects of the roots during the procedure. The evidence for the effectiveness of this procedure to thicken the buccal plate and to reduce recessions is yet to be proven.

If the recession occurs during or following orthodontic treatment, it must first be established whether the tooth root is aligned with the adjacent teeth. If the root is prominent, it is critical that the root be torqued into the bony arch boundary before any periodontal treatment is started. Once the root has been torqued back into its correct position, in many instances this will suffice and obviate the need for surgery. If the recession still persists, surgical techniques for root coverage may be considered (Figure 18.17a–c).

**Figure 18.16**

(a) Localized gingival recession in a 20-year-old female who had undergone orthodontic treatment in her teens. (b) Improved clinical appearance following oral hygiene instruction, plaque and calculus removal.

**Figure 18.17**

(a) Localized gingival recession (dehiscence) associated with tooth #41 showing marked gingival redness and swelling. The root is positioned buccally out of the bony envelop. Abundant plaque accumulation can be seen at the gingival margin. (b) Significant improvement is seen after scaling, oral hygiene instructions, and orthodontic retraction of the root back into the arch. (c) Same tooth showing full root coverage 3 months following surgical root coverage.

Irrespective of whether the patient underwent periodontal therapy, all adult patients should undergo a periodontal assessment by the orthodontist at the end of active orthodontic treatment and the patient should be informed of the current status. Patients who may develop periodontal disease at some future date need to be aware that the condition did not exist at the end of orthodontic treatment.

We hope that this presentation will assist in the understanding that periodontal disease *per se* is not a contraindication for orthodontic treatment provided the case is managed on an interdisciplinary basis. It is gratifying to see mutilated dentitions with periodontal involvement work out successfully when managed correctly.

## 18.3 ORTHODONTIC/ ORTHOGNATHIC SURGERY INTERFACE: RELEVANT CLINICAL NOTES

Antony GH McCollum

Orthognathic surgery currently continues to occupy an increasing component of the multidisciplinary approach to the treatment of dentofacial deformities. While I accept that for many orthodontists this form of therapy is excluded from their daily practice, nevertheless, there are many orthodontists who have a keen interest in orthognathic surgery and whose practices are geared to include this component of multidisciplinary treatment into their practice

The purpose of this contribution is to highlight some key aspects of orthognathic surgery from the orthodontic perspective that may be helpful to the orthodontist in the treatment of patients with dentofacial deformities.

### *18.3.1 Welcoming the Patient to the Practice*

I accept all that has been written in earlier chapters regarding the importance of welcoming a new patient into the practices; however, if you have a reputation and your practice is known for its high involvement in orthognathic surgery cases, many patients come or are referred to your practice specifically for this form of treatment. Under these circumstances, it is important to appreciate that for many of these patients, there is an underlying psychological component which the orthodontist needs to start evaluating from day one.

It is a good policy for the orthodontist to go into the waiting room, introduce himself, and welcome the new patient to his or her practice. He or she should personally escort them through to the operatory. This immediately tells the patient that the practitioner cares.

**Pearl:** Observations such as body posture, how the patient walks, head posture, speech and lip movements are all helpful in assessing the psychological wellbeing of the patient.

The accompanying person should also be welcomed and made comfortable in an adjacent chair to that of the patient and opposite the orthodontist.

### *18.3.2 The Importance of External and Internal Motivation*

**Pearl:** It is imperative to discern between external and internal motivation for treatment.

External motivation may be identified by the main complaint, for example, the patient might say: 'My girlfriend or boyfriend sent me to you as they say that my teeth protrude or my chin is too small.' These patients are internally reasonably happy with their appearance or function. Treatment is contraindicated as the source of their main complaint is external. They should have the clinical diagnosis explained to them and be invited to return at any time in the future if their main complaint changes.

The most satisfying results are obtained when the motivation for treatment is internal;

for example, the patient might say: 'I know that my chin recedes and I cannot close my mouth properly'. This patient is likely to be enthusiastic and compliant and will appreciate the outcome.

### 18.3.3 Examination of the Patient Standing Up

**Pearl:** It is critical to examine the patient standing up with the head in the natural head position so that the soft tissue drape of the face is subject to gravity.

In this way the most consistent assessment of facial proportions and relationships is obtained. When the patient is in a supine position in the operatory chair the measurements can be quite discrepant. For example, some key diagnostic points such as the interlabial gap and the extent of exposure of the upper incisor below the relaxed upper lip can vary significantly between the two positions.

### 18.3.4 Cephalometric Radiographic Technique: Lips Relaxed

The cephalometric radiograph should be taken with the lips in complete repose. On many occasions it will be necessary for the orthodontist to supervise this whilst the patient is in the cephalostat before the radiographer exposes film.

**Pearl:** This will, amongst other details, reveal the true shape of the soft tissue chin, the lengths of the lips, the extent of the interlabial gap, and the exposure of the upper incisor teeth beneath the relaxed upper lip.

The relaxed soft tissue total profile forms the basis for accurate diagnosis and treatment planning. In some instances it is helpful to take an additional cephalometric radiograph with the lips in the closed position in order to measure the degree of lip strain.

### 18.3.5 Relative and Absolute Posterior Crossbites

A relative posterior crossbite is recorded when at clinical examination some posterior teeth are in a crossbite relationship with each other and then subsequently when the study models are hand held in as close as possible to a Class I relationship, the posterior teeth are no longer in crossbite.

An absolute posterior crossbite occurs when at clinical examination there is a normal buccolingual relationship of the posterior teeth in centric relation and then subsequently when the models are hand moved to simulate the surgical movement of the jaws, a posterior crossbite then develops.

**Pearl:** This may require surgical intervention if it is larger than 3 mm. Generally, posterior orthodontic expansion of 1.5 mm per side in the upper jaw is permissible, beyond that, stability is jeopardized.

### 18.3.6 Decompensation of the Incisor Teeth

In so many dentofacial deformity cases the incisor teeth tend to compensate for the malrelationship of the jaws. It is the orthodontist's role to decompensate the incisor teeth where necessary in order to optimize their position in the alveolar bone and at the same time create the presurgical ideal overjet or reverse overjet. This creates the space for the maxillo-facial surgeon to adequately advance or retract the jaw(s) which in turn produces a totally new profile and lip position as well as dental and skeletal changes.

**Pearl:** In the treatment planning stage, the amount of decompensation of the incisors is determined by the desired soft tissue profile changes.[20–22]

### 18.3.7 Class II DIV I Cases

The most common dentofacial deformity that confronts the orthodontist is the Class II

mandibular anteroposterior deficient case. Creating the ideal presurgical overjet in order for the surgeon to adequately advance the mandible may involve several scenarios.

**Pearl:** In most instances the upper incisors are in a reasonable position in the alveolar bone and it is the lower incisors that will be required to be decompensated, that is retracted, in order to create the optimum presurgical overjet.

If there is crowding, the extraction of upper second premolars and lower first premolar teeth is usually indicated. In other less common instances, it is necessary to retract the proclined upper incisors to reduce the prominence of the upper lip before setting up the ideal overjet. Some cases even require the reduction of the over jet so as to reduce the extent of the mandibular advancement. In many of the cases the curve of Spee should not be entirely levelled, and it is the surgical downward and forward advancement of the mandible that will correct the deep overbite and, in turn, advance the often recessive lower lip.

#### 18.3.7.1 Soft Tissue Reaction to Mandibular Advancement

**Pearl:** The lower lip at labrale inferius does not respond in a 1:1 ratio with that of the lower incisor tip but stretches or thins at a ratio of 1:0.75. The soft tissue chin responds at a ratio that is close to 1:1 of the movement of the underlying bony chin.

On the above basis, the orthodontist needs to decide whether the postsurgical overjet will end up at the correct position to achieve the desired lower lip and chin profile changes. It is important to remember that ratios are only based on mean values and that for the individual patient, the use of multiple regression equations will more accurately predict the lower lip response.[23]

#### 18.3.7.2 Stability Limits for Mandibular Advancement

In general, the mandible should not be advanced more that 6–8 mm lest stability be jeopardized.

**Pearl:** The decompensated presurgical overjet should therefore, be limited to this distance.[23]

### *18.3.8 Class II DIV II Cases*

In these cases it is usual that the presurgical decompensation of the retroinclined upper incisor teeth should involve some proclination in order to establish the final postsurgical ideal overjet.

**Pearl:** This will have very little effect on the position of the upper lip as there is commonly much residual lip tissue in the vicinity of the vermillion of the upper lip.

The surgical advancement of the mandible is generally modest but it is the downward surgical vector of rotation of the mandible that corrects the deep overbite associated with these cases. The soft tissue of the lip responds by advancing and increasing in length but the chin advancement is minimal.

### *18.3.9 Class III Cases*

Maxillary anterior/posterior deficiency is more common than true mandibular anterior/posterior excess but in most cases a combination of these skeletal abnormalities occurs to a greater or lesser extent. Orthodontic decompensation requires that the upper incisors be retracted and that the lower incisor teeth be advanced in order to achieve the optimum presurgical reverse overjet. In many of these cases the extent of decompensation is limited due to the shape and thickness of the alveolar bone. In the upper jaw the dentoalveolar process is narrow and protrusive and in the lower jaw the symphysis is thin and upright thus limiting the incisor movement. In most cases,

the surgical option of maxillary advancement offers better long-term stability and more favourable soft tissue changes than mandibular setback.

**Pearl:** There is nothing aesthetically worse than a short chin further reduced in length when a perceived excessive mandible is set back instead of the maxilla advanced! If the reverse overjet is larger than 8 mm then a combination of maxillary advancement and mandibular setback is probably the first choice.

### 18.3.10 Upper lip Reaction to Maxillary Anterior/Posterior Advancement

With advancement of the maxilla, the nose tip responds at a ratio of up to 1:0.25 and subnasale by 1:0.5, the upper lip at labrale superius thins and responds by 1:0.6 of the movement at the upper incisor tip.

**Pearl:** Thin lips less than 14 mm (measured from labrale superius to upper incisor anterius) experience up to 2.8 times more movement than thick lips.[24]

### 18.3.11 Stability of Maxillary Anterior/Posterior Advancement

**Pearl:** Generally, maxillary advancement is stable for surgical movements up to 8 mm.[25]

Corrections of discrepancies greater than this may require additional mandibular reduction surgery.

### 18.3.12 Lower Lip Response to Mandibular Anterior/Posterior Reduction

The lower lip generally responds at 1:0.8 of the movement at the lower incisor tip. The soft tissue chin responds at a ratio of 1:1 to movement of the bony chin.[24]

### 18.3.13 Stability of Mandibular Anterior/Posterior Reduction

**Pearl:** Mandibular reduction is the least stable of the surgical movements of the jaws.[26]

Mandibular reduction, generally, should be limited to 6 mm or less. In the longer term, besides relapse in the position of the body of the mandible, the lower incisor teeth become splayed due to encroachment on tongue space.

### 18.3.14 Open Bite

In cases of vertical maxillary excess with anterior open bite, there is most often a natural step between the anterior and posterior segments. In this instance, no attempt must be made by the orthodontist to use continuous archwires to level the teeth as this will contribute to an open bite relapse following the surgery.

**Pearl:** Instead the teeth should be levelled in independent segments, usually from the upper canines to the second molar teeth and from the upper left lateral to the upper right lateral incisor teeth, that is the orthodontist should encourage the open bite to slightly worsen prior to the surgery.

For presurgery the roots of the lateral incisors should be deviated mesially so as to avoid surgical trauma to them when the surgeon sections the upper jaw and the posterior segments are intruded and if necessary widened. At six weeks postsurgery the upper lateral incisor teeth are rebonded at normal angulations and continuous arches are used to relevel the case.

### 18.3.15 Testing Arch Coordination

**Pearl:** In most cases it is essential for the orthodontist to take working study models towards the later stages of the presurgical orthodontic preparation in order to assess whether the arches coordinate when the models are hand held in the simulated surgical position.

Well-coordinated arches help the surgeon stabilize the jaws accurately. With intraoral scanning techniques, it is possible to carry out this procedure with virtual models on the screen monitor.

### 18.3.16 Stabilizing Wires

**Pearl:** Prior to the surgical phase, the arches should be stabilized with archwires that are close to full thickness and cinched back to prevent any untoward movement of the teeth during the surgical phase.

Movement of the teeth could jeopardize the surgical accuracy and stability.

### 18.3.17 Postsurgical Orthodontics

Three weeks postsurgery the orthodontist should monitor the light elastic therapy that the surgeon would have instructed the patient to wear. At six weeks postsurgery when oedema and pain has subsided orthodontic treatment can be resumed to complete the occlusion.

**Pearl:** This usually entails removing the stabilizing wires and replacing them with light steel or more flexible wires. Vertical elastics with moderate Class II or III vectors of force are used to commence seating the occlusion.

Midline discrepancies of up to 3 mm, that is 1.5 mm per arch, can be corrected. Finishing arches and procedures will be required to finalize the case.

### 18.3.18 Retention Protocols

In most cases the ideal retainer is a removable appliance in the upper arch, preferably a Goshgarian type, and in the lower arch a customary fixed intercanine retainer. The removable type retainer is usually worn for three months fulltime and thereafter for 10 to 12 hours per day for the next year (Figure 18.18a and b).

**Figure 18.18**

Goshgarian upper removable retainer. (a) Anterior view; (b) palatal view.

**Pearl:** The upper removable appliance retainer encourages natural settling of the teeth whereas a clear Essex type retainer covering all the teeth does not allow this settling to occur.

The invisible retainers are only recommended once the teeth have settled, perhaps after six months. In open bite cases, the removable appliance of choice is a wraparound type without a wire crossing the occlusion, thus encouraging stability of the open bite correction.

Clearly this presentation is not an in-depth study on orthognathic surgery but is intended to assist the orthodontist by highlighting what I consider to be important features.

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# 19 IMPACTED CANINES

Adrian Becker and Stella Chaushu

CONTENTS



## 19.1 IS THERE AN IMPACTED MAXILLARY CANINE?

### *19.1.1 Clinical Examination*

The first clinical examination can be enlightening if undertaken with care. Several clinical features may be associated with the impaction of maxillary canines and these are important clues that should be looked for

- Missing permanent teeth
- Anomalous lateral incisors
- Small teeth: Small teeth generally go together with spaced dentitions. Conversely a lack of space may also be a link with canine impaction, but then the incisor teeth are often unusually large
- Delayed dental age
- Full eruption of the canine on one side with delayed eruption on the other side
- Infraoccluded deciduous molars in either jaw are often found associated with impacted maxillary canines

Each one of the above is an important indicators. All these features should be identified in the clinical examination of the dentition of a young patient.

The role of overretained deciduous canines has long been debated as to whether it is a cause of the canine impaction or the unresorbed result of its aberrant eruption path.

### *19.1.2 Radiographic Examination*

Radiography is the obvious next step and most orthodontists will commission an initial panoramic view to permit a broad scan of the dentition and to seek out other associated/aetiological/pathological factors. Supernumerary teeth are rare in the canine area, but small odontomes may be seen very occasionally in this connection. Distally tipped, unerupted, second mandibular premolars have also been linked to canine ectopia. It is important to take note of carious or nonvital deciduous canines, since the accompanying apical granuloma is a potent cause for the deflection of the eruption path of the impacted permanent canine. Rarer entities, such as dentigerous or radicular cysts and invasive cervical root resorption, will prevent eruption and need to be specifically looked for and identified on the films.

## 19.2 WHY HAS THE TOOTH NOT ERUPTED?

**Pearl:** Ask yourself why the tooth has not erupted – if you cannot come up with an answer, suspect pathology.

Spontaneous eruption of teeth is the norm. In the event of noneruption, we must eliminate the cause if treatment is to be successful. This means that diagnosing the aetiology is an essential step to success in treatment. The reasons for failure are many,[1] and, for the most part, they are easy to detect from the first panoramic view. The addition of a well-taken periapical radiograph will provide the best and clearest qualitative plane film view of the tooth and its surrounding tissues and is an important means to check for local pathology. If we do not know the reason for the failure to erupt, then we cannot predict the outcome.

### *19.2.1 Accurate Positional Diagnosis*

Orthodontic treatment planning for teeth in the erupted dentition is easy to determine, because we can see them. When it comes to impacted teeth, we can only aim to obtain a clear mental reconstruction of the position of the tooth in 3-D. Without it, we cannot hope to approach orthodontic alignment with any confidence and, indeed, this is one of the principal reasons for failure in the resolution of impacted teeth.[1] Accordingly, the orthodontist should use the panoramic view as a guide to determine the presence of an impacted canine. Palpate the entire alveolus, palpable labial or palatal displacement of the root of the lateral incisor may indicate palatal or labial presence of the canine, respectively. The buccolingual juxtaposition of one tooth with another, within a narrow alveolus, must create a palpable bulge on one side or the other.

**Pearl:** Try to construct a 3-D mental picture from the clinical examination and the existing radiographs before moving to cone beam computed tomography (CBCT).

Is a CBCT the next step? (See Chapter 5.) Most orthodontists will already have commissioned a lateral cephalogram of the patient. This, together with the panoramic and periapical views, provides much information in terms of the buccolingual relationship between the canine and the adjacent teeth. Taking any two of these three films will provide simple tube-shift (parallax) pairs, since each of these films view the tooth from a different angle. Furthermore, the periapical view will additionally offer much qualitative detail. So, before automatically considering exposing the patient to CBCT technology, these plane film combinations should be carefully studied to see if they contribute a sufficiently comprehensive positional diagnosis for the case in hand.

CBCT imaging is extremely valuable in the majority of the impacted canine cases, because it will offer views of tooth surfaces in the buccolingual dimension unachievable by plane film radiography.[2] These serve to make 3-D positional diagnosis almost foolproof. Thus, whenever there is doubt, a CBCT should be prescribed. However, it is important to ensure that the radiography technician provides the orthodontist with all possible views of which the device is capable. This means performing axial (horizontal) and transaxial (vertical) cuts at intervals of 1–1.5 mm, but it also means obtaining good 3-D views and, where possible, a 3-D video clip of the teeth with the bone 'stripped away'. Armed with this comprehensive information, root resorption of the adjacent teeth and other pathological entities, such as ankylosis and invasive cervical root resorption, may be diagnosed (Figure 19.1).

**Pearl:** When requesting a CBCT be sure to instruct the CT technician to provide the maximum 3-D information of which the machine is capable.

Thorough preparation of the raw data from CBCT, with attention to detail, will make the strategic planning of a system of directional forces straightforward and permit the resolution of a case that in preCBCT days could have failed for lack of accuracy in the positional diagnosis.

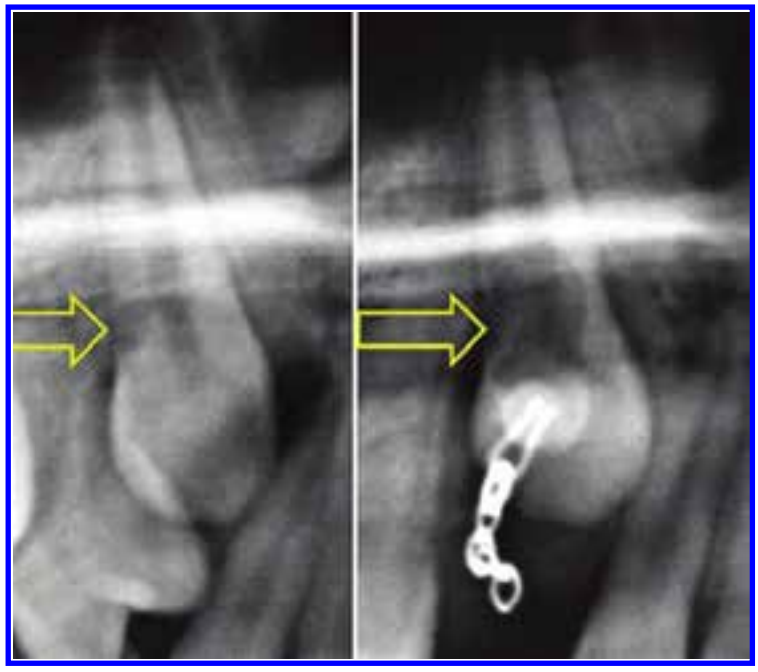

**Figure 19.1**

Two radiographs of the right maxillary canine of a patient taken before (left) and following two years of unsuccessful orthodontic traction (right) aimed at resolving the canine impaction. The arrows indicate the existence of ICRR prior to the commencement of treatment and the severe degree of its encroachment into the body of the root, during this time period.

*For the e-edition:*
Videos 19.1 through 19.3 show the great advantage that CBCT offers over routine plane film radiography. As a learning exercise, the reader is invited to study Video 19.3 of the 360° revolving views and to evaluate the spatial location and orientation of the canine and its relationships to the following teeth on the right side of the patient's mouth:

a. Between the canine and the lateral incisor
b. Between the canine and the central incisor
c. Between the canine and the palatal root of the first premolar
d. Between the orientation of the canine and the position of its apex to the space available in the arch

The reader should replay the video for each of the above and try to build a treatment strategy for the resolution of the impaction (Videos 19.1 through 19.3).

## 19.3 IS CREATION OF SPACE IN THE DENTAL ARCH OBLIGATORY BEFORE EXPOSURE OF AN IMPACTED CANINE?*

**Pearl:** In general, the answer to this question is a resounding *yes*! There are many good reasons for this…

1. By creating space, the canine will often reawaken its natural eruptive potential and begin to move in the right direction. In the most favourable scenario, this could result in the avoidance of surgery, although it may take a very long time before a maxillary canine erupts (Figure 19.2).

   Normally canine eruption is slow, and, when there is some deviation from its normal path of eruption, spontaneous eruption will take considerably longer, sometimes

**Figure 19.2**

The right maxillary canine has been diagnosed to be impacting palatally. Additionally, the mandibular second premolars have insufficient space to erupt due to early loss of the deciduous molars. Appliances were used simply to create space in both arches and the teeth erupted spontaneously, without surgical intervention. (a–c) A class 2 division 2 case with crowding in the maxillary arch and severe space loss due to early extraction in the mandibular arch. (d) A panoramic view shows a palatally displaced right maxillary canine. (e) A similar radiograph taken following distal movement of all four first molars and space reopening. Note improved position and prospects of all the unerupted teeth, particularly the canine. (f–i) The final dental alignment and occlusion. The right maxillary canine erupted unaided. (From Becker A: *The Orthodontic Treatment of Impacted Teeth*. 3rd ed. Oxford, 2012. Copyright Wiley-VCH Verlag GmbH & Co. KGaA. Reproduced with permission.)

stretching into a year or more. This means leaving the orthodontic appliances in place to maintain space and to later complete the finishing procedures, which may include rotation, uprighting, and root torque of the canine. This extended appliance therapy could be a high price to pay to justify such a conservative approach. In this situation, it is often wiser to expose and actively erupt the canine, thus reducing treatment time and the possible risk of collateral damage such as decalcification, caries, and periodontal disease.[3]

2. Even without spontaneous eruption, often by opening the space, the intrabony position and orientation are usually improved, which in turn simplifies the surgical exposure, reduces treatment time and improves final outcome.
3. By creating space, we also create an area of attached gingiva through which a displaced tooth may erupt or be erupted. Without the creation of space, a labially displaced canine will likely erupt through the very mobile and nonkeratinized oral mucosa, high in the sulcus and thus start intraoral life at a periodontal disadvantage.
4. The lateral incisor root and the palatal root of the first premolar are usually lingually oriented and, as such, often interfere with a palatal canine (Figure 19.3).
5. When creating space, therefore, it is important to mesially upright the root of the lateral

* Reproduced from the website of the author at: http://www.dr-adrianbecker.com/page.php?pageId=281&nlid=21

**Figure 19.3**

Pretreatment intraoral views of a patient with a right maxillary canine impaction. (From Becker A: *The Orthodontic Treatment of Impacted Teeth*. 3rd ed. Oxford, 2012. Copyright Wiley-VCH Verlag GmbH & Co. KGaA. Reproduced with permission.)

incisor and distally upright the root of the premolar, at the same time rotating its palatal root distally to facilitate eruption of the canine.

6. Creating space and levelling the teeth permits the placement of a heavy base archwire providing rigidity and more secure anchorage for extrusive traction forces.

> **Pearl:** There are some situations in which space opening should be avoided until after the surgical exposure has been made and sometimes until certain other functions have been carried out.

Space opening is contraindicated as a first step in the following situations:

1. When the root of the lateral incisor/central incisor is undergoing resorption in association with the close proximity of the advancing canine crown.

   Creating space and alignment takes time; resorption progresses rapidly so this delay is unacceptable once resorption has commenced. In these circumstances, canine exposure is a first and urgent prerequisite to any other form of treatment and active traction should be applied to move the crown of the canine away from the threatened incisor root. This force may be labially or palatally directed using a custom-made spring or elastic tie to a soldered palatal arch or self-supporting buccal arm, until the tooth is distanced from the incisor roots and erupted into a 'neutral corner'. The root resorption of the lateral may then confidently be expected to arrest and space preparation initiated.[4]

2. When the canine is in the line of the arch and is in close relationship with the distal aspect of the root apex of the lateral incisor, with no apparent overlap seen with Clark's tube-shift (parallax) method of radiographic positional diagnosis. In these circumstances, the orientation of the canine is mesioangular, with a distal inclination of the lateral incisor (Figure 19.4).

   Mesial uprighting the incisor would appear to be the logical way of increasing the space in the arch for the canine, but the resulting distal movement of the apex of the lateral incisor, will move it against the crown

**Figure 19.4**

The panoramic view shows the impacted right maxillary canine in the line of the arch, displacing the lateral incisor root mesially.

of the canine introducing a distinct danger of iatrogenic root resorption of the incisor (Figures 19.5 and 19.6).

Therefore, it would be advisable to leave the lateral incisor without a bracket, until the canine has been drawn clear of its proximity to the incisor apex.

3. In the adult patient, there is reason to believe that the canine may not move due to ankylosis, crown or cervical root resorption.[5] In many such cases, the treatment plan will involve either surgical extraction of the ankylosed canine, or surgical exposure and canine repositioning. To determine if the canine is ankylosed without getting involved in a full bond-up, it is worthwhile placing a miniscrew in a convenient location in the palate or elsewhere, at the same time as the impacted canine is being exposed. An attachment should be bonded to the tooth and an elastic tie drawn under tension between the two. This will quickly permit the diagnosis to be made, without involving unnecessary appliance construction, discomfort, time, and money (Figure 19.7).

**Figure 19.5**

Bonded appliances were placed to reopen space for the canine prior to surgical exposure.

**Pearl:** When there may be the suspicion of ankylosis, check the ability of the tooth to move by first applying traction force to a temporary anchorage device, before submitting your patient to fixed orthodontic appliances.

4. In any patient where there is loss of integrity/continuity of the outline of the follicle or where there is invasive cervical root resorption (ICRR) of the canine itself. A collapsed or undefinable follicle around the unerupted tooth or ICRR should always make the orthodontist suspicious that the tooth may not respond to orthodontic forces. By contrast, follicular enlargement is not a contraindication.

As mentioned previously, comprehensive radiography of the impacted canine is crucial and it has two important aspects. A good quality periapical view is the best plane film method of diagnosing local pathology, in the forms of ICRR of the affected tooth or root resorption of the neighbouring teeth, lack of dental follicle integrity, follicle enlargement, and other strictly local conditions. The second aspect is in relation to its 3D orientation within the maxilla and its proximity to the adjacent teeth and to other structures. There are some situations in which well-chosen plane radiographic films alone will provide this information, but there are many others in which CBCT is crucial.[2,3,6]

## 19.4 AT SURGICAL EXPOSURE, BOND A PRESCRIPTION BRACKET OR BOND AN EYELET?

The first opportunity to achieve access to an impacted tooth occurs at the time of surgical

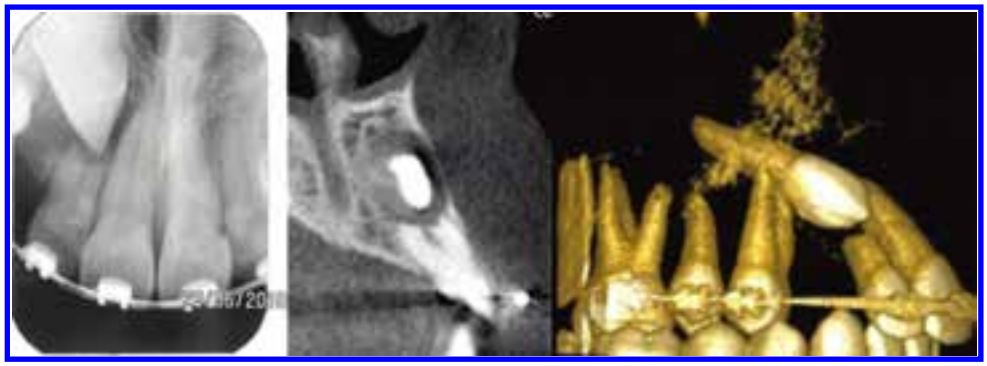

**Figure 19.6**

Periapical and CBCT views of the patient featured in Figures 19.4 and 19.5 indicate that premature root uprighting of the lateral incisor has caused severe resorption due to resistance from the canine crown. It also shows how space opening at the occlusal level has caused some tipping and rotation of the premolar, bringing its palatal root into contact with the canine in the area of the cementoenamel junction, further blocking its eruption path. (From Becker A: *The Orthodontic Treatment of Impacted Teeth*. 3rd ed. Oxford, 2012. Copyright Wiley-VCH Verlag GmbH & Co. KGaA. Reproduced with permission.)

**Figure 19.7**

(a) The palatal canine in an adult patient has been exposed and an eyelet bonded. (b) The twisted steel ligature has been drawn through the fully sutured flap and turned into a hook, which is linked to the temporary anchorage device by an elastic chain under tension. (Reproduced from the website of the author at http://www.dr-adrianbecker.com/page.php?pageId=281&nlid=21).

exposure of the tooth. Once exposed, it is important that the orthodontist has the ability to apply forces to that tooth whenever he/she considers it necessary. To this end an attachment must be placed on the tooth, with some form of connector (gold chain or twisted steel ligature) to maintain contact with the exterior, while the surgical wound may be fully reclosed. This is called a 'closed surgical procedure'. Alternatively, the tooth must remain visible and clinically accessible thereafter and the tissues must be prevented from healing over to recover the crown. This is an 'open surgical procedure'.

**Pearl:** At first glance, bonding a regular bracket seems the obvious thing to do, but for many reasons, this is a mistake.

1. A precision prescription bracket is only an asset when placed at the correct height on the midlabial aspect of the canine. This is rarely possible to achieve at surgery due to restricted access.
2. The sophisticated bracket has no advantage over the simple eyelet but has drawbacks if placed on any other location on the canine crown.
3. The base of a bracket is rigid and shaped to suit the average shape of the midlabial position of the average tooth. It is impossible to adapt its base to fit another surface thus contributing to an increased risk of debonding.[7]
4. Precision prescription brackets have been designed to move a tooth accurately over small distances and through just a few degrees of rotation, uprighting, and root torque. They are not well suited for major tooth movements.
5. It is difficult to ligate an archwire to a bracket on a severely displaced tooth.
6. Even following an open exposure procedure, there is a liberal collar of soft tissue surrounding the tooth which will be irritated by the bulky and sharp-profiled bracket, causing discomfort, swelling, pain, and bleeding.
7. Once the tooth has erupted sufficiently, the bracket will anyway need to be relocated to its ideal position on the crown of the tooth.
8. The full potential of the slot prescription cannot be exploited until the tooth has erupted fully and the main archwire engaged in the bracket.
9. Until this time, the only directional forces that can be brought to bear on the tooth are those involved with extrusion (active eruptive forces), tipping, and some rotational movement.
10. As the tooth approaches its place in the arch, particularly from a palatal displacement, the gingiva bunches up ahead of it and the bulky profile of the bracket impinges on the tissues, with accompanying inflammation, swelling and discomfort, and possible periodontitis; furthermore, reactivation is also a problem.

**Pearl:** In direct contrast, a simple eyelet attachment,[3] is much more versatile and adaptable in the early stages of resolution of the impaction and it has numerous advantages (Figure 19.8).

**Figure 19.8**

Hand-welded eyelets showing rounded profile and pliable band material with mesh base. A tightly twisted 0.305 mm or 0.356 mm (0.012 inch or 0.014 inch) stainless steel wire rides freely in the eyelet and when formed into a hook or loop, it is stiff enough to withstand traction.

1. The base is smaller and its shape easily adapted to approximate to the shape of the bonding site, be it on the mesial or distal corner, the cuspal tip, or the undulating palatal surface. So bonding is far more reliable.[7]
2. It can be placed in limited access areas because of its low profile.
3. Because of its size and shape, it is much kinder to the tissues, as it emerges through the attached gingiva.
4. Ligation is much simpler and partial ligation can be done securely and quickly without fear of it coming loose.
5. Once a canine has been erupted into the palate, the eyelet may be relocated on the labial aspect and oriented parallel to the long axis of the tooth. A fine nickel-titanium auxiliary archwire may then be threaded through it, achieving rapid extrusion and rotational correction of a severely displaced tooth (Figure 19.9a and b).

   This is far more efficient and economical than using a regular bracket.
6. Bonding a prescription bracket may postponed until uprighting and root torque are needed (Figure 19.9c and d).

The orthodontic supply companies make eyelets on steel bases with a mesh bonding

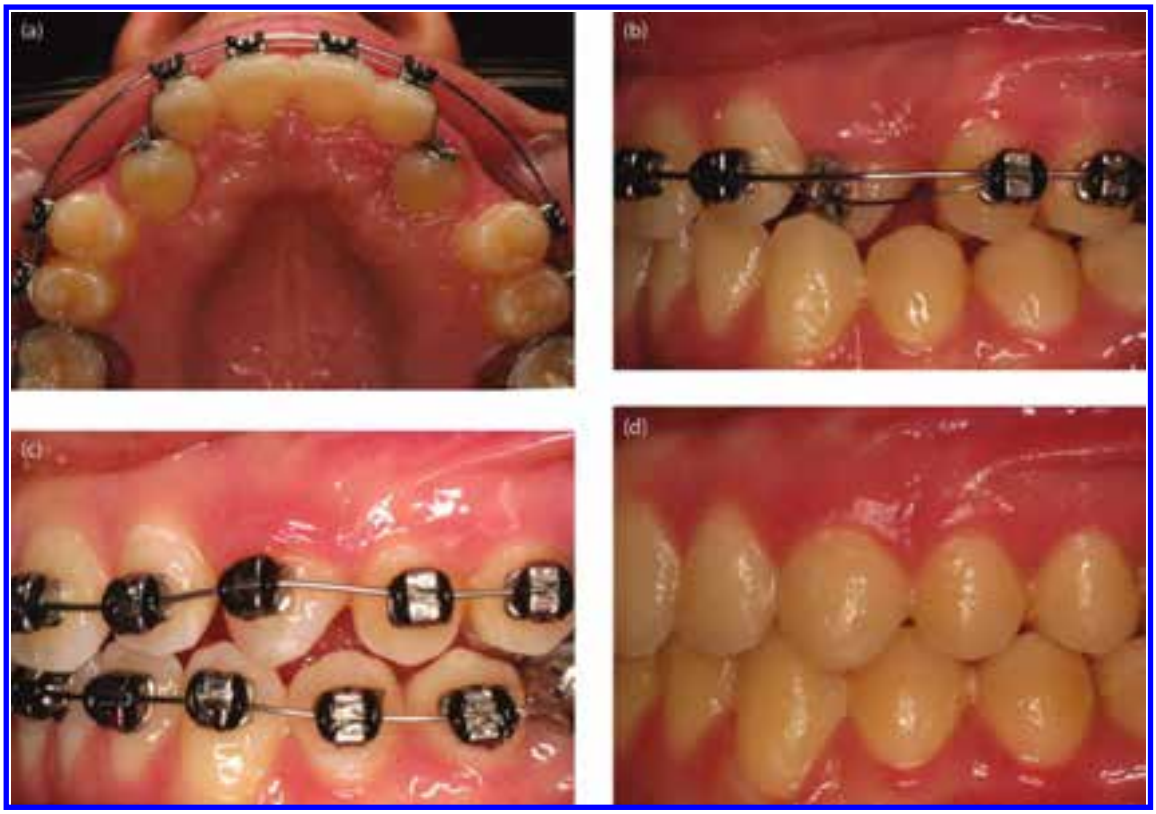


**Figure 19.9**

(a) Occlusal view of impacted canines after eruption into the palate. An auxiliary Nickel Titanium (NiTi) archwire has been threaded through the vertically-oriented eyelet, while a rigid base arch holds the overall archform. (b) A view of the left side of the patient. (c) The same view taken four weeks later, following the rapid movement achieved and bracket now substituted. (d) The same view at the completion of treatment.

surface but, for the most part, the bases are still fairly rigid. It is advantageous to have your assistant or your lab technician weld a strip of soft steel eyelets to a length of steel band material backed by a strip of steel mesh. This has proved to be a cheap, readily available, easily pliable and convenient attachment for the purpose. Incidentally, when exposing an impacted molar, the surface area is very large and two eyelets may be bonded as a form of insurance against possible bond failure.

Threading a dead soft 0.305 mm or 0.356 mm (0.012 inch or 0.014 inch) stainless steel ligature wire and twisting it into a tight braid, should be prepared before surgery. This secure ligature rides freely in the eyelet and it can be drawn subsequently in any direction through the sutured edges of the flap or the dressed open exposure. It is cut and bent over to form a hook or loop, for applying traction from a spring, auxiliary nickel titanium archwire, an elastic tie or chain.

**Pearl:** Eyelets, rather than sophisticated prescription brackets, should be bonded to impacted teeth in line with the long axis of the canine, at the time of surgery. The eyelet should be left in place until the tooth has been drawn down to the dental arch and the archwire threaded through it.

## 19.5 WHAT TO DO WHEN A SUPERNUMERARY TOOTH IS ASSOCIATED WITH AN IMPACTED INCISOR

The obvious answer to this dilemma is to extract the supernumerary tooth on the premise that elimination of the cause should bring about the resolution of the problem. Generally this is what is recommended, often with assurances to the parent that the tooth will erupt spontaneously within a reasonably short period of time.

Over the past half century, studies have pointed to highly disappointing outcomes, even in the relatively successful cases, the time period may be excessively long. Months or years may elapse with little or no obvious progress and, all this time, the child is without a front tooth. A recent study has shown impacted incisors failed to erupt in 64% of the cases and in a further 9% there was partial eruption. In 17% eruption was successful but into an ectopic (i.e. unacceptable) location. Only 10% ended up with full eruption and 'adequate' alignment. The upshot was that 90% required a first phase of orthodontic extrusive traction in the early mixed dentition combined with incisor alignment.[8]

So the problems involved after extracting the supernumerary tooth are

1. Spontaneous eruption will probably not occur.
2. If the incisor erupts, it is likely to be unacceptably ectopic.
3. There is an extended time factor associated with successful autonomous eruption.

The solution may be found by using the following definitive orthodontic-surgical treatment protocol:

1. Place a maxillary fixed appliance to align and level the erupted incisors and to reopen space.
2. Surgery; raising an attached gingival flap taken from the crest of the ridge.
3. Remove the supernumerary tooth/teeth, minimally expose the crown of the impacted incisor and bond a small eyelet attachment, to which a twisted stainless steel ligature or gold chain is tied.
4. Resuture the full flap back into place, with the ligature or chain exiting the wound at its sutured inferior edge.
5. Apply active traction from the main arch to the ligature or gold chain.
6. Draw the tooth down to the archwire through the attached gingiva.
7. Torque and upright as needed for adequate repositioning.
8. Debond, place simple removable retainer and follow-up.
9. Re-evaluate periodically to consider the necessity for routine orthodontic treatment.

**Pearl:** Apply active orthodontic traction to extrude the impacted incisor immediately following removal of the obstructive cause.

Phase 1 orthodontic treatment requires bonding brackets to all the teeth which for a young group of patients includes three maxillary deciduous teeth on each side. However, this tends to generate an increased rate of shedding of these teeth and the patient is often left with too few teeth to adequately hold the appliance. Alternatively, a two by four appliance with molar bands, soldered palatal arch, and soldered round 0.914 mm (0.036 inch) buccal tubes (stainless steel tubing of lengths adjusted for each case) is particularly well suited, with these tubes creating rigidity of the long span between permanent molar and lateral incisor, while permitting the use of a light and flexible anterior portion.[3,9,10]

Most treatments will be completed well within 18 months.

## 19.6 THE PIGGY-BACK ARCHWIRE INCORPORATING A LOOP FOR EXTRUDING CANINES

In view of the anatomy of the palatal vault and the palatal inclination of the long axis of the lateral incisor root, this apical portion of the root will often become the obstacle that

prevents the impacted canine from moving directly towards its place.[11,12]

In this situation, certain practical problems arise:

1. The only surface of the canine that will be accessible at the time of surgery will be its palatal aspect, to which an attachment will need to be bonded. A gold chain or twisted steel ligature will become the sole accessible means by which traction may be vicariously applied to the tooth whether an open or closed surgical exposure technique is selected.[1,3]
2. Traction of the canine directed towards its place in the arch cannot succeed, *because* the lateral incisor root obstructs its path. An alternative strategy is needed.[1,3]
3. It is necessary to design a means of applying an efficient mechanism with a wide range of action generating a suitable force on the palatal side of the maxilla. Since the orthodontist generally places brackets and archwires only on the labial side of the dental arch, this requires a little thought 'outside the box'.

As discussed previously, it is generally standard practice to align, level, and create space for the impacted tooth. Having achieved this, a heavy base archwire will act as the source of anchorage for the resolution of the impaction. In a simple impaction case, where the tooth is immediately opposite the created space, elastic ligature or a piggy-back nickel-titanium wire may be used to draw the ectopic tooth to its place. However, for the case where the root of the lateral incisor is in the direct path to the canine location in the arch, a different strategy is required.

**Pearl:** The strategy must be to first move (extrude) the canine into a position where it will be in a direct line with the prepared space and from where the lateral incisor root is no longer an obstacle.[3]

This may be achieved in two different ways. In the horizontal plane, an elastic tie may be drawn from the canine to the lingual cleat on the molar band on the same side or on the opposite side, depending on the direction that is needed to avoid the clash with the lateral incisor root. At the completion of this initial movement, the tooth will be erupted high in the vault of the palate and there will be a height discrepancy between it and the main arch. If it is then drawn directly to the archwire at this level, it may become reburied in the mucosa covering the medial side of the alveolar ridge, where it may sometimes cause a very painful acute lateral periodontal abscess.

For this reason, the canine should be extruded downwards towards the tongue, clearing it from interference from the root of the lateral incisor. When the canine crown has erupted to the occlusal level, moving the tooth in the direction of the main arch becomes routine.

There are several techniques for achieving the vertical resolution of the palatally impacted canine and probably the most efficient and user-friendly device is the auxiliary labial wire[13] (Figure 19.10a–c).

It does not require any special preparation, no additional attachments, no palatal arches, soldering, or other laboratory procedures. The auxiliary wire may be simply fabricated chairside from a preformed archwire blank of round 0.406 mm (0.016 inch) hard stainless steel wire and ligated into the brackets in piggy-back style over (for a labial canine) or under (for a palatal canine) the existing passive base arch and into one of the molar tubes. Although the archwire is ligated on the labial side, its vertical loop will be turned across the space in the arch that has been prepared for the canine and its terminal helix engaged in the canine attachment ligature at a carefully predetermined point in the mid-palate.

It is from this point that the traction force will be directed to draw the tooth in a downward movement, and it is at this point in the palatal area that the tooth will erupt. Once erupted, the canine will have an uninterrupted and direct line to its place in the dental arch.

At this stage it is *essential* to move the bonded attachment from the palatal to the labial surface of the canine crown (Figures 19.11a and b and 19.12a and b)

**Figure 19.10**

(a) The auxiliary labial archwire has been tied into the bracket in piggy-back fashion under the heavy base arch, immediately prior to the surgical procedure. Note the passive position of the vertical loops. (b) An occlusal view during surgery. The deciduous canines have been extracted and the right canine exposed. The surgeon holds the elevator and suction tip in position to maintain a dry field to facilitate attachment bonding by the orthodontist. The left canine has already been exposed, an attachment placed and the twisted steel ligature can be seen to exit from the middle of the loosely replaced flap. (c) At the completion of the surgical episode, the flaps have been sutured back to their original place (closed eruption procedure) and the vertical loops of the auxiliary archwire have been turned palatally and held tightly against the palatal mucosa by ensnaring them in the shortened twisted ligatures. A positive extrusive force is now applying traction to the canines.

**Figure 19.11**

(a) The right canine has just erupted through the mucosa, while the left canine erupted a month earlier and was detached from the auxiliary archwire. (b) Eyelets have been bonded on the labial side and in an axial orientation, so that an auxiliary NiTi archwire may later be threaded through them to rapidly reduce the rotations. Regular sophisticated prescription brackets of the type used on the other teeth were placed at the following visit to complete the treatment.

**Figure 19.12**

(a) Occlusal view of the completed case. (b) Anterior view of the completed case.

The auxiliary labial arch is also a valuable asset for a canine that needs to be moved labially away from its entanglement between the incisor roots and brought down on the labial side of the arch (Figures 19.13a and b and 19.14a–c).

## 19.7 CANINES THAT RESORB LATERAL INCISORS: CAN IT BE A WIN-WIN SITUATION?

The cause-and-effect relation between incisor root resorption and an adjacent impacted canine is well known. The first recorded investigation in the literature was published in 1987, when Kurol and associates found 12% prevalence among Swedish schoolchildren using plane film radiography.[14] With the advent of computerized tomography (CT) and its ability to image in the buccolingual plane, the same group of researchers repeated the study, using a regular hospital spiral CT machine. They found that nearly half the cases of canine impaction within their sample exhibited incisor root resorption.[15]

In a further update using cone beam 'dental' CT equipment, the group of James Mah in Southern California was able to detect incisor root resorption in almost two thirds of the cases.[16]

So, the question is: 'What is appropriate treatment and can we offer a reliable degree of hope that the resorption will stop, that the

**Figure 19.13**

(a) Anterior view of the auxiliary arch, in its passive state, immediately prior to surgery of a labial canine. Note there is no bracket on the lateral incisor because of the relationship of its root to the canine and the risk of root resorption. (b) Occlusal view.

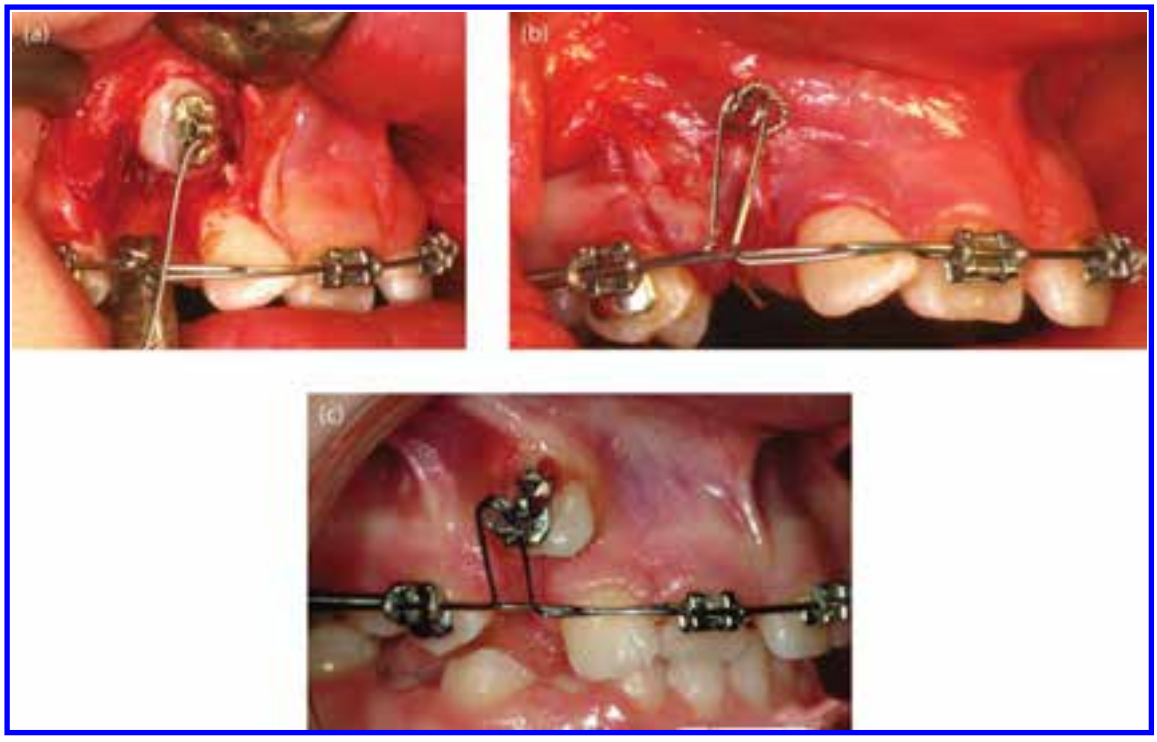

**Figure 19.14**

(a) A full flap incorporating attached gingiva is raised, the canine minimally exposed, and an eyelet attachment with twisted steel ligature is bonded. (b). The full flap is resutured with the steel ligature passing through the flap opposite the eyelet on the canine. The loop of the auxiliary archwire is raised and ensnared by the steel ligature to thereby apply a labially directed force, to avoid clashing with the lateral incisor. (c) The canine has emerged through the oral mucosa. Note the spontaneous improvement in the angulation of the lateral incisor.

affected incisor can be moved to its place, that it will last for many years hence and that the canine can be brought into the dental arch?'

In general, the 'collision course' eruption path of the errant canine is at an angle to the orientation of the long axis of the incisor root. Depending on the track of the canine, and the site of contact with the incisor root, the damage may range from a minor 'side-swipe', with little damage, to severe root destruction, leading to shedding of the incisor.

Despite the fact that case reports have been published in support of the 'no treatment' option, this option is risky and should be weighed up very carefully, having full knowledge of the location and eruption path of the canine, for which a CBCT examination is essential.

In 2005, we published a study of a cohort of patients with severely resorbed maxillary incisors from this cause.[17]

**Pearl:** The results clearly showed that the progress of the resorptive process halts when the canine is distanced from the area.

It also showed that the prognosis of the affected teeth was much improved following the treatment, none were lost during the treatment and in the (often many) years that they were followed up, despite their extremely short roots and despite the fact that they had also been subjected to orthodontic movement, as an integral part of the overall treatment.

Patients with impacted canines generally present as Class I nonextraction malocclusions with little or no crowding. In this type of case, if a decision is taken to extract the impacted canine, the final outcome will be either artificial replacement, or a Class II buccal occlusion and a possible midline shift. For these reasons, therefore, achieving a satisfactory result that includes alignment of both canine and incisor with a good long term prognosis has important advantages.

### *19.7.1 Case Report**

The case presented is of a female patient aged 10.9 years, referred by an orthodontist who considered that the resorbed lateral incisor, due to an impacted canine, should be extracted. The parents requested a second opinion.

#### 19.7.1.1 Clinical Examination

Significant features included:

- Mild skeletal Class III profile with a minor degree of facial asymmetry.
- The maxillary midline was coincident with the facial midline, while the mandibular midline was 2–3 mm to the left side.
- The dentition was fully erupted, including mandibular second molars.
- The maxillary left lateral incisor and the deciduous canine were in crossbite.
- The left side premolar/molars were in Class 1 relation, while the right side was almost a 1/2 unit Class III.
- The maxillary lateral incisors were peg-shaped. The left lateral incisor exhibited a considerable degree of mobility (Figure 19.15).

#### 19.7.1.2 Radiographic Examination

The panoramic and periapical radiographs showed the left maxillary canine to be impacted and pointing in the direction of the adjacent lateral incisor, whose root was severely resorbed with less than half remaining. The root of the deciduous canine was completely resorbed. The radiographs depicted the relation of the crown tip of the canine to the resorption front of the incisor root, with no apparent superimposition (Figure 19.16).

The 'tube-shift' diagnostic parallax views indicated that the canine could be directly in line with the incisor or only very marginally buccal or lingual to its root.

In order to decide whether to expose the tooth from the buccal or palatal side and to determine the direction of traction, a CBCT was considered essential (Figures 19.17a and b and 19.18).

The 3-D views (Figure 19.18) indicated that the canine nestled in a resorption crater which was buccolingually longer on the palatal side than on the labial. Logically, therefore, it was determined that the tooth had to be exposed and traction applied on the labial side.

#### 19.7.1.3 Biomechanics 1

Given the degree of resorption present, there was considerable urgency to expose the canine and initiate traction as resorption in these cases may be aggressive. The case was fully bonded and levelling and alignment were undertaken before the surgery.

In January 2012 a maxillary Tip-Edge Plus appliance was bonded to all the erupted teeth except the lateral incisor and the deciduous canine on the left side to avoid further aggravating the resorptive process. After eight weeks, a heavy round stainless steel main arch 0.508 mm (0.020 inch) could be placed. At this point the patient was referred for surgery (Figure 19.19).

Immediately prior to surgery, a labial 0.406 mm (0.016 inch) stainless steel auxiliary archwire, fashioned to include a long horizontal loop was placed. Activation of the loop by tying it to the impacted tooth will move the canine labially away from the lateral incisor root apex.

#### 19.7.1.4 Surgery 1

Under local anaesthetic, the surgeon exposed the labial and distal aspects of the canine using a labial mucogingival flap, taking care not to

* Reproduced from the website of the author at: http://www.dr-adrianbecker.com/page.php?pageId=281&nlid=43

**Figure 19.15**

Intraoral views of a 10.9-year-old female patient, showing overretained deciduous left canine, peg-shaped lateral incisors and the maxillary left lateral incisor in crossbite.

**Figure 19.16**

Periapical and panoramic radiographs showing the impacted canine and associated severely resorbed lateral incisor. Note also the apparently arrested root development of several other teeth with open root apices and the absence of third molars.

expose the cuspal tip of the canine, which was in close proximity to the resorption front of the incisor (Figure 19.20).

An eyelet attachment was bonded to the labial side of the canine crown and the entire labial flap sutured to recover the tooth (Figure 19.21).

The twisted pigtail ligature that was tied into the eyelet was brought horizontally through the flap and fashioned into a hook, close to the mucosa.

The loop of the auxiliary stainless steel archwire was pressed upwards into the sulcus area and engaged by the hooked end of the twisted


**Figure 19.17**

(a) Axial (horizontal) cuts from the CBCT at three different levels, which show the resorption of the root of the lateral incisor and a large void of bone destruction surrounding it. (b) Transaxial (vertical) cut shows the degree of root resorption of the incisor and the cusp tip of the canine above it. The void of bone destruction associated with the resorption process is evident.

**Figure 19.18**

A 3D screen shot from the CBCT.

**Figure 19.19**

The Tip-Edge Plus appliance was placed in January 2012, with no bracket placed on the affected lateral incisor and the deciduous canine. Following levelling and alignment and immediately prior to surgery, a heavy 0.508 mm (0.020 inch) steel main arch was placed, with an auxiliary arch of 0.406 mm (0.016 inch) stainless steel ligated over it, in piggy-back style. The auxiliary arch carried a long loop opposite the canine area, with a terminal helix which, in its passive mode, protruded horizontally outward.

pigtail ligature. A labially directed force was thus effective immediately.

### 19.7.1.5 Biomechanics 2

Sutures were removed after one week. Twelve days postoperatively it was noted that the canine had moved buccally and was about to break through the oral mucosa (Figure 19.22).

The auxiliary archwire was discarded and elastic thread was tied from the pigtail ligature to the main archwire distal to the first premolar to move the canine to a more favourable position while still under the mucosa (Figure 19.23).

### 19.7.1.6 Surgery 2

The plan was to perform a secondary surgical procedure to raise and apically reposition an attached gingival flap when the tooth had reached its predetermined buccal location while still high in the sulcus. Unfortunately, the tooth broke through the oral mucosa during distal traction and the opportunity was lost.

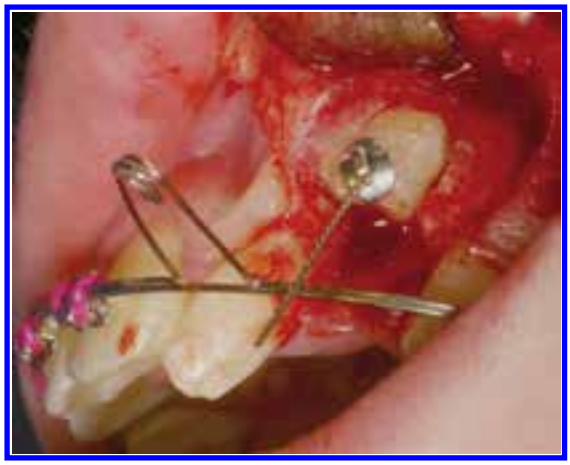

**Figure 19.20**

In March 2012, the middle of the labial aspect of the canine crown was exposed, with care taken not to approach the tip of the crown because of its proximity to the resorbed apex of the lateral incisor which was left undisturbed (surgery by Professor Raffi Zeltser). A small eyelet was bonded to the canine, as close to the tip as was possible, with a twisted soft steel ligature threaded through it and twisted tightly.

### 19.7.1.7 Biomechanics 3

When the tooth had reached a point vertically above its intended location, Tip-Edge brackets were bonded to the lateral incisor and canine. Using a 0.305 mm (0.012 inch) nickel-titanium wire threaded through the horizontal deep channels of the Tip-Edge bracket from second premolar to second premolar, via the lateral incisor bracket and a similar 0.356 mm (0.014 inch) nickel-titanium archwire ligated into the regular slots and engaging the canine, two separate and parallel systems were created using the full upper dentition as anchorage (Figure 19.24).

Because orthodontic alignment in the mandibular arch required very little time, brackets were only bonded there at this late juncture.

Active treatment was completed in September 2012 and the passive appliances left in place for a further three weeks. The priority to minimize further overall tooth movement dictated that no attempt be made to correct the mild Class III occlusion of the right side of the mouth.

Debonding was performed in October 2012, with extreme care being exercised in relation to the lateral incisor (Figure 19.25).

Retainers were placed and, and one month later, prescribed for night-time use only.

At this time, the lateral had become much firmer and has a similar degree of mobility to that of the other teeth. Presently a composite enlargement of the lateral incisor has been made but eventually a laminate restoration will be considered, despite the short root (Figure 19.26).

Well-trabeculated bone support can be seen in the posttreatment and in the 15-month follow-up radiographs (Figure 19.27).

Fixed splinting is not necessary from the periodontal point of view, although it might be a consideration for the long-term retention of the orthodontic alignment.

**Figure 19.21**

The long horizontal loop of the auxiliary archwire was raised with light finger pressure and ensnared in the twisted ligature which had been shortened and turned into a small hook. The full flap was resutured under the loop, to cover the exposed canine, and the distal side of the incisor, leaving only the hooked end of the twisted ligature visible.

**Figure 19.22**

The rapidity of the initial movement is seen in these views, taken 12 days postsurgery and is almost certainly due to the resorption void that surrounds the canine crown. As may be seen, once the canine is palpably clear of the incisor root, the direction of traction is altered by drawing the tooth distally towards the premolar.

**Figure 19.23**

Elastic thread from the canine puling distally towards the molar.

**Figure 19.24**

After five weeks of distal movement the eyelet was removed and Tip-Edge brackets bonded to the lateral incisor and canine. Note the use of two different NiTi archwires. The 0.356 mm (0.014 inch) main arch was ligated in the bracket slots and applied eruptive force to the canine, while a 0.305 mm (0.012 inch) auxiliary arch was threaded through the deep channel in the Tip-Edge Plus bracket, to engage the lateral incisor.

**Pearl:** Perhaps the most important contribution to come out of an earlier 2005 study[22] was that the severe resorption of incisor roots by an aberrant canine will be arrested as soon as the impacted tooth is distanced from the immediate area of the root apex.

Nine years since publication of the original article in 2005,[17] the affected teeth in the cases reported, are still in place, firm and without further root loss. Hence the confidence that is offered in presenting this case, not as a 'one-off' success, but rather as a recommended modus operandi for these types of cases.

The second point worth noting is that almost half the cases of palatally impacted canines are associated with anomalous lateral incisors, that is, missing, peg-shaped, and small. Nevertheless, it has been shown that associated resorption of the lateral incisors occurs far more frequently in the cases with normal lateral incisors than those with lateral incisors of reduced dimensions.[18] The present case is unusual in this respect.

An open exposure procedure is contraindicated in this type of case, because of the proximity of the intended exposure site and the vital

**Figure 19.25**

Panoramic radiograph taken immediately following debonding.

**Figure 19.26**

At 15 months post-treatment, it will be noted that there are minor discrepancies in the occlusal relations, which were deliberately left untreated in what may be described as an optimal (rather than ideal) result, given the need to avoid unnecessary forces that could undermine the prognosis of the resorbed lateral incisor. Note the normal clinical crown height of the canine in relation to the adjacent teeth and the excellent periodontal condition. Mobility of the lateral incisor was markedly reduced and only marginally greater than that of the other incisors.

but resorbed root end of the incisors. A closed eruption exposure is the only way in which all the aims of the treatment plan may be achieved.[19–21]

A word of caution is appropriate in the present context in regard to the orthodontic movement of these resorbed teeth. While we have asserted that further root resorption is most unlikely to occur once the canine is distanced


**Figure 19.27**

Periapical radiographs taken pretreatment, immediately at the end of treatment and 15 months later show elimination of the resorptive void with bony fill-in and a good trabecular pattern and lamina dura. The resorptive process has come to a complete halt and there has been no change in root length in the lateral incisor during this entire period.

from the area and that these teeth can be subsequently moved orthodontically, we would recommend that the orthodontic treatment should be kept to the minimum that is absolutely necessary. We would warn against large-scale orthodontic movements and, as in the case described here, being prepared to accept reasonable compromises for an optimal result. It should be remembered that the antithesis of accepting the 'good' may be the striving for 'excellence'.

## VIDEOS

19.1 This CBCT construction presents three separate frames in the three planes of space that is, anteroposterior, vertical, and horizontal and presents continuous 'slices' in one and how these are reflected in the other two. (Available at http://goo.gl/emfsbS.)

19.2 This video clip is an excellent example of 3-D viewing of the location of the teeth in space in 3-D and in relation to one another from every possible angle. It simplifies the planning of the directional traction that needs to be applied and helps to decide which aspect of the tooth should be exposed during the surgery. (Available at http://goo.gl/RYsRPK.

Courtesy of Amnon Leitner, Panorama, Nahariya, Israel.)

19.3 This 3-D video clip shows the location of the canine tip to the severely resorbed root of the adjacent lateral incisor. Note the difference in height of the labial and palatal rims of the residual root stub, which assist in judging the direction that traction needs to be applied to minimize further damage. (Available at http://goo.gl/p3V827. Courtesy of Amnon Leitner, Panorama, Nahariya, Israel.)

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# 20 LINGUAL TECHNIQUE IN CURRENT ORTHODONTIC PRACTICE

Alan Rumbak

CONTENTS



## 20.1 INTRODUCTION

Lingual orthodontics is regarded by many orthodontists as the most technically difficult of all the orthodontic techniques. The clinician has limited access to the orthodontic brackets placed on the lingual side of the teeth and the different biomechanical reaction of the teeth to forces applied on the lingual, as opposed to the buccal surface, introduces many unwanted side effects.

One of the first clinicians in the USA to start using the lingual technique in the 1970s was Craven Kurz.[1] He adapted buccal brackets to fit on the lingual surfaces of teeth; this was followed in the 1980s by the Ormco Orthodontic Corporation setting up a lingual orthodontic taskforce of prominent orthodontists to develop a more user-friendly efficient lingual orthodontic appliance.[2] Concurrently in Japan Dr Fujita was treating lingual cases using a mushroom-shaped lingual arch.[3]

The concept of invisible orthodontic treatment was publicized in the American press; courses were popular and well attended by many orthodontists. The early lingual brackets developed and periodically modified by Ormco were large, difficult to use, and uncomfortable for patients, wire bending was difficult, and results unpredictable. Many orthodontic cases that were started with lingual appliances had to be completed with buccal appliances and the technique rapidly lost its popularity in America.[4] However, during the mid-2000s the technique experienced a resurgence in Europe and the Far East which has continued to the present day.

A comprehensive discussion on the development of the technique falls outside the scope of this chapter, suffice to mention that a number of European, Japanese, and Korean clinicians have promoted, developed and continue to drive forward the lingual technique.

The advances in digital technology, computer-aided design software and computer-aided manufacturing (CAD/CAM), intraoral and cast model scanning techniques have all contributed to a number of sophisticated lingual appliance systems, the latest of which will be briefly described.

Currently, for all the lingual techniques, accurate polyvinyl silicone (PVS) impressions of the dentition are required. The regime recommended is a two-stage procedure: first a heavy PVS base impression using a plicafol separator followed by light PVS wash. More recently, with the development of intraoral scanning devices it has become possible to produce 3D images of the mouth. Instead of impressions, these STereoLithography (STL) 3D image files can be sent directly to a laboratory for the production of 3D images, 3D printed models, and appliance manufacture (Lythos-Ormco).

**Pearl:** Before taking the impressions or scanning, the lingual surface of the teeth should be free of all extraneous deposits (calculus).

The continuing technical advances and some of the clinicians driving forward the development of new lingual appliances will be briefly described.

## 20.2 ORAPIX® (EURAPIX) SYSTEM

This system was developed by Dr Fillion, one of the pioneers of the lingual technique in Europe.[5] He has lectured widely, published extensively, and runs many clinical courses. The Orapix (Eurapix) appliance has been marketed as a fully individualized lingual bracket positioning and a transfer jig system manufactured by CAD/CAM technology allowing the use of straight archwire as opposed to the mushroom-shaped arches. There is no offset in the wire between the canines and premolars and between the premolars and molars.

There are four main steps in this technique[5]:

1. Creation of a virtual setup produced after scanning the original malocclusion study models.
2. Virtual bracket positioning.
3. Customized transfer jigs.
4. The technique uses standard straight archwires which are provided with each case. The shape and size of the wires are selected from the occlusal view of the setup.

Two types of standard horizontal slot brackets are offered with this technique. The Scuzzo Takemoto bracket (STB) and the Kurz 7th generation bracket (Ormco).

**Pearl:** The bracket bases incorporate a thicker composite base to compensate for the different tooth thicknesses thus allowing the use of a straight wire approach as opposed to the mushroom-shaped arch.

### *20.2.1 Advantages of the Orapix System*

- Eliminates some of the laboratory procedures
- Uses straight archwires with no bends or, in some cases, minimal bends
- Teeth move gradually during treatment towards the ideal occlusion determined by the original set up

### *20.2.2 Disadvantages of the Orapix System*

- To compensate for the variation in tooth thickness, the bracket bases on certain teeth need to be thickened. Due to the thickness of the bracket base the site of force application is further away from the centre of resistance of the tooth and the resulting tooth movements may be less efficient.
- If a bracket debond occurs during treatment, this type of base may make accurate repositioning of the bracket difficult.

Accurate planning is the key to this technique which allows a large variety of malocclusions to be treated to a successful outcome.

## 20.3 INCOGNITO® TECHNIQUE (I BRACES)

Dr Dirk Wiechmann based in Bad Essen, Germany, developed the Incognito technique.[6]


**Figure 20.1**

Incognito appliance. (a) Maxillary appliance; (b) mandibular appliance.

He also ranks as a leading developer, appliance designer, clinician, and teacher in lingual orthodontics (Figure 20.1).

Features of this technique are detailed in this section.[7]

### 20.3.1 Individual Treatment Objectives

From study models of the original malocclusion, the teeth are sectioned and set up (Kesling setup) as close to an ideal occlusion as possible using the orthodontist's instructions, the technician's skill, and Andrew's six keys of occlusions as a guideline.[7]

### 20.3.2 Scanning the Study Model Setup and Tooth Surfaces

The setup is scanned using a 3D high resolution scanner producing an accurate digital 3D virtual model.

### 20.3.3 Individualized Bracket Bases

The Incognito technique uses a low profile customized bracket that is made from the 3D scanned image of the laboratory setup. Each bracket base is individualized to fit the lingual surface of a specific tooth conforming accurately to the dental anatomy. This feature results in a thin layer of bonding composite and higher bond strength. Accurate rebonding of a failed bracket is easier due to the key lock fit of the bracket base to the tooth lingual surface anatomy.

### 20.3.4 Bracket Manufacturing

Low profile brackets are computer generated and individually cast in gold alloy. The bracket incorporates 0.457 mm (0.018 inch) vertical slot which contributes to good torque control of the anterior teeth.[7]

**Pearl:** When using a lingual appliance, it is important to be aware that due to the position of the lingual bracket in relation to the centre of resistance of the tooth, any error in torque expression manifests as a vertical discrepancy.

### 20.3.5 Archwire Fabrication

For stainless steel and titanium molybdenum alloy wire (TMA), the wire geometry is calculated from the 3D study model CAD/CAM computer program and the information sent to a wire-bending robot for manufacturing. The

nickel-titanium wires are shaped and heat treated in the same geometric shape as the stainless steel and titanium molybdenum alloy arches using a special heating process. Each wire in the sequence has the same geometry which enables the teeth to be moved gently to their final position.

The original Incognito Company has been taken over by 3M Unitek. They have introduced a computerized setup system thus eliminating the original laboratory setup. There has been some debate as to which is the better option.

### 20.3.6 Advantages of Incognito Appliance

- There are very good practical courses, an E-learning platform, and excellent clinical guides available.
- Laboratory back-up, technical and biomechanical advice is available on all cases.
- It is user friendly for the orthodontist as long as the specified treatment protocols are followed.
- Screen shots of the appliance *in situ* may be supplied by the laboratory to the clinician to aid in bracket placement for rebonding (Figure 20.2).
- If you still have the bracket, repairs are easily done and the bracket can be placed in the correct position due to the key lock fit of bracket base and tooth surface. It is useful to refer to the screen shots for better accuracy. If a tooth height discrepancy arises, examination of the lingual brackets will indicate that the error occurred in the bracket bonding position. This can be corrected either by rebonding the bracket or adjusting the archwire (Figures 20.3 and 20.4).

**Pearl:** The screen shot is available and should be referred to for checking bracket placement.

- Due to the combination of the ribbon arch format and the vertical bracket slot in the anterior region, torque control is good and best expressed using full a thickness archwire. Furthermore, due to the close position of the bracket slot to the tooth surface and to the centre of resistance of the tooth, the transmission of the forces generated by the archwire is more efficient. Good torque control improves the accuracy of the finished result.
- For extraction cases, bodily movement of the tooth is achieved with less lingual tipping; in addition extra torque can be ordered for the anterior teeth to compensate for tipping that may occur when retracting the anterior teeth.
- Cast occlusal pads on the posterior teeth may be incorporated in the brackets to disarticulate the occlusion and increase the

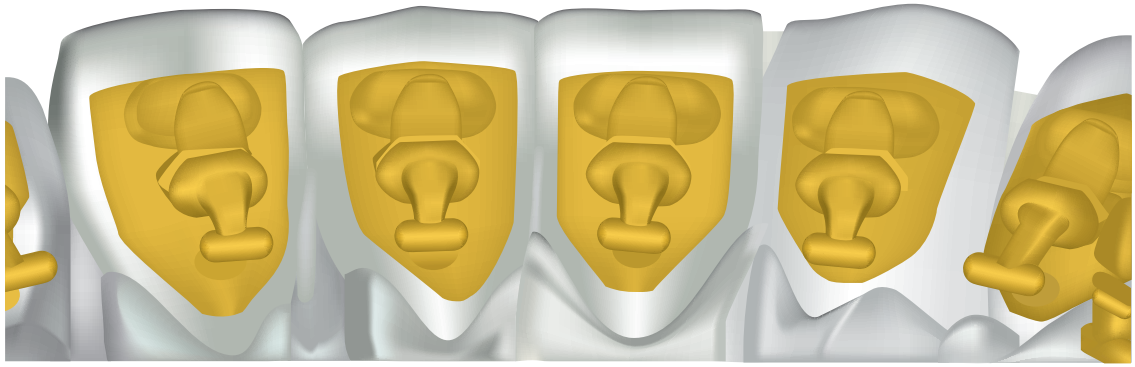

**Figure 20.2**

Screen shot showing correct placement of brackets for the lingual surface of the lower four incisors.


**Figure 20.3**

(a) Discrepancy in vertical height of LR1. (b) Incorrect lingual bracket height on LR1.


**Figure 20.4**

(a) Lingual arch adjusted to elevate LR1. (b) Vertical height of LR1 corrected by the archwire adjustment.

bonding surface area for teeth that have a short clinical crown.

- The brackets are comparatively small in a mesiodistal dimension thus increasing the interbracket widths. This facilitates access for intraoral adjustments and for reducing the forces between the teeth especially between the lower incisors (Figure 20.5).

### *20.3.7 Disadvantages of Incognito Appliance*

- The turnaround time for an Incognito brace is about six weeks.

**Figure 20.5**

Narrow brackets for the lower incisors contributing to a larger interbracket span.

- Lost brackets have to be reordered so there is a four week wait before the new bracket is received for replacement.
- If archwire breakage occurs and a new wire needs to be ordered, the time delay can be four weeks. If the case is in a large size archwire, the tooth may move, thus requiring a drop to a lower archwire size.

**Pearl:** A useful tip. While waiting for a replacement bracket if the case is in a large rectangular archwire or close to the end of treatment, I have found that to maintain the tooth in the correct position, it is helpful to bond the tooth directly to the archwire using Triad Gel® light cure acrylic (Densply); this holds the tooth while I am waiting for the replacement bracket (Figure 20.6).

- Due to the presence of a cast vertical slot as opposed to a horizontal edgewise slot, it is difficult to control tipping of the anterior teeth in the mesiodistal plane.

**Pearl:** All the archwires, from the smallest diameter to the largest rectangular wires, need to be ligated firmly into the base of the bracket slot. Control of tip is important from the very start of treatment.

- Incognito uses self-cure Reliance maximum cure® unfilled resin A and B (Reliance Orthodontic Products). These resins should be kept in the fridge until just before bonding as the material may set before the bonding trays are seated. Aluminium metallic cooling holders may be used to keep the materials cool at the chairside (Peltz and Company GmbH) (Figure 20.7).

As for any indirect bonding procedure, always try-in the tray before you start bonding. Where teeth have not erupted fully at the time of taking the impression, for example, second premolars, some eruption may occur during the intervening six weeks before the appliance arrives.

**Pearl:** In such cases, sectioning of the tray is essential, enabling the second premolar bracket to be bonded individually. Also, where deep undercuts exist, such as in the case of a lingually inclined lower first molar, it is preferable to section the tray and to seat it in stages.

- Before applying resin onto the bracket bases, carefully examine the fitting surface of the tray to check if all the brackets are seated down correctly in the tray, as any obstacle preventing seating of the tray is a disaster.

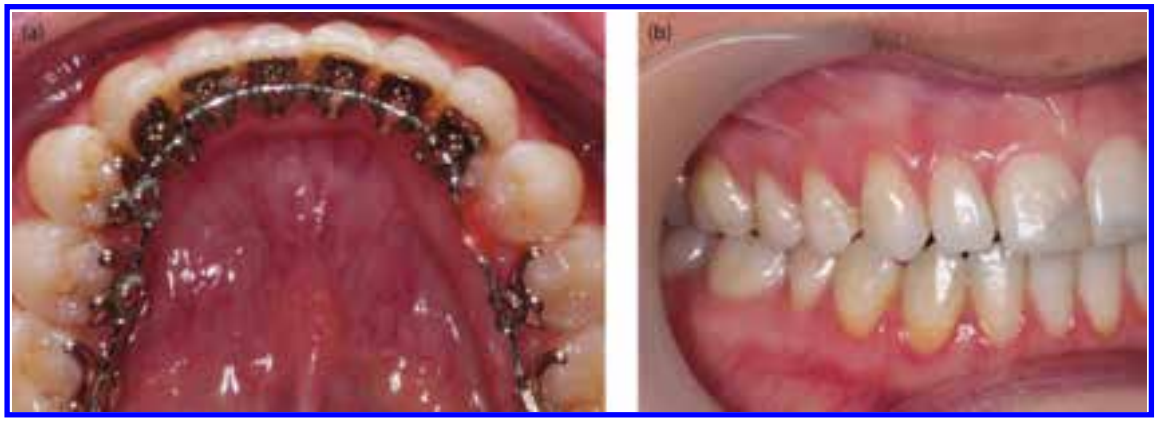

**Figure 20.6**

(a) Approaching the end of treatment, bracket de-bond LR4, held in place with Triad Gel until replacement bracket arrives. (b) Buccal view shows LR4 maintained in good position.


**Figure 20.7**

Aluminium metallic cooling holder for resin bottles.

If any problems become evident when trying in the tray, the tray and brackets will have to be returned to the laboratory to be reset.

## 20.4 E-BRACE®

Produced by Guangzhou Riton Biomaterial Co., Ltd., these lingual braces are manufactured in a similar way to Incognito except they have a shorter turnaround time and the brackets have a CAD/CAM designed fine mesh on the bases.[8] It is possible to request vertical or horizontal slots of either 0.457 mm or 0.559 mm (0.018 inch or 0.022 inch). The brackets can be supplied with a self-ligating mechanism the e-Lock system at an extra cost. It is also possible to order the brackets in gold, nickel-chrome or chrome cobalt together with clear transfer trays of your choice.[8]

## 20.5 HARMONY® LINGUAL ORTHODONTIC APPLIANCE

Patrick Curiel based in France designed this lingual appliance produced by American Orthodontics (Figure 20.8).[9]

This system is also manufactured using CAD/CAM technologies and produces an individualized self-ligating lingual appliance which has metal bases similar to the Incognito appliance. Due to the self-ligating mechanism the bracket does not have as low a profile as the Incognito appliance. Initially, the case is bonded with conventional indirect bonding trays. Special positioning jigs are provided routinely for the anterior and posterior teeth. These can be used subsequently if needed, to aid in bracket positioning either during treatment, or for brackets requiring rebonding after failure. Archwires are robotically formed from the CAD/CAM set up.[9]

Dr Curiel maintains that self-ligation is much easier to manage compared to the conventional lingual ligation techniques, such as overties which take time and increase the friction between the wire, the bracket, and elastomeric tie. This may cut down on appointment times and the length of treatment. He maintains that


**Figure 20.8**

(a) Harmony® self-ligating bracket appliance designed by Patrick Curiel. (b) Harmony self-ligating brackets.

his technique takes the best concepts from the labial self-ligating system, that is low force and low friction, combined with digital customization. To be used with his lingual appliance, he recommends finishing in 0.457 mm × 0.635 mm (0.018 inch × 0.025 inch) nickel-titanium archwire in conjunction with 0.457 mm × 0.635 mm (0.018 inch × 0.025 inch) slots.

The Harmony appliance system has online certification courses and also set protocols for impression taking and clinical bonding to different types of surfaces such as enamel, metal, and porcelain. There are also instructions for opening and closing anterior and posterior self-ligating clips.

This appliance system does not dictate the course of treatment, but it tries to adapt to the clinical philosophy of each orthodontist. The orthodontist can go online and access the digital setup for the case and instruct the Technical Centre to make any required changes. Once the changes are made the orthodontist gives the go ahead to manufacture the brace from the digital setup.[9]

**Pearl:** An important feature of this system is that based on his/her philosophy, the orthodontist can choose the shape of the archwire, either straight or mushroom shaped.

If you choose a straight wire, the bracket bases are thicker to compensate for the differential width of the teeth (see Orapix described above). Mechanically this places the centre of resistance of the tooth further away from the plane of force and introduces larger moments which may be unfavourable. Choosing the mushroom-shaped archwire whereby the bases are thin and placed closer to the lingual surface of the teeth has biomechanical advantages as the point of force application will be closer to the centre of resistance of the tooth (see Section 20.3). However, the wire will have numerous bends produced by a wire-bending robot.

A disadvantage of this system is the width of the bracket; a wider bracket reduces the interbracket distance between the lower anterior teeth and may present a problem in ligating severely imbricated lower incisor teeth.

## 20.6 DW LINGUAL SYSTEM: THE WIN® APPLIANCE

Dr Dirk Wiechmann has recently developed the WIN appliance, a new customized appliance where the bracket base is cast in chrome cobalt and is perfectly adapted to the tooth shape. As with other techniques, the individual archwires are bent by computer-assisted

**Figure 20.9**

(a) New DW Lingual System, full arch. (b) DW Lingual System Incisor brackets.

wire-bending robots (DW Lingual Systems GmbH) (Figure 20.9).

The principal feature of this technique is that the bracket bases are produced to fit accurately on the tooth surfaces and then the bracket body is attached to the base in a separate procedure. As with his earlier Incognito appliance, this allows the wire to produce forces on the bracket which are closer to the centre of resistance of the tooth for more efficient tooth movement.

An important feature of this appliance is that the bracket slot is cut using a high speed milling process. This process leads to precise bracket slots with little tolerance, enabling the full expression of torque with the final archwires. The orientation of the bracket slot is still the same as in the original incognito bracket, namely, vertical.

**Pearl:** This high precision slot-to-wire relationship together with the new shaped 0.090 inch Easy On elastic ligatures (Peltz and Co) eliminates the use of elastomeric power ties and overties generally required to achieve the full expression of tip and torque in a customized vertical slot appliance.

The new Easy On elastomeric ligature ties have been manufactures specifically for this bracket. They are made from a different composition, and in cross-section they are rectangular, so they lie flat on the bracket. They do not deform or stretch easily, and they hold the archwire firmly in place in the base of the bracket slot eliminating the use of overties used to achieve full expression of the second order movement (mesiodistal tipping) (Figure 20.10).

**Pearl:** In cases with crowded and malaligned teeth, when placing the initial archwire, use the standard elastomeric ligatures to ligate the crowded teeth as the high forces generated when stretching the new Easy On ligatures may lead to debonding.

The clinical procedure for bonding the brackets is similar to that of the Incognito appliances.

**Figure 20.10**

Easy On elastomeric ligature modules.

The orthodontist can choice either hard or soft transfer trays. When ordering the transfer tray from the laboratory, request on the order form for the buccal/labial part of the tray to be removed from the upper right canine to the upper left canine.

**Pearl:** This procedure allows the fit of the tray to be accurately assessed prior to bonding. This is done by observing the width of the gap between the incisal edge of the tooth and the tray (Figure 20.11).

Photographs of the original setup are supplied by the laboratory so bracket placement can be

**Figure 20.11**

Indirect bonding tray with the labial section cut away to visualize the accuracy of the fit.

checked and used as a reference when doing repairs. It is important to always make reference to the setup photographs when repairing the appliance.

## 20.7 2D® APPLIANCE

Vittorio Cacciafesta is an exponent of this technique which is based on a simple bracket design introduced essentially to decrease the cost of lingual treatment (Forestadent). These brackets have a limited application as the teeth can only be moved in two planes, either anteriorly/posteriorly or up and down. They can be bonded either directly or indirectly quite inexpensively. They have a low profile, are comfortable, and do not significantly affect speech. There is a bracket library so certain standard brackets can be selected for different teeth and situations.

Dr Cacciafesta[10] recommends this bracket system for the following clinical situations:

- To hold teeth as a lingual retainer after treatment
- To close minor spaces
- To partially reduce overbites
- Alignment of teeth in maxillary and mandibles arches
- Alignment of impacted or ectopic canines
- Eliminate anterior and posterior crossbites
- Orthodontic preparation for orthognathic surgery

I believe this to be the appliance of choice for the correction of mild lower anterior orthodontic relapse. The Forestadent 2D brackets are bonded from lower canine to canine and aligned with a 0.305 mm (0.012 inch) nickel-titanium sectional arch (Figure 20.12).

**Pearl:** One of the advantages of using such a simple bracket system for lingual treatment is that it allows the clinician to produce the appliance within his/her in-house laboratory.

A detailed description of the laboratory procedures falls outside the scope of this chapter; however, I would be happy to provide any reader with such details should they wish to contact me.

A comprehensive round table discussion was presented in 2012, covering many aspects of the lingual technique; moderated by B. Ludwig; it included eight orthodontists highly experienced in the lingual technique.[11] Any clinician wishing to become more familiar with this subject is advised to read this discussion and consider attending a formal course.

## 20.8 CLINICAL TIPS

**Pearl:** When working with all types of lingual appliances it is highly recommended that you work with at least 2.5× magnification optical loops with LED illumination attached to the loops.

### *20.8.1 Instrumentation*

Working on the lingual with the incorrect instruments is very stressful. The correct instruments and materials are essential to make lingual orthodontics stress free and enjoyable. Every clinician, over time, will acquire a variety of instruments that they find helpful. However, as a basic requirement, I have found the following instruments to be essential (Peltz and Company GmbH):

- Short probe
- Curved and straight ligature tying forceps
- Ligature director, straight and curved
- Weingart pliers with different degrees of curvature
- Flush cut distal end cutter
- Cinch back pliers
- Lingual debonding pliers
- Wire cutters for hard wire

### *20.8.2 Protruding Distal Archwire Ends*

The distal end of the archwire as it extends through the tube of the second molar can cause irritation to the tongue unless it is tucked snugly out of the way (Figure 20.13).

**Figure 20.12**

(a) Mild lower incisor crowding. (b) Simple sectional 2D lingual appliance fitted from lower canine to canine incorporating a 0.305 mm (0.012 inch) NiTi wire. (c) Aligned lower incisors with a bonded lower lingual retainer.

**Figure 20.13**

Distal ends of the archwire protruding through the lingual tubes on the lower second molars.

To facilitate this procedure, first disengage the archwire from the lower anterior brackets (Figure 20.14).

Secondly, move the archwire distally allowing it to extend out of the lower right second molar tube.

With the cinch back pliers bend protruding wire inwards towards the crown.

Finally, move the archwire forward and reengage the anterior brackets. The distal end will then lie tucked in snugly against the distal of the second molar.

### *20.8.3 Patient Selection*

There is no difference in the types of malocclusions that can be treated with lingual

**Figure 20.14**

(a) The archwire is disengaged from the lower anterior brackets. (b) The archwire is moved distally to extrude further through the lingual molar tube. (c) The protruding distal end is tucked in towards the crown. (d) The archwire is moved forwards and ligated with elastomeric ties to the anterior teeth; the distal end will lie neatly tucked into the distolingual embrasure of the lower second molar.

appliances as opposed to buccal appliances. The only reservation is the type of patient treated; older patients do not seem to tolerate the appliance as well as adolescents. Patients with tongue issues such as macroglossia or sensitivity to spices may not be suitable for lingual appliances.

### *20.8.4 Patient Management*

The case discussion appointment for a patient requiring or requesting lingual appliance should be longer that the regular case discussion appointment. There is more to explain and invariably there will be more than the usual questions. The documentation and all letters must be comprehensively and carefully worded. The patient should be in no doubt as to what they must expect and what you the clinician will expect form them.

When starting to use lingual appliances, there is a steep learning curve. It may be beneficial for the patient to be scheduled at the end of the clinical session in case of over running the allocated time slot. I recommend that longer appointments are scheduled until you have gained some experience in the technique.

### *20.8.5 Working Position*

The operator's working position is important. To improve visual access for the upper and lower lingual surfaces, both left and right handed operators should be prepared to move around and work on both the left and right of the patient.

**Pearl:** When ligating the wire into the brackets either with elastic or wire ligatures, the dominant hand should always hold the ligature director (tucker) and the nondominant, the forceps. This gives better control and less chance of slipping and injuring the patient.

## 20.9 CONCLUSION

While this technique may be considered difficult, time consuming, and frustrating, once managed correctly and with experience, it is rewarding and highly satisfying. The type of patient that chooses to select the lingual appliance option is generally demanding but very appreciative in the end.

For clinicians who wish to offer a wider appliance option to their patients and who wish to provide a specialized service for their patients, I highly recommend the lingual technique with a proviso that clinicians should be prepared to attend special training in whichever appliance they select.

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# 21 TEMPOROMANDIBULAR JOINT: DISC DISPLACEMENT

Brian Nebbe

CONTENTS



Temporomandibular joint dysfunction (TMD) is defined as: 'signs and symptoms originating from the musculoskeletal structures of the masticatory system'. Disc displacement is a single entity included under the differential diagnosis of TMD, and TMD is a subcategory of craniofacial pain. Clearly, a comprehensive presentation on TMD and craniofacial pain falls outside the scope of this book; however, a more complete understanding of disc displacement, its clinical presentation, and treatment options, could be of benefit to the treating orthodontist.

The temporomandibular joints (TMJs) form bilateral articulations between the mandibular condyles and temporal bones. Interposed between the osseous articular surfaces of each joint is a fibrous articular disc. In the normal, healthy joint the disc remains interposed between the osseous articular surfaces during all movements of the mandible. Occasionally, the disc is displaced and no longer functions between the osseous articular surfaces.

The consequences of disc displacement are numerous and depend on the degree of displacement, inflammation, and joint damage associated with the displacement, as well as the adaptive capacity of the individual. Clinical signs and symptoms are associated with disc displacement and occur with mandibular movement.

**Pearl:** These may be summarized as: preauricular pain; joint sounds; limited mouth opening; deviation of the mandible to the affected side; joint and capsular tenderness, tenderness of the muscles of mastication, and occlusal changes.

In addition to the clinical symptoms identified, it has been suggested that in the adult population disc displacement may be associated with osteoarthrosis.[1] Further associations between disc displacement, osteoarthrosis, degenerative joint disease, and the development of progressive malocclusion in an adult sample have also been shown.[2]

Minor disc displacement affecting only a small region of the disc may pass unnoticed and show little evidence of tissue change. Minor disc displacement in closed mouth position often shows disc reduction on mouth opening. On disc reduction, the disc moves back onto the head of the condyle with the intermediate zone of the disc interposed between the head of the condyle and opposing posterior slope of the articular eminence as the condyle translates anteriorly during normal mouth opening. Therefore, disc displacement with reduction during condylar translation may show only minor tissue changes since most of the loading during joint function occurs on the reduced articular disc, preserving the integrity of the retrodiscal tissues and discal attachments. On the other hand, disc displacement without reduction on normal condylar translation may be associated with

severe changes of the articular structures, particularly when joint loading continues to be excessive. Articular and nonarticular components of the joint may show changes as a result of disc displacement where the disc is no longer interposed between osseous joint surfaces during any phase of condylar translation.

**Pearl:** Displacement of the disc with or without reduction implies that during some stages of joint loading the intermediate zone of the disc is no longer interposed between the condyle and posterior surface of the articular eminence.

Where the disc is only slightly anteriorly displaced, joint loading will occur on the thickened posterior band of the disc. Collagen in this region of the disc has a transverse arrangement and is less capable of supporting functional loads than the intermediate zone of the disc which has a sagittal collagen orientation.[3,4]

The compressibility of discal tissue is reduced with the loss of discal fluid, and loading in this region produces increased tissue damage. Loss of lubrication normally provided by the disc,[5,6] together with increased frictional drag, disturbs the coordinated movement of the disc relative to the condyle.[7]

**Pearl:** In the closed mouth position with full disc displacement, the condyle rests on the posterior attachments and retrodiscal tissues of the disc. The highly innervated and vascularized retrodiscal tissues are subject to loading and trauma producing joint symptoms of pain.

Joint inflammation is often described as a response that occurs in synovial membrane or fluid. Cartilage and the disc have not been regarded as active participants in joint inflammation. However, the production of potent proinflammatory mediators by chondrocytes and fibrocytes is now known to initiate and maintain joint inflammation.[8] Continued functional loading on retrodiscal tissue in the presence of acute inflammation, reduced tissue repair, and regeneration may lead to perforation of the posterior attachments which further interferes with condylar mobility.

Alternatively, the tissue switches to a reparative mode as granulation tissue replaces the acute inflammatory exudate and fibrous scar tissue eventually replaces the retrodiscal tissues. This tissue assumes the function of the displaced disc and the retrodiscal tissues remodel into a functional pseudodisc and a new equilibrium is established.[9]

Continued joint function and remodelling of the posterior attachments is accompanied by morphological changes in the disc. In the closed mouth position, a fully displaced disc is situated anterior to the condyle in the anterior joint recess at the height of the articular eminence.[10] Overall, it has been suggested the disc shows a loss of morphology and a reduction in anteroposterior dimensions.[11–15] Minimal disc displacement ensures that during most functional movements of the condyle, the disc is interposed between the functional osseous articular surfaces. The normal articular position of the disc provides the fibrocartilage of the joint with lubrication and nutrition. The disc also functions as a shock-absorber and load-distributor during mastication.

**Pearl:** Displacement of the disc disrupts the normal function provided by the disc.

In the presence of disc displacement, areas of the condyle not in contact with the articular disc are approximated to the osseous articular surface of the articular eminence with elongated discal attachments interposed. The opposing osseous articular surfaces are incongruous, since the articular disc usually fills the space between the two convex osseous surfaces. During mastication the incongruous surfaces are approximated with point localization of loads. The force per unit area experienced by the fibrocartilage covering the osseous articular structures is increased during mastication, leading to localized tissue fatigue, loss of tissue fluid, and reduced compressibility.

Initially the damage is localized to the surface articular layer of the fibrocartilage and further damage is prevented by normal tissues regenerative capacity. However, continual loading of the joint together with reduced

surface lubrication and nutrition eventually affects the regenerative capacity of chondrocytes within the cartilage.

**Pearl:** If regressive remodelling exceeds the attempts at tissue repair, degeneration occurs which in turn may be superficially localized to the articular cartilage or extend more deeply to involve the osseous tissues.[16]

The severity of surface damage depends on the degree of disc displacement, the presence of posterior discal attachment perforations, loss of lubrication, inflammation, regenerative capacity of tissues, and the duration and intensity of masticatory force application.

**Pearl:** Damage to the fibrocartilage articular surface is not experienced as joint pain since no nerve endings extend to innervate this tissue. Pain may only be experienced once the nerves in elongated capsular and discal structures are stimulated or when inflammatory products stimulate nerve endings in the osseous medullary spaces or capsular elements of the joint.

A synovial membrane lines the nonarticular surfaces of the joint and produces synovial fluid for joint lubrication and nutrition. Synovial membrane is delicate and well-supplied by a subintimal vascular plexus which is unable to withstand joint loads and, for this reason, does not occur on articular surfaces.

Loading of synovial tissues results in hyperaemia with the formation of chronic inflammatory exudate and cellular infiltration in the subintimal tissues. Compression of tissues exceeding their adaptive capacity results in tissue breakdown and reduction of the surface area covered by synovial membrane. The intra-articular pressure may be further elevated, depending on muscle recruitment and occlusal contacts employed during mastication. In the chronically inflamed joint an increase in intra-articular pressure occurs with function which exceeds the capillary perfusion pressure and occludes the synovial capillary bed resulting in hypoxia.[16]

**Pearl:** Imaging studies have shown disc displacement to occur in adults with a prevalence of approximately 30% in the asymptomatic individual,[17,18] and to occur in approximately 82% of individuals presenting with signs and symptoms of craniomandibular disorders or pain.

It is generally accepted that adolescent individuals are also affected by disc displacement.[19–21] It has been suggested that the localization of pain is less specific in younger individuals.[22] This makes it increasingly difficult to identify and study adolescents with disc displacement of the TMJs.

The interpretation of clinical signs and symptoms is complicated by the lack of standardization in obtaining clinical information, the subjective nature of the evaluation, and the fact that ambiguous findings may be attributed to the investigation. For example, the detection of a silent joint is generally interpreted as normal disc position. This may not necessarily be the case, since in joints with disc displacement without reduction the condyle may translate normally and no longer move over the posterior band of the disc, producing no joint sounds and leading to a false-negative interpretation of disc position.[23]

**Pearl:** Therefore joint sounds alone may not be accurate indicators of disc status unless an accurate history of joint sounds is obtained.

Improvements in clinical data acquisition have been made possible using visual analogue scales for pain scores and standardization of palpation pressures to assess muscle and joint tenderness. Despite these improvements, clinical information and joint sounds only identify approximately half of the joints affected by internal derangement as assessed by magnetic resonance imaging (MRI).[24]

Determinations of occlusal variables that are clinically assessed, and potentially associated with joint symptoms have led to contradictory and confusing results. Some studies report associations between Angle malocclusions, crossbites, overbite, and overjet measurements

and joint symptoms, while other studies show no associations.[25,26]

**Pearl:** It appears that clinical signs and symptoms are at best indicators of disc displacement but cannot be used with confidence in the diagnosis of joint status or for determining the extent of the disc displacement.

Panoramic radiographs can be used as screening images of the TMJ as they are adequate for the detection of fractures and gross degenerative changes of the condyles. As with any of the other plain film imaging techniques, these images have limitations since they are subject to magnification, superimposition, and decreased image resolution. In addition, the formed image of the condyle needs careful interpretation since the orbiting radiation source produces superimposed projections of the medial and lateral poles of the condyle and distortion of osseous structures[27] (Figure 21.1).

Axially corrected tomographic imaging and, more recently, cone beam computed tomography (CBCT) imaging are of great value in identifying small osseous changes of the articular surfaces by producing sectional views through the joint free of distortion or superimposition of other bony structures. These imaging modalities are used to stage the degree of osseous change or degeneration but are not capable of identifying disc position or imaging joint effusion and inflammation (Figure 21.2a–c).

Direct imaging of soft tissue articular structures of the joints, using MRI,[18] has greatly enhanced the study of the TMJ and may be of use in understanding the pathophysiology of disc displacement.

A number of factors have been identified which have an influence on the development of the growing mandible. In particular, factors which may be classified as local environmental factors seem to have a great impact on condylar cartilage development. Factors such as local inflammation, trauma, and altered muscle function seem to reduce the contribution of the condyle to vertical development of the ramus.

**Pearl:** The literature agrees that the condylar cartilage is not a primary growth centre but rather an adaptive growth site which contributes to the vertical and sagittal development of the mandible.[28]

Numerous studies have concentrated on the condylar contribution to normal growth, while others have investigated factors that may be associated with altered condylar development.[29–31]

If disc displacement can be considered as an alteration in the local functional environment of the joint, then can disc displacement be associated with altered facial morphology in an adolescent sample?

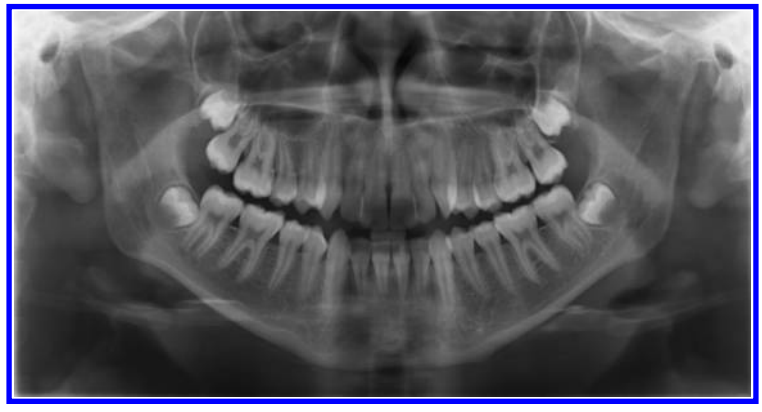

**Figure 21.1**

Panoramic radiograph depiction of the temporomandibular joint structures.

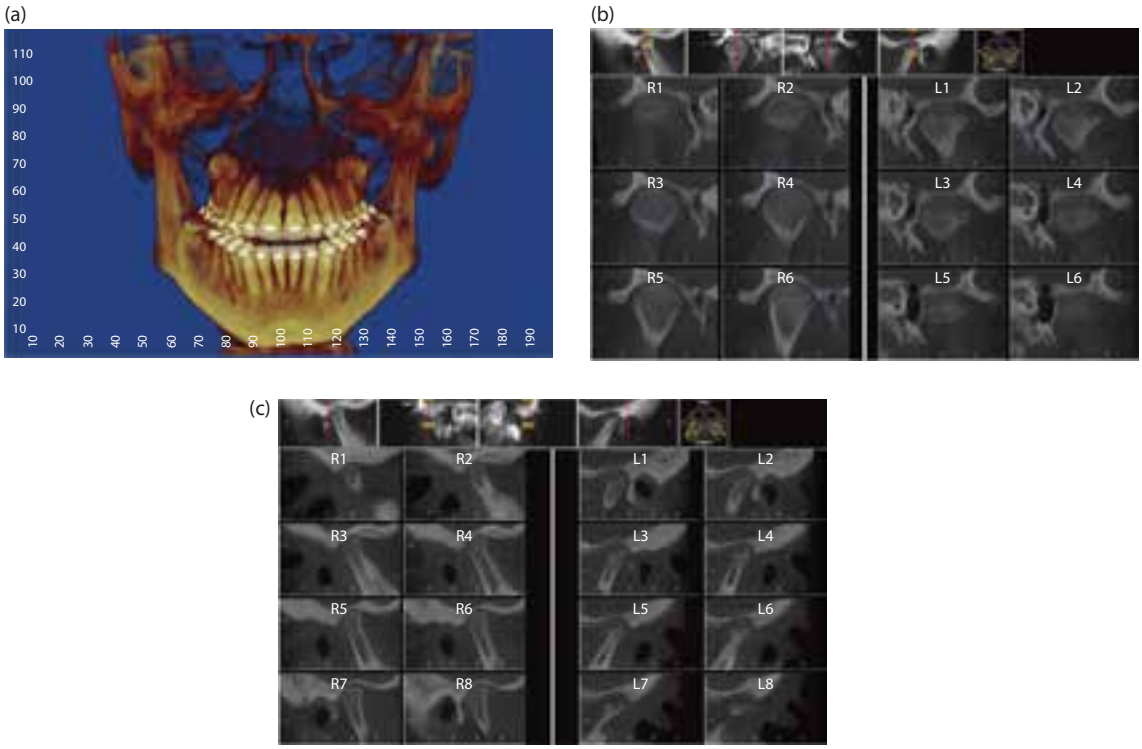


**Figure 21.2**

(a) Cone beam computed tomography, depicting volumetric image of the craniofacial region. (b) Formatted coronal images of the TMJs from volumetric imaging. (c) Formatted sagittal images of the TMJs from volumetric imaging.

A study was carried out at the University of Alberta (Canada), to determine whether associations exist between TMJ disc displacement and craniofacial morphology in an adolescent sample of 119 female subjects.[32]

The details of this study and other supporting work can be found in the listed references.[33–36] The significant findings of this body of work can be summarized as follows.

An increase in internal joint derangement was associated with

1. A decrease of mandibular ramus height, body length, a reduction in total posterior facial height, and an increase in gonial angle
2. An increase in mandibular plane angle
3. An increase in the inclination of the palatal plane in relation to the cranial base and mandibular plane, and a reduction in vertical height of maxillary molars to palatal plane
4. Less significantly, an overall reduction in size of the anterior and posterior cranial base regions together with a more acute cranial base angle as noted

These studies show associations between internal derangement of the TMJ and craniofacial morphology.

**Pearl:** In the growing patient, TMJ internal derangement might have a significant impact on maintaining the balance in facial proportions with time, thus impacting decisions regarding treatment. These individuals may not respond to normal growth modification and treatment if interceptive orthodontics is initiated. They may however benefit from treatment at a later stage when growth is complete and the full extent of the discrepancy between facial components can be determined.

Growth modification making use of functional appliances supposes that the TMJ is intact and functional. In Class II patients the mandible is advanced in an attempt to stimulate condylar proliferation, guide tooth eruption, and effect fossa remodelling.[37–40] The exact extent and mechanisms of change in the relationship of the mandible to the maxilla is highly controversial, but it has been claimed that functional appliances can change the direction, or stimulate mandibular growth. Anterior positioning of the condyle relative to the posterior slope of the articular eminence in a joint with disc displacement may contribute to further soft tissue damage and inflammation if the disc is not reduced with mandibular advancement. This procedure could interfere with the adaptive capacity of the retrodiscal tissues and result in condylar remodelling and a loss of condylar vertical height.

Adolescents are extremely adaptive, undergoing change in size and shape as they grow. In the facial region, the condyle and dentoalveolar regions are extremely adaptive growth sites.[41] Other regions are also constantly undergoing remodelling and growth. Muscle attachments are constantly adjusting to the growing face, while the functional environment develops.[42,43] Once growth is completed, relative stability is attained and tissues assume a lower level of cellular turnover for maintenance of structures. At this stage, if the regenerative capacity of tissues is exceeded by tissue breakdown, degenerative changes occur.[44,45] These changes are usually associated with an increased risk of development of signs and symptoms of TMJ internal derangement.

**Pearl:** The clinician should be aware that individuals experiencing TMJ internal derangement as adolescents may not present with significant signs and symptoms at an early age, but may convert to symptomatic patients once growth has ceased. Furthermore, the loss of condylar structure associated with the degenerative process may be interpreted as a relapse of orthodontic correction if treatment had been attempted at an earlier age. Symptoms of internal derangement may now erroneously be ascribed to the orthodontic treatment which was completed sometime prior to the onset of symptoms (Figure 21.3a and b).

Preorthodontic TMJ investigation of adults and adolescents should include:

1. Evaluation of quality and quantity of condylar movement, range of mouth opening, and deviation on mouth opening
2. Palpation of the capsular regions and masticatory musculature for indication of tenderness or symptoms
3. Detection of joint sounds associated with all condylar movements, loaded and unloaded
4. An evaluation of the malocclusion with special emphasis on lateral or anterior openbites and occlusal asymmetries
5. Evaluation of facial symmetry and vertical growth disturbance

Joint management essentials in adults and adolescents should include:

1. No management of joint sounds is indicated unless associated with pain or restricted condylar motion and mouth opening.
2. Habit and diet modification (avoid repetitive gum chewing) is implemented to control joint or muscle symptoms.
3. Restricted mouth opening and deviation on opening is treated by physical therapy for the guarded musculature and mobilization of the interfering displaced disc.
4. Capsular tenderness is managed with cold packs, and topical or systemic nonsteroidal anti-inflammatory medications (NSAIDs).
5. Night guard therapy is indicated only if symptoms do not improve with palliative care as implemented above, or if occlusal interferences produce ongoing muscle guarding.
6. Centric and eccentric bruxism can be treated with night guards to limit tissue and tooth damage.

**Pearl:** Joints that are refractory to conservative care should be imaged.

CBCT or MRI should be used to determine the joint status and further treatment needs.

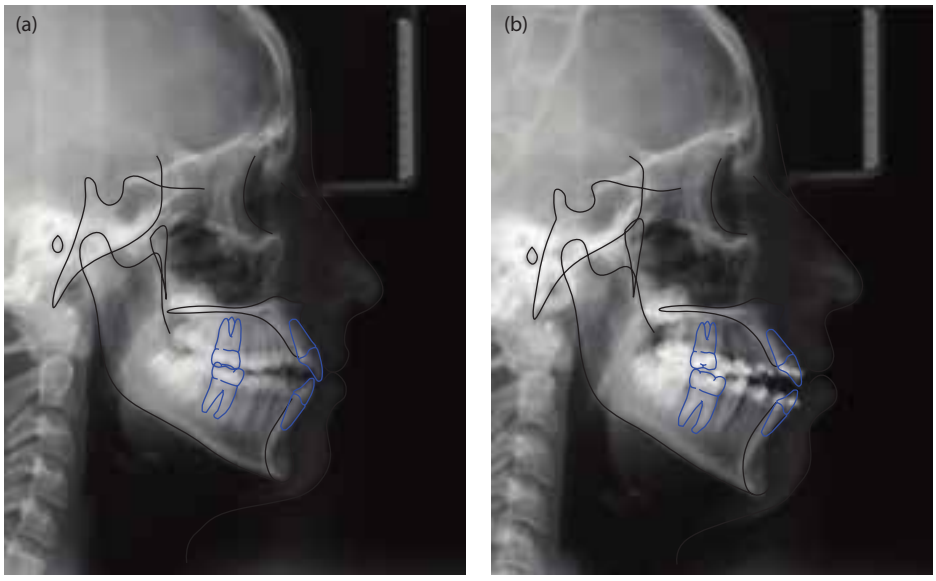


**Figure 21.3**

(a) Pretreatment lateral cephalogram and (b) mid-treatment lateral cephalogram depicting skeletal and dental changes associated with condylar remodelling occurring over a 12-month period.

CBCT is used to stage the degree of osseous remodelling and determine whether active osseous breakdown is occurring. MRI is used to determine disc dynamics and joint effusion when a disc displacement is suspected. Degenerative joint changes are treated with all of the palliative care modalities described above, as well as

1. Longer-term use of NSAIDs to manage inflammation.
2. Joint mobilization and physiotherapy as required.
3. Bone stabilizing pharmacology such as low dose tetracycline (doxycycline), Humira, or Enbrel is of great benefit.
4. Patients are also advised to ensure adequate vitamin C (1000 mg/day) and vitamin D (1000 iu/day) are being used as an antioxidant, and building blocks for cartilage and bone synthesis, respectively.
5. Systemic evaluation of females for low oestrogen, elevated prolactin, or hyperparathyroidism could be beneficial in individual with regressive condylar resorption. Excessive laxity of ligaments is usually an associated finding in these blond female individuals.

**Pearl:** Patients developing TMJ symptoms during orthodontic treatment should be thoroughly investigated to determine origin, onset, and history of symptoms. Determine precipitating, perpetuating, and ameliorating factors. Re-evaluate original records and history of preorthodontic joint symptoms. Assess for changes in occlusal relationships such as unilateral open bite, anterior openbite, or development of centric slides that are not occlusal in nature.

A panoramic radiograph may be used to screen for condylar asymmetry. CBCT imaging is ordered to rule out osseous change and establish treatment needs, whereas MRI can be used to determine dynamic disc position and joint inflammation.

Treatment of patients during fixed orthodontic care should include:

1. Conservative home care, habit modification, followed by short-term NSAIDs.
2. Discontinue night time intermaxillary elastics, if refractory; then stop all elastic wear.
3. Physical therapy and joint mobilization may be required.

4. Regressive osseous remodelling should be treated with removal of fixed orthodontic appliances and judicious use of a night guard and pharmacological intervention.
5. Condylar remodelling may be accelerated with night guard wear with resultant exacerbation of openbite malocclusions.
6. Aim to maintain condylar volume to reduce potential of developing a significant malocclusion.
7. No further orthodontic treatment should be attempted until CBCT imaging shows osseous sclerosis and end stage remodelling, usually after 18–30 months.
8. Surgical correction of severe malocclusions should not be attempted until sexual maturity, stabilization of hormones, and stabilization of osseous joint components has been determined.

In spite of the tremendous amount of research work, courses, and publications that have been and continue to be carried out on this subject, it remains an aspect of orthodontic treatment that concerns many orthodontists, to the extent that a number of clinicians will shy away from any form of TMJ treatment and will refer such cases to colleagues who they feel are more competent to treat such conditions.

I hope that this short chapter on TMJ dysfunction and disc displacement will help the clinician appreciate that the most important aspect of the approach to TMJ problems is to be able to recognize the onset and the development of the condition; once this is accomplished, each clinician, based on his/her philosophy and level of knowledge will either treat or refer for treatment.

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# 22 DETAILING THE FINAL OCCLUSION

Eliakim Mizrahi, Luc Dermaut, Richard N Carter and Ronald G Melville

CONTENTS



## 22.1 FINAL DETAILING OF THE OCCLUSION

Despite the sophisticated prescription appliances currently in common usage, there are minor adjustments that can be incorporated into the final stages of treatment, which contribute to improving the functional and aesthetic features of the final occlusion. Apart from clinical evaluation of the occlusion, it is at this stage that precompletion radiographs, dental panoramic tomograms and cephalographs need to be taken to assess root parallelism, anterior root torque, root resorption, alveolar bone status, position, and angulations of unerupted third molars and the possible development of any other anomalies. Radiographs taken at this stage still allow for the possible corrective procedures to be instituted as opposed to radiographs taken after the removal of appliances.

As you near the end of active treatment tell your patients, particularly adult patients, that as the treatment is approaching the final stages, you would like them to start checking their teeth periodically in the mirror and to make a note of any feature about which they are unhappy. They need to let you know at the next appointment before appliances are removed, not after they have been removed.

**Pearl:** The patient may see a feature or have a perception of their teeth of which you are unaware; it is far preferable to be in a position to correct this particular feature or perception prior to the removal of appliances.

Apart from the input given by your patient, there are a number of features you need to examine carefully as you approach the end of active treatment. As you examine the dentition it is a good idea to bear in mind Andrews' six keys of occlusion.[1]

### *22.1.1 Visual Aids*

Luc Dermaut

As an aid to final detailing of the occlusion, it helps to have an overall view of the entire dental arch. To get a better view of the dental arch use a large mouth mirror (No. 6) or the occlusal mirror used for intraoral photography.

Progress study models also help to identify errors and details that need to be corrected. Intraoral scanning together with the associated software provides a comprehensive view of the dentition from the labial and the lingual

aspect and allows you to visualize errors that need correcting.

## 22.2 ANTERIOR SEGMENTS

From the patient's point of view, the aesthetic component of the final occlusion is of greater significance than the functional component. However, it is incumbent on you, the clinician, to also evaluate and correct the functional component.

### *22.2.1 Angulation of Anterior Teeth*

The centrals, laterals, and canine teeth should all have a mesial tip. While this feature may be built into the bracket prescription, it is possible that an incorrect placement of the bracket at the initial strap-up will only start to express itself as an incorrect tip when the final archwires fully express the bracket prescription. It is a common fault to leave the lower lateral incisors either upright or with a distal tip. If there is a problem with tooth angulation it may be corrected by

- Repositioning the bracket and correcting for tip
- Placing corrective bends in the archwire
- Using an uprighting auxiliary

### *22.2.2 Alignment of Incisal Edges*

Look carefully at the incisal edges, check for chipped or excessively worn incisal edges. Marked incisal mamelons may also be aesthetically unacceptable.

I have found over the years that dentists are reluctant to carry out minor aesthetic restorative work while fixed appliances are still in the mouth. It is far easier and efficient for me to use flowable composite and correct the problem in a few minutes. It is important to explain to the patient/parent, that what I am about to do must be considered only as a temporary solution, the final restorative procedure will be completed by their dentist after removal of all appliances.

The advantage of this approach is that you as the clinician and the patient get a better overall view of the projected final aesthetics and position of the incisal edges. Furthermore, thermoplastic retainers will still fit after the dentist replaces the flowable composite with a more durable restoration at the end of orthodontic treatment (Figure 22.1a–d).

The incisal edges of the four maxillary incisor teeth should be in the same horizontal plane or the lateral incisors slightly palatal to the central incisors; in the vertical plane, the maxillary lateral incisal edges should be 0.5 mm (0.2 inch) shorter than the central incisors. This arrangement contributes to a more youthful smile – placing the four maxillary incisors at the same vertical level ages the smile. When the patient smiles the incisal edges of the maxillary anterior teeth should curve and follow the smile line of the lower lip (see Chapter 18).

Check the horizontal cant of the occlusal plane, ask the patient to close on a flat tongue depressor (flat wooden blade) held across the front of the mouth. Check the level with the rest of the face with particular reference to the interpupillary line.

Correcting the levels of the incisal edges can be done by

- Repositioning the brackets to correct for vertical height discrepancies.
- Adjusting the archwires using vertical offset second order bands.
- Selective grinding of the incisal edges with a mounted stone or diamond burr. Minor artistic grinding or reshaping of the incisal edges, particularly the mesial and distal incisal angles, can make a tremendous difference to the final smile. If you use a slow handpiece, then support the tooth with finger pressure to reduce the sensation of vibration.
- Aesthetic composite bonding can also mask certain anatomical deficiencies. You have the choice of either carrying out this procedure yourself or requesting the patient's dentist to do the aesthetic bonding according to your prescription.

**Figure 22.1**

(a) Approaching the end of treatment. Incisal edges irregular and in need of slight lengthening. (b) Isolate, pumice, wash, etch, wash, and dry. (c) Flowable composite added to the incisal edges of the central incisors, archwire adjusted to correct incisal levels. (d) Improved anterior aesthetics prior to completion of orthodontic treatment.

### *22.2.3 Recontouring Technique*

Richard N Carter

In my adult practice, I reshape and make slender some teeth on virtually all patients.[2] I have found a thin, double-sided diamond disc can be bent slightly to contour the teeth, not just flatten them. The procedure is fast, painless, clean, and simple. It can be done at any stage of treatment. Remove the archwire first.

With a flexible disc it is easier to round the incisal edges than using a burr, a flame-shaped diamond, or a wheel. After any recontouring, polish with an abrasive-impregnated wheel. These wheels are very soft and will last for only a few teeth, but this softness is the secret for attaining a beautiful, smooth surface while removing a minimum of enamel.

### *22.2.4 Torque of Anterior Teeth*

Check for expression of the correct torque for all the anterior teeth. Examine the anterior crowns from the front and the side. It is also helpful to examine the maxillary teeth from the palatal aspect and the mandibular incisors from the lingual aspect.

**Pearl:** Look at the palatal and lingual gingival margins; uneven torque will show up clearly.

Inadequate labial root torque of initially palatally displaced maxillary lateral incisors will become more obvious when the palatal aspect is examined. Surgically exposed impacted maxillary canine teeth also need to be evaluated for adequate labial root torque. Uneven

torque between central incisors may be due to abnormal crown anatomy or failure to seat the bracket flat on to the labial surface at the time of the initial bonding. Uneven or inadequate torque can be corrected by

1. Repositioning the bracket
2. Incorporating torque adjustments into the archwire or by using individual or multiple, palatal or labial torquing auxiliaries (see Chapters 14 and 15)

### 22.2.5 Rotations of Anterior Teeth

Rotations are notorious for their relapse tendency.

**Pearl:** It is advisable for all rotations to be corrected to ideal or slightly overcorrected positions in the early stages of treatment. The longer the rotated teeth are held in the correct position, the greater the chances of stability.

If you correct a rotation just before the end of treatment, there is a good chance that this will relapse very quickly after the removal of appliances. Irrespective of how good your memory is, you cannot recall the original position of the teeth. Therefore, to assess whether all rotations have been correctly managed, it is essential to have either the original study models or clinical photographs at hand or on the computer screen.

**Pearl:** The mesiolabial rotations of maxillary lateral incisors in Class II division 2 malocclusions should be slightly overcorrected; they relapse very easily.

Rotations can be corrected by

- Incorporating mild artistic palatal offsets into your final archwire. Maxillary lateral incisors should generally be fractionally more palatally placed than the central incisors.
- Offset the bracket base on the tooth surface either at the time of initial bonding or as a corrective measure during treatment. To create a predictable base offset, spot-weld a small piece of 0.356 mm (0.014 inch) wire to the mesh base at either the mesial or distal edge of the bracket base as the case requires.
- Rotation wedges are fairly efficient on flat surfaced teeth but not on curved canine and premolar teeth.
- If the brackets incorporate vertical slots, clockwise or counterclockwise rotation springs are efficient; they may be made in-house or purchased commercially (see Chapter 15).

### 22.2.6 Facial and Dental Centre-Lines

Check the maxillary and mandibular centrelines. They should be coincident with each other and with the facial centre-line. Centre-line discrepancies may be due to many dental or skeletal factors and in certain cases accepting a centre-line discrepancy may be unavoidable.

**Pearl:** However, if you planned for the centrelines to be coincident, then it is essential to see that this has been achieved some time prior to completion before all available space has been closed.

If the centre-line needs to be corrected as you approach the end of treatment, then this can only be achieved by

- Mild tooth tipping of selected teeth in one or both arches. If the correction requires bodily tooth movement, then this should have been carried out earlier on in treatment.
- The use of anterior diagonal elastics as well as unilateral Class II or Class III elastics can achieve mild tipping. Or if your brackets incorporate vertical slots, unilateral uprighting springs will assist in tipping teeth and correcting centre-line discrepancies.

Whatever method you choose, if you want the teeth to tip at this late stage you will need to reduce archwire thickness; with full thickness archwire engagement, the teeth will not tip.

It is assumed that overjet and overbite have been adequately corrected with due regard to the original malocclusion. The overbite should provide adequate incisal guidance and posterior disocclusion on mandibular protrusion.

### *22.2.7 Closing a Small Diastema*

Ronald G Melville

If a patient has been scheduled for removal of appliances and you notice that there is still a small midline diastema (Figure 22.2a), you are faced with three choices:

1. Both you and the patient accept the space and all appliances are removed.
2. *Or* the two central incisors are tied with an elastomeric thread and a new appointment is scheduled for the removal of appliances.
3. *Or* take two lengths of band material (stainless steel tape) folded over two or three times and force it between the centrals and the lateral incisors on each side. This will close a diastema of about 0.50 mm (0.02 inch) instantly. A fixed palatal retainer can be bonded to hold the central incisors together. The lateral incisors 'spring back' so no gaps are left between them and the central incisors (Figure 22.2b and c).

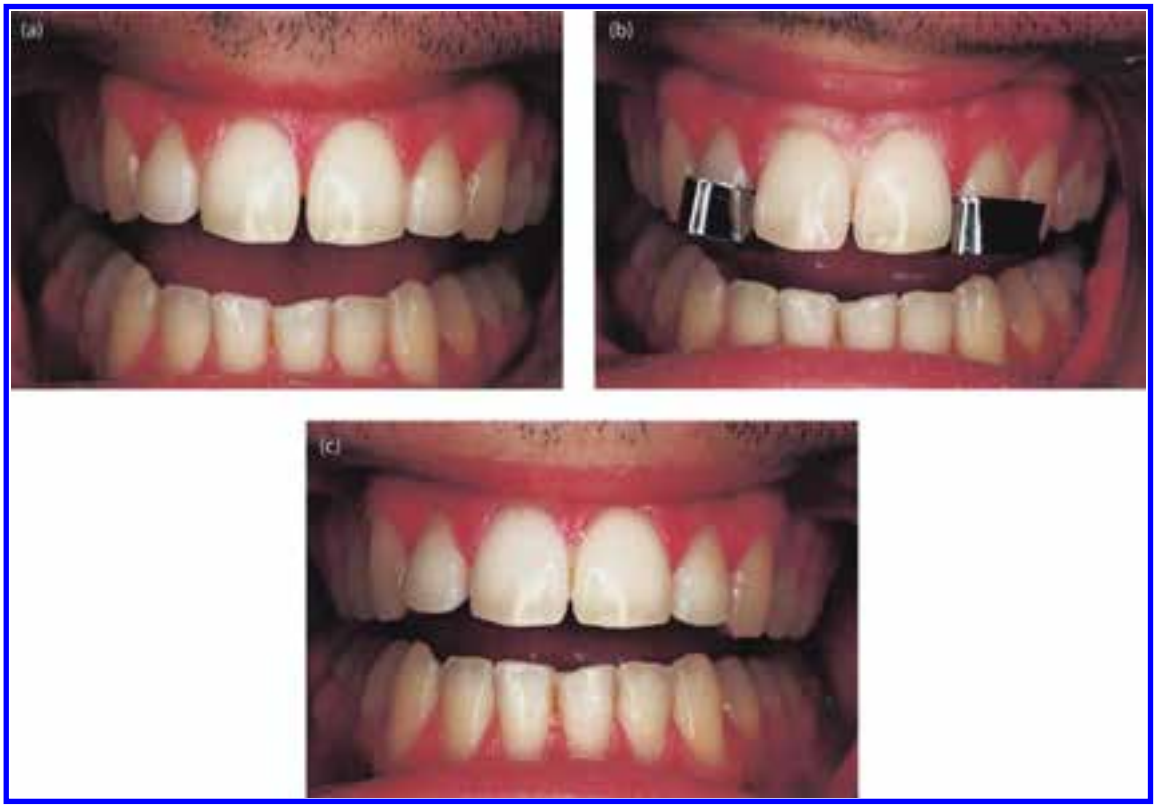


**Figure 22.2**

(a) Small residual midline diastema. (b) Stainless steel band material (tape) placed as a wedge between the central and lateral incisors, note the closure of the diastema. (c) The wedges are removed after placing a lingual retainer to hold the central incisors, the lateral incisors move back into contact with the central incisors.

## 22.3 POSTERIOR SEGMENTS

When evaluating the posterior segments, it is incumbent on you, the clinician, to examine and correct the details of the buccal occlusion irrespective of the patient's perceptions regarding their significance. Patients generally are not too concerned about the aesthetic or functional features of the buccal occlusion.

### *22.3.1 Root Parallelism*

Check to see that all the buccal teeth are upright and the roots are parallel, particularly on either side of an extraction site.

**Pearl:** In second premolar extraction cases, special attention needs to be paid to uprighting distally tipped first premolars and mesially tipped first molars.

Failure to achieve this parallelism will be due to incorrect bracket placement or failure to reach full thickness archwire engagement in relation to bracket slot size. Correct this fault by

- Repositioning the relevant brackets and introducing the correct tip.
- Rebending the archwire placing corrective second order bends.
- If the brackets incorporate vertical slots, place the correct uprighting or sidewinder springs.

If molar teeth have been moved distally as part of the original treatment plan, check to see that they are not left with a distal crown tip. Distal molar tip, particularly of the maxillary molars, will relapse and what looked like a Class I molar occlusion will relapse to a cusp-to-cusp Class II relationship. Molar teeth can also finish with either a mesial or distal tip due to poor initial buccal tube placement. Try to seat the distobuccal cusp of the maxillary first molar down into the embrasure between the mandibular first and second molars.[1] To correct poorly tipped molars, it will be necessary to

- Place corrective second order bends in the archwire.
- Reposition the buccal tubes. The maxillary first molar will have a slight mesial crown tip. If the case finishes with a Class II molar relationship, the maxillary first molar will need to be more upright.

### *22.3.2 Premolar Rotations*

These rotations should be carefully checked in relation to the original malocclusion; rotations should be slightly over-corrected. Conventional bands on premolars generally incorporate buccal brackets and lingual buttons; this arrangement makes it easy to rotate premolars, using palatal and buccal elastomeric threads. The presence of a lingual button on a premolar tooth also provides the facility for a lingual ligature tie, which can be used to hold the rotation throughout treatment. With the current replacement of conventional bands by brackets bonded only to the buccal surface, correcting rotations becomes more difficult and unfortunately in certain cases, may be overlooked.

**Pearl:** Poor initial bracket placement will also lead to poor rotation control.

If detected, rotations can be corrected before finishing by

- Repositioning the bracket to aid in overcorrection if desired
- Bonding a lingual button and placing elastomeric threads to create a rotational couple
- Use clockwise or counterclockwise rotating springs if vertical slots are present
- Although not very efficient on curved teeth, rotation wedges can assist

### *22.3.3 Molar Rotations*

At the end of treatment maxillary first molars should exhibit a mild mesiobuccal rotation.

**Pearl:** Unfortunately, it is not uncommon in an extraction case or in a case exhibiting initial generalized spacing, for the molars to exhibit some mesio-palatal rotation due to the action of buccal space closing mechanics.

Undesirable molar rotation can also occur as a result of using molar tubes with no distal offset, or placing the buccal tubes either too far mesially or distally. To correct the rotation of the molars:

- Final space closing should be carried out using an elastomeric chain or thread from a palatal cleat or button on the molar to a hook on the main archwire placed between the canine and lateral incisor.
- If necessary, reposition the buccal tube, or replace it with a tube having the correct distal offset; this will vary with the appliance prescription.
- It is also possible to correct molar rotations by placing toe-in or toe-out bends in the main archwire.

Lower molars should exhibit no rotation and should finish with the buccal cusps lined up with the premolars and the second molars.

### 22.3.4 Premolar and Molar Torque

Finishing off with full thickness archwires should express the predetermined torque as designated by the prescription brackets and appliance of your choice. Failure to achieve the correct torque may be the result of incorrect bracket placement, anatomical variation in crown shape, or failure to match archwire size with bracket slot size.

**Pearl:** Carefully examine the buccolingual inclination of the teeth, particularly the palatal cusps of the maxillary molars; they tend to 'hang down' if there is inadequate buccal root torque. Check for excessive buccal root torque of the lower molars, the lingual cusps may be positioned too far below the level of the buccal cusps.

To correct errors in torque

- Place adjusting torque in the main archwire
- Reposition the bracket or buccal tube
- If the brackets have vertical slots, an individual tooth-torquing auxiliary may be placed on any premolar or molar tooth (see Chapter 14)

### 22.3.5 Marginal Ridge Heights

It is good practice to check that the marginal ridge heights of adjacent teeth are correct and match up with each other. Inadequate matching of marginal ridge heights will result in poor intercuspation and poor occlusion. Extrusion of one or more teeth above the occlusal level of adjacent teeth may lead to cuspal interference. Marginal ridge discrepancies are a result of incorrect bracket heights. The most common site for bracket height errors to occur is in the region of the second premolars and is due to either incomplete tooth eruption at the time of bonding or due to poor access or visibility in the presence of hypertonic buccal musculature interfering with accurate bracket placement. Marginal height levels can be corrected by

- Repositioning the bracket.
- Placing compensating vertical offset bends in the main archwire.
- Using vertical intraoral elastics either from single opposing teeth or multiple teeth. The vertical elastic will not override the main archwire, although, it will complement the action of a vertical offset bend. These elastics are more effective if the archwire is sectioned between adjacent teeth that need vertical movement. As an alternative to sectioning the archwire, replace it with a dead soft arch made by twisting two strands of 0.254 mm (0.010 inch) dead soft stainless steel ligature wire as described by Binder and Scott.[3] Pay careful attention to the direction of pull or force vectors of the vertical elastics. If, for example, you require vertical eruption of a maxillary canine, then use triangular elastic from the maxillary canine to the mandibular canine and first premolar; if you require some slight Class II correction as well as vertical eruption, then use angulated vertical elastic from the maxillary canine to the mandibular first premolar.

Where it is necessary to extrude a tooth on which the bracket cannot be moved further gingivally, scale back to a 0.406 mm (0.016 inch) or 0.457 mm (0.018 inch) nickel-titanium wire and place the archwire under the gingival tie

wing of the bracket; tie the archwire to the bracket to prevent it slipping out. This will extrude the tooth at least 1 mm.

The use of 'W'-elastic as described originally by Wick Alexander is very useful and effective in improving overall inter-cuspation.[4] As an example, in a Class II division 1 extraction case, using a large 1.88 cm (3/4 inch) elastic, start by hooking it on to the buccal hook of the first maxillary molar then taking both strands of the elastic hook it in a zig-zag fashion down to the mandibular molar, up to the maxillary premolar down to the mandibular premolar, and finish up at the maxillary canine. Either the maxillary or the mandibular or even both main archwires need to be sectioned distal to the canine teeth. In a Class II malocclusion, the elastics finish off at the maxillary canines with a Class II directional pull. In a Class III case, the elastic should finish off at the mandibular canine with a Class III directional pull.

## 22.4 FUNCTIONAL EVALUATION

Prior to the removal of appliances, it is essential to evaluate the occlusion in function. Check the occlusion in lateral excursions and forward excursion. Look for cuspal interferences; generally the main culprits are the palatal cusps of the maxillary second molars hanging down too low below the level of the buccal cusps. This interference may be eliminated by

- Judicious occlusal grinding of the offending cusps
- Introducing further buccal root torque of the offending tooth, generally the second maxillary molar

The teaching in most schools favours the establishment of canine guidance or a 'canine-protected' occlusion. However, there is still much debate concerning the long-term benefits of both canine-protected occlusion and group-function occlusion. Many believe that what may start off as a canine-protected occlusion in a young patient, will with age, develop into a group-function occlusion. If you aim to finish off with canine guidance, then the bracket heights on the canine teeth need to be placed about 0.5 mm (0.02 inch) higher than the premolars and central incisors. The final position of the canine teeth can be further adjusted by placing vertical offsets in the archwire or with vertical elastics. To check for canine guidance or canine protection, ask the patient to slowly slide the mandible to one side. Then, when they disocclude on the canine, ask them to gently tap up and down on the canine cusp tip, and ask them to the try and feel if any other teeth are making contact. Use articulating paper to assist and confirm the presence or absence of cuspal interference in lateral excursions.

Excursions in the sagittal plane should exhibit incisal guidance with complete disocclusion of the posterior teeth. While deep overbite cases are notorious for their relapse tendency, it is necessary to avoid the temptation to finish off the case with no overbite and no anterior incisal guidance. An overbite covering one third of the lower incisors can be established by reducing the curve of Spee in the maxillary archwire and increasing it in the mandibular archwire; this can be further supplemented with anterior vertical elastics.

Establishing incisal guidance in anterior openbite cases remains an intractable problem dependent on the degree of skeletal contribution to the aetiology. In many cases, orthodontic treatment alone without surgical intervention cannot satisfactorily treat this type of malocclusion.

Removal of bonded brackets is a routine procedure that has been well documented over many years. However, with the increasing number of adult patients receiving orthodontic treatment, two issues need to be emphasized. Firstly, a greater number of anterior teeth are being bonded with porcelain brackets and the risk of creating or widening existing micro cracks has increased. A study by Dumbryte et al. has shown that even debonding metal brackets can create new and widen old enamel microcracks.[5] Secondly, any scratches produced by debonding burrs on the labial surface of anterior teeth are easily noticed by adult patients. I have found it safer to remove residual composite on the labial surface of anterior teeth with sandpaper discs starting with a medium or coarse grit and finishing off with

the finest grade grit to produce a highly polished enamel surface.

## 22.5 FINAL RECORDS

It is essential that final records including study models and photographs are made at the end of treatment. As stated previously, radiographs should have been taken some time prior to the completion of treatment.

Following removal of appliances impressions are taken for retainers and duplicated for final study models. Final study models are essential for a number of reasons

- As a medicolegal aid. Final study models will assist in the defence against any claims related to the treatment and the final occlusion.
- Patients who fail to wear their retainers cannot claim that the teeth were not well aligned at the conclusion of treatment. Patients have poor memories.
- A comparison of before and after study models impresses patients and helps to enhance your reputation.
- As a possible requirement by a third party payer.
- As a teaching aid for yourself, close examination of study models may reveal deficiencies and inadequacies that you did not pick up on clinical examination. Such evaluations help to continually raise your own standards.
- As a teaching aid for students. If you are involved in orthodontic teaching either at graduate or postgraduate level, before and after study models are essential for case discussions with students.

### *22.5.1 Final Photographs*

Ronald G Melville

Apart from final study models, intra- and extraoral photographs should be taken. I duplicate all photographs routinely, so that I have a full set for myself and I give one set to the patient on completion of treatment.

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# 23 REMOVABLE APPLIANCES

Eliakim Mizrahi, Matie Grobler, Luc Dermaut,
Robert A Katz, Ronald G Melville and John J Sheridan

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## 23.1 REMOVABLE APPLIANCE DESIGN FEATURES

A removable orthodontic appliance may be defined as an appliance that can be inserted and removed from the mouth, at will, by the patient.

**Pearl:** By virtue of this definition it follows that the success or failure of removable appliance therapy is dependent to a very large extent on the full participation and compliance of the patient. To this end, it is essential that the design and construction of the appliance should assist in maximizing patient cooperation.

The design of removable appliances is open to many variations and modifications as required by different malocclusions as well as the preferences of different clinicians. However, excluding the design factors that are dictated by a specific malocclusion, there are certain general principles that need to be borne in mind when designing any removable appliance.

### *23.1.1 Patient Comfort*

If the appliance is uncomfortable the patient will have an excuse to take it out of the mouth. The appliance should be smooth, well polished, and have no protruding sharp wires.

### *23.1.2 Simplicity*

The patient should be able to remove and insert the appliance easily. Keep the design simple; do not try to do too much with one appliance; limit the active components of the appliance to two finger springs. If the patient finds difficulty in inserting an appliance, either because it is too tight or there are too many active components, they will tend to leave it out.

### 23.1.3 Retention

It is essential that the appliance be well retained. Make sure there is adequate retention with particular regard to the sites where there are active components, such as finger springs. Select the correct clasp design and wire size to maximize retention on specific teeth.

### 23.1.4 Strength

The risk of breakage while in the mouth should be minimized. The acrylic base should have adequate thickness and should not be unduly weakened by the wire components. Gentle handling of the wire during construction can reduce the risk of breakage. If you are making the appliance in-house, do not forget that stainless steel becomes work-hardened with repeated bending. Be accurate in the placement of bends; discard and start afresh rather than correcting an inaccurate bend.

### 23.1.5 Oral Hygiene

Removable appliances can cover a large area of the mouth. It is essential that they are kept clean and debris is not allowed to accumulate and remain between the appliance and the oral tissues. The design should contribute to easy cleaning by eliminating boxed-in areas where debris collects and is difficult to dislodge.

### 23.1.6 Aesthetics

This is generally not a problem. However, in certain cases with very self-conscious patients, if cooperation can be enhanced by the removal of a labial bow, then this should be considered in the original design.

### 23.1.7 Limitations of Tooth Movement

Design factors related to a specific malocclusion need to be determined after careful study of the malocclusion and should be related to an overall treatment plan.

**Pearl:** Of the five possible tooth movements namely, tipping, rotation, bodily movement, extrusion and intrusion, removable appliances are efficient only in tipping a tooth.

While it may be possible to design a removable appliance to execute some of the other tooth movements, generally, for those tooth movements, fixed appliances are more efficient.

## 23.2 REMOVABLE APPLIANCES

Matie Grobler

Patients should be instructed not to remove a removable appliance for eating, for if they do, they will invariably lose or break the appliance. Never wrap the appliance in a tissue or napkin; it will probably be thrown away.

Allow at least one or two weeks for a removable appliance to settle in before activating any finger springs.

## 23.3 FITTING AND ADAPTING REMOVABLE APPLIANCES

Luc Dermaut

When fitting a removable appliance, if it does not fit well, first deactivate all clasps then check to see if the acrylic base is the cause of the problem. When you have corrected the acrylic fault, then activate one clasp at a time until the appliance fits well and stays in place.

When using finger springs to move teeth mesially or distally, make sure that the springs lie against the mesial or distal surface of the teeth near the gingival margin. It is important to check that active springs do not slip on to the occlusal surface of the teeth.

If active finger springs dislodge the appliance, deactivate them and then gradually increase the activation. Thus, activate finger springs gradually and see the patient more frequently.

## 23.4 ENHANCED RETENTION FOR REMOVABLE APPLIANCES

Robert A Katz

Retention of a removable appliance in young dentition can be a problem. To enhance retention, I have found it helpful to place a small 'button' (1–2 mm, 0.04–0.08 inches) of composite on to the buccal surface of one or more primary teeth. A suitable clasp (C-clasp) can then be hooked above the composite to aid in retention. This method can also be used with functional appliance treatment in the mixed dentition when retention of the removable appliance is a problem (Figure 23.1).

## 23.5 RETENTION FOR REMOVABLE APPLIANCES

Ronald G Melville

Retention is vital if you expect the patient to wear the appliance. In this respect placing Adams clasps on anterior teeth is very helpful. When moving an upper incisor over the bite, clasp one of the other incisors to prevent the appliance from displacing downwards when activating the palatal spring. A modified arrowhead clasp can be used as a clasp between maxillary incisor teeth.[1]

Avoid using removable appliances for expansion in the deciduous or mixed dentition stages because of the difficulty of obtaining good retention. Rather, use a fixed 'Rapid Expansion' appliance, banding only the maxillary second deciduous molars.

Removable appliances with wraparound labial bows have the advantage of eliminating occlusal interference produced by conventional clasps as they traverse the embrasure areas. Unfortunately, the retention of wraparound appliances is often reduced due to the absence of clasps. Retention of such removable appliances may be enhanced by a modification of the labial bow.[2] Locks et al. describe a technique whereby they use a wraparound 0.813 mm (0.032 inch) labial bow fitted accurately to the buccal contour of the premolar teeth.[2] In this region small vertical posts are spot-welded to the labial bow to assist in the retention of acrylic resin applied over the labial bow to fit the contour of the premolar teeth. They maintain that the heavy labial bow together with the acrylic coverage of the buccal surface of the premolar teeth enhances retention of the appliance.

**Figure 23.1**

Composite material placed as a mound on the first deciduous molar to enhance retention of the C-clasp.

## 23.6 THE ESSIX APPLIANCE MODIFIED FOR TOOTH MOVEMENT

John J Sheridan

The Essix appliance was first introduced in 1993.[3] It is a plastic removable device that snaps over the teeth and, for all practical purposes, is invisible (Figure 23.2).

Additionally, it is inexpensive, quickly fabricated in the office, has minimal bulk, high strength, and does not interfere with speech. It is retentive without clasps, usually requires no adjustment, does not interfere with function, and has little, if any, influence on the efficiency of the occlusion when the patient follows the proper schedule of wear. For instance, when an Essix appliance is used for

**Figure 23.2**

An Essix appliance is an efficient retainer and can be modified for selective tooth movement.

orthodontic retention, data indicate that it is as efficient as bonded wire or Hawley-type appliances.[4–6] Therefore, it makes professional sense to become familiar with the applications of an appliance that offers so many advantages.

Delivering a satisfactory Essix appliance is directly correlated with arch preparation, impression technique, cast construction, and associated materials.

**Pearl:** The fabrication of a working cast should be done with the precision applied to crown and bridge standards.

A restorative dentist would not conceive of taking an alginate impression for a bridge in a nonrigid tray and pouring it with stone that has been in an open bin absorbing humidity. The fit of the resultant restoration would be compromised because a precision impression is necessary for an accurate cast. The detailed cast is, in turn, necessary to fabricate the well-fitting appliance.

Sheridan's First Law of Biomechanics states that Force + Space + Time = Tooth Movement, and this law must be observed with Essix mechanics. There must be adequate *force* to move a tooth without inducing pathology; there must be enough *space* to accomplish the desired tooth movement; and there must be an appropriate length of *time* for the patient to wear the appliance for the induced force to be effective.

The clinician can control two out of three of these essential prerequisites, force and space. However, as with any dynamic removable appliance, the patient must provide the third essential, time. The patient must wear the appliance as directed by the clinician who can, in turn, create and direct the force within the appliance.

**Pearl:** Therefore, the target populations who are most eligible for tooth movement with an Essix appliance are adults and responsible adolescents because cooperation is mandatory and this population will usually use the appliance as directed.

The Essix tooth-moving system is centred on the clinician modifying the appliance during the course of treatment when it is necessary to make in-course corrections. The clinician constantly modifies conventional fixed appliances because of the multiple variables that arise during treatment. That can also be done with Essix clear plastic appliances. The Essix system has these specific advantages:

- The clinician can precisely apply and incrementally augment force as the case progresses.
- The clinician can quickly and precisely modify the initial appliance at the chairside.
- The appliance is practically invisible, and patient acceptance is usually enthusiastic.
- Fabrication is a fraction of the cost of multiple laboratory-fabricated appliances.
- The appliance is most efficient in tooth tipping. However, to a limited degree, tooth movement is possible in all three planes of space.

When using the Essix appliance, you must remember that as a full coverage appliance, fluids will accumulate and stagnate in the space between the plastic and the enamel surface. If these fluids are acidic (carbonated beverages) then there is a high risk of enamel decalcification occurring.[7]

### 23.6.1 Gaining Space to Move Teeth into

If at all possible, I avoid extractions or expansion on adults. I find that mild-to-moderate crowding is best resolved by gaining space with interproximal reduction with the air-rotor stripping technique.[8,9] This works well in conjunction with clear plastic appliances, especially if the anterior crowding, the usual chief complaint, is mild-to-moderate and evenly dispersed throughout the incisors.

### 23.6.2 Generating Tooth Moving Force by Mounding

Treatment results can be obtained with one or, at most, a few appliances that can be fabricated and adjusted in-house with routine laboratory procedures, with minimal cast modification, with minimal expense, and very little chair time.

The original article on the Essix tooth-moving appliance described cutting a window in the clear plastic appliance to provide space for the target tooth to move into, and placing a force-inducing divot (bump) in the plastic appliance with an instrument heated to a specific thermoforming temperature (Figure 23.3).

**Figure 23.3**

The bump in the labial plastic will induce lingual tooth movement when the appliance is seated. The window cut into the lingual of the appliance will afford the necessary space.

The same bump could be made sequentially deeper to induce additional tooth movement at subsequent visits. However, as the divot was made deeper the plastic became thinner and the force-inducing bump could collapse.

An equally efficient method of inducing a force on the tooth is to turn the concept around and rather than placing a projection in the plastic appliance, place a projection on the enamel surface of the target tooth by adding a small mound (1.0 mm thick, 0.04 inch) of light-cured bonding composite to the enamel surface. This involves negligible chair time with light-cured composite. When the appliance, fabricated from the unmodified working cast, is seated, the resiliency of the plastic will create a tooth moving pressure due to the composite mound on the enamel surface that is interfering with the plastic returning to its resting shape. The mound can be sequentially built up, 1.0 mm (0.04 inch) at a time, during the patient's periodic visits, and with each additional composite layer, the mound becomes increasingly sturdier (Figure 23.4).

Also, the mound can be placed anywhere on the crown to affect different tooth movements: more incisally for tipping, gingivally for more bodily movement, and to the left or right of the midpoint to change the vertical axis of rotation.

When the appliance is seated, use the patient's input to evaluate the induced force by simply asking if the patient feels pressure on the target tooth. If so, then schedule the next appointment. If not, add an additional thickness of composite until pressure is apparent. If the thickness of the mound is excessive and the appliance cannot seat correctly, remove a slight amount with a sandpaper disc mounted in a handpiece.

The adult or responsible adolescent patient should be seen every two to three weeks; this time span is more than adequate to induce additional tooth movement. Six to eight week intervals between appointments extends the treatment time and are at odds with my 'adult chief complaint' treatment philosophy. I want to treat adults rapidly, consistent with the resolution of the patient's chief complaint and quality of occlusion.

The concept of retaining and moving teeth with Essix appliances has gained wide

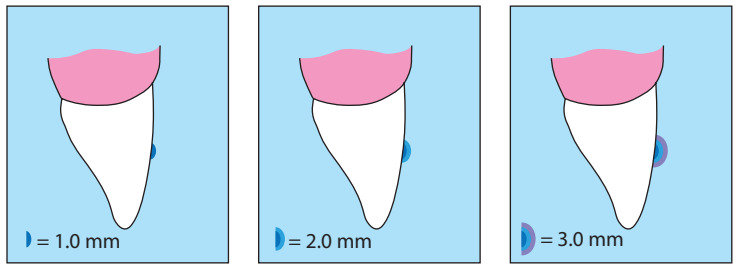


**Figure 23.4**

The mound of composite on the labial of the tooth can be built up to move the tooth 1 mm (0.04 inch) at a time at subsequent visits. The resiliency of the plastic returning to its resting state will induce tooth movement. It is still necessary to cut a window into the lingual of the appliance.

acceptance. It is incumbent on the professionally competent clinician to be familiar with the fabrication and application of these appliances.

A publication by Rinchuse et al. indicates that it is possible to use elastic traction in combination with upper and lower Essix appliances.[10] The prerequisite for this form of traction is enhanced retention of the appliance; this can be achieved either by placing undercuts in the dental cast prior to forming the appliance or by using thermopliers to increase retention in the interproximal areas. Elastics are attached by placing a 'Rinchuse Slit' at specific locations depending on the elastic traction required. Using scissors, cut a slit into the gingival margin of the appliance: for Class II traction this would be in the region of the mandibular molars and maxillary canines and the opposite for Class III traction. The elastics are hooked into the slit.

A neat technique for extruding a maxillary incisor using a combination of a composite button bonded to the labial surface and a thermoformed appliance is well described and illustrated by Pithon et al.[11] Essentially, three buttons are bonded, one at the cervical third of tooth needing extrusion, and two to the thermoplastic appliance, one on either side of the tooth in question but closer to the incisal region. The section of the appliance covering the tooth to be extruded is cut away, and an elastic or elastomeric chain is stretched across the three buttons, The discrepancy in height of the buttons will create an extrusive force on the tooth in question.

Thermoplastic appliances, whether used as active appliances or passive retainers, should be kept very clean. Recent studies have shown that these appliances might have a positive effect on *Streptococcus mutans* and *Lactobacillus* colonization on dental surfaces.[12,13] These patients should be advised to take extra care with their dental hygiene during treatment and retention with thermoplastic retainers.

## 23.7 INVISALIGN APPLIANCES

Clearly the development Invisalign technology (Align Technology, Inc., www.aligntech.com) has taken the concept of thermoplastic appliances to a different level. Its general acceptance by orthodontists, general dentists, and the public is testament to its success. It is beyond the scope of this chapter to report on all the literature, data, and clinical innovations that are available. However, it is important to understand that to use this appliance efficiently, certain concepts should be borne in mind:

- Irrespective of the appliance, diagnosis and treatment planning should follow the well-established principles governing all orthodontic treatment.
- This appliance is aesthetically very appealing to patients.
- Success with Invisalign is very dependent on patient compliance.
- Like most removable appliances, it is efficient for tipping teeth.

- It is efficient for the alignment of teeth, particularly anterior teeth.
- It is not efficient for bodily tooth movement, rotation of canines and premolars, and vertical tooth movements. A number of modifications in the form of attachments to the teeth have been developed by the manufacturers to enhance these tooth movements. However, there are clinicians who have raised their level of expertise in the use of Invisalign appliances and I believe they can achieve results that are considered excellent.
- It is not efficient for root torquing; once again the manufacturers have developed a modification, the Power Ridge, to enhance this form of root movement.[14]
- Some clinicians, perhaps not well versed in the science of orthodontics, tend to forget that even cases that have had only minor tooth movement need to be retained, irrespective of which type of appliance was used to treat the case.
- While one would assume that it would be easy to maintain a good standard of oral hygiene, unfortunately, this not always the case. Moshiri et al. report that many patients will drink liquids without removing their aligners, providing the opportunity for pooling of these liquids between the teeth and the aligner.[13] This is problematic when the liquid is acidic, cariogenic soft drink, sports drinks, or fruit juice. The extent of demineralization can be dramatic and disastrous. Some patients do not remove their aligners during meals, if they are too lazy to remove the aligner, the chances are they are too lazy to clean their teeth immediately following a meal. Once again, food accumulating between the teeth and the aligner will soon destroy sound enamel.

Clinicians need to emphasize that aligners must be removed before eating; the only liquid allowed is still water. If the patient has a high caries rate, consider using the aligners as fluoride trays. Avoid giving the patient a number of aligners which would keep them away from the practice for an extended period of time. I routinely fit one set and give one set; this allows me to see the patient at four weekly intervals. I find this frequency allows me to monitor the case closely and also to monitor any hygiene issues that may arise.

The hygiene issues described apply to all thermoplastic appliances, whether they are designed to act as retainers or tooth moving appliances.

Removable appliance therapy although not the mainstay of current sophisticated appliances, nevertheless still has an important role to play in the treatment of selected cases.

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# 24 RETENTION

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**Editor's comments**

While orthodontists may differ in their diagnosis and treatment planning philosophies, there is little doubt that most clinicians will agree on the importance of the retention phase of treatment. However, as with other aspects of orthodontics, they differ in their choice of retainers and their protocol for retention. This is evident from the variation in views expressed by the contributors to this chapter. While we accept that their views are based on many years of clinical experience, we also note that the results of research studies indicate a wide range of views. The work of Little et al., showed that only 10% of the extraction cases examined 20 years postretention were judged to have clinically acceptable mandibular alignment at the last stage of diagnostic records.[1] By contrast a recent study of 66 subjects examined 15.6 ± 5.9 years posttreatment by Myser et al. concluded that orthodontic treatment is not inherently unstable.[2]

The reader will notice a degree of repetition in this chapter; I have accepted this shortcoming in order to convey the areas of both agreement and disagreement held by different clinicians.

Clearly, one of the objectives of orthodontic treatment is to place the teeth in a stable position within the oral cavity, although this ideal in not always achievable. Both patients and clinicians should appreciate that the oral cavity is a vital, living environment which, like the rest of the body, is in a continual state of flux and change. What may be a stable position of the dentition for an adolescent will not necessarily be stable for a 20- or 40-year-old individual.

**Pearl:** The supporting alveolar bone, the periodontium, the surrounding tongue, lips, and cheeks all mature and change with age and so the effect of these surrounding tissues on the dentition also changes.

With the increasing demand for orthodontic treatment by adult patients specifically for aesthetic considerations, orthodontists are being obliged in many cases to place the dentition in positions which we know from the outset are unstable; in such cases permanent retention is inevitable.

Whether you include the cost of retainers and the subsequent supervision within the cost of overall treatment or whether you charge a separate fee for retainers, is your choice. However, it is essential that the patient or parents be informed at the outset how the cost of retention is managed in your practice. I prefer

to charge a separate fee for retainers and their supervision and I explain to the patient or parents that the type of retainer and the cost will only be determined at the end of treatment. I will give them an idea of the approximate fee usually charged for retention.

**Pearl:** At the case discussion (Chapter 7) it is incumbent on the clinician to inform the patient that following completion of active orthodontic treatment a stage of retention will be essential.

## 24.1 INTERDENTAL STRIPPING

In cases that display initial incisor crowding, some gentle interdental stripping should be carried out one or two appointments prior to debonding. The stability of the anterior dentition posttreatment and postretention has been a subject of much research and debate over many years. The theoretical advantage to flattening the incisor contact points and its potential for increasing stability was discussed by Barrer in 1975.[3] He described the concept and technique for creating 'keystone architecture' for the anterior dentition; I believe that the use of handheld metal abrasive strips should be adequate for this type of interdental stripping; handpiece-mounted abrasive discs may be rather aggressive. The technique is a gentle procedure designed to break a tight contact point and gradually convert a contact 'point' into a contact 'surface'. In cases retained with a removable appliance, I do some mild interdental stripping at each posttreatment six monthly and subsequent yearly appointments. Interdental stripping should be followed by topical fluoride application to enhance the resistance of the interproximal enamel to caries. (For interdental stripping with a handpiece, see Chapter 12).

The use of interdental stripping as an aid to retention is different to the use of air-rotor stripping (ARS) as advocated by Sherridan and Sherridan and Hastings.[4,5] Air-rotor stripping is more aggressive and is a technique designed to create space within the dental arch as an alternative to extractions in specific mild crowding cases.

The degree to which interdental stripping contributes to long-term incisor stability is uncertain and to a certain extent may be anecdotal. However, in 2001 Sparks showed that interdental stripping following removal of fixed retainers contributed to 25% less crowding than in a nonstripped group.[6]

## 24.2 TYPES OF RETAINERS

There are essentially two groups of retainers, fixed and removable; before deciding on the type or coverage of the retainer, it is helpful to re-examine the original study models or photographs.

**Pearl:** Before deciding on which type of retainer to fit, do not rely on your memory; check the original overjet, overbite, buccal occlusion, and the position of individual teeth with particular reference to rotations.

### *24.2.1 Fixed Retainers*

These generally comprise sectional arches bonded to the lingual surface of mandibular incisors or the palatal surface of maxillary incisors, extending from canine-to-canine. However, depending on the original malocclusion the fixed sectional arch may extend to include premolars. In some cases where the reopening of extraction spaces in the posterior quadrants may be a problem, a small sectional arch may be bonded across the extraction site either on the lingual or on the buccal surfaces.

The fixed retention arches may be constructed from braided wire, round wire, or flattened chain; the extremities may be bent into a small circle or left straight. If the extremities are left straight and not bent into circles, they should be sandblasted just prior to bonding. All teeth across the retainer may be individually bonded to the arch or only the two terminal teeth. Once again, this depends on the original malocclusion and your decision as to which teeth need to be retained.

The need for permanent fixed retention is well described by Durbin.[7] His study showed

that 86% of a sample of 100 adult patients, who had been given removable lower retainers, showed various degrees of crowding seven years posttreatment. After further examination of a comparable group of patients who received fixed lower retainers, he concluded that patients were happy to accept lifetime stability; the teeth remained stable, with less staining and calculus than with removable appliances and virtually no decay.

#### 24.2.1.1 Technique

Retainer arches may be purchased preformed with individual mesh-backed steel pads for each tooth or they may be constructed at the chairside. Fixed retainers may be constructed either indirectly or directly.

> **Pearl:** Whichever wire or technique you use, it is essential that the sectional arch be made of soft wire; hard spring wire will not allow for individual tooth adaptation and may with time gradually change its shape.

#### 24.2.1.2 Indirect Retainers

For indirect retainers, an impression is taken one appointment before debonding, sent to the laboratory and an accurately fitting lingual retainer is fabricated. If the retainer is made with a carrier, it can only be bonded after the removal of all brackets. If the retainer is made as a unit on its own it can be bonded either prior to or after removal of all appliances. Depending on the availability of laboratory services, some clinicians will take an impression immediately following removal of fixed appliances and fit the retainer either later on the same day or a few days later.

A simple technique for the construction of an indirect lingual retainer using a transfer tray made from light body silicone and putty is described by Haydar and Haydar.[8]

#### 24.2.1.3 Direct Retainer

This form of retainer is constructed at the chairside prior to debonding. To make a braided lingual arch, take three or four pieces


**Figure 24.1**

Fabricating a lingual retainer. (a) Three strands of dead soft stainless steel ligature wire. (b) Using two artery forceps held in tension, the strands are twisted into a cable. (c) With fingers and pliers, the twistflex cable is formed into a lingual arch and (d) canine offsets placed if necessary.

of 0.25 mm (0.010 inch) soft steel ligature wire about 75 mm (3 inches) in length and hold them as a bunch; grip them at both ends with artery forceps, keeping them under tension wind them up to produce an evenly braided soft wire which can be easily curved and shaped as necessary (Figure 24.1).

- Conventional lip retractors are placed and a saliva ejector is adjusted to lie lingual to the mandibular incisors.
- Curve the soft twist flex arch to fit the lingual contour of the incisor teeth.
- Place a canine offset at one end of the arch; replace it on the lingual surface of the incisors and mark the arch between the lateral and the canine teeth at the other end; place the second canine offset. Check to see the arch is symmetrical and flat, and place the arch aside.
- Using a small round mounted green stone, gently abrade the lingual surface of the mandibular and maxillary incisors.

> **Pearl:** Although the lingual surface of the mandibular incisors may appear clinically clean, it is possible that a thin layer of calculus not easily seen may cover part of this surface; bonding to this film of calculus invites bond failure.

- The palatal surfaces of maxillary incisors are not smooth; they are often covered with

irregular ridges and crevices. To adequately abrade and clean deep fissures, it is necessary to use a high speed handpiece (or a slow speed handpiece) with a small round diamond burr. (Use this gently and slowly.) This should be followed by a small round green stone on a slow hand piece to abrade and smooth the palatal surface. The smoother surface will contribute to a stronger and longer lasting bond.

- Pumice the lingual surface with glycerine-free pumice. Because the lingual surfaces of incisors are concave as opposed to the convex labial surfaces, it is preferable to use a bristle 'tuft' brush rather than a bristle 'cup' brush (Figure 24.2).

  The tuft brush is more efficient than a cup brush in cleaning the concave surface. Make sure you do not impinge on the gingival margins; blood seepage from the gingival tissues will interfere with the integrity of the bond and compromise the lifespan of the retainer. If you need to get close to the gingival margin, use a slowly rotating rubber cup.
- Take a length of waxed dental floss, holding the two ends with tweezers thread them under the labial archwire from the incisal aspect and pick up the ends gingival to the labial archwire. Pull the floss labially and holding the closed loop of the floss lingual to the teeth, gently slip the floss through the contact point taking care not to traumatize the gingiva. Leave a 1 cm (0.5 inch) loop protruding lingually. Usually, three loops are sufficient, one in the midline, and one on either side between the laterals and the canines (Figure 24.3).
- Pick up the lingual retainer arch with tweezers and thread it through the three lingual loops of floss.
- Gently move the arch against the lingual surface by pulling on the free ends of floss, first the midline loop then the side loops. Check the position of the arch, adjust if necessary, then pull the floss tight. The lingual arch can be further adapted by pressure with an amalgam plugger. Holding all six floss tails with an artery forceps, twist up the six strands of floss until they are tight against the labial surface of the teeth and can hold the lingual arch in position under pressure. Let the artery forceps rest gently on the lips while the bonding procedure continues (Figure 24.4).
- Apply the etchant to the enamel and lingual archwire; make sure it covers all the necessary areas. Wash and dry well, ensure that the enamel under the wire is dried thoroughly.
- Bond the lingual archwire to each tooth with either chemical or light cured composite. The use of a flowable composite has been described by Elaut et al.; their technique appears to be quick, easy, and apparently reliable.[9] In a recent study, Pandis et al.

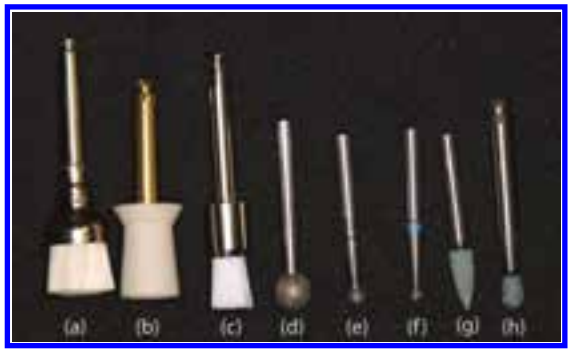


**Figure 24.2**

(a) Bristle cup brush. (b) Rubber prophy cup. (c) Bristle tuft brush. (d–f) Round diamond burrs selected to suit palatal enamel topography. (g and h) Mounted stones for fast or slow speed handpiece.

**Figure 24.3**

Loops of waxed dental floss threaded under the labial archwire from the incisal aspect and pulled through the contact points.

**Figure 24.4**

Lingual arch threaded through the palatal loops, placed into position by pulling the labial free ends of floss, which are then twisted up with an artery forceps. Etching material is placed over the lingual archwire and tooth surfaces.

claim that there is no evidence that survival of mandibular lingual retainers differs between chemically and light-cured adhesives.[10] Once the composite is cured, untwist the floss, cut one end short and gently pull the longer end out. If you use waxed floss, it should slip out without any difficulty.

- Using a very fine tapering fissure burr make sure there is no composite in the lingual interdental areas, a small tapering mounted stone can be used to smooth around the gingival margins. Gingival seepage at this stage will not compromise the bond strength. A metal abrasive strip should be used to ensure there is no composite material in the interdental area incisal to the lingual retainer.
- After placing a maxillary palatal retainer check the occlusion with articulating paper to ensure there is no occlusal impingement on the retainer.

With minor variations Cook has described the same technique.[11]

#### 24.2.1.4 Bonded Retainers

Farah R Padhani

To easily measure the correct length of wire for a lingual retainer, I use the labial surface from the distal of the left lateral incisor to the distal of the right lateral incisor. This length fits perfectly on the palatal surface of canine to canine without it being too long or too short.

I do not coil wire on canines. My lingual arch of choice is two ligature wires twisted up (as above) and annealed.

Instead of using dental floss to hold the lingual arch in place, I routinely use blue elastics 6 mm (¼ inch) for each contact point prior to bonding with composite.

### *24.2.2 Removable Retainers*

There are many different types and designs of removable retainers. The type and design of retainer you select will be dependent on many factors. These include the original malocclusion, the corrective tooth movements, the age of the patient, anticipated compliance, and aesthetic considerations. To maximize patient compliance, the retainer should be comfortable and well retained; unfortunately, clasp-held lower removable appliances are not easily retained. Removable retainers do provide the facility for a limited degree of corrective tooth movement to be carried out as part of the retention stage.

The conventional Hawley-type retainer is frequently used for retaining the maxillary dentition, with variations in the clasps and labial bow and the possible incorporation of anterior bite planes. The labial bow can provide a degree of labiolingual tooth movement of the incisors.

If control is required in the vertical plane, particularly when trying to retain an anterior open bite, composite mounds can be bonded to the labial surface of the incisor teeth. The labial bow can be activated in an incisal direction and after insertion it should rest on the gingival margin of the composite mound.[12]

The pressure or vacuum-formed clear plastic Essix-type retainer described by Sherridan et al. is also extensively used; it provides efficient retention, particularly for the mandibular dentition and it is also possible to carry out minor corrective tooth movements using differential pressure on selected teeth.[13,14] (See Chapter 23.) In the presence of missing teeth, such as second premolars, artificial teeth can be incorporated in these retainers.

**Pearl:** A replacement denture tooth is positioned on the working model and held in place with a little plaster or stone. Make sure there is sufficient undercut for the soft plastic sheet to flow around the tooth; to assist in retention of the artificial tooth, a small amount of epoxy adhesive may be placed on the tooth an instant before the plastic material is sucked down on the model or the tooth can be grooved (Figure 24.5).

The use of an Essix-type retainer as a temporary bridge to replace missing anterior teeth is well described by Moskowitz et al.[15] Essentially, plastic denture teeth are selected and fitted to a stone model over which the plastic material is formed. The artificial teeth are retained in the appliance by cutting a mesiodistal groove 4 mm (0.16 inch) wide and 3 mm (0.12 inch) deep into the palatal surface of the plastic teeth. The appliance is trimmed to cover the six anterior teeth.

Prior to forming the appliance, use a universal scaler to clean around and define the gingival margins of the teeth on the working model; this procedure can enhance the retention of the appliance. The working model should be allowed to dry for at least two days before creating the vacuum-formed retainer; if the model is wet, the steam generated by the hot plastic coming into contact with a wet model will inhibit close adaptation of the plastic material resulting in poor fit and poor retention of the appliance.

The vacuum- or pressure-formed retainers are aesthetically very acceptable and are well


**Figure 24.5**

(a) End of treatment with absent LL7 and 8. (b) Vacuum-formed retainer incorporating denture teeth to replace LL7 and 8. Teeth are grooved on the lingual and buccal surfaces to aid retention and cold cure acrylic used to adapt to the gingival mucosa. (c) Retainer in position to be used until the patient can receive a more permanent solution for the absent teeth.

tolerated by most patients. While they are efficient retainers for most tooth movements, they are not reliable for the retention of posterior maxillary expansion. If you particularly wish to retain posterior expansion, it is preferable to use a Hawley-type of retainer with acrylic palatal coverage. A comparison of Essix and Hawley retainers showed no significant difference in their effectiveness in retaining orthodontic corrections.[16] If a patient requests tooth bleaching following completion of fixed appliance therapy, an Essix retainer can be modified to double up as a bleaching tray and a retainer.[17] Whether you believe bleaching falls within your domain, depends on your relationship with the referring dentist; if the patient's dentist feels that you are taking away work, which he or she would normally do, you risk alienating a source of referral.

White advocates giving each patient a syringe of tooth-bleaching gel to inject into their Essix retainer; he believes it encourages patient cooperation and more consistent wearing of the retainer.[18] Apart from a fixed mandibular lingual retainer, he also provides a removable Essix retainer to be worn as insurance against future breakage of the fixed retainer. He encourages his patients to take responsibility for the long-term retention of their occlusion.

#### 24.2.2.1 Essix Retainers

Victor Lalieu

I usually use Essix full coverage upper and lower retainers. The patient is always provided with a spare lower polycarbonate retainer (cheaper and more rigid) and they are given both their working models. If retainers are lost or break, these models are used to remake the retainers. If minor tooth movements are required, then the tooth in question is reset on the model and a new Essix retainer made on the adjusted model.

#### 24.2.2.2 Tooth Positioners

Custom-made or preformed tooth positioners are very useful retainers. They are active appliances and are specifically selected to assist in the final settling in of the occlusion. Preformed tooth positioners can be fitted at the time of appliance removal while custom-made positioners need some laboratory time. Unfortunately, the appliance is not very comfortable; however, if the patient is compliant, they are very successful. But if compliance is suspect, then this form of retention should not be selected. They are also *not* very efficient in retaining posterior expansion. In some cases they may induce some temporomandibular joint discomfort. At the first sign of any joint dysfunction, this form of retention should be discontinued.

**Editor's comment**

While the use of preformed tooth positioners as retainers may vary greatly amongst clinicians, I was pleasantly surprised to learn that in certain countries in Europe there is a very high frequency of usage of this type of retainer.

#### 24.2.2.3 Prefinisher Retainers

Gerald Gavron

The majority of malocclusions are primarily related to skeletal differences between the maxilla and mandible, and the goal of treatment is to correct this discrepancy by so-called growth adaptation. To obtain maximum effect, treatment is often carried out during the pubertal growth period, when the intensity of growth is greatest. Whereas facial growth can be of great help during treatment of skeletal problems, it can also cause instability of the treatment result. As growth in most orthodontic patients is not completed by the end of the pubertal growth spurt but continues for several years beyond this, retention of the treatment result should also continue for several years.

Upper removable retainers and fixed lingual-bonded retainers are commonly used for extended periods of time. I believe there is also a useful role for preformed or custom-made prefinishers for retention purposes. For prefinishers, I have developed a modified regime, which I believe to be more acceptable to patients, more sensible, logical, and useful; furthermore it extends the life and use of the appliance.

The prefinisher is fitted immediately after removal of all fixed appliances. This appliance guides the teeth into 'ideal' occlusal relationships while allowing soft tissue and periodontal adaptations to take place.

Patients are usually given standard instructions to wear the prefinisher for three to four hours, alternating clenching with relaxation. This is followed by night time wear. After four to six weeks this programme ends and more commonly recommended retainers are then worn. This routine is not necessarily the most suitable approach.

**Pearl:** My experience indicates a more logical and more acceptable approach is to ask the patient to start wearing the pre-finisher for 10 to 15 minutes each afternoon, and increase this gradually over a number of weeks to a limit of two hours per day. Night time wear is continued.

This routine enables the patient to adjust gradually to the two hour period of wear rather than immediately to the unnecessarily long four hours, which is usually far too demanding. After six months, this is reduced gradually for a further six months, followed by night time use only. This is sufficient to maintain an excellent occlusion and healthy supporting tissues until the third molars have erupted or been extracted. Indefinite wear may be necessary. The prefinisher may also serve as a mouth protector for contact sports.

The final occlusion has fully 'Stollerized' first molars and when the study models are viewed from the lingual, the cuspal relationships are optimal, a feature not usually seen with the use of standard retainers, which do not allow this final guidance and settling-in of the occlusion.

As long ago as 1934, Oppenheim said that: 'Retention is the most difficult problem in orthodontics, in fact it is the problem.' Even pre-dating this statement, Hawley in 1919 wrote: 'If anyone of them would take my cases when they are finished, retain them, and be responsible for their further progress, I would gladly give them half the fee.'

Kesling described a variation of the spring aligner/retainer where the stainless steel loops were replaced by nickel-titanium loops.[19] These were put under tension during the fabrication thus providing a means of maintaining permanent activation. The nickel-titanium loops were joined to straight sections of stainless steel wire, which were bent and embedded in the lingual acrylic section of the appliance.

## *24.2.3 Fixed and Removable Retainers*

Ronald G Melville

I tend to use fixed retainers as far as possible with the intention of stabilizing maxillary and mandibular incisors, particularly where these teeth originally had vertical, horizontal, and rotational discrepancies. I leave maxillary fixed retainers *in situ* indefinitely unless there are indications that they may cause periodontal problems. In general, I favour prolonged retention with removable retainers (about two years for children). I insist on permanent retention for adults and I confirm the importance of retention by letter.

I never really dismiss patients, but suggest that they return for a yearly check-up.

## *24.2.4 Fixed Retainers*

Richard N Carter

Bonded retainers allow clinicians to offer extended retention periods; they may give excellent service for 10 or more years without replacement. Usually, lower bonded retainers extending from canine-to-canine are only bonded to the canine teeth. This is important, as the teeth must be relatively free to move independently with function. Lingual retainer arches, 0.76 mm (0.030 inch) are formed by bending around a 'turret'; they should not be bent with pliers in order to avoid marking the wire and creating asymmetries. To compensate for the difference in thickness between the canines and lateral incisors, you need to

place a horizontal offset at the contact area. The arch should rest at the level of the contact points, namely, the incisal/middle third junction of the crown. Placing the arch at the middle or gingival third of the crown will allow the contact points to slip and the incisors will crowd.

Rotations should be considered differently from crowding. They should be held firmly for two years after active treatment. In addition, free gingival fiberotomies, as described by Edwards, should be done six months before brackets are removed.[20] In order to hold the rotations and still allow the periodontal ligaments to function, retainer arches made from flexible spiral wires are used to hold adjacent teeth.

**Figure 24.6**

Preformed lingual retainer with mesh-backed pads bent and modified for bonding to the buccal surfaces of a mandibular first premolar and first molar. Retaining space for an absent second premolar.

## *24.2.5 Retainers/Space Maintainers*

Ronald G Melville

In order to maintain absent premolar space in the mandibular arch, I use a commercially available canine-to-canine lingual retainer with mesh pads at the extremities. In the case of an absent second premolar tooth, this is bent and adapted to fit along the gum and alveolar ridge in the buccal sulcus; one pad will be bonded to the buccal surface of the first premolar and the other pad bonded to the buccal surface of the molar tooth (Figure 24.6).

## *24.2.6 Fixed and Removable Retainers*

Simon Ash

Fortunately, teeth move throughout life; this physiological process enables orthodontists to provide their services to adults as well as adolescents and children. By virtue of the same process, following removal of orthodontic appliances, teeth will continue to move but unfortunately they generally move in a direction aimed at re-establishing the original malocclusion.

Permanent or semipermanent retention may be provided in the form of either a fixed appliance bonded to the teeth or as a removable appliance worn at a set time for an indefinite period. I have found the following groups of retainers provide the versatility to cover most retention demands.

- Bonded lingual retainers using a hands-free carrier
- Whipps retainer
- Chrome-cobalt retainer
- The Quatro appliance

### 24.2.6.1 The Bonded Lingual Retainer Using a Hands-Free Carrier

Bonded lingual retainers are widely used and extensively reported in the literature. However, the method for placing a bonded lingual retainer is highly technique-sensitive and impacts on the long-term success of the retainer. The hands-free carrier was devised to simplify the bonding of a fixed multiflex wire to the lingual or palatal surface of teeth (Figure 24.7).

Immediately following removal of fixed appliances, an alginate impression is taken and a stone model cast. On the model, a multistrand wire 0.41 mm (0.0175 inch) is accurately adapted to the lingual surface of the relevant teeth. The distal ends of the wire are

**Figure 24.7**

A hands-free lingual retainer constructed on a model incorporating acrylic extensions on the premolar teeth.

bent into loops, conventionally overlying the lingual surface of the canine teeth. The wire is then continued further distally to form tags, which will be embedded in the acrylic carrier.

The carrier can be constructed either in the laboratory or in the surgery. On the model a wax strip is placed covering the gingival quarter of the labial surface of the teeth to be bonded. Cold cured acrylic is mixed and at the dough stage the acrylic is placed on the model covering the exposed labial surfaces of the relevant teeth. To provide adequate strength, the acrylic should not be thinner than 3.0 mm (0.12 inch). The wire extensions at both ends of the retainer are embedded in the carrier by extending the acrylic over the occlusal and lingual surfaces of the teeth distal to the last tooth to be retained. Once cured, the retainer is removed and the acrylic carefully trimmed.

At the chairside, the lingual retainer plus its carrier is tried-in, and if necessary, adjusted. Remove the retainer and prepare the lingual or palatal surfaces of the teeth to be bonded using the standard procedure of pumice, etching, and drying. Unfilled resin is placed on the tooth surface, the retainer with its carrier is carefully refitted and the lingual arch is bonded in position using either light or chemically cured composite resin. With a fine tapered diamond burr, cut through the distal extensions of the retainer to separate it from the carrier, smooth, and polish the distal ends.

**Pearl:** The advantage of this technique is that the retainer can be accurately positioned and retained in place throughout the bonding procedure. The operator has both hands free and can concentrate on the bonding procedure without being concerned with possible movement of the lingual archwire.

There is good visibility and adequate access for the placement of the bonding material. This technique is fast, economical and reliable.

Banks described a variation on this design. He uses a single acrylic carrier or index covering only one distal extension of the retainer.[21]

### 24.2.6.2 The Whipps Retainer

Unfortunately, patients frequently do not report any failures of fixed retainers until they experience discomfort or notice unwanted tooth movements or relapse. In addition, the teeth occasionally may still move despite the bonded retainer. Furthermore, these retainers do not retain the buccal teeth in the transverse plane. In some instances where the arches have been significantly expanded, maintenance of the expansion is required. The Essix retainer has previously been described; however, this retainer being thin has a limited life, it provides little transverse control and is liable to fracture. The ability to improve retention of this appliance is limited. The 'Whipps' and 'chrome skeleton' retainers are designed to overcome these problems.

#### *24.2.6.2.1 Construction*

The Whipps retainer is a clear plastic tooth-borne retainer constructed in the laboratory using a 'Biostar' vacuum machine. Following the fitting of a conventional bonded lingual retainer, an accurate impression is taken including a record of the occlusal surfaces of all standing teeth and the appliance is constructed on a stone model. The bonded retainer is blocked out with plaster. Ball-ended clasps constructed from 0.9 mm (0.036 inch) hard stainless steel wire are placed passively in the premolar region on both sides of the arch. A 2 mm (0.08 inch) thick plastic transparent blank is heated and vacuum formed on to the

stone model embedding the tag arms of the ball clasps. When cool, the retainer is cut out and trimmed.

As this plastic material is thicker and considerably more rigid than the Essix retainer, the plastic is cut so that the occlusal surfaces, lingual surfaces and only the incisal third of the labial surface are covered. If the plastic is overextended into undercuts then it may prove difficult to remove. If necessary, retention of the appliance can be enhanced by adjusting the ball clasps (Figure 24.8).

Patients are advised to wear the Whipps retainer at night following teeth cleaning. The patient is warned that if the bonded retainer fails at any stage, they need to wear the Whipps retainer constantly until a repair to the fixed retainer can be made. This belt-and-braces approach to supplement the fixed retainer prevents relapse following fixed retention failure. Since bruxism and parafunctions are mainly nocturnal habits, then the wearing of the Whipps retainer will also act as a protective occlusal splint. By virtue of the thickness of the material used for this retainer, it is effective in *retaining buccal expansion* that may have been carried out during active treatment.

The retainers should be kept damp when out of the mouth and should be cleaned before and after use with cold water only. Hot water will cause distortion and result in a poor fit. Bleach or toothpaste may damage the plastic material. Patients should be warned not to drink or eat while wearing the Whipps retainer.

**Figure 24.8**

Whipps retainer constructed from 2 mm (0.08 inch) thick plastic material and incorporating ball clasps.

#### 24.2.6.3 The Chrome-Cobalt Retainer

Patient compliance with retainers is principally influenced by comfort, ease of cleaning, and durability of the device. Chrome-cobalt is a well-established material for use in the oral cavity. Removable chrome-cobalt retainers carrying close fitting labial bows and an occlusal rest or clasp placed on selected buccal teeth provide an alternative to acrylic and thermoplastic devices. Chrome-cobalt retainers being very strong in thin section, can be made with minimal palatal and lingual cover and are otherwise tooth borne. They can be boiled, autoclaved, and cleaned in a domestic dish washer. Cast metal retainers are very durable. Over the last 10 or more years of making these retainers, I have found that patients have accepted these extremely well and prefer them to the acrylic and thermoplastic devices.

In practice I carry out the usual sequence of fitting either bonded or thermoplastic retainers as required. After the post settling stage for example, three month after fixed appliance removal, master impressions are taken. New alginates such as Hydrogum 5 (Zhermack.com), if used correctly are satisfactory for these records; as an alternative, silicone impressions may be taken. The model is cast in hard stone, surveyed, and unwanted undercuts blocked out. A skeleton chrome framework is then cast with mini interproximal occlusal clasps placed to ensure good retention and to assist in the prevention of undesirable tooth movements. If necessary, denture teeth may be incorporated where relevant. Patients are advised to wear the chrome retainers during sleeping hours only. The thermoplastic retainers are used as a backup if they fail to wear the chrome retainers, if there are any minor changes, if they go on holiday, or sleep away from home. Clearly if there are changes to the oral anatomy, for example, restorations or tooth loss then the chrome retainers will not fit. Patients must be warned of this risk and ensure that they take the retainers with them on visiting their dentist.

**Figure 24.9**

(a) Occlusal and lingual view of cast chrome-cobalt retainers. (b) Labial view showing fitted labial cast arch bars to be used when necessary.

**Pearl:** Chrome-cobalt retainers are especially useful as a long-term solution for an inherently unstable correction, especially in the transverse dimension.

These retainers are very comfortable, durable, thin, and kind to the oral tissues (Figure 24.9).

### 24.2.6.4 The Quatro Appliance

This is named after a well-known musical star. It is a removable appliance, which can be used either as an active appliance or a passive retainer.

There are occasions when minor relapse occurs in the labial segments or when minor corrective tooth movements are required (e.g. slipped contacts, minor rotational relapse, or slight misalignment). While the ideal approach is correction with fixed appliances, in some cases this may not be acceptable or practical. The 'Barrer' appliance (spring aligner) may be used; however, it is poorly retained and has limited adaptability. The Quatro appliance solves these problems.[1]

#### *24.2.6.4.1 Construction*

The Quatro appliance is constructed in the laboratory on an accurate stone model. As for any removable appliance, the appliance is well clasped. An ideal palatal or lingual stainless steel archwire 1 mm (0.036 inch) is fitted to contact the palatal surface of the maxillary incisors. If the intention is to slightly retract the incisors, the palatal arch should be positioned distal to the palatal surfaces of the incisors. Two buccal arms of 1 mm (0.036 inch) stainless steel wire support the locks soldered to their ends (Rocky Mountain, USA). These locks may also be purchased presoldered to the arms (DB Orthodontics). These arms pass over the embrasure between the canine and premolar teeth; the locks should stand just proud of the canine eminences, with the slot parallel to the occlusal plane preferably at the maximum bulbosity of the crowns. An acrylic base is poured, cured, and polished in the conventional manner. In the laboratory, an accurately fitting sectional archwire is constructed to extend bilaterally through the locks (Figure 24.10).

When the appliance is available, first check the retention and fit of the passive appliance, and then insert the sectional archwire into the two locks. These locks carry milled slots and small grub screws, which are tightened on to the sectional archwires using a hex wrench. The locks are placed so that as the grub screw is tightened, it pulls the archwire slightly tighter in a distal direction. These sectional labial arches can be selectively adjusted with first order bends and minor tooth movements may be accompanied with interproximal stripping. In addition, slight adjustments of the two

**Figure 24.10**

The Quatro removable appliance (retainer). Removable labial bow attached (adjusted) to a sliding lock. The grub screw is adjusted using a hex wrench.

arms supporting the locks can alter the vertical height of the sectional archwire.

This appliance is comfortable, well tolerated, and efficient. I find it a useful adjunct when selecting retainers.

## 24.3 SUPERVISION AND RETENTION PROTOCOL

How frequently should you see a patient under retention, for how long should you provide supervision, and for how long should the patient wear retainers? These are questions that orthodontists have always asked and will probably continue to ask for the foreseeable future.

- If the patient is compliant, and the retainers are passive and fit well; I believe it is only necessary to see them after three months then, if all is well, at six months and then yearly intervals.
- If the original dentition showed incisor crowding, then at each visit during retention, I prefer to do some interdental stripping of the incisors. This stripping is done by hand using a fine metal lightening strip.
- If the retainers are actively moving certain teeth then during this active process, the patient should be seen at more frequent intervals, possibly six weekly. Once they become passive, then the above regimen may be adopted.
- Generally, patients are advised to wear removable retainers permanently for the first six months and thereafter at night only.
- The duration of retention must depend on the original malocclusion; conventionally for adolescent patients, they are advised to continue with retention, both fixed and removable until the third molars either erupt or in some cases, are removed. The reason for this timing is not so much that the third molars are responsible for relapse, but because the eruption of the third molars generally coincides with the completion of mandibular growth and it is a convenient time for patients to remember.

**Pearl:** As mentioned previously adult patients often require their teeth to be placed in less than stable positions; these patients require permanent retention.

For how long you are required to supervise a patient in retention is very much dependent on your own philosophy and on how you run your practice. Some orthodontists will inform their patients that after two years they are 'on their own' and they must assume responsibility for their retention. They need to continue to visit their general dentist at regular intervals and if they have a problem with their retainers, they should return. Other orthodontists are happy for their patients to continue to return for recall visits for many years.

Patient compliance, particularly with removable retainers, will continue to be an issue over which we have little control. While we would like our patients to follow our instructions, experience and research data indicates otherwise. A study by Kacer et al. showed that even after a comparatively short period of 24 months, compliance rates (as defined in their study) dropped to 45%.[22]

Electronic wear-time documentation with microelectronic devices incorporated into removable retainers has been suggested as a means of improving compliance. While the results over a 15-month period appeared to be

encouraging, long-term compliance is still an unquantified matter.[23]

### 24.3.1 Orthodontic Retention – A Protocol

Brett Kerr

Once you have been in the same practice for a number of years you understand why retention has been described as *'the* problem in orthodontics'.

Years ago it was common for retention to be a finite entity. This changed when patients demanded a permanent result from their expensive and extensive course of orthodontic treatment.

**Pearl:** For most orthodontists and their patients this led to the concept of lifelong retention. This is logical since there is no other aspect of medicine or dentistry that does not need ongoing maintenance.

Having been in my own practice for over 30 years I have tried most, if not all, types of retention, including:

- Bonded
- Hawley
- Spring aligner
- Barrer
- Positioner
- Functional appliances
- Invisible

Each form of retention has its own set of advantages and disadvantages. We can basically divide the types of retainers into bonded and removable.

#### 24.3.1.1 Bonded

For many orthodontists today bonded retainers are high on their preferred option list. Although these can survive for many years in the right environment, they are not without their problems. Reports have suggested an unacceptably high failure rate, although this is highly technique and operator specific. Failure rates of 35%–50% over 6–24 month studies are common.

Scheibe and Ruf (2010) found 34.9% of all patients experienced retainer failure in a study where 'the mean retention phase amounted to 30 ± 19.5 months'.[24]

Taner and Aksu (2012) quoted a total failure rate of 37.9% over a 6-month period.[25]

An 18-month study by Salehi et al. (2013) showed that ribbon retainers showed a failure rate of 50% in the maxillary and 42.6% in the mandibular arches, and flexible spiral retainers showed a failure rate of 36.5% in the maxillary and 37.8% in the mandibular arches.[26]

Pandis et al. (2013) followed patients with bonded retainers for a minimum of two years, and found some type of failure in 47 of 110 (42.7%) chemically cured adhesive, and 55 of 110 (50.0%) light-cured adhesive. The overall failure rate was 46.4%.[10]

**Pearl:** My concern with bonded retention is that, when it inevitably fails, movement occurs. By the time this is finally noticed, or repairs can be effected, the amount of movement is often unacceptable to the patient and retreatment is necessary. This does not make for a happy patient, since there is often the misconception that bonded retainers are perfect.

Many cases are now treated by nonextraction with arch expansion. We know this expansion will not hold up if only the anterior teeth are retained. It is therefore common for a removable invisible retainer to be made over bonded retainers as a form of a 'belt and braces' security.

This is the ultimate in redundancy. If a patient wears the invisible retainer, sufficient to hold the arch, then there is no need for a bonded retainer. If they do not wear the removable, then the bonded retainer will not hold the posterior teeth.

Another problem with bonded retainers is the question of who is responsible for their long-term care and maintenance. Is it the orthodontist, the patient, or the general dentist? And for how long?

#### 24.3.1.2 Removable

With removable appliances the balance can be shifted towards patient responsibility. Unfortunately, otherwise excellent removable retainers such a Hawley, spring aligner, Barrer, etc. have problems of comfort, longevity, and tolerance. They are complex and expensive to replace.

Co-operation with removable retention is imperfect and is out of the orthodontist's control. Studies, such as that by Kacer et al. (2010), are as yet unable to produce good long-term data, as they rely on subjective questionnaires.[22]

However, recently Schott et al. (2013) used microsensors to provide objective statistical data for Hawley-type appliances in their 15-month study.[23]

The bottom line is that there is no one ideal retainer, and there is no universal retainer. Each orthodontist has to find a protocol that works for him or her, and of course, retention should be modified to best suit the patient and the malocclusion.

The search, therefore, is for a retention regimen that works most of the time for most people, and is efficient and cost effective.

The following is the protocol that I have followed for the past decade, and which I believe offers a good option for the majority of patients.

#### 24.3.1.3 Technique

1. At the end of treatment alginate impressions are taken, from which upper and lower invisible retainers are made from Essix ACE 0.040 inch plastic (Dentsply International). Any similar material can be used.

   This material is stiff enough to provide complete security of retention. Even in young patients after fixed braces there are usually sufficient undercuts to make this a well-retained and tolerated appliance.

   Depending on the orthodontist's preference, these retainers are worn full time for a period, following which wearing can be reduced to night time only as the individual patient's status dictates.

   The problem is that this type of material tends to crack after a few months because of its stiffness, although in some patients these retainers can last for many years.

   Once initial stability has been achieved and any gingivitis has been resolved, the next step is instituted.
2. This involves taking polyvinyl siloxane (PVS) impressions in a disposable plastic tray. From these a second set of retainers is made, using a more flexible, abrasion-resistant plastic, such as Tru-Tain 0.30 inch Coping (Tru-Tain Orthodontic and Dental Supply) or Essix 0.040 inch C+ (Densply International).
3. When the second set of retainers is fitted *the patient is given the PVS impressions to keep.*

The patient now has two sets of retainers which they are instructed to keep in different locations to avoid accidents. They are instructed to wear them every night, 12 hours per night, ad infinitum. They are also told never to have less than two sets of retainers.

Of course, how they actually behave is up to the individual.

#### 24.3.1.4 Rationale

If a set of retainers is lost, broken, or damaged, the PVS impressions can be repoured and a new set of retainers made to match the end of treatment alignment.

This, of course, is only useful if the patient has worn their retainers to that stage. If not, it is *their* responsibility and further treatment would be necessary.

If there has been a small amount of movement for any reason, retainers made on the PVS impressions will be able to realign the teeth with full time wear for a month or two. This may be uncomfortable, or tight, but is considerably simpler, quicker, and cheaper than any other form of active retreatment.

> **Pearl:** The key to all of this is communication. Patients need to be advised before treatment commences that retention will be forever, that they will be provided with these two sets of retainers, and that the responsibility for wearing them is theirs and theirs alone.

If they do not accept these points then they are at liberty, of course, not to proceed with

treatment. In litigious countries this could be put into an informed consent document, and signed and witnessed.

My belief is that the benefits of this protocol are

1. Putting responsibility for retention with the patient.
2. Providing them with the best opportunity for long-term co-operation.
3. Providing, if needed, a record of the resulting alignments.
4. Protecting against damage from bruxism.
5. A cost-effective, and time-efficient replacement of retainers if required, avoiding the need for further impressions if there has not been major movement.

### *24.3.2 Retention Protocol – An Alternative Protocol*

Demetri Patrikios

Nobody likes the bearer of bad news (Sophocles).

I do not know of any text in orthodontics that starts with the 'end' at the beginning, but that is the way I see things philosophically. Why? Because the 'retention' phase in orthodontic treatment relates so much to the target we are aiming for at the beginning of treatment and unless we consider it at this stage, failure is assured.

**Pearl:** In discussing the orthodontic treatment of a child with the parents at the first or second visit, I normally referred to the 'retention' phase of treatment after explaining and describing all that I intended to do to treat the case.

Many parents accepted what I proposed without question. Others, however, wished to know more details and asked how long their child was to wear 'retainers'. This was difficult to answer and the difficulties increased as a few perceptive people asked 'Doctor, what do these retainers actually do?'

I found the latter question impossible to answer accurately as quite frankly, it is a question I continuously asked myself throughout my orthodontic career. The supposed facts that come to mind are

1. Once the bone around the roots recovers from the osteoclastic process induced by the pressure of tooth movement during treatment, osteoblasts lay down new bone and the roots 'firm up'. Good in theory and the bone probably recovers well, but this is no guarantee that the teeth involved will remain where you have put them however long you may hold them.

**Pearl:** Isaac Newton taught us that for a body to be at 'rest' all the forces acting on it must add up to zero. Hence unless this condition is present, the length of time of holding a tooth will not help it to be stable, since, once you remove the holding appliance, the surrounding forces will act until they add up to zero.

   This fact generally means that a tooth will move until it is in equilibrium. If it does not move, then it is in equilibrium and has no need to be held there! Hence time alone will not improve matters. This process has been experienced time and again.
2. Perhaps we are waiting for the surrounding musculature to adapt to the new position of the teeth after treatment. I think this is futile as any battle between bone and muscle is always won by muscle, at the age of our patients anyway. Bone adapts to muscular pressure as opposed to muscle adapting to bony position in the case of orthodontic treatment. So we have no hope in this direction either.
3. Occlusal contact: Edward H Angle believed this. He was of the opinion that if you expanded the arches and gained perfect occlusion, the surrounding bone and muscle would eventually adapt to the teeth in perfect occlusion. We all know that this is not true and that subsequent orthodontists resorted to extraction to avoid the above trap. This improved matters, but still 'retention' was a problem.
4. The periodontal ligament: Pericision or fiberotomy performed at retention around

the roots of the teeth that were rotated before treatment, goes some way to prevent the rerotation of these teeth, but is still no guarantee of posttreatment stability.
5. Wisdom teeth: These teeth have been blamed for so many things that blaming them for recrowding after orthodontic treatment is natural. As far as I know, we have no proof of this.

The answer to the question 'Doctor, what do these retainers do and why should my child wear them? If you have finished treatment, why do you need to go on?' is difficult to deal with. In reply, you could say:

1. I am scared to let go in case of a relapse.
   or
2. I want my patients to wear the 'retainers' until I have confidence in letting go (how long is that and what makes you confident to let go?).
   or
3. I want you to wear these retainers forever as I am frightened to let go. This is the so-called 'permanent retention'. This is indeed a protection for the orthodontist and an admission of failure of part of the orthodontic treatment.

**Pearl:** Who wants to wear retainers forever and why should they? Do we really think that the majority of patients do? There are other important events in life. Orthodontic anomalies are in no way life threatening and need not take priority in life's health problems.

   or
4. I am waiting for the roots 'to firm up' and for biological adaption to occur. How long does this take? 'Don't know, but when the patient loses their retainer, we won't make a new one. We will wait and see how things pan out.'

Now, if you were as explicit as the above when parents ask you questions before treatment, how many of them do you think would accept treatment for their children? I believe many would not. So perhaps some operators are simply not as explicit as the above. They emphasize how beautiful the teeth will look at the end of treatment and quietly avoid detailed discussion of the 'retention' phase.

I am being both cynical and philosophical here because I think our profession ought to look at the end of treatment at the beginning that is, at the record taking and diagnostic stage.

I am aware that there are new brackets designed to minimize friction and allow a greater degree of freedom of tooth movement. I am also aware that the frequency of tooth extraction has reduced and arch expansion has become more acceptable. I also believe that in years to come, the cycle may once again turn.

To me it appears that treatment is being subservient to the appliance instead of the appliance being subservient to the operator and the treatment plan. I am of the opinion that the orthodontist makes a diagnosis and then the treatment plan for each individual case. It is essential to establish your goals and make a 'target' for which to aim at. You need to know what you want, what you need to do, and how to get there. The appliance is only a tool which the orthodontist manipulates for his ends and it must be flexible enough to allow him to change anything at will.

Now it is time to put my views down. I accept that one will always have some movement of teeth after orthodontic treatment ceases purely because, as operators, we are not perfect. However, that does not mean we should not try to place our patient's teeth in the best possible position both aesthetically and as regards stability, without subjecting them to wearing appliances forever. In attempting to do this, we have to keep in mind the original planned goal or target.

To this end one has to consider the fact that when a patient comes to see you, regardless of the malocclusion present, the position of the teeth is fairly stable and they will remain so unless you intervene. In essence, you are destabilizing a stable situation and you have to consider what is keeping it stable in order to design a treatment procedure that will give you the best chance of posttreatment stability. The bony shape of the jaws reflects the tooth position, but more importantly the result of the pressures of the surrounding musculature. The latter is the object that will limit to where you are going to relocate the teeth. Just expand the lower intercanine width against the group of

muscles found at the corner of the mouth then let go and see what happens. The muscles will simply push the teeth back to the equilibrium position they were at the start. Hence you have to set your goals to accommodate the 'muscular envelope' that is present.

**Pearl:** You may be a good orthodontist, but nature will not let you get away with everything, so learn the lesson and save yourself some heartache.

I offer no excuses for the forthright language used in this chapter. Perhaps it is my didactic style, but I wish to make the point that orthodontic treatment should be planned and executed *with the end in mind and conforming* to the 'muscular envelope' which we find in each case we are called upon to treat. Then our 'retention phase' will not present us with real problems. Some failures will inevitably take place. We are but human and we all have to grin and bear this fact.

Personally, I have used an upper Hawley retainer for two months fulltime (after treatment), then one month at night only followed by one month for two times a week at night and then discontinued completely. The lower had a fixed lingual retainer until growth was complete and then discontinued.

I believe this is as much as we can ask of our patients. Not every treatment works out as planned but I am satisfied that the vast majority do.

## *24.3.3 Correcting Incisor Relapse with Removable Appliances*

Adam A Ryan

During the retention phase, maxillary or mandibular incisors occasionally relapse as a result of inadequate wear, loss or fracture of removable retainers. 'Active' retention may then be indicated, with retainers used to correct rotations, labiolingual displacements or occlusogingival displacements.

### 24.3.3.1 Labial Displacements

The correction of labial displacement or rotation is readily corrected with a lingually directed force from a labial bow of a retainer. The required point of application of the wire is marked with a chinagraph pencil and a dimple inserted at the point with triple beak pliers. Any interproximal enamel stripping or selective trimming of the lingual acrylic is carried out as necessary. A degree of overcorrection is recommended. Some clinicians prefer the use of acrylic facing on the labial bow and in these circumstances an alternative method of producing a lingually directed force is required. Rather than insert a dimple in the labial bow, cold-cure acrylic can be employed to serve the same purpose. First, the required point of application is noted and the adjacent area on the fitting surface of the acrylic facing is cleaned and roughened with a tapered acrylic burr. Cold-cure acrylic is then mixed to a thin consistency and a small drop applied with a probe to the area on the acrylic facing. The acrylic will set rapidly if held for a short time in hot water. (Beware: distortion of the baseplate is a distinct possibility if the entire retainer is immersed in hot water!) Some minor trimming of the added acrylic may be needed.

### 24.3.3.2 Lingual Displacements

The correction of a lingual displacement or lingual rotation requires a labially directed force and therefore an active component on the lingual aspect of the tooth is needed. An elastomeric separator can be adapted to serve as the active component in a modification of the method suggested by Cureton.[27] Again, the point of application is noted and at that point, a hole is drilled through the baseplate from the fitting surface to the polished surface using a fine composite removing burr (8000–1171, Tip 1.2 mm, Ortho-Care, UK). An elastomeric separator is threaded on to a steel ligature. The ligature is in turn threaded through the hole in the baseplate, and the separator is pulled into the hole. Approximately one quarter of the separator is left protruding from the fitting surface, although this can be varied to suit the degree of activation required.

Melting it with a hot wax knife can reduce the separator protruding from the polished surface. This improves patient comfort and also aids the retention of the separator with the baseplate. Adjustment of the labial bow may be needed to permit labial movement of the incisor, along with interproximal enamel stripping as necessary.

It should be noted that in cases of rotation relapse, correction might involve a combination of the techniques described above, with active components on both the labial and lingual aspects.

#### 24.3.3.3 Occlusogingival Displacements

Sometimes, occlusogingival displacements of incisors occur during retention, and hence corrective movements will involve either extrusion or intrusion. A modification of the method described by Picard may be employed to create a small-customized ledge on the labial surface to permit engagement of an activated labial bow.[28] The incisor is etched and primed with light-cured composite resin primer. The retainer is inserted and if extrusion is required, the labial bow is activated by holding it 1–2 mm (0.04–0.08 inch) gingival to the passive position. A small dab of composite paste is placed along the occlusal aspect of the bow, smoothed with a Microbrush dipped in primer, and then cured. Care should be taken to ensure the composite does not run over the labial bow thus making removal of the retainer somewhat difficult. The composite is then smoothed with the retainer removed. When inserting the retainer, the labial bow is lifted over the composite ledge to permit engagement. As it returns to the passive position, the incisor will be extruded. Again, a degree of overcorrection is recommended.

Should intrusion of the incisor be required, a similar procedure is followed, with the composite ledge created on the gingival aspect of the activated labial bow.

With experience, these techniques for correcting incisor relapse can be carried out rapidly. Patients are usually appreciative of the efforts made to improve the alignment of their anterior teeth.

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# 25 LABORATORY AIDS

Eliakim Mizrahi, Desmond Solomon and Ronald G Melville

CONTENTS



## 25.1 ORTHODONTIC LABORATORY

All orthodontic practices, to a greater or lesser extent, make use of dental laboratories. Depending on the size of the practice and the preferences of the orthodontist, the laboratory may be: an external concern, an in-house laboratory employing a dental technician, or on a smaller scale, an in-house laboratory where limited procedures are carried out by the orthodontist and/or his or her staff. Most orthodontic practices will have at the very least a designated area where some technical procedures can be carried out. By the very nature of the work a degree of mess is created in the daily routine of a small laboratory.

**Pearl:** Keep the laboratory clean at all times. Use plastic film, changed daily, to cover and protect working equipment, such as dental vibrators.

I know it is not always easy to keep the laboratory clean, shiny, spick and span, but working in such a laboratory is so much more pleasant, than working in a messy, plaster-encrusted environment. After working with plaster or stone, clean all working surfaces and hand instruments, such as spatulas, before the plaster has a chance to set hard. Once plaster has set, it is hard to remove it from the working surfaces; it needs to be scraped off which in turn, roughens the surface making it more difficult to keep clean. Working surfaces should be sprayed or cleaned regularly with a silicone furniture polish; this prevents any set plaster from sticking to the surface.

The availability of a vacuum cleaner in the laboratory is very useful; it can be adapted to act as a dust extractor and to routinely clean spilt plaster powder or acrylic dust. Plaster powder will stick to your shoes and spread throughout the office, and acrylic cuttings and powder render a floor slippery and dangerous. Plaster powder or alginate powder allowed to flow down a drain will guarantee a blockage soon or later.

## 25.2 POLISHING DISC

### *25.2.1 Polishing Disc for Soft Mouth Guards and Invisible Retainers*

Desmond Solomon

Conventional Lisco discs (Erkodent, Germany) supplied by EM Natt, Ltd. (UK) are used for finishing and polishing soft mouth guards and vacuum-formed retainers. The following alternative is both cheaper and more effective (Figure 25.1a–d).

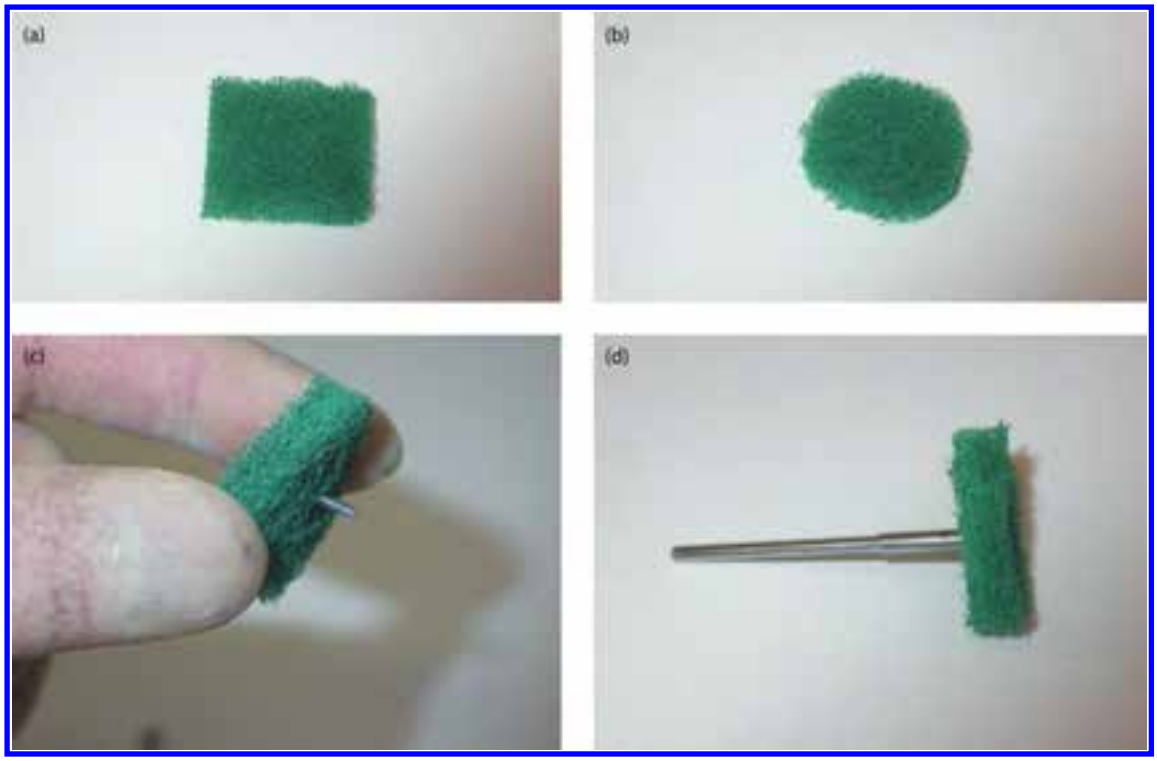


**Figure 25.1**

(a) Fabrication of a laboratory polishing wheel. With heavy duty scissors cut the scouring pad into 20 mm (0.75 inch) squares. (b) Trim the squares into circles. (c) Push a mandrel screw through the centre. (d) Screw the polishing wheel to a straight or contra-angle mandrel.

#### 25.2.1.1 Requirements

- A green scouring pad available from local supermarkets and hardware stores. Select pads approximately 6.0 mm (0.25 inch) thick.
- Straight screw-type mandrel.
- Pair of heavy duty scissors.

#### 25.2.1.2 Method

- Using heavy-duty scissors, cut the green scouring pad into 20 mm (0.75 inch) squares. Round off the square edges to create a circular wheel.
- Unscrew the screw from the mandrel and push it through the centre of the scouring pad wheel.
- Replace the screw, together with the scouring pad wheel, into the mandrel.

This type of polishing wheel can be used on all soft materials, such as gum shields and also hard, thin, clear retainer material. If used at high speed, it will cut the material, while at slow speed it will smooth and polish the material. I recommend that you first cut the mouth guards/invisible retainers to shape, smooth off any sharp edges in the normal manner and then smooth the edges with this finishing wheel.

It is also useful for cleaning and polishing soldered joints. The rough feel of the fitting surface of an acrylic appliance can be smoothed by lightly running this polishing wheel over the acrylic. The advantages of this type of polishing wheel are

- It is very inexpensive.
- It is flexible.
- It is possible to vary the size of the wheel to suit your specific requirement.

- It has no sharp edges, so there is no danger of cutting, nicking or scarring any plastic or metal components.

I find them very useful and I keep a stock at all times.

## 25.3 PLASTER

### *25.3.1 An Alternative Method for Mixing Plaster*

Desmond Solomon

My great mentor, William Johnstone, passed down this simple method to me. Apart from the plaster, all you need is a small rubber bowl and a sheet of semirigid plastic material that covers the circumference of the bowl.

Fill the bowl with the required amount of water and gently sprinkle the required plaster into the water until it forms a crust, and then sprinkle a bit more on top of that. Leave it at this stage for a minute or so until all the plaster is completely saturated, then put your hand under the tap and dribble little drops of water on the crust of the plaster. Place the plastic sheet over the top of the bowl. Firmly holding the plastic sheet in place with both thumbs and your fingers under the bowl, give it a good vigorous shake for about a minute. This results in excellent, smooth bubble-free plaster.

## 25.4 MODELS

Irrespective of how the plaster is mixed, it is important to cast air bubble-free models. Air bubbles trapped in the dental component of the model detract from the accuracy and quality of the final model. The following technique will almost always produce a good quality model:

- Under running water, rinse the impression well.
- While holding the impression tray on a vibrator, run plaster off a spatula at one end of the arch and let it run through to the opposite end. Do not be afraid to use excess plaster, as it runs along the arch it will displace any free water that may have accumulated in the dental component of the impression.
- Invert the impression over the plaster bowl and firmly tap the handle on the rim of the bowl. This should throw most of the plaster back into the bowl.
- Replace the impression tray on the vibrator and without adding any further plaster, watch the surface plaster that remained on the impression filling the dental component of the impression. Once the dentition is filled with plaster, the rest of the impression can be filled with plaster run off a spatula.

At this stage there are two options available:

1. Leave the cast impression to set and, as a separate procedure at a later stage, the set model separated from the impression may be based and trimmed.
2. As part of the same procedure, fill a rubber base mould with the same plaster mix and invert the cast impression over the base. Once the impression and base have set, the model can be trimmed.

## 25.5 EQUIPMENT

### *25.5.1 Protecting Equipment*

Ronald G Melville

One of the problems of keeping a small in-house laboratory is maintaining and cleaning the standing equipment. All personnel using the laboratory need to be instructed to clean plaster off all instruments and equipment immediately after use while the plaster is still soft. If a plaster vibrator is used, place it in an open plastic bag or cover it in plastic film (cling film) to prevent plaster flowing over and sticking to the vibrator. The plastic covering can be discarded at the end of each working day.

#### 25.5.1.1 Casting Models

In order to obtain really good study models, deep impressions are essential and should be cast using high quality plaster mixed under vacuum. Use commercially available rubber

base moulds to cast the bases, this reduces waste of plaster and is a much cleaner and neater procedure.

Trimming of models is usually a chore; they can be sent out to a professional dental laboratory or done in-house. The time and effort spent can be greatly reduced if the models are trimmed and sculptured as soon as the plaster is set. If you wait hours or days, the plaster will be very hard and more difficult to work. Once the models have been correctly trimmed, smoothed, and sculptured, they must be left to dry completely for about three days to prevent the models turning yellow. Follow this with immersion in liquid model soap for about four hours. Rinse the models well in warm water, allow to dry, and then rub with a cloth to shine. Total working time involved in preparing a set of models should not exceed one hour.

**Editor's Comment**

Currently, I believe we are in a transition time period, impressions can be replaced by intra-oral scanning, study models can be replaced by virtual models and 3D printers can reproduce working models from digital files; so the question arises, where do we stand and what does the future hold? (See Chapters 4 and 16.)

With specific reference to laboratory procedures, I believe most of this new technology will be taken up and reside in the larger commercial dental/orthodontic laboratories. Considering the cost of hardware, software and the technicians required to operate these systems, it is unlikely that the small in-house laboratory will take up the change; but the in-house laboratory will continue to be useful for small technical procedures related to clinical orthodontics.

For the clinician, like the introduction of most innovations a lot will depend on your financial status, your age, your location and your philosophy on orthodontic practise and life. But once we get through this transition time period, I predict that plaster study models and impressions for routine procedures, will largely be consigned to history.

# APPENDICES

## DISCLAIMER

While the sample letters listed in Appendices A–E, are in many cases currently being used by their respective authors, these authors do not accept any responsibility or liability for the legal correctness or status of these documents. Notwithstanding the fact that these letters have served the authors well over many years, the suitability of these letters should be assessed in relation to the laws and practices pertaining to each country, state and individual practice.

# APPENDIX A: SPECIMEN FORMS AND LETTERS

Eliakim Mizrahi

Specimen forms and letters published with permission from Dr Eliakim Mizrahi, 9 Aspen Court, 86 Holders Hill Road. London NW4 1LW.

**LETTER TO PRIVATELY TREATED ADULT PATIENT FOLLOWING A CASE DISCUSSION**

Dear. . . . . ,

1. This is to confirm our discussion regarding the proposed orthodontic treatment for yourself.
2. You have an acceptable relationship of your lower jaw to your upper jaw.
3. You have a retruded lower jaw in relation to your upper jaw.
4. You have a protrusive lower jaw in relation to your upper jaw.
5. There is crowding of the teeth in. . . . . arch resulting in their malalignment and an incorrect bite.
6. In order to try and correct the position of your teeth, it will be necessary for you to wear orthodontic appliances.
7. In order to try and correct the position of your teeth, it will be necessary for . . . . . teeth to be extracted and for you to wear orthodontic appliances.
8. In order to try and correct the position of your teeth, it will be necessary for you to wear orthodontic appliances. It may become necessary for certain teeth to be extracted at a later date.
9. The duration of treatment will be approximately . . .. . .., however this may vary greatly.
10. The cost of orthodontic treatment is made up as follows:

    INVESTIGATIONS £ . . . . . .
    TREATMENT £ . . . . . .

    This fee is payable by means of an initial payment of £. . . . . at the start of treatment plus the cost of investigations and the balance by means of a monthly bankers standing order payment of £ . . .. . .. . .. . .. . ...

10a. Should you request porcelain brackets there will be an additional charge of £ . . . . . payable at the start of treatment.

11. This fee is charged irrespective of the number of visits during the period of treatment. The fee does not include the cost of regular dental care such as fillings or extractions. In the event of an appliance being lost or broken an extra charge will be made.

11a. The cost of any future treatment will only be assessed if and when it becomes necessary.
11b. I must point out to you that in view of the close proximity of the crown of the impacted ..... to the roots of the adjacent teeth, it is possible that the roots of these teeth may be damaged either during surgical exposure or during and/or following orthodontic treatment.
12. Please note that throughout the period of orthodontic treatment, it is essential for you to continue to visit your dentist for your regular dental examinations as well as for any necessary dental treatment.
13. Following completion of active orthodontic treatment, there is a tendency for teeth to move back to their original position (relapse). Therefore, it will be essential for you to wear a retainer for an extended period of time. The cost of the retainer will only be assessed at that time.
14. The success of orthodontic treatment is dependent on the highest degree of patient cooperation. Unfortunately, should this cooperation become inadequate at any stage during treatment, you will be notified and reluctantly the treatment may have to be terminated prematurely.
15. In fairness to all the patients in the practice, should you fail to attend for your scheduled appointment without adequate prior cancellation, you will be charged on a time related basis for the missed appointment.
16. As acknowledgement of having received, read and understood this report together with the notification on *'Potential Risks and Limitations of Orthodontic Treatment'*, please sign and return the enclosed *'Consent Form'* prior to the commencement of treatment.
17. If you have any queries I would be pleased to discuss them with you.

Thank you.

Yours sincerely,

**Dr .....**

**(Select paragraphs 1 to 17 where relevant.)**

## LETTER TO PARENT/GUARDIAN FOLLOWING A CASE DISCUSSION FOR A MINOR PATIENT

Dear. . . . . ,

1. This is to confirm our discussion regarding the proposed orthodontic treatment for (*Name*)
2. (*Name*) has an acceptable relationship of (*his/her*) lower jaw to (*his/her*) upper jaw.
3. (*Name*) has a retruded lower jaw in relation to (*his/her*) upper jaw.
4. (*Name*) has a protrusive lower jaw in relation to (*his/her*) upper jaw.
5. There is crowding of the teeth in (*both/upper/lower*) jaw/s resulting in their malalignment and an incorrect bite.
6. In order to try and correct the position of (*Name*)'s teeth, it will be necessary for (*him/her*) to wear orthodontic appliances.
7. In order to try and correct the position of (*Name*)'s teeth, it will be necessary for certain teeth to be extracted and for (*him/her*) to wear orthodontic appliances.
8. In order to try and correct the position of (*Name*)'s teeth, it will be necessary for (*him/her*) to wear orthodontic appliances. It may become necessary for certain teeth to be extracted at a later date.
9. The treatment will be divided into two stages. The object of the first stage is to (specific to each case). The need for a second stage of treatment will only be assessed at a later date. The availability of the second stage of treatment under the NHS will be dependent on the waiting list at that time.
10. The duration of treatment will be approximately . . . . . , however, this may vary greatly.
11. The cost of orthodontic treatment is made up as follows:

    INVESTIGATIONS £. . . . . .
    TREATMENT £. . . . . .

    This fee is payable by means of an initial payment of £. . . . . at the start of treatment plus the cost of investigations and the balance by means of a monthly bankers standing order payment of £. . . . . .

11a. Should *(Name*) request porcelain brackets there will be an additional charge of £. . . . . payable at the start of treatment.
12. This fee is charged irrespective of the number of visits during the period of treatment. The fee does not include the cost of regular dental care such as fillings or extractions. In the event of an appliance being lost or broken an extra charge will be made.

12a. The cost of any future treatment will only be assessed if and when it becomes necessary.

13. I must point out to you that in view of the close proximity of the crown of the impacted . . . . . to the roots of the adjacent teeth, it is possible that the roots of these teeth may be damaged either during surgical exposure or during and/or following orthodontic treatment.
14. Please note that throughout the period of orthodontic treatment it is essential for (*Name*) to continue to visit (*his/her*) dentist for regular dental examinations as well as for any necessary dental treatment.
15. Following completion of active orthodontic treatment there is a tendency for teeth to move back to their original position (*relapse*). Therefore, it will be essential for (*him/her*) to wear a retainer for an extended period of time. The cost of the retainer will only be assessed at that time.
16. I must point out to you that the result of this case will depend to a large extent on the degree of growth taking place in the lower jaw over the next few years.
17. The success of orthodontic treatment is dependent on the highest degree of patient cooperation. Unfortunately, should this cooperation become inadequate at any stage during treatment, you will be notified and reluctantly the treatment may have to be terminated prematurely.

18. In fairness to all the patients in the practice, should (*Name*) fail to attend for (*his/her*) scheduled appointment without adequate prior cancellation, you will be charged on a time related basis for the missed appointment.
19. As acknowledgement of having received, read and understood this report together with the notification on *'Potential Risks and Limitations of Orthodontic Treatment'*, please sign and return the enclosed *'Consent Form'* prior to the commencement of treatment.
20. If you have any queries I would be pleased to discuss them with you.

Thank you.

Yours sincerely,

**Dr ……**

**(Select paragraphs 1 to 20 as considered relevant.)**

## LETTER TO A PATIENT'S DENTIST FOLLOWING AN INITIAL CONSULTATION

Dear. ….……..…,

Re: ….……..…..…

1. Thank you for your confidence and courtesy in referring this patient to me.
2. *(Name*) has a Class …… malocclusion.…..…(with superimposed crowding, spacing, etc.).
3. A full orthodontic investigation has not as yet been carried out *(Name)* has been requested to return for a re-evaluation at …… intervals. When records have been taken you will be sent a full report.
4. I would, however, suggest that at this stage you extract……, complete any necessary conservation and carry out a fluoride application at your convenience.
5. This patient is now ready to start active orthodontic treatment.
6. A full orthodontic investigation has not as yet been carried out. When *(Name or Parents*) agree to have records taken, you will be sent a full report.
7. If you have any queries I would be pleased to discuss them with you.

Thank you.

Yours sincerely,

**Dr ……**

**(Select paragraphs 1 to 7 as considered relevant.)**

## LETTER TO A PATIENT'S DENTIST FOLLOWING FIRST VISIT WHEN RECORDS HAVE BEEN TAKEN AND AN APPOINTMENT HAS BEEN MADE FOR A CASE DISCUSSION

Dear……,

Re: ……

Thank you for your confidence and courtesy in referring this patient to me.

Following a comprehensive orthodontic investigation, an appointment has been scheduled for a case discussion following which you will be sent a full report.

If you have any queries I would be pleased to discuss them with you.

Thank you.

Yours sincerely,

**Dr ……**

## LETTER TO A PATIENT'S DENTIST FOLLOWING FIRST VISIT WHEN AN APPOINTMENT HAS BEEN MADE FOR INVESTIGATIONS

Dear ……,

Re: ……

Thank you for your confidence and courtesy in referring this patient to me.

An appointment has been scheduled for orthodontic investigations to be carried out following which you will be sent a full report.

If you have any queries I would be pleased to discuss them with you.

Thank you.

Yours sincerely,

**Dr ……**

## REPORT TO THE PATIENT'S DENTIST FOLLOWING CASE DISCUSSION

Dear. . . . . ,

Re: . . . . . .

1. Thank you for your confidence and courtesy in referring this patient to me.
2. This is a report on the proposed orthodontic treatment for (*Name*)
3. (*Name*) has a Class . . . . . skeletal pattern. There is crowding of the teeth in (*both/upper/lower arches*) resulting in their malalignment and an incorrect bite (overjet, overbite, crossbite, missing teeth, etc.).
4. (*Name*) has a Class . . . . . skeletal pattern. There is...(overjet, overbite, crossbite, missing teeth, etc.)...(case with no crowding).
5. After considering the relevant data, I have decided on the following treatment plan:
    1. Extract. . . . . .
    2. Full fixed appliance therapy
    3. Retention
6. **If the patient/parent/s decide** to go ahead with the treatment, I would appreciate it if you would (extract. . . . . if relevant) complete any necessary conservation and carry out a fluoride application at your convenience.
7. It has been pointed out to the patient/parents that in view of the close proximity of the crowns of the unerupted . . . . . to the roots of the adjacent teeth, it is possible that these roots may be damaged either during surgical exposure or during and/or following orthodontic treatment.
8. It has been pointed out to the patient/parent/s that the final result of this case will depend to a large extent on the degree of growth taking place in the mandible over the next few years.
9. It has been pointed out to the parent/s that this type of malocclusion does have a tendency to a certain amount of relapse following completion of orthodontic treatment.
10. Although the patient has been instructed to return to your surgery for regular consultations throughout active treatment, it has been our experience that they often neglect to do so. I would appreciate it if you could make a special note to recall this patient periodically during orthodontic treatment.
11. If you have any queries, I will be pleased to discuss them with you.

Thank you.

Yours sincerely,

**Dr . . . . . .**

**(Select paragraphs 1 to 11 where relevant.)**

## LETTER TO THE PATIENT'S DENTIST REQUESTING EXTRACTIONS

Dear ……,

Re: ……

This patient appears to be progressing satisfactorily.

I would appreciate it if at this stage you would extract the ……, complete any necessary conservation and carry out a fluoride application at your convenience.

If you have any queries I would be pleased to discuss them with you.

Thank you.

Yours sincerely,

**Dr ……**

## LETTER TO A PATIENT'S DENTIST FOLLOWING REMOVAL OF FIXED APPLIANCES

Dear……,

Re: ……

This is to inform you that your patient (*Name*) has completed active orthodontic treatment and is now in retention.

The patient has been instructed to return to you for a general dental examination and a fluoride application.

Thank you for your referral.

Yours sincerely,

**Dr ……**

## LETTER TO PATIENT: RETENTION

Dear ……,

Now that your phase of fixed appliance treatment has been completed, I wish to thank you for your cooperation and hope that you are pleased with the result.

We have now instituted the use of a special appliance to help complete orthodontic treatment.

This is an appliance designed to either move the teeth to their final positions and/or hold them until the bone becomes stabilized. It is absolutely essential for the appliance to be worn according to the instructions so that we can attain maximum correction.

Because of the importance of this phase of treatment, we must ask you to wear the appliance as directed during the time between surgery visits.

The duration of the retention phase varies with each individual case. Please follow our instructions regarding your retention schedule.

The appliance is difficult and expensive to make. Therefore, we suggest that care be taken to prevent its loss or destruction, to avoid replacement costs.

At this stage we advise you to return to your general dentist for a full examination and fluoride application.

Please note fixed retainers encourage the accumulation of food and plaque. They need to be cleaned thoroughly daily and checked at six monthly intervals by your dentist or orthodontist.

Thank you for your understanding and cooperation in this phase of the treatment. If you have any questions, please feel free to contact us.

Yours sincerely,

**Dr ……**

**(Given in conjunction with written instructions on the care of removable appliances.)**

## LETTER TO PARENT REGARDING POOR COOPERATION

Dear ……,

1. This letter serves to inform you that we are experiencing certain problems with the progress of (*Name*)'s orthodontic treatment.
2. (*Name*) is not maintaining an adequate level of oral hygiene. It has been explained to (*Name*) that this will lead to the teeth being permanently marked and the development of cavities.
3. General cooperation regarding the care of (*Name*)'s orthodontic appliances is poor. Failure to take care of the appliances or to wear elastics as directed will slow down the treatment progress.
4. In my original letter to you dated……, it was pointed out that the success of orthodontic treatment is dependent on the highest degree of patient cooperation. I would appreciate it if you could point out to (*Name*) that for the treatment to reach a successful conclusion it will be necessary for (*him/her*) to improve the level of (*his/her*) cooperation.
5. Please attend together with (*Name*) at (*his/her*) next appointment on…… to discuss the discontinuation of (*Name*)'s treatment.

Yours sincerely,

**Dr ……**

**(Select paragraphs 1 to 5 where relevant.)**

## LETTER TO PATIENT/PARENT FOLLOWING FAILURE TO RETURN FOR APPOINTMENTS

Dear ……

It has become apparent that (*Name*) failed to attend for (*his/her*) regular appliance adjustments since the ……

I must point out to you that as mentioned in our original letter dated ……, it is essential for us to have full cooperation and to adjust (*Name*)'s appliances regularly in order to achieve a satisfactory result. Failure to monitor and adjust appliances can result in permanent damage to (*Name*)'s teeth, gums and supporting bone. Under these circumstances I must point out to you that we cannot accept any responsibility for damage that will occur to (*Name*)'s teeth, gums or bone due to (*his/her*) failure to attend for regular maintenance.

Should you prefer to discontinue (*Name*)'s treatment it will be necessary for you to make an appointment at your earliest possible convenience to arrange for the removal of (*Name*)'s braces.

If you have any queries I would be pleased to discuss them with you.

Thank you.

Yours sincerely,

**Dr ……**

## POTENTIAL RISKS AND LIMITATIONS OF ORTHODONTIC TREATMENT

To our patients:

As a rule excellent orthodontic results can be achieved with informed and cooperative patients. The following information is routinely supplied to anyone considering orthodontic treatment in our office. While recognizing the benefits of a pleasing smile and healthy teeth you should also be aware that orthodontic treatment, like any treatment of the body, has some inherent risks and limitations. These are seldom enough to contraindicate treatment, but should be considered in making the decision to wear orthodontic appliances. Please feel free to ask questions about this at the pre-treatment consultation.

Decalcification (permanent markings), decay, or gum disease can occur if patients do not brush their teeth properly and thoroughly during the treatment period. Excellent oral hygiene and plaque removal is a must. Sugars and between meal snacks should be eliminated.

Teeth have a tendency to rebound towards their original position after orthodontic treatment. This is called relapse. Very severe problems have a higher tendency to relapse and the most common area for relapse is the lower front teeth. After band removal a positioner or retainers may be placed to minimize relapse. Full cooperation in wearing these appliances is vital. We will make our correction to the highest standards and in many cases over-correct in order to accommodate the rebound tendencies. When retention is discontinued some relapse is still possible.

A non-vital or dead tooth is a possibility. A tooth that has been traumatized from a deep filling or even a minor blow can die over a long period of time with or without orthodontic treatment. An undetected non-vital tooth may flare up during orthodontic movement requiring endodontic (root canal) treatment to maintain it.

In some cases the root ends of the teeth are shortened during treatment. This is called root resorption. Under healthy circumstances the shortened roots are no disadvantage. However, in the event of gum disease in later life the root resorption could reduce the longevity of the affected teeth. It should be noted that not all root resorption arises from orthodontic treatment. Trauma, impaction, endocrine disorders or idiopathic reasons can also cause root resorption.

There is also a risk that problems may occur in the temporo-mandibular joints (TMJ). Although this is rare, it is a possibility. Tooth alignment or bite correction can improve tooth related causes of TMJ pain but not in all cases. Tension appears to play a role in the frequency and severity of joint pains.

Occasionally a person who has grown normally and in average proportion may not continue to do so. If growth becomes disproportionate, the jaw relation can be affected and original treatment objectives may have to be compromised. Skeletal growth disharmony is a biological process beyond the orthodontist's control.

The total time for treatment can be delayed beyond our estimate. Lack of facial growth, poor elastic wear or headgear cooperation, broken appliances and missed appointments are all important factors which could lengthen treatment time and affect the quality of the result.

Headgear instructions must be followed carefully. A headgear that is pulled outward while the elastic force is attached can snap back and poke into the face or eyes. Be sure to release the elastic force before removing the headgear from the teeth.

So please, lets make every effort to do it right. This takes cooperation from everyone, orthodontist, the staff, your family and most of all the patient.

**Dr .....**

# APPENDIX B: SPECIMEN INTRA- AND EXTRAOFFICE COMMUNICATIONS

Laurance Jerrold

**THANK YOU TO REFERRING AND NON-REFERRING DOCTOR**

Dear Dr _____

(If to a referring doctor):

This is to acknowledge, with thanks, your referral of (Name of patient) to our office. It is a pleasure to assist you in (Name) overall dental treatment needs.

Insert appropriate paragraph 1–4 below

(If to the patient's GP who did not refer the patient):

This is to acknowledge, that ____(Name of patient)____ is being seen by our office for orthodontic treatment. It is a pleasure to work with you concerning (Name) overall dental treatment needs.

Insert appropriate paragraph 1–4 below

If Option #1: An appointment has been made for ____(Name)____ and complete records and a comprehensive evaluation will be made. We will furnish you with a synopsis and orthodontic treatment plan as soon as possible.

If Options #2 or #4: When ____(Name)____ is ready to initiate active orthodontic therapy, we will furnish you with a synopsis and treatment plan at that time.

Cordially,

1. We fully agree that now is an opportune time to begin orthodontic therapy. Please let us know your usual office procedure with regard to periodic examination and prophylaxis. We shall be happy to cooperate with you in every possible way.
2. We have recommended that ____(Name)____ be kept under periodic observation until such time as treatment is indicated. We sincerely feel that postponing treatment at this time is the procedure of choice in this type of malocclusion. It is our sincere belief that ____(Name)____ will significantly benefit from monitoring his/her dentofacial growth and development and instituting appropriate timely therapy at some later date.

3. After preliminary examination, we feel that the risk/benefit ratio in this particular case is such that orthodontic treatment is unwarranted. We will be happy to discuss this matter with you at your convenience.
4. We fully agree that now is an opportune time to begin orthodontic therapy.

   a. (Name) is considering undergoing treatment.
   b. However due to undisclosed reasons ____(Name)____ wishes to delay the start of treatment.
   c. However due to financial considerations (Name) wishes to delay the start of treatment.
   d. ____(Name)____ has indicated however that he/she wishes to forego the benefit of orthodontic therapy.
   e. Ideal treatment for this patient may involve orthodontics and ____(State the form of interdisciplinary therapy)____. The patient is considering this option.

**REQUEST FOR MEDICAL HISTORY TO PRIMARY CARE PROVIDER**

Dear Dr

I would appreciate your letting me know if there is any information in your records regarding diagnosis or treatment for any of the following disorders:

Autoimmune diseases
Allergies
Endocrinopathies
Upper respiratory impairments
Cardiopathies
Hereditary or genetic diseases
Infectious diseases
Bone metabolism disorders

Trusting I have the pleasure of hearing from you soon, I am

Cordially,

**********

Records release

I authorize the release of the above requested medical information pertaining to myself/my child as requested by Dr _____

(Patient's/parent's signature)

**********

**REQUEST FOR MEDICAL HISTORY AND ADVICE FROM CARDIOLOGIST**

Dear Dr _____,

(Patient's name) is under our care for orthodontic therapy. Our medical history intake form reveals that (Patient's name) indicated a positive history of having suffered from (fill in choices from 1–5 below) .

Please advise us as to the following:

1. The nature of the cardiac problem.
2. Whether or not you recommend prophylactic antibiotic coverage for IE.
3. If so, should we follow the American Heart Association regimen or one of your own?

Thank you for your prompt reply.

Respectfully,

**********

I authorize the release of the above requested medical information pertaining to myself/my child as requested by Dr _____.

Patient's/parent's signature

**********

---

1. A heart murmur
2. Had rheumatic fever
3. Had prosthetic joint replacement
4. Mitral valve prolapse
5. Unspecified cardiomyopathy

**REFERRAL TO OTOLARYNGOLOGIST/ALLERGIST/PAEDIATRICIAN**

Dear Dr _____,

(Name) has been evaluated by our office for orthodontic therapy. Our examination revealed the presence of or history of:

[] Steep mandibular plane
[] Open bite tendency
[] Excessive lower face height
[] Mouth breathing
[] Radiographic large adenoidal tissue mass w/nasopharyngeal obstruction
[] Deviated septum
[] Engorged turbinates
[] History of allergic rhinitis
[] High narrow palatal vault
[] Obstructive sleep apnea
[] Antral polyps
[] _____

As you are aware, upper airway obstruction in the formative years can significantly affect one's dentofacial growth and development. Untreated obstructions can also seriously affect the stability of any orthodontic treatment rendered. Please examine ____(Name)____ regarding the above noted factors and evaluate him/her for any necessary treatment.

If you wish to discuss ____(Name)____ case with us, please feel free to call.

Respectfully,

cc: Allergist
Pediatrician
Dentist
ENT Physician

## PERIODONTAL REFERRAL LETTER

Dear Dr _____ :

(Patient's name) [presented to our office for] or [in the midst of orthodontic therapy] and upon examination we believe that his/her oral environment is not compatible with the [initiation of] or [continuation of] orthodontic treatment.

Please evaluate the need for:
[] Oral hygiene instruction
[] Prophylaxis
[] Deep scaling & curettage
[] Other

In addition, please evaluate the following areas/tooth numbers for the following procedures. In conjunction with Patient's name treatment.

Area/tooth Number(s):_____

[] Exposure
[] Frenectomy
[] Circumferential supercrestal fiberotomy
[] Free gingival graft
[] Gingivectomy
[] Gingivoplasty
[] Apically repositioned graft
[] Crown lengthening
[] _____

If you feel that more extensive treatment or therapy is indicated, please inform our office so that we may aid in any way possible and also to allow us to reschedule the patient accordingly.

Respectfully,

Doctor's name

## REFERRAL FORM TO GENERAL DENTIST

Dear Dr

We recently evaluated (Patient's name) regarding orthodontic therapy. Please examine the following teeth for caries/decalcification management:

[] Entire mouth
[] Specific teeth/surfaces:

_____ _____
_____ _____
_____ _____

Some of these surfaces may be small, however, these teeth will have orthodontic appliances placed on them, and therefore we leave it to your clinical judgment as to whether you wish to restore them at this time. Our examination was performed [] with [] without the benefit of radiographs.

Remarks: _____
_____
_____

Respectfully,

Doctor's name

## TRADITIONAL VERSION OF INFORMED CONSENT FORM

## IMPORTANT INFORMATION ABOUT YOUR ORTHODONTIC TREATMENT

Orthodontic treatment like other forms of medical treatment offers tremendous benefits. Likewise, there are occasional problems that patients sometimes encounter. Most of the time these problems are usually not severe enough to contraindicate treatment, they should be considered by you before deciding to undergo orthodontic treatment. Please indicate your understanding of these facts by placing your initials in each box below.

DISCOMFORT: As your teeth move they may become slightly loose and this may be uncomfortable. Patients usually get used to this within a short period of time and once the braces are removed the teeth tighten up again. If you are having any pain – call your doctor, let us help. Also, your teeth may hurt for a day or two after an adjustment. This is normal and simple over-the-counter painkillers will be helpful. _____

ORAL HYGIENE: Properly brushing your teeth is a MUST. If proper oral hygiene is not maintained, permanent marks and scarring of the teeth can result. Poor brushing can also lead to cavities as well as to gum disease. In severe cases, treatment may have to stopped before it is completed or teeth may be lost. *You are responsible for continuing to see your regular dentist for check-ups and cleanings at least twice a year. Please don't expect us to replace your general dentist*. _____

ROOT DAMAGE: During tooth movement it is not unusual for the tips of the roots of your teeth to shrink slightly. This is not significant unless it becomes severe. This may also occur as teeth are developing and erupting into the mouth. We will monitor your teeth throughout treatment and alert you to any significant changes.

TEMPOROMANDIBULAR DYSFUNCTION AND MYOFACIAL PAIN DYSFUNCTION: Sometimes during treatment, a patient's jaw joint will become inflamed. On rare occasions it becomes severe enough to require additional treatment by your dentist or other specialists. If you are having any problems be sure to speak with your doctor. _____

RELAPSE: Change is everywhere and orthodontics is not immune. In children there are rapid periods of growth that cause dramatic changes in the size or jaw position of one's jaws. In adults, this change is merely the result of aging. Either way, orthodontic results are not 100% stable and some movement is normal. We can't control genetics, habits, growth, the size of your teeth, and other factors that can cause teeth to shift slightly after treatment is completed. When treatment is complete, we will provide you with retainers which you will have to wear to help minimize this movement but nothing lasts forever, including straight teeth. _____

DAMAGE FROM APPLIANCES: Certain types of braces carry some associated risks. Ceramic braces may cause slight damage to the teeth they are attached to as well to the teeth they bite against. Patients have occasionally reported allergic reactions to the acrylic in their removable appliances, the latex used in the rubber bands or gloves, while others have had similar reactions to some of the metals used in traditional braces. Finally, there have been rare instances where a patient has suffered an eye injury because of improper headgear (night brace) use. _____

TREATMENT DECISIONS: Occasionally, patients have skeletal problems but are unwilling to undergo facial surgery to correct them. When this happens, certain compromises in the result have to be accepted. Similar compromises result when one chooses to only treat a limited aspect of a more involved problem. Braces are also often undertaken in preparation for other dental procedures that may not be followed through on. Finally, prolonging treatment can sometimes result in not being able to achieve the best correction. Decisions like these can cause a less than ideal result. _____

OTHER DENTAL TREATMENT: On rare occasions the nerve of a tooth undergoing orthodontic treatment will die and require a root canal. In addition, the inability to fully close an extraction space, or the loss of a tooth undergoing surgical exposure are also rare side effects associated with those treatments. _____

ANATOMIC LIMITATIONS: Occasionally, a patient's teeth are not the correct size or shape for the size of the patient's jaw. This may result in slight spacing or the need for bonding or caps at the end of treatment. Also teeth can only be moved so far and if the jaws are too big or too small facial surgery may be necessary. _____

PATIENT COOPERATION: Patient cooperation such as following your doctor's instructions and keeping regularly scheduled appointments is absolutely necessary for optimal results to be achieved. If not, treatment time may have to be extended. Also, if patients continue to engage in harmful oral habits such as thumb sucking or grinding your teeth, the stability of the finished result may be compromised. _____

PATIENT PRIVACY: Like all healthcare services, my doctor may have to consult with other healthcare professionals concerning my treatment. Permission is hereby granted to exchange medical and dental information about me/my child only as it relates to providing and paying for orthodontic treatment. In addition, I give permission for photos, x-rays, models and clinically relevant data of me/my child to be used in scientific publications and/or presentations and for no other purpose. _____

OTHER: _____
_____
_____
_____ _____

My orthodontic treatment has been thoroughly discussed with me. I have had the opportunity to ask questions about my proposed treatment and I understand the potential benefits and risks as noted above. I also understand that during treatment, circumstances may arise requiring either a discontinuation of or a change from the original treatment plan. If either of these occurs, it may result in adjustments to the cost of treatment. Lastly, I understand that the fee presented to me is only for orthodontic treatment and if other dental treatment is necessary, there will be additional fees charged for those services.

_____ _____
Signature of patient or parent if patient is a minor Date

_____ /_____

Signature and printed name of witness

## CHECKLIST TYPE INFORMED CONSENT FORM

## CHECKLIST FOR INFORMED CONSENT REGARDING RISKS, COMPROMISES AND LIMITATIONS

[] HYGIENE RELATED PROBLEMS
- caries and/or decalcifications

[] ROOT RESORPTION
- Does the root structure or intended mechanics predispose a greater risk of this occurring
- Is there risk to an adjacent tooth i.e. an impacted canine and its effect on the root of the lateral

[] PERIODONTAL COMPLICATIONS
- Will the intended mechanics heighten the potential for this sequelae
- Is the patient's existing periodontal condition compromised or predisposing to negative sequelae

[] REBOUND AND/OR RELAPSE VS. NORMAL TOOTH MOVEMENT
- The natural phenomenon for teeth to respond to environmental factors should be discussed

[] TMJ/MPD
- The transitory and multifactoral nature of this potential problem should be discussed particularly if there are pre-treatment symptoms

[] ENDODONTIC PROBLEMS
- This should be discussed if there is a history of trauma, deep decay and/or restorations, or teeth that are out of or will be moved through or against the buccal plate or palatal cortex

[] ALLERGIES
- Acrylic appliances, latex sensitivity, nickel

[] CERAMIC BRACKETS
- If using a chemical bond enhancing agent the patient should be informed regarding debonding fracture
- in addition, attrition and/or cusp fracture of the opposing dentition should be noted

[] REMOVABLE APPLIANCES
- Ingestion, aspiration, and additional charges for lost or broken appliances

[] HEADGEAR
- The potential for soft tissue and/or ocular injury

[] ORAL SURGERY
- Inability to close extraction spaces or osteotomy sites
- Uncertainty related to the exposure of impacted teeth

[] GROWTH
- Excessive, unanticipated, or insufficient growth can occur during or after treatment

[] INSUFFICIENT COOPERATION
- Can extend the length of treatment
- Can affect the amount of correction achieved
- If related to hygiene see above

[] SECONDARY RESTORATIVE TREATMENT NEEDED
- Will the patient need implants, prosthetics, permanent splinting, etc.
- Discuss that the fee for these secondary procedures is not part of the orthodontic fee charged

[] SKELETAL COMPONENT WITH ASSOCIATED DENTAL COMPENSATIONS
- If there is a skeletal component and camouflage therapy is recommended, discuss the anatomical limitations and the associated dental compensations that will remain at the end of treatment

[] RETENTION
- Long term, lifetime, fixed or removable
- Discuss with the patient that active treatment is completed and that the retention phase of treatment will last for "x" period of time
- Discuss the prognosis for long term stability

[] LIMITED TREATMENT
- Discuss the specific goals and objectives
- Stop treatment when the goals/objectives have been met
- If a second phase of treatment will be necessary discuss that and that there will be a separate fee for that service

[] TOOTH SIZE/ARCH LENGTH DISCREPANCIES
- Discuss the effect on the completed occlusal scheme
- Discuss post treatment spacing
- Discuss the need for post treatment restorative dentistry and that these fees are not part of the patient's orthodontic fee

[] CONTINUED DELETERIOUS HABITS
- If habits persist or develop post treatment, discuss the negative effect on stability

[] TIMING OF TREATMENT AND RELATED PROBLEMS
- Discuss the option of 2 phases of treatment verses 1 phase
- Be sure to include the fiscal, temporal, and psychosocial aspects of each

*This form can either be used as a guide for the consultation visit or can be modified from checklist style to paragraph style to accommodate a patient's signature on the bottom or their initials next to each item, if desired.*

## INFORMED CONSENT FORM FOR TADS

CONSENT FOR USE OF TEMPORARY ANCHORAGE DEVICE (TAD)

Your doctor has recommended the use of a temporary anchorage device (TAD) also known as a micro screw or mini screw. This device is to aid your doctor in his ability to move certain teeth while not affecting the position of other teeth. While this is not the only method to achieve the desired result, it is a very effective and efficient means of doing so, but it does carry some risks of which you should be aware. The following paragraphs are designed to inform you of the known risks associated with this procedure thereby providing you with sufficient information to make an informed decision about accepting this form of treatment.

PLEASE PLACE YOUR INITIALS IN THE BOX NEXT TO EACH PARAGRAPH INDICATING THAT YOU HAVE READ AND UNDERSTOOD WHAT IT SAYS.

ALTERNATIVE TYPES OF TREATMENT

The TAD procedure has been explained to me and I understand that it is one of several alternative means to achieve a desired result. The other anchorage alternatives along with any compromises and limitations associated with them has been explained to me. _____

PAIN AND/OR DISCOMFORT

Any surgical procedure carries the risk of some degree of pain or discomfort. Inserting a TAD is no different, however any pain or discomfort can usually be addressed through the use of simple over the counter pain medication. There is usually no problem with returning to work or school the next day. If you are still experiencing significant discomfort after 48 hours, call your doctor immediately. _____

INJURY TO THE ROOTS OF TEETH

As TADs are placed in close proximity to the roots of your teeth, the implants may occasionally come into contact with them. While this may cause minor damage to the roots, in most cases this type of injury is not clinically significant. On rare occasions a root canal procedure may be required. It is also remotely possible for TAD placement to result in loss of a tooth. _____

BLEEDING AND/OR POST OPERATIVE INFECTIONS

All surgical procedures carry the risk of excessive bleeding or post operative infection. While the potential for excessive bleeding is extremely rare, occasionally a minor infection may result from the placement of a TAD. Should this occur, routine antibiotic therapy may be necessary. _____

INJURY TO THE NERVES

Placing a TAD may injure a nerve leading to a tooth or to the jaw. The resulting tingling and/or numbness is usually temporary but on rare occasions it may become permanent. _____

PERFORATION OF THE SINUS

Occasionally, a portion of the TAD may perforate the sinus. Usually this does not present a problem. On rare occasions, if a perforation does not heal properly, a second surgical procedure by another doctor may be necessary to repair the sinus. _____

REMOVAL OF IMPLANT/CHANGE OF TREATMENT PLAN

All TADs need to be removed after your treatment is completed. However, if one or more TADs should have to be removed early because of any of the above noted factors, even at the time they are placed, your treatment plan may have to be changed. It may be as simple as using another form of anchorage, having to extract teeth, or, in rare situations, jaw surgery may be required. Your doctor will discuss these options with you if the need arises. _____

PATIENT COOPERATION

Patient cooperation such as following your doctor's instructions regarding the wearing and changing of any elastics, as well as following precisely any oral hygiene instructions, is critically important to minimize negative occurrences and maximize the results of therapy. _____

OTHER FEES

I understand that the fee presented to me is only for orthodontic treatment including the placement of the TADs. If other dental or surgical treatment is necessary, there will be additional fees charged for those services by the doctors who provide those services. _____

PATIENT PRIVACY

Like all healthcare services, my doctor may have to consult with other healthcare professionals concerning my treatment. Permission is hereby granted to exchange medical and dental information about me/my child only as it relates to providing and paying for my treatment. In addition, I give permission for photos, x-rays, models and clinically relevant data of me/my child to be used in scientific publications and/or presentations and for no other purpose. _____

GUARANTEES

I understand that perfect results are not guaranteed in the delivery of oral health care services and that the use of TADs as part of my treatment will neither guarantee a better result nor faster treatment. _____

MY UNDERSTANDING

I certify that I speak, read, and write English or, have had the contents of this form translated to me in my native language. I fully understand the benefits and risks associated with using TADs and voluntarily accept them. _____

| _____ | _____ | _____ |
|---|---|---|
| Printed name of patient or parent (if a minor) | Signature of patient or parent (if a minor) | Date |
| _____ | _____ | _____ |
| Printed name of witness | Signature of witness | Date |

## INFORMED CONSENT FORM FOR LIMITED TREATMENT

CONSENT FOR LIMITED TREATMENT

Orthodontics provides you with the opportunity to improve certain aspects of not only how your mouth functions but also, how your smile looks. Generally speaking when a patient goes to an orthodontist for a consultation, they are presented with the best treatment plan that addresses all of the patient's complaints as well as the doctor's concerns. Occasionally however, orthodontists find that their patients desire to only have limited treatment performed.

For example, lets say that you have some crooked or crowded upper front teeth. You also have an overbite with your top teeth sticking out a little bit past your lower front teeth. Your doctor may want to fix the overbite as well as the crowding. You on the other hand, don't care about the overbite and merely want your front teeth aligned to improve your smile.

Enter the world of limited treatment. If you decide you only want to correct part of your total orthodontic problem, that's fine; however you must be aware of certain facts.

1. Deciding to accept limited treatment means just that. Your doctor will only address those concerns. Other orthodontic problems will not be corrected.
2. If, after correcting what you were concerned about, you now choose to have the remaining problems addressed, an additional fee will be charged and additional time in braces will be necessary.
3. We will not offer a patient the limited treatment option if the patient's periodontal support cannot withstand the rigors of orthodontic tooth movement OR, if in our opinion, limited treatment will cause other harm to the supporting hard and/or soft tissues in your mouth.
4. In some cases the ideal result cannot be achieved because we are not treating all of the teeth. This is a limitation YOU, the patient, must accept.
5. Limited treatment results must be maintained after treatment is completed in the same way that full orthodontic therapy must be retained. Your doctor will explain the necessary retention protocol to follow.
6. Over time, there may be detrimental effects from not having comprehensive or full treatment performed. Remember this would have happened anyway had you had no treatment; and it may still occur even though you had limited treatment, as the cause may have been the problem(s) you chose not to treat.

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

I, _____, have had the option of limited treatment explained to me and understand that only a portion of my orthodontic problem(s) will be addressed. The choice to accept limited treatment is mine alone and I am aware of the limited benefits to be achieved. I understand and release Dr _____ for any negative occurrence I may encounter as a result of allowing only limited treatment to be performed.

_____ _____

Signature of patient/parent Date

_____ _____

Signature of witness Date

## INFORMED CONSENT FORM REGARDING IPR/REPROXIMATION/STRIPPING

INFORMED CONSENT REGARDING INTERPROXIMAL REDUCTION

You have been advised that as part of your orthodontic treatment plan, it is necessary to remove some enamel from the sides of some of your teeth. This procedure goes by various names. It is often referred to as interproximal reduction, reproximation, stripping, IPR, and enamelplasty.

WHAT IS INTERPROXIMAL REDUCTION (IPR)?
Essentially, what the procedure involves is removing small amounts of enamel from the sides of one or more teeth in an effort to make a tooth's dimension smaller. This is most often done to create additional space to resolve mild to moderate crowding as well as to recreate normal anatomy for a tooth that was slightly malformed. The alternative methods to create this space would be either to extract permanent teeth or to flare out the teeth and expand the dental arch form, each one of which has potential negative consequences.

HOW IS IPR PERFORMED?
There are two basic approaches to removing enamel from the sides of teeth. The first is to take 'sandpaper' like strips and rub them back and forth along the sides of the teeth removing a small amount of the outer layer of enamel. The other more common way is to use rotary instruments (dental drills) with either very thin discs or very small burrs to file down the sides of the teeth.

WHAT ARE THE RISKS OF THIS PROCEDURE?
For the most part, the risks are very small. Occasionally however, the following occurrences sometimes happen:

- Small step like projections can occur along the side of a tooth
- Cavities may occur in areas where the tooth has been filed down
- The affected tooth may become sensitive to hot or cold stimulation
- The gum tissue around the tooth may become cut, inflamed or swollen
- The shape of the affected teeth may be different from the adjacent teeth
- The patient's gums, lips or tongue may be cut during the procedure
- While the above occurrences do sometimes occur, when they do most of the time they are of such a minor nature that there are no long lasting negative effects. In very rare cases, IPR may lead to the nerve of a tooth being permanently injured.

DO I HAVE TO HAVE THIS PROCEDURE PERFORMED?
No you do not, but as previously mention, the only other alternative would be the extraction of permanent teeth, or placing teeth in positions that might be very unstable.

CONSENT
I have been informed that [] my [] my child's orthodontic treatment requires IPR and I acknowledge that I am aware of what the procedure is, what it entails, and the potential risks associated with the procedure. I have also been informed about other alternatives to IPR. I have had the opportunity to have all of my questions concerning IPR asked and answered.

_____ _____

Patient, parent or legal guardian Date

## TRADITIONAL FINANCIAL CONTRACT LETTER

CONTRACT LETTER

Dear Patient,

Thank you for choosing our office for the treatment of (your/your child's) orthodontic needs. We look forward to providing you with all of the benefits that orthodontics has to offer. In order that there be no misunderstanding regarding some of our office policies or the financial arrangements you have agreed to, this letter serves to review the terms of our agreement.

As we discussed it will take approximately _____ months to treat (your or patient's first name)__ orthodontic problem. The fee for this treatment is $____ which includes all necessary appliances, insertion visits, active treatment, retainers and retention care. This amount is to be paid in the following manner: a down payment of $ _____, and payments of $ _____ per month for ___ months.* Please be advised that these payments are not based on the number of appointments per month nor the time spent at each appointment but instead are merely a convenient method for you to budget the fee for the services rendered with no interest or finance charges during the above period of time.

The fee quoted above is based in part on the sincere cooperation of the patient with regard to 1) the keeping of regularly scheduled appointments and providing advance notice of scheduling changes; 2) following all instructions in order for the estimated treatment time to not be unnecessarily extended; 3) ensuring that your appliances are not lost or repeatedly broken beyond normal wear and tear; 4) our right to charge additional fees for the costs associated with collecting unpaid balances including reasonable attorney's fees; and 5) our right to impose fees for returned checks and late payments.

The responsibility for maintaining periodic dental examinations and checkups remains with you and your general/pediatric dentist; *we strongly recommend that you see your dentist at least twice a year during the time you are undergoing orthodontic therapy***.**

The treatment plan agreed upon has been explained to you and you have had the opportunity to question any aspect of the proposed treatment. If additional questions arise during treatment, please don't hesitate to discuss them with us. You have made a very wise decision by taking advantage of the many benefits that may be obtained from undergoing orthodontic therapy. We look forward to serving your orthodontic needs.

Respectfully,

Doctor's name

* Insert the following sentence when the patient has insurance coverage and you are accepting assignment of benefits:

> The remaining balance of $_____ is to be paid to us directly by your insurance carrier. If your insurance carrier defaults in any way, regardless of the reason, you will be responsible for any remaining amount due by them until the total fee is paid in full.

**TRUTH-IN-LENDING FORM VERSION 1**

FEDERAL TRUTH IN LENDING STATEMENT
For professional services rendered

Patient: _____
Address: _____
Financially responsible party/relationship: _____

| | |
|---|---|
| 1. Professional fee for services rendered | $ _____ |
| 2. Less down payment | $ _____ |
| 3. Balance due | $ _____ |
| 4. Finance charge | None |
| 5. Annual percentage rate | None |
| 6. Total fee remaining (3 + 4 + 5 above) | $ _____ |

"Total Fee Remaining" (6 above) is payable to Dr _____ at the above address in_____monthly installments of $_____the first installment being payable on_____ 20…, and all subsequent installments are due on the same day of each consecutive month until paid in full. Although we accept payments from 3rd party carriers, you are ultimately responsible for the total fee should benefits be denied to you for any reason.

The following additional costs will be passed along to you:

* All costs associated with the collection of past due accounts including reasonable attorneys fees.
* A late fee of $ _____ if payment for services rendered is not received within two weeks of the date it is due.
* A service charge of $ _____ for all returned checks.
* A fee of $ _____ for repeated instances of missed or broken appointments without twenty four hours notice.
* A reasonable fee for excessive breakage or loss of appliances.

I freely consent to the terms and conditions as stated above and I have received a copy of this agreement.

_____
Signature of patient/financially responsible party & date

**TRUTH IN LENDING FORM VERSION 2**

FEDERAL TRUTH IN LENDING STATEMENT
For professional services rendered

Patient: _____
Address: _____
Financially responsible party/relationship: _____

| | |
|---|---|
| 1. Professional fee for services rendered | $ _____ |
| 2. Less down payment | $ _____ |
| 3. Balance due | $ _____ |
| 4. Finance charge | None |
| 5. Annual percentage rate | None |
| 6. Total fee remaining (3 + 4 + 5 above) | $ _____ |

"Total Fee Remaining" (6 above) is payable to Dr _____ at the above address in _____ monthly installments of $ _____ the first installment being payable on _____ 20…, and all subsequent installments are due on the same day of each consecutive month until paid in full. *Although we accept payments from 3rd party carriers, you are ultimately responsible for the total fee should benefits be denied to you for any reason.*

MISSED APPOINTMENTS

– Please note that the time of your appointment was specifically reserved for you.
– Instances of broken appointments without 24 hours notice WILL result in additional *charges depending on the length of appointment missed.*

SERVICE CHARGES

– *Please note our office policy regarding the following service charges.*
– There will be a service charge of $ _____ if payment is not received within 2 weeks of *the date due.*
– There will also be an added service charge of $ _____ for handling any returned checks.
– *All costs incurred for the collection of past due accounts, including reasonable attorney's fees will be passed on to you.*
– *An additional fee will be for repeated or excessive breakage, and for loss of appliances when either inordinately extends treatment time estimates.*

FINANCIAL CONSENT

I agree to be fully responsible for the total payment of all fees for professional services rendered by Dr _____ I have read, understood and freely agree to the terms and conditions set forth herein. I have also received a copy of this agreement.

_____ _____
Date Financially responsible party

## REFERRAL LETTER TO GENERAL DENTIST

Dear Doctor _____,

In conjunction with (Patient's name) orthodontic therapy, please:

[] Extract
[] Expose
[] Consult on
[] Provide

the following:

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | a | b | c | d | e | f | g | h | i | j | | |
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| R | | | | | | | | | | | | | | | | | | | L |
| | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | | |
| | | | | | t | s | r | q | p | | o | n | m | l | k | | | | |

COMMENTS: _____

_____

_____

_____

## POOR COOPERATION LETTER TO GENERAL DENTIST AND TO PARENT

Dear Dr _____,

As you know we are currently providing orthodontic care for (Patient's name). Even though we are giving our closest attention to (Patient's name) case, his/her response to treatment has been slower than normally expected. The problems to date appear to have been * (insert from categories below).

We will continue with (Patient's name) treatment as long as it is clinically feasible to do so in order to achieve the best possible clinical result. However, due to the situation as previously described, some limitations or compromises regarding our initial treatment goals may occur including the early termination of treatment.

If you have any questions, please call us. You may wish to recall (Patient's name) at this time to examine him/her and re-enforce to him/her and his/her parents, the positive benefits of orthodontic therapy and the cooperation needed to achieve these ends.

We have discussed this with (Patient's name) parents so they are aware of the situation.

*i.e.: – Not wearing appliances as instructed
– Not complying with oral hygiene instructions
– Not keeping appointments
– Poor skeletal growth/response
– Slow dental development
– Chronic breakage or distortion of appliances
– Other: _____

**********

Dear _____,

We are encountering problems with your/your child's cooperation which may result in achieving less than a desirable orthodontic result. The problems so far are:

[] not brushing teeth, gums and appliances as instructed.
[] not wearing rubber bands as required.
[] not wearing the Head Gear/Night Brace the required amount of time.
[] not wearing or caring for the removable appliance(s) as instructed.
[] eating foods that break or loosen the appliances.
[] not keeping regularly scheduled appointments.

Patient cooperation is essential if we are to achieve the best result possible. Please see what you can do to address and rectify the above noted concerns. If you wish to discuss this matter with us, please feel free to call.

## RELEASE FOR PATIENT STOPPING TREATMENT AGAINST MEDICAL ADVICE

RELEASE FROM LIABILITY FOR REMOVAL
OF ORTHODONTIC APPLIANCES AGAINST MEDICAL ADVICE

This is to certify that I, (Parent's or Patient's name), voluntarily request the removal of [my/my child's] (Insert patient's name if a minor) orthodontic appliances and the termination of my/his/her orthodontic treatment.

I have been informed that [my/my child's] orthodontic treatment is not completed and that (Doctor's name*) strongly recommends the continuation of treatment in order to obtain the best possible result. In addition, I have been informed of and I understand the probable negative consequences that may occur as a result of my discontinuing treatment before it is completed and against the advice of (Doctor's name*)

I hereby release (Doctor's name*) from any responsibility and for any and all injuries or damages that I may suffer both presently and in the future as a result of my decision to terminate my/my child's treatment against the sound medical advice of my orthodontist.

Signature of patient Date Witness Date

* NOTE: If Doctor is a professional corporation, partnership, LLC, etc. or has any associate doctors providing treatment in the office, place the name of the business entity, the names of everyone who treated the patient as well as the Doctor's personal name in this space.

## LETTER DISMISSING PATIENT FROM DOCTOR'S CARE

DISMISSAL LETTER

Dear _____,

Due to the fact that (choose from one or more of the five categories below) we must inform you that we are withdrawing from rendering further professional attendance to (your/your child's) orthodontic needs.

Since (her/his/your) dental condition requires further treatment, we urge you to seek continued orthodontic care and treatment with another orthodontist without delay.

If you wish, we will be available to attend to any orthodontic needs you may have for the next (30, 45, 60) days on an emergency basis only or to help you with a referral or in seeking another doctor. This should give you ample time to select another orthodontist. If you need help in finding another orthodontist, please contact us. (If the patient asks, you can (1) give them the names of a few doctors in your area; (2) copy a page or two from the phone book, search engine site, etc.; 3) give the patient the phone number of a local teaching hospital, clinic or school; (4) or, provide the patient with the number of the local dental society for their referral base).

Should you authorize the release of your/your child's orthodontic records, we will be happy to forward them to you or the orthodontist of your choice along with any other clinical information concerning the diagnosis and treatment rendered by us. (If you are charging a fee for duplicating records, state that here.)

We regret having to take this action but the situation as noted above has left us no other option.

1. There has been a lack of cooperation regarding following instructions which has been very detrimental to (your/your child's) dental health thus potentially compromising our ability to achieve an adequate orthodontic result.
2. We are unable to coordinate the scheduling of appointments which in turn is jeopardizing (your/your child's) treatment; and, after repeated attempts have still been unable to do so.
3. You have not kept up with your financial obligations, under the terms that you agreed to, to pay for orthodontic services rendered.
4. You have not been honest and or forthright in dealing with our office regarding required clinical or administrative inquiries thus impacting our ability to serve you.
5. There are significant interpersonal differences and problems between (you/your child) and members of our office staff which have created disharmony and/or disruption to our daily office routine and activities.

**RELEASE IN RETURN OF FEES PAID**

GENERAL RELEASE

This agreement between [(Parent) as legal guardian for (Patient's name) ] or [(Patient's name if adult) ] and (Dr's name)* is being executed to resolve a disputed claim regarding orthodontic services rendered. It does not imply nor constitute an admission of liability on the part of (Dr's name)* , or his/her employees or professional contractors.

In consideration of $_____paid by (Dr's name)* to (Patient's name); (Patient's name) , his/her heirs, executors, administrators, assigns, and/or guardians hereby fully releases (Dr's name)* , his/her employees, agents, his/her professional corporation (if you use an independent contractor include that name here) from all claims and causes of action stemming from any injury suffered, or sustained presently, or in the future as a result of the orthodontic treatment rendered between (dates of treatment).

I (Patient's name) have read and fully comprehend all of the foregoing agreement, I also understand the rights I am waiving, I have had the opportunity to consult with an attorney, and freely agree to the terms and conditions of this letter.

(Patient or legal guardian)
Signature

(Doctor)*
Signature

(Witness)
Signature

***If Dr is P.C. list both names.**

**PATIENT REAFFIRMATION OF DEBT POST BANKRUPTCY**

REAFFIRMATION AGREEMENT

I (Legal name) on this____day of _____, 20____ by this letter, voluntarily reaffirm my financial obligation to Dr_____ for orthodontic services rendered to me/my child in the amount of $_____. I wish to reaffirm this debt notwithstanding my present petition in bankruptcy, case number_____, which has been filed in the (State the name and location of the bankruptcy court) .

I understand that the continuation of treatment for me/my child is not conditioned upon my signing this letter.

_____
Debtor

_____
Date*

*The date must be AFTER than the first meeting of the creditors.

## COMPLETION OF PHASE 1 LETTER TO GP AND TO PARENT

Dear Dr _____,

____(Name)__ has recently completed his/her first phase of orthodontic treatment. Through early intervention we have sought to maximize (Name's) potential for proper dental and orofacial growth and development.

__(Name)__ has been placed under periodic recall observation. He/She/You will be monitored at regular intervals to determine if a second phase of treatment is indicated and if so, the extent and timing of such intervention.

(If certain treatment goals were not realized or clinically relevant negative sequelae occurred, insert that here)

We have recommended that (Name) call your office to make an appointment for routine dental care. If you have any questions regarding (Name's) treatment to date, specific future concerns, or about the philosophy or goals of interceptive orthodontics in general, please feel free to call.

NOTE: The following is a modification of the same form to be sent to the patient/parent.

Dear _____,

(Name) has recently completed his/her first phase of orthodontic treatment. Through early intervention we have sought to maximize (Name's) potential for proper dental and orofacial growth and development.

(Name) has been placed under periodic recall observation. He/She/You will be monitored at regular intervals to determine if a second phase of treatment is indicated and if so, the extent and timing of such intervention.

(If certain treatment goals were not realized or clinically relevant negative sequelae occurred, insert that here)

We strongly recommended that you call your dentist to make an appointment for routine dental care during this break in (Patient's name) orthodontic therapy. If you have any questions regarding (Name) treatment to date, specific future concerns, or about the philosophy or goals of interceptive orthodontics in general, please feel free to call us.

## COMPLETION OF ACTIVE TREATMENT LETTER TO GP AND TO PARENT

Dear Dr _____,

At this time it is important to let you know that (Name) has recently completed active orthodontic treatment. We were happy we could provide (Name) with all of the benefits that orthodontics has to offer. Every effort has been made to address our original treatment goals regarding the establishment of good function, optimum esthetics and maximum stability.

We will continue to monitor (Patient's name) during the period of retention which normally lasts about (insert whatever period of time you routinely monitor patients in retention). Once the period of retention observation has expired, we expect that you will continue to monitor the patient's orthodontic status at your normal recall appointments.

(Name) has been told to call your office to make an appointment for routine dental care. Should you have any questions concerning (Name) treatment or orthodontics in general please feel free to call us.

NOTE: The following is a modification of the same form to be sent to the patient/parent.

Dear _____,

At this time it is important to let you know that (Name) has recently completed active orthodontic treatment. We were happy we could provide (Name) with all of the benefits that orthodontics has to offer. Every effort has been made to address our original treatment goals regarding the establishment of good function, optimum esthetics and maximum stability.

(Name) will now enter the retention phase of therapy. The retainers you have been given are vitally important if one is to achieve optimal stability of the finished result. Please wear them and care for them as instructed.

We will continue to monitor (Patient's name) during the period of retention which normally lasts about (insert whatever period of time you routinely monitor patients in retention). Your orthodontic status will then be monitored by your general dentist once the period of retention observation has expired.

Please call your dentist to make an appointment for routine dental care. Should you have any questions concerning your/your child's treatment or orthodontics in general please feel free to call us.

## STAFF PERFORMANCE REVIEW FORM VERSION 1

STAFF PERFORMANCE APPRAISAL

Name: _____
Position: _____
Date: _____
Reviewer: _____
Date of last review: _____

TYPE OF REVIEW
[] End of trial employment period
[] Periodic
[] Specific performance
Proposed date of next review: _____

RATING SYSTEM:
++ very positive
+ positive
0 neutral/not applicable
- could do better
- - needs improvement

INSTRUCTIONS:
Circle the sign that best describes your your assessment of yourself or your abilities relative to the tasks or the character traits described. If you do don't understand a question, please ask.

FOR BUSINESS/FRONT DESK PERSONNEL

| | | | |
|---|---|---|---|
| **Attendance/punctuality** | ++ + 0- — | **Professional demeanor** | |
| | | Appearance | ++ + 0 - — |
| **Communication Skills** | | Attitude re: work | ++ + 0 - — |
| Telephone | ++ + 0 - — | Attitude re: patients | ++ + 0 - — |
| With patients | ++ + 0 - — | Attitude re: co-workers | ++ + 0 - — |
| With co-workers | ++ + 0 - — | Influence on morale | ++ + 0 - — |
| **Technical performance** | | **General performance traits** | |
| Scheduling | ++ + 0 - — | Initiative/Generally | ++ + 0 - — |
| Filing | ++ + 0 - — | Initiative/Specific tasks | ++ + 0 - — |
| Correspondence | ++ + 0 - — | Organizational skills | ++ + 0 - — |
| Patient finances | ++ + 0 - — | Learning skills | ++ + 0- — |
| Inventory mgt. | ++ + 0 - — | Accepts criticism | ++ + 0 - — |
| Data control | ++ + 0 - — | Teamwork skills | ++ + 0 - — |
| Accuracy | ++ + 0 - — | Prepares for day | ++ + 0 - — |
| Insurance tasks | ++ + 0 - — | Cleans up/backs up | ++ + 0 - — |

FOR CLINICAL/CHAIRSIDE PERSONNEL

| | | | |
|---|---|---|---|
| **Attendance/punctuality** | ++ + 0 - — | **Professional demeanor** | |
| | | Appearance | ++ + 0 - — |
| **Communication skills** | | Attitude re: work | ++ + 0 - — |
| With vendors | ++ + 0 - — | Attitude re: patients | ++ + 0 - — |
| With patients | ++ + 0 - — | Attitude re: co-workers | ++ + 0 - — |
| With co-workers | ++ + 0 - — | Influence on morale | ++ + 0 - — |
| **Technical performance** | | **General performance traits** | |
| Record Keeping | ++ + 0 - — | Initiative/General | ++ + 0 - — |
| Record Taking | ++ + 0 - — | Initiative/Specific tasks | ++ + 0 - — |
| Equip. Maint. | ++ + 0 - — | Organizational skills | ++ + 0 - — |
| Infec. Control | ++ + 0 - — | Learning skills | ++ + 0 - — |
| Band/Bonding | ++ + 0 - — | Accepts criticism | ++ + 0 - — |
| Gen. Assisting | ++ + 0 - — | Teamwork skills | ++ + 0 - — |
| Inventory mgt. | ++ + 0 - — | Coverage/Errands | ++ + 0 - — |
| Lab Skills | ++ + 0 - — | Prepares for day | + + 0 - — |
| Exp. Duty Skills | ++ + 0 - — | Cleans up/backs up | ++ + 0 - — |

_____ Employee signature

_____ Reviewer's signature

**STAFF PERFORMANCE REVIEW FORM VERSION 2**

STAFF PERFORMANCE APPRAISAL

Name: _____
Position: _____
Date: _____
Reviewer: _____
Date of last review: _____

TYPE OF REVIEW
[] End of trial employment period
[] Periodic
[] Specific Performance
Proposed date of next review: _____

INSTRUCTIONS:
Circle the rating that best describes your assessment of the employee regarding their abilities to perform the tasks or the character traits described. If a question or area is not applicable, leave it blank.
Key: E = Excellent, G = Good, F = Fair, P = Poor.

| OFFICE MANAGER | | RECEPTIONIST | |
|---|---|---|---|
| Hiring/Training Staff | E G F P | Maintain Workplace | E G F P |
| Staff Evaluation | E G F P | Telephone Skills | E G F P |
| Work Delegation | E G F P | Dealing w/Pt. Problems | E G F P |
| Scheduling Staff | E G F P | Control of Charts | E G F P |
| Office Supply Inventory | E G F P | Interpersonal Skills | E G F P |
| Statistics & Reporting | E G F P | Appointment Control | E G F P |
| Practice Promotion | E G F P | Communications Control | E G F P |
| Maintain Office Policy | E G F P | Dealing w/Problem Pts. | E G F P |
| Professional Demeanor | E G F P | Professional Demeanor | E G F P |

| CHAIRSIDE ASSISTANT | | RECORDS & LAB TECH. | |
|---|---|---|---|
| Keeps on Schedule | E G F P | Quality of X-Rays | E G F P |
| Construction Skills | E G F P | Darkroom Skills & Maint. | E G F P |
| Archwire Fabrication | E G F P | Quality of Photos & Imaging | E G F P |
| Pt. Management Skills | E G F P | Quality of Impress. & Casts | E G F P |
| Dealing with Problems | E G F P | Appliance Construc. Skills | E G F P |
| Record Keeping | E G F P | Tracing & Analysis | E G F P |
| Maintenance of Workplace | E G F P | Maintenance of Workplace | E G F P |
| Professional Demeanor | E G F P | Professional Demeanor | E G F P |

_____ _____
Employee's Signature Reviewer's Signature

## STAFF PERFORMANCE REVIEW FORM VERSION 3

STAFF PERFORMANCE APPRAISAL

Name: _____
Position: _____
Date: _____
Reviewer: _____
Date of last review: _____

TYPE OF REVIEW
[] End of trial employment period
[] Periodic
[] Specific Performance
Proposed date of next review: _____

RATING SYSTEM:
5 = Superior
4 = Above average
3 = Average
2 = Below average
1 = Not acceptable

INSTRUCTIONS:
Circle the sign that best describes your assessment of the employee relative to the tasks or character traits described. If the question is not applicable, leave it blank.

| JOB TASK OR CHARACTER TRAIT | RATING |
|---|---|
| QUALITY OF WORK – accuracy & thoroughness | 5 4 3 2 1 |
| QUANTITY OF WORK – efficiency & best use of time | 5 4 3 2 1 |
| KNOWLEDGE OF JOB – gestalt & interrelationship | 5 4 3 2 1 |
| DEPENDABILITY – capable & reliable to get job done | 5 4 3 2 1 |
| COOPERATION – with employer/coworkers/patients | 5 4 3 2 1 |
| APTITUTDE – mental and technical ability | 5 4 3 2 1 |
| JUDGEMENT – intelligence and thoughtfulness | 5 4 3 2 1 |
| INITIATIVE & CREATIVITY – attacks problem solving | 5 4 3 2 1 |
| ATTITUDE – job versus career | 5 4 3 2 1 |
| ATTENDANCE & PUNCTUALITY – adjusts time as nec. | 5 4 3 2 1 |
| MARKETING – helps grow practice (internal & external) | 5 4 3 2 1 |
| TEAMWORK – cross trained coverage/leadership | 5 4 3 2 1 |
| COMMUNICATION – pts./coworkers/vendors/gossip | 5 4 3 2 1 |
| DESIRE FOR GROWTH – inter & intra office | 5 4 3 2 1 |
| DEDICATION TO GOALS – mission & philosophy | 5 4 3 2 1 |

_____ Employee's Signature

_____ Reviewer's Signature

# APPENDIX C: PRACTICE COMMUNICATION LETTERS

Brett Kerr

Specimen forms and letters published with permission from Dr Brett Kerr, 256 Waterworks Road, Ashgrove, Q 4060, Australia.

**LETTER TO PATIENT/PARENT – PRIOR TO FIRST CONSULTATION**

Dear Mr & Mrs ……,

This letter will explain ……' s appointment, please take a few moments to check it.

1. We wish to confirm your consultation appointment on …… at …… at the …… rooms. At that appointment …… will be fully assessed, the problem and likely treatment will be outlined in general, and you will have the opportunity to ask any questions. We have enclosed a questionnaire and referral for orthodontic x-rays. Please bring the completed questionnaire and x-rays to this appointment.
   The fee for this consultation appointment is $ …
2. To achieve a full diagnosis study casts (moulds), computer analysis of the x-rays, and clinical intra- and extra-oral photographs are required. A further appointment is sometimes necessary to explain the problems with the aid of these records.

   The fee for these records is $ … If you are covered by a health fund, you are likely to receive a refund of 50–75% of this fee.
3. You will receive a written report on any treatment recommended, applicable fees, appointment details, and other important information.

   If you have any questions please call the above number.

Yours sincerely,

Secretary

Please note: We have allowed forty minutes for the consultation appointment. If you are unable to keep this appointment, please notify us as soon as possible so we can allocate it to another patient on our list.

## LETTER TO PATIENT/PARENT FOLLOWING AN INITIAL CONSULTATION

Dear Mr & Mrs ……,

As was discussed on the …… the suggested treatment for……'s malocclusion would involve:

1. Taking records to review the treatment plan that is, study casts (moulds), clinical intra- and extra-oral photos, and computer analysis of x-rays.

   *The current fee for records is* $.…

2. Referral to your general dentist for extraction of …… teeth, and a check-up and fluoride treatment if considered necessary.

   *Your dentist will quote a fee separately for this treatment.*

3. Fixed 'braces' on the upper and lower teeth.

   *The fee for this treatment is* $.… *Unless other arrangements are made, the usual payment schedule is an initial amount of* $… *at the commencement of treatment, followed by eighteen monthly payments of* $… *These payments are not in any way related to the number of times the patient is seen during treatment, but merely spread the fees for convenience of payment.*

   *If preferred this amount may be paid in full at the commencement of treatment.*

4. On removal of the appliances, we will provide one set of retainers which will be supervised for a further year. To keep the teeth straight, continued part-time wear of retainers would be essential after orthodontic supervision is complete.

   *The fee quoted for the fixed braces includes provision of one set of retainers, and one year's supervision.*

During treatment time these appliances would need to be checked and adjusted at regular intervals usually about every six weeks. Full patient cooperation is essential to successful orthodontic treatment.

If you wish to discuss ……' s treatment further, or if there is any aspect of the treatment plan that concerns you or is unclear, please call the above number or make a further consultation appointment. It is possible that there may be alternative treatment plans if the above is unsuitable, but on the information obtained so far, I believe that this would give the optimum result.

Yours sincerely,

## INFORMATION SHEET FOR PATIENT/PARENT

**General dental treatment**
As ours is a specialist orthodontic practice, you must continue visits to your regular dentist for general dental check-ups.

**What to do if you wish to go ahead with orthodontic treatment**
If you wish to go ahead with treatment, you should contact this surgery for banding appointments, then arrange an appointment with your general dentist for the extractions, a check up and fluoride treatment as necessary.

**Fees**
The fees quoted cover all routine orthodontic treatment over several years including fitting, adjustments and removal of fixed braces, provision of one set of retainers and their supervision for a further year.

This fee is fixed if treatment commences now and is based on both the difficulty of treatment and its expected duration. Extra charges would only be incurred for repeated damage to appliances, or poor cooperation resulting in extended treatment time, or if retainers have to be replaced because of loss, damage or poor cooperation.

If you wish to discuss fees, please contact the secretary at our practice address or call Tel No. . . . . .

**Types of braces**
The fees quoted are for the normal stainless steel (silver) braces. Clear braces can be fitted to the upper front teeth, or gold braces to upper and lower front teeth for a further fee of $… (paid at the commencement of treatment). NOTE we normally fit stainless steel braces (please read the enclosed leaflet). If you wish to have clear or gold braces, please let us know in advance.

**Credit card payments**
We can accept credit cards (Visa/Bankcard/Mastercard) and if desired can bill monthly installments directly to your card.

**Appointment scheduling**
The first one or two appointments require up to two hours for the appliances to be fitted and instruction and explanations given. These appointments are scheduled late morning or early afternoon.

After the initial one or two long appointments, we make every effort to schedule regular short appointments before or after school. To enable us to book these short visits after school, longer appointments have to be scheduled during school hours or school holidays. We will endeavour to schedule any longer in-school appointments during a study period or some other time, which will not result in the patient having to miss work, which has to be made up. We work with the child and their school schedule on an individual basis and will co-operate in every way possible to minimize any inconvenience. With mutual understanding of each other's problems, appointment scheduling does not, as a rule, present problems. In order to be fair to every patient, we are unable to make exceptions to our scheduling requirements.

Beginning with the first active treatment appointment for your child, it is not necessary for a parent to accompany the patient into the treatment room. We want the child to feel responsible for their treatment. Your child needs to get to know us, and we need to get to know them. Experience has taught us that the patient is more receptive and more self-expressive without a parent present. Strange as it may seem, this is particularly true in the case of children who are of a nervous disposition. This lends itself to a happy, relaxed atmosphere, which we strive to maintain at all times.

You will, at all times, be kept up to date with progress.

Dr . . . . . .

## LETTER TO PATIENT/PARENT PRIOR TO FITTING APPLIANCES

Dear Mr & Mrs ……,

We would like to confirm ……'s appointments on the …… at ……, and …… at ……, at the …… rooms.

Having braces fitted requires two appointments. This letter will explain what to expect at these visits.

The first appointment involves placing separators between the back teeth. These little elastics are extremely important as they create small spaces where the molar bands will be fitted.

Having separating elastics placed does not hurt. It feels just like floss going between the teeth. They will usually make the teeth feel tender for a couple of days afterwards. If necessary NSAIMs (non-steroidal anti-inflammatories) such as Nurofen, Brufen, Advil, etc., may be taken, as you would for a headache.

PLEASE NOTE: NSAIMs are not recommended for asthmatics, or if allergic to aspirin or NSAIMs. If in any doubt ask your doctor.

At this appointment, impressions (moulds) of the teeth and photos will also be taken. You will be given an information pack, and a set of videos to take home and watch. These will explain how the braces are fitted, and how to floss and brush the teeth with braces on. Please return these videos to us at the second appointment when the braces are fitted.

You should allow approximately half an hour for this visit.

The braces are then fitted at the second appointment, which takes about 1 hour. Approximately another half hour is spent giving instructions on how to take care of the braces (diet, oral hygiene, elastics, etc.), and you can ask any questions you may have.

This again does not hurt, but again, the teeth may be sore for a couple of days. Studies have shown that taking NSAIMs 1 hour before the second appointment can reduce the level of soreness considerably.

Should you have any questions at any time, please call us on the above number.

Yours sincerely,

Secretary

## LETTER TO PATIENT AFTER REMOVAL OF FIXED APPLIANCES

Dear. . . . . ,

We're sure that it feels really great now that you've got your braces off – and we're sure you would never want to go through that again. The retainers you have been fitted with will make sure that your teeth don't move – if you wear them as we tell you to.

Unfortunately some patients don't wear their retainers, and their teeth go crooked again. We don't want this to happen to you. Because of this we decided to write you a note to make things as clear as possible.

Usually you will have to wear the retainers for one week, night and day, then every night for one year (twelve hours per night).

After that, if you want your teeth to stay straight, you will have to wear them for the rest of your life (enough so that the retainers fit perfectly and the teeth stay put).

As we arranged at the start of treatment, we provide one set of retainers and supervise these for another year. With care a retainer should last for five years or more. If you lose or break the retainers (or, worse still, need braces again), you should expect to pay for this out of your pocket money or savings.

We hope you get the idea that we want you to wear your retainers, so that all of your hard work with the braces isn't ruined.

Remember we are always here to help. If the retainers don't fit, they get stolen by Martians, or the dog eats them, let us know straight away.

Also remember you must see your general dentist soon for a check up.

If you have any questions we would be delighted to help you.

Keep Smiling

## LETTER TO PATIENT/PARENT – FOR RETENTION FOLLOW-UP

Dear Mr & Mrs ….. ,

We note that…… has no further appointments made with us.

The fee quoted for treatment included one year of supervision of retention. This period has passed, and orthodontic treatment is now considered complete.

When our patients complete their treatment we give them the following information at their last appointment.

PLEASE ASK …… TO READ CAREFULLY

It is important to remember that teeth move throughout life. This is normal, and it happens at any age – whether you have had braces or not.

You will therefore need to continue to wear the retainers enough to keep the teeth straight.

The retainers must be tried in every night. If they feel tight, but still fit, they must be worn that night. If they fit, but are loose, they don't have to be worn that night, but must be tried in again the next night.

This must be continued as long as you want the teeth to stay straight.

If you stop wearing the retainers, the teeth will move. This movement may only be a small amount, we do not know. However they could move a lot, and braces would then be needed again.

With care the retainers should last up to 5 years. If they become worn out/cracked/too disgusting to wear, or if they are lost, contact the surgery as soon as possible, as it's time for new retainers.

Currently the cost of new retainers is $… each, depending on the type needed. If you wish us to continue to supervise retention, normal consultation fees will now apply, since the period of supervision covered by the original quote has now finished.

Remember we are always here to help. If you have any questions please phone.

Yours sincerely,

Secretary

## LETTER TO DENTIST FOLLOWING FIRST CONSULTATION

Dear ……,

Re:

Thank you for referring …… I examined …… on the …….

Occlusion:

Overbite:

Overjet:

Upper arch:

Lower arch:

Other findings:

Suggested orthodontic treatment plan:

I have recommended a treatment plan involving upper and lower fixed braces, probably with extractions. I estimate an active treatment duration of approximately eighteen to twenty-four months, followed by long term retention.

Prior to commencing treatment I would take clinical records of ……. and assess these. I would then contact you again to confirm the treatment plan.

I have asked them to consider orthodontic treatment and am waiting for them to contact me with their decision.

I will keep you informed of developments.

Best wishes.

## LETTER TO DENTIST – OUTLINING TREATMENT PLAN

Dear Dr ……,

Re: ……

Thank you for referring …… I examined him on … (date).

He has a Class II tendency with an increased overbite and overjet, and some upper and lower crowding. 12 is peg shaped and 22 congenitally absent. His OPG suggests a possible odontome in the 22 region near the apex of 21, and 13 is delayed in its eruption, which is suspicious. The 62 is retained but may not last much longer.

I have recommended a treatment plan involving full braces, holding space for future prosthodontic replacement of 22 and build up of 12.

Prior to this I have asked them to return to you for periapical x-rays of the 13 and 22 regions. Could you please let me know of any pathological problems in either of these areas.

I have asked them to consider and am waiting for them to contact me with their decision.

I will keep you informed of developments.

Best wishes.

## LETTER TO DENTIST CONFIRMING START OF TREATMENT

Dear ……,

Just a note to advise that the……s have made appointments to go ahead with……'s treatment in ……

I estimate an active treatment time of approximately…… months, followed by long-term retention.

I will keep you informed of any developments.

Best wishes.

## LETTER TO DENTIST REQUESTING EXTRACTIONS

Dear ……,

Re: ……

We have reached a stage in……'s treatment where extractions have proved essential.

**Would you please extract** ……

Don't worry if any damage occurs to the archwires. I will repair this at ……'s next appointment.

Thank you for your assistance with……

Best wishes.

## COMPLETION LETTER FOR DENTIST

Dear Dr ……,

……'s active treatment has been completed and ……has been requested to return to see you.

……'s treatment summary is:

Problem:……

Treatment:……

Oral hygiene:……

Cooperation:……

Treatment time:……

Retention:……

I will be keeping ……under observation for at least another year. Please let me know if……has any orthodontic problems either now or in the future.

Here are ……'s before and after photographs.

Regards.

# APPENDIX D: EXAMINATION AND TREATMENT REPORT TEMPLATE

Winston B Senior

Specimen forms and letters published with permission from Winston B Senior, Northenden House, Sale Road, Northenden, Manchester M23 0DF, United Kingdom.

**EXAMINATION AND TREATMENT REPORT TEMPLATE**

GENERAL INFORMATION

Date of birth……, referral……,
Relevant medical history……

EXTRA-ORAL EXAMINATION

En face – noting asymmetries, scars, facial heights……

Profile ……

Soft tissues……

Morphology. Muscle tonus, lip competence……

Behaviour, lip chapping, sucking habits……

INTRA-ORAL EXAMINATION

Teeth present……

Oral hygiene condition……

Periodontal condition……

Caries condition……

Observed Dental and Orthodontic Abnormalities. These are listed……

TREATMENT
This is left blank to be 'filled in' after the Second Consultation.

## DRAFT OF A LETTER SENT TO A PATIENT FOLLOWING A SECOND CONSULTATION

Dear ……,
I am writing as promised to confirm that a report outlining the treatment explained to you today has been sent to your dental surgeon _____, I have suggested that your treatment should be considered under the following phases.

Phase I
You should have two upper and two lower teeth extracted by your dental surgeon. These are marked as the number 4s on your study casts. You would then have an upper removable appliance, which would not show. It would be directed towards moving the canine teeth – (marked as number 3s on your study casts) back into the spaces created by the extractions. A lower appliance would be introduced later, which would not show, to move the lower canine teeth (marked as number 3s).

Phase II
This would be directed towards the precise alignment and the correction of the relation between the upper and lower front teeth. This appliance would show but would be fabricated from transparent materials and therefore not as conspicuous as the traditional metal appliances.

Phase III
This would be a retention phase directed to holding and consolidating the new positions of the teeth created during the phases I and II described above. During this phase, you will need to wear upper and lower retainers. The upper would need to be worn all the time for a brief period and then 'tapered' to wearing at night only until the teeth become stable. The lower will probably take the form of a wire bonded behind the lower front teeth. Because the lower front teeth are notoriously bad at remaining in perfect alignment, this lower fixed retainer may have to remain *in situ* for many years. These lower retainers do not show, are comfortable and hygienically designed.

My fees for treatment will be as follows:

Phases I and II – £X per month. This covers all appliances, total supervision, and the provision of any special cleaning materials such as special toothbrushes, and special orthodontic sports guards. I anticipate these phases will last Y months. All will be done to reduce the duration of these phases of treatment.

Phase III. During a retention phase I will need to see you two or three times a year and will charge a fee per visit. I would prefer to discuss this fee per visit with you when and if such visits become appropriate.

If you find this arrangement acceptable, I would be grateful if you would:

Contact your dentist and arrange the necessary extractions with him.

Phone my secretary giving her the extraction dates so that she can give you an appointment shortly afterwards to have your first brace started. This could be made ready for fitting approximately one week after the first appointment.

Yours sincerely,

……

## DRAFT OF A LETTER SENT TO A REFERRING DENTIST FOLLOWING A SECOND CONSULTATION

(Sent together with the report completed after the 2nd Consultation)

Dear Dr ……,

Re: (Name)

Enclosed is a report following a clinical and radiographic examination of your patient. ……..

The treatment has been carefully explained to (both) the patient (and his/her parent/s). I have given them a set of study casts and confirmed my recommendations to them by letter.

I have suggested that if they find the arrangements acceptable they should:

Contact your practice to arrange for the extractions of ……

Let my secretary know when these extractions will be carried out so that a further appointment can be arranged for them, shortly afterwards, to commence the fabrication of their first orthodontic appliance.

Thank you once again for referring …… to me and for your help.

Yours sincerely,

……

# APPENDIX E: INITIAL NON-COMPLIANCE LETTER

Kees Booij

Specimen letter published with permission from Dr Kees Booij, Gezellelaan 11, 9721 WJ Groningen, Netherlands.

**EXAMPLE OF LETTER TO A PATIENT DESIGNED TO AVOID FALSE ACCUSATION OF NON-COMPLIANCE**

Dear.....,

I am writing to you in person because I am somewhat uneasy about the progress of your orthodontic treatment.

We have been working on your teeth for some months now and I know that you are doing your best; however, in other cases like yours we see more progress over a similar period of time. At the last visit I again checked all the points where things could have gone wrong and I have really done my best to find a reason for the delay in your treatment. Unfortunately I cannot find the cause. I have thought things over, and it might be that there is some shortcoming or misunderstanding on your side of our partnership; perhaps you are having some difficulty following my instructions.

As I stressed before, for the treatment to progress smoothly and rapidly, and to achieve a good result, we need close cooperation between the two of us.

Please think this over and tell me at your next appointment how we might improve your participation. Please forgive me if I am mistaken in my judgement.

With kindest regards

Yours,

.....

[If you use digital photography this is a good place to insert a composite photograph of the patient's extra- and intra-oral photographs and or radiographs]

# INDEX

D