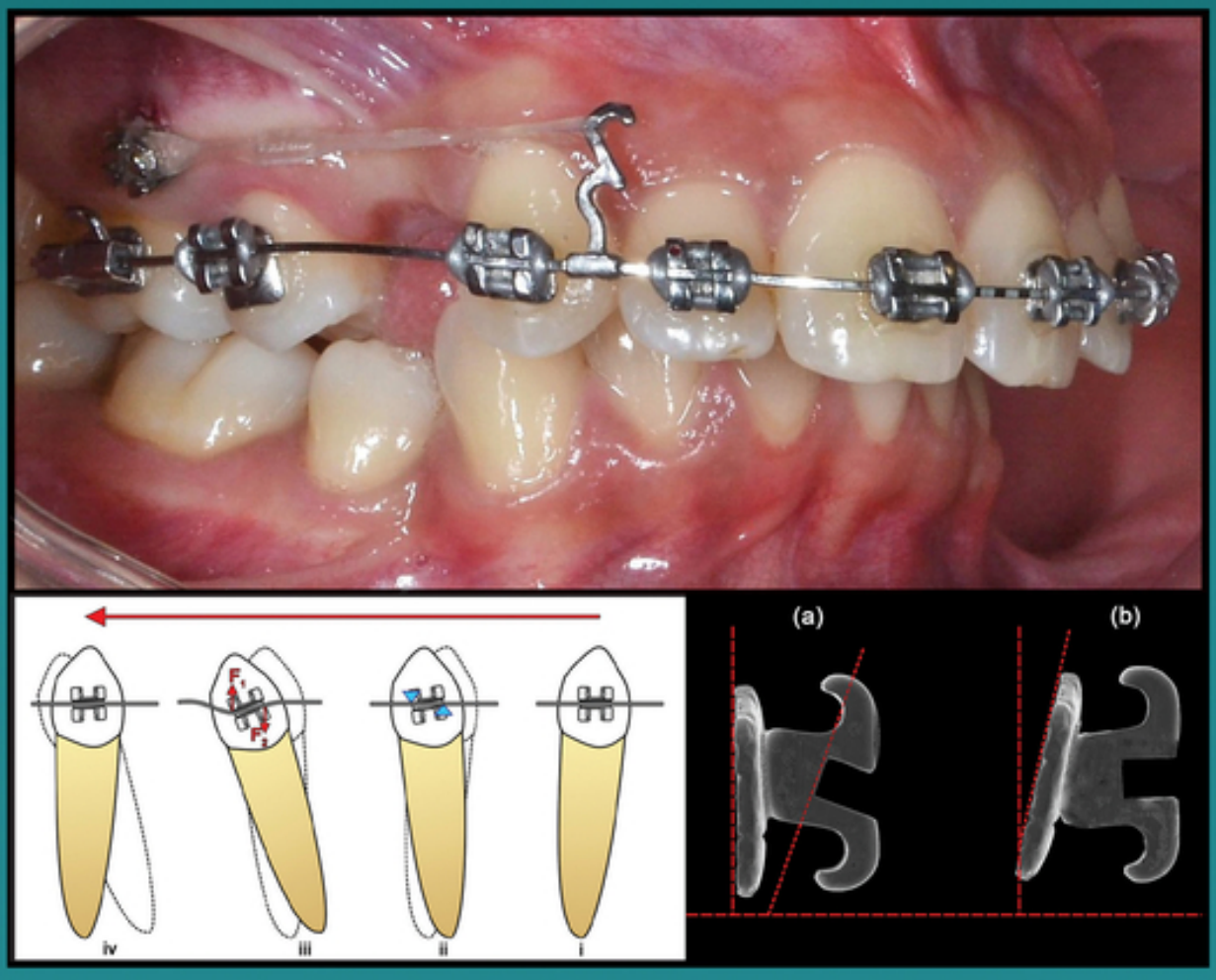
Preadjusted Edgewise Fixed Orthodontic Appliances

Principles and Practice

Edited by

Farhad B. Naini and **Daljit S. Gill**



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Farhad B. Naini
BDS (Lond.), MSc (Lond.), PhD (KCL), FDS.RCS (Eng.), M.Orth.RCS (Eng.), FDS.Orth.RCS (Eng.), GCAP (KCL), FHEA, FDS.RCS.Ed
Consultant Orthodontist
Department of Orthodontics
Kingston Hospital NHS Foundation Trust
St George's University Hospital NHS Foundation Trust
London, UK

Daljit S. Gill
BDS (Hons), BSc (Hons), MSc (Lond.), FDS.RCS (Eng.), M.Orth.RCS (Eng.), FDS (Orth) RCS (Eng.), FHEA
Consultant Orthodontist
Department of Orthodontics
Great Ormond Street Hospital NHS Foundation Trust and UCLH Eastman Dental Hospital
London, UK

WILEY Blackwell

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Preface

'We find that the very principle upon which teeth are made to grow irregularly is capable, if properly directed, of bringing them even again. This principle is the power which many parts (especially bones) have of moving out of the way of mechanical pressure.'

John Hunter (1728–1793), Chapter VI, Irregularities of the teeth, History of the Human Teeth *(1771)*

Sustained mechanical pressure will move teeth that are not ankylosed. Needless to say, placing a fixed appliance, ligating an archwire and watching the teeth move over time may appear relatively easy to the uninitiated. However, planned and guided movement of teeth into their ideal aesthetic, functional and stable positions, whilst mitigating the undesirable effects of treatment, and achieving this in a reasonable time frame with minimum patient discomfort, is far from easy.

Dental students and orthodontic trainees in their early years will often observe their teachers assessing a patient's teeth intently, deep in thought. It is no coincidence that orthodontics has long been known as the 'thinking person's specialty', and is, in fact, the first established specialty in dentistry and one of the first throughout medicine. Orthodontics is a complex and multifaceted specialty, requiring, amongst other things, a thorough understanding of normal and aberrant craniofacial growth and development, dentofacial aesthetics and function, and the biomechanical principles and utilisation of a variety of appliances. As such, learning orthodontics requires dedication and hard work – there is no effortless path and no available shortcuts.

Most credible graduate orthodontic specialty training programmes now run over three years full-time (this has been the UK model for many years), or a part-time equivalent. In the UK, those desiring to learn more about multidisciplinary care, orthognathic surgery, and cleft and craniofacial surgery require an additional two years of full-time training and further examinations. First-year graduate trainees in orthodontics often feel like outsiders, overwhelmed by the highly esoteric and technical language being used around them, new concepts and even new instruments. Confusion is the order of the day. It takes sustained effort to assimilate and grasp the significance of all the factors required in orthodontic treatment, particularly with fixed appliances. However, over time, and usually by the middle to the end of the second year, through practice and immersion, the language becomes comprehensible, the concepts understandable, and the invisible connections between the various aspects of orthodontics become visible.

Modern preadjusted edgewise bracket designs can trace their ancestry to the original edgewise appliance, designed by Dr Edward H. Angle, and first introduced on 2 June 1925 at the Fourth Annual Meeting of the Edward Angle Society of Orthodontists. Interestingly, initially Angle did not name the appliance. The term 'edgewise' refers to the archwire, meaning that a rectangular archwire is placed into a horizontal bracket slot via its narrower edge, such that it has a larger buccolingual dimension compared with its occlusogingival dimension. A number of important advances in orthodontics followed; however, from a technical perspective, the next notable advance was the introduction, by Dr Lawrence Andrews, of preadjusted brackets to be used with straight wires. Added to this was the development of the acid-etch bonding technique and its subsequent application in orthodontics, together with developments in archwire materials, all of which have advanced fixed appliance therapy significantly.

Preadjusted edgewise orthodontic appliances provide the clinician with the unique ability to control tooth movement reliably, in the three planes of space and round the three axes of rotation. This three-dimensional control over tooth movement requires expertise, discretionary judgement and finesse, and is subject to misapplication in untrained hands.

Didactic teaching of orthodontics can only be delivered in segments, each of which, metaphorically speaking, is analogous to the fragments of a jigsaw puzzle. No matter in which order the segments are presented to the student,

until all the segments have been positioned accurately, the full picture will not be apparent or completely coherent. The purpose of this book is specific: it is to cover comprehensively the information required to understand and use preadjusted edgewise appliances. It is our intention that having read all the chapters in this book, together with practical chairside training, the reader will view the whole picture of preadjusted edgewise fixed appliance treatment with complete clarity.

The book comprises 22 chapters separated into four sections. Although most of the chapters can be read independently, the ideas have been presented in an order chosen with some care. Section I (Principles) covers the principles of treatment planning, orthodontic biomechanics, anchorage, consent and dentolegal considerations. Section II (The Preadjusted Edgewise Appliance) provides an in-depth description of the appliance systems, including bracket design, bracket placement, bonding, debonding, archwires, the use of orthodontic auxiliaries, mini-implants (temporary anchorage devices) and care of fixed appliances. Section III (Stages of Treatment) provides a comprehensive, step-by-step account of the four stages of treatment, with separate chapters on alignment and levelling, controlled space closure, finishing and retention. Section IV (Management of malocclusions) covers the treatment of each major category of malocclusion, with separate chapters on the management of Class II malocclusions, Class III malocclusions, deep bite malocclusions, anterior open bite malocclusions, and malocclusions with transverse problems. The two appendices at the end cover orthodontic instruments and orthodontic elastics.

Many of the authors invited to contribute chapters to this book are internationally renowned leaders in orthodontics. The contributing authors have provided comprehensive and practical chapters, analysing the scientific literature and providing their technical expertise, all complemented with sound judgement. They have described the rationale for their decisions based on up-to-date evidence and long-term clinical experience. The editors' desire is that the chapters in this book will be used by the spectrum of clinicians, from junior trainees through to qualified orthodontists at all levels.

There is a simple rule for clinical practice: excellent clinicians produce consistently excellent results, and 'bad workmen blame their tools'. There is a vast array of bracket designs and fixed appliance systems, and proponents of each extol their virtues whilst trivialising the limitations. This is to be expected in the marketplace, but has no place in a scientifically based clinical endeavour such as orthodontics, where the dominating value is the ability to achieve reliably excellent results for consecutive patients. The development of orthodontic materials and refinements in techniques will no doubt continue, but none will replace sound clinical judgement based on a comprehensive understanding of biological principles, the biomechanical foundations of fixed appliance treatment, and the arduous task of obtaining and cultivating technical ability and thereby gaining legitimate experience. The best clinicians are those who can identify the problems, judge and plan the appropriate treatment together with the patient, and apply selectively the appropriate appliance and mechanics to deal with the patient's presenting problems.

Orthodontics is a beautiful specialty. Unlike most of medicine, our patients do not just need treatment, they desire it, making the ability to undertake orthodontic treatment for patients a distinct privilege.

Farhad B. Naini and Daljit S. Gill

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The influence of great teachers always remains with their students. We owe a debt of gratitude to our teachers in orthodontics. We were very fortunate to undertake our specialty training at a time when our teachers were at their peak; many were pioneers in the introduction, development and use of preadjusted edgewise appliances in the UK. Most are now retired and some are, sadly, no longer with us, but their influence remains through their students and the continuing excellence of their departments.

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Farhad B. Naini and Daljit S. Gill

To my parents and brother, who introduced me to the importance of attempting to understand the world, with gratitude, admiration and love.

As ever, I am indebted to my wife, Hengameh, for her unyielding support. As well as being a graphic designer, Hengameh is a consultant in animal behaviour and welfare and head veterinary nurse in a busy veterinary surgery in Kent, the 'Garden of England'. This book was completed during the time of a global pandemic. During this difficult time, she refused to stay away from work, and worked tirelessly to care for sick, injured and vulnerable animals. Yet, she made time to create the illustrations for my chapters. I am forever humbled by her intellect, compassion and dedication. She demonstrates, every day, that it takes a lot more courage and strength of character to stand against the crowd and show that kindness and compassion to non-human animals, with whom we share this small planet, are far more important than antiquated attitudes, unjustifiable habits and the excuse of 'tradition'. This book would not have been possible without her enthusiasm and commitment.

Farhad B. Naini

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Daljit S. Gill

We are donating the royalties for this book to animal welfare charities chosen by Hengameh Naini.

Contributors

Nazan Adali, MSc, BDS(Hons), BSc, FDS.RCS(Orth), M.Orth.RCS(Eng), MFDS.RCS(Eng), FHEA
Consultant Orthodontist and Cleft Lip and Palate Lead
Maxillofacial Centre
Luton and Dunstable University Hospital NHS Foundation Trust
Visiting Postgraduate Lecturer, King's College London
London, UK

Zaid B. Al-Bitar, BDS, MSc, MOrth.RCS (Eng.)
Professor of Orthodontics
Vice Dean for Graduate Affairs
Faculty of Dentistry, University of Jordan
Senior Consultant Orthodontist
University of Jordan Hospital
Amman, Jordan

Stephen M. Chadwick, FDSRCS, MSc, MOrthRCS, MA, FDS(Orth)RCS, FDS(Orth)RCPS
Consultant Orthodontist
Countess of Chester Hospital NHS Foundation Trust
Chester, UK

Martyn T. Cobourne, BDS (Hons), FDS.RCS (Eng.), FDS.RCS (Ed.), MSc, MOrth.RCS (Eng.), FDS.Orth.RCS, PhD, FHEA
Professor and Honorary Consultant in Orthodontics
Academic Head of Orthodontics
Centre for Craniofacial and Regenerative Biology
Faculty of Dental, Oral and Craniofacial Sciences
King's College London
Guy's Hospital
London, UK

Richard R.J. Cousley, BSc, BDS, MSc, FDS, MOrth, FDS(Orth) RCS
Consultant Orthodontist
The Priestgate Clinic, Peterborough and Honorary Consultant Orthodontist at Peterborough City Hospital
Peterborough, UK

Lucy Davenport-Jones, BDS (Hons), MSc, MFDS.RCS (Edin.), M.Orth.RCS (Edin.), FDS.Orth.RCS (Edin.)
Consultant Orthodontist
St George's University Hospital and Kingston Hospital
Clinical Lead for Dentistry
St George's University Hospital
London, UK

Andrew T. DiBiase, BDS (Hons), FDS.RCS (Eng.), MSc, M.Orth.RCS (Eng.), FDS.Orth.RCS
Consultant Orthodontist
East Kent Hospitals University NHS Foundation Trust
Canterbury, UK

Chris D. Donaldson, MBBS (Lond.), BDS (Lond.), MFDS.RCS (Ire.), MSc (KCL), M.Orth.RCS (Edin.)
Senior Specialist Registrar
Department of Orthodontics
King's College Hospital and St George's Hospital
London, UK

Umberto Garagiola, DDS, PhD
Professor of Orthodontics
Biomedical Surgical and Dental Department
Maxillo-Facial and Odontostomatology Unit
Fondazione Cà Granda IRCCS
Ospedale Maggiore Policlinico
School of Dentistry
University of Milan
Milan, Italy

Daljit S. Gill, BDS (Hons), BSc (Hons), MSc (Lond.), FDS.RCS (Eng.), M.Orth.RCS (Eng.), FDS (Orth) RCS (Eng.), FHEA
Consultant Orthodontist
Department of Orthodontics
Great Ormond Street Hospital NHS Foundation Trust and UCLH Eastman Dental Hospital
London, UK

Mithran S. Goonewardene, BDSc(Hons), Cert.Ortho., MMedSc, FICD, FADI, FPFA
Head of Orthodontics
UWA Dental School
Faculty of Health and Medical Sciences
Oral, Developmental and Behavioural Sciences
University of Western Australia
Perth, Australia

Chung H. Kau, BDS, MScD, MBA, PhD, MOrthEdin, FDS-Glas, FDSEdin, FFDIre (Ortho), FICD, FACD, FAMS(Ortho), Cert (Ortho), ABO
Professor and Chairman
Department of Orthodontics
School of Dentistry
University of Alabama
Senior Scientist
Global Center for Craniofacial, Oral and Dental Disorders, University of Alabama
Director
UAB Craniofacial Disorders Clinic in Collaboration with Children's Rehabilitation Services of Alabama, University of Alabama
Birmingham, Alabama, USA

Leila Khamashta-Ledezma, BDS (Lond.), MJDF.RCS (Eng.), MSc (KCL), M.Orth.RCS (Edin.), FDS.Orth.RCS (Edin.), GCAP (KCL), FHEA
Specialist Orthodontist
Wetzikon, Switzerland
Former Consultant Orthodontist
Department of Orthodontics
Guy's and St Thomas' NHS Foundation Trust
London, UK

Simon J. Littlewood, BDS, MDSc, FDS(Orth)RCPS(Glasg), MOrthRCS(Edin), FDSRCS(Eng)
Consultant Orthodontist and Specialty Lead
Orthodontic Department
St Luke's Hospital
Bradford, UK

Gavin J. Mack, BDS (Hons), MSc, MFDS.RCS(Eng), M.Orth.RCS, FDS.Orth.RCS(Eng)
Consultant Orthodontist
Department of Orthodontics
King's College Hospital London
London, UK

Grant T. McIntyre, BDS, FDS.RCPS, M.Orth.RCS, PhD, FDS.Orth.RCPS
Consultant Orthodontist
Professor of Orthodontics
Dundee Dental School and Hospital
Dundee, Scotland

Declan Millett, BDSc, DDS, FDS.RCPS (Glasg.), FDS.RCS (Eng.), DOrth.RCS (Eng.), M.Orth.RCS (Eng.), FHEA
Professor and Head of Orthodontics
Orthodontic Unit
Cork University Dental School and Hospital
University College Cork
Cork, Ireland

Farhad B. Naini, BDS (Lond.), MSc (Lond.), PhD (KCL), FDS.RCS (Eng.), M.Orth.RCS (Eng.), FDS.Orth.RCS (Eng.), GCAP (KCL), FHEA, FDS.RCS.Ed
Consultant Orthodontist
Department of Orthodontics
Kingston Hospital NHS Foundation Trust
St George's University Hospital NHS Foundation Trust
London, UK

Jonathan Sandler, BDS (Hons), MSc, PhD, FDS.RCPS, M.Orth.RCS
Consultant Orthodontist
Chesterfield Royal Hospital
Professor of Orthodontics
University of Sheffield
Sheffield, UK

Hemendranath V. Shah, BDS (Bris), MFDS.RCS(Eng), PG Cert Med Ed (Bris), MOrth.RCS(Ed), DDS (Bris), FDS.Orth.RCS(Eng)
Consultant Orthodontist
Royal Berkshire Hospital NHS Foundation Trust
Reading, UK
Specialist Practitioner
Staines-Upon-Thames and Watford, UK

3

Anchorage

Zaid B. Al-Bitar

CHAPTER OUTLINE

'Give me but one firm spot on which to stand, and a lever long enough, and I will move the world.'

Archimedes (c. 287–212 BC)[1]

Introduction

Anchorage is considered to be one of the most important and limiting factors in orthodontic treatment. It is an essential part of orthodontic treatment planning, regardless of

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the type of appliance or treatment technique used. For this reason, patients also should have some understanding of anchorage considerations, which should form part of any informed consent discussion. Since orthodontists cannot accurately measure the force systems used with fixed orthodontic appliances, anchorage monitoring is essential throughout treatment progress.

In clinical orthodontics, teeth are moved from one location to another within the dental arch via applied forces (through archwires, elastics or springs). The forces used to move a tooth or segments of teeth are usually applied from other teeth (the anchor teeth), either within the same arch or the opposing arch.[2] If the anchor teeth are in the correct position, the clinician will not want them to move. Anchorage is simply the term used to describe the process of ensuring that desired tooth movements occur whilst undesirable tooth movements are controlled and, where necessary, prevented. The anchor teeth, or any other structures providing anchorage, provide resistance to undesired tooth movements.

The importance of anchorage for tooth movement was recognised well before the invention of the modern fixed appliance. Pierre Fauchard (1678–1761), considered by many as the father of modern dentistry, with his of invention of the 'Bandeau' arch in 1728 (Figure 3.1) was one of the pioneers who recognised the need for the provision of adequate anchorage in order to move teeth.[3] This became the basis for Edward Angle's E-arch more than a century later. Recognising the importance of anchorage for his 'edgewise' technique, Angle wrote a whole chapter in his textbook discussing the principles of anchorage and proposed a classification and methods of anchorage management.

During active orthodontic treatment teeth are exposed to forces and moments (see Chapter 2). According to Newton's Third Law of Motion, also referred to as the law of reciprocal action (Box 3.0), this will always generate reactionary forces in opposite directions.[4] Orthodontic appliances usually have two main parts: the part that is involved directly in tooth movement is referred to as the **active unit** and the part that is involved directly with anchorage, utilising anchor teeth that are not to be moved or to be moved minimally, is referred to as the **reactive (anchor) unit**. It is the duty of the clinician to have a clear understanding of the biomechanics involved in treatment and be equipped with the necessary tools to maximise the desired movements and minimise the unwanted tooth movements. In fact, in many situations, more effort is needed to deal with minimising the reactionary movements than the desired ones. Failure to prevent this undesired movement of the reactive segment is called **anchorage loss**. With the introduction of new fixed appliance techniques and materials, improvement of anchorage control represents one of the main factors that has advanced clinical practice. Traditionally, orthodontists have used the term 'minimise' in relation to anchorage loss, as it was not possible to prevent anchorage loss completely. However, with the advances in bone anchors (termed orthodontic mini-implants, miniscrews or temporary anchorage devices), significant steps towards achieving absolute anchorage have been reached (see Chapter 12).

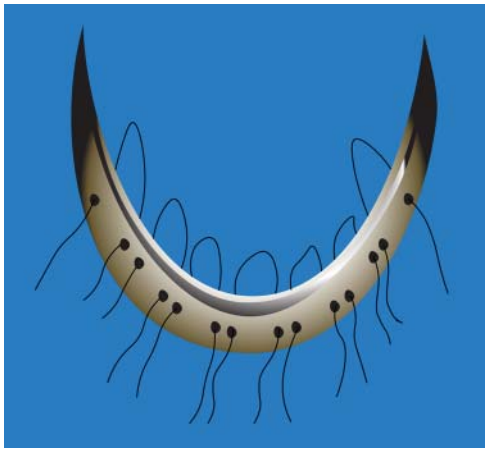

Figure 3.1 Fauchard's 'Le Bandeau' arch.

Box 3.1 Newton's Third Law of Motion

To any action there is always an opposite and equal reaction; in other words, the actions of two bodies upon each other are always equal and always opposite in direction.[4]

In clinical orthodontics, this means that for any action (which refers to the applied force) in a given biomechanical system, there is an equal and opposite reaction force; and that the sum of all the forces and the sum of all the moments in this system will always equal zero.

When talking about anchorage, the anteroposterior plane is what is classically considered. However, the other two planes, i.e. the vertical and transverse planes, should also be considered and are equally important. In fact, treating a malocclusion in one plane could have anchorage implications in the other planes.

Terminology

Prevention of the movement of anchor teeth is termed **anchorage conservation**. Methods of conserving anchorage with fixed orthodontic appliances include involving as

many teeth as possible in the anchorage unit in order to distribute the force over a larger root surface area, moving teeth separately or in small numbers, using light forces sufficient for desired tooth movement but too small to move the anchor unit, and pitting differential mechanics against one another, e.g. tipping the active unit versus bodily translation of the reactive unit. The **anchorage value** of a tooth, a group of teeth, or an appliance relates to their capacity to resist movement.

Just as an anchor is used to moor a ship to the sea bottom, thus preventing its movement, sometimes **anchorage reinforcement** is required (e.g. Nance palatal arch, headgear, and bone-anchored miniscrews) in order to reduce or eliminate anchorage loss, i.e. the undesirable tooth movement. The term **reciprocal anchorage** refers to situations where equal movement of teeth on either side is desired, e.g. closing a symmetrical maxillary dental midline diastema with elastic force placed between the central incisors.

Anchorage Value

There are many factors that affect the relative ability of a tooth (or a segment of teeth) to act as an anchorage unit in comparison to another. These include the following:

- Force magnitude and pressure distribution in the periodontal ligament
- Quality of the supporting structures
- Occlusal intercuspation
- Facial growth and the vertical dimension
- Root morphology
- Interproximal contacts.

Force Levels and Pressure Distribution in the Periodontal Ligament

Orthodontic tooth movement occurs as a response of the periodontal ligament to mechanical load that results in alveolar bone remodelling. This involves complex molecular and cellular interactions that are still not clearly understood. Important aspects of orthodontic forces to consider in relation to anchorage are force threshold and the rate and type of tooth movement.

In 1932, Schwarz proposed the concept of **optimum force**.[5] An optimal continuous force, according to him, was defined as the 'force leading to a change in tissue pressure that approximated the capillary vessels' blood pressure, thus preventing their occlusion in the compressed periodontal ligament'. Forces well below the optimal level will cause no reaction in the periodontal ligament while forces exceeding this level would lead to tissue necrosis causing delay in tooth movement. Therefore, the concept of an optimal force level (within a certain range) for tooth movement is based on the hypothesis that a force of a certain magnitude and duration is capable of producing a maximum rate of tooth movement without tissue damage and with the least patient discomfort. This force level may differ for each tooth and each patient. Below this level, the teeth will not move, or not adequately enough for orthodontic treatment. After reaching the threshold for initiation of tooth movement, the rate of movement increases proportionally with increasing force levels until a plateau is reached where further increase in force levels does not augment this rate. In fact, increasing orthodontic force beyond this plateau level results in a reduced rate of tooth movement in addition to risks of tissue damage and root resorption. However, it is the pressure distribution (force per unit area) in the periodontal ligament rather than the absolute force value that is important when considering force levels. Therefore, it is essential when planning for anchorage that the forces per unit area for the active units be within the optimal range, whereas reactive forces should be distributed over a large root surface area within the anchorage unit so that force per unit area lies below the threshold level. This can be accomplished by utilising teeth with larger roots and or increasing the number of anchor teeth compared to the active unit.

The magnitude of this optimum force is different for each type of tooth movement as the distribution of forces within the periodontal ligament are different depending on the ratio of the applied moment relative to the applied force. Approximate values for the forces required to produce different types of tooth movements, based on clinical experience rather than scientific data, are provided in Table 3.1. In a recent systematic review, Theodorou et al.[6] found that the optimal forces for bodily orthodontic movement of teeth with fixed appliances range between 50 and 100 cN (~50 to 100 g). This was based on measuring forces applied directly to teeth rather than measuring stress and strain levels with the periodontal ligament, which is potentially impossible to perform.

As noted in Table 3.1, among the other types of tooth movement, bodily movement requires the largest force level. As far as anchorage is concerned, more strain on anchor teeth are generated when moving teeth in the active unit bodily as compared with other types of tooth movement. Also, the anchorage value of a tooth that is free to tip is less than a tooth that is restricted in tipping when applying a force couple. Based on this finding, Begg proposed the 'differential force theory', which represents the basic philosophy behind his and the subsequent Tip-Edge appliance techniques. According to Begg, the force applied

Table 3.1 Force levels required for different orthodontic tooth movements (approximate values, based on clinical experience).

Type of movement	Single-rooted teeth (grams of force)	Multirooted teeth (grams of force)
Root uprighting	50	100
Bodily translation	50	100
Tipping	30	60
Rotation	30	60
Extrusion	30	60
Intrusion	10	20

for space closure should be light enough to exceed the 'critical threshold of stress' needed for tooth movement on the active segment of teeth, but should be below this threshold for movement of the anchorage segment. The type of anchorage utilising this theory is called stationary anchorage.

Teeth that have initial angulations or inclinations that are opposite to the direction of applied force usually have better anchorage resistance. For example, during space closure, distally angulated molars have greater anchorage value than molars with mesial angulations. On the other hand, alignment of canines with initial distal angulation will cause greater anchorage strain on the molars compared to canines with mesial angulations.

Many researchers have rejected the optimal force level hypothesis and concluded that there is no relationship between the force magnitude and the rate of tooth movement. They have also shown that the threshold of force level that will start tooth movement is not known, and there is considerable individual variation.[7–10] According to these findings, many clinicians have adopted a different way of anchorage management that will be discussed later in this chapter.[9]

It can be concluded that the relationships between force levels and the threshold or rate of orthodontic tooth movement are not completely understood, and that many additional factors, possibly related to occlusion and facial growth, in addition to other factors, are involved which require further investigation. The majority of studies are based on animal research, which explains the conflicting results within the literature. In spite of this, increasing the anchorage value by increasing the number of teeth and reducing the force levels remains a sound strategy for anchorage management, although this should not be completely relied upon and should be supplemented by other means in cases with increased anchorage demands.

Quality of the Supporting Structures

Teeth with a healthy periodontium offer greater anchorage resistance than teeth with reduced periodontal support. This is because in patients with reduced periodontal support the force levels are distributed over a smaller root surface area.

The quality of the alveolar bone is also an important factor affecting anchorage value. For example, dense bone around mandibular molar teeth results in slower movement of these anchor teeth compared to maxillary molars. This also explains the slower rate of tooth movement into an old extraction space within the mandibular arch.

Occlusal Intercuspation

The effect of occlusion on tooth movement and anchorage has been given more attention in recent years. Dudic et al.[11] found that the rate of orthodontic tooth movement cannot be explained only by force levels; other factors to be considered include inter-arch or intra-arch occlusion and patient age. Teeth within the anchorage unit with good occlusal intercuspation usually have a greater anchorage value and less rate of tooth movement. Occlusal interferences, on the other hand, could impede the movement of the active unit and increase the strain on the anchorage unit.

Facial Growth and the Vertical Dimension

Facial growth can also greatly influence anchorage. Its effect can be favourable if the direction of growth is in the same direction of movement as the active unit. For example, anterior mandibular growth or growth rotation can help with overjet reduction in Class II malocclusions, whereas a posterior growth rotation will have the opposite effect. The same considerations should be taken when treating vertical malocclusions, i.e. deep or open bites in relationship to mandibular growth, and when treating transverse malocclusions, i.e. crossbites and midline shifts. During orthodontic space closure, there is usually more anchorage loss in patients with increased lower anterior face height and maxillary–mandibular plane angles. This may be due to reduced occlusal forces and a more mesial path of eruption in these patients.

Xu[12] has proposed two types of anchorage loss during orthodontic treatment:

1. Mechanical: related to reaction to orthodontic forces.
2. Biological: due to effects of growth and biological forces.

This conclusion was based on the results of his own studies on anchorage loss and from reviews of previous studies on craniofacial growth.[13–17] These studies have shown that

in growing subjects, upper molars usually move and tip mesially to a significant extent, which explains anchorage loss even in cases where miniscrews have been used. The other biological forces causing mesial movement of upper molars, according to Xu, were the horizontal component of bite force and the periodontal ligament force.

Root Morphology

Root morphology can also have an effect on a tooth's anchorage value by affecting the force distribution within the periodontal ligament. For example, lower incisors have a flat surface with wider buccolingual dimension. They will, in turn, have less anchorage resistance for labiolingual than mesiodistal movements.

Interproximal Contacts

Teeth with broad and intact contact areas may provide greater anchorage value but this needs to be further investigated.

Assessment of Anchorage Need

As mentioned earlier, anchorage requirements should be assessed during the treatment planning stage. Having a clear vision of treatment goals, type and amount of tooth movement, amount of space needed, a clear understanding of the treatment mechanics involved, and the effects that different components of the appliance have on the different factors affecting the anchorage value will enhance the ability to estimate the anchorage needs of patients. Careful assessment of patient records and applying a comprehensive space analysis method such as the Royal London Space Planning will enable clinicians to objectively assess the anchorage needs.[18, 19] Fiorelli and colleagues[20, 21] introduced computerised methods to predict the force systems for patients with fixed appliances. Although these methods are still not widely used and need further investigation, they could greatly enhance the perfectibility of treatment mechanics and estimation of anchorage requirements in the future. It is usually more prudent to overestimate the anchorage needs as the consequences of underestimations usually have more negative effects on the treatment outcome.

Classifications of Anchorage

Anchorage has been classified in different ways.[22, 23]

Classification of Anchorage According to the Site of Anchorage

Intraoral Anchorage

This type of anchorage is provided by sites located inside the oral cavity. Intraoral anchorage can be further classified as follows.

Source of Anchorage

1. Teeth
2. Soft tissues: anchorage is provided by the actions of intraoral musculature such as cheeks and lips
3. Bone, classified into:
   (a) Direct bone anchorage
      (i) Ankylosed teeth
      (ii) Implants
      (iii) Miniscrews
      (iv) Miniplates
   (b) Indirect bone anchorage.

Jaws Involved

1. **Intramaxillary anchorage**, i.e. provided by the same arch.
2. **Intermaxillary anchorage**, i.e. provided by the opposing arch.

Manner of Force Application

1. **Simple**: resistance to tipping movement where the tooth is free to tip during movement.
2. **Stationary**: resistance to bodily movement where the tooth is permitted to translate only.
3. **Reciprocal**: a situation where movement of a tooth or group of teeth is balanced against movement of another tooth or group of teeth. This movement of the active and reactive units is desirable.

According to the Number of Anchorage Units

1. **Single anchorage**: involves one tooth only.
2. **Compound anchorage**: involves two or more teeth.
3. **Reinforced anchorage**: involves adding non-dental structures to the anchorage unit.

Extraoral Anchorage is Provided by Sites Located outside the Oral Cavity

1. Headgear
2. Facemask.

Classification of Anchorage According to the Anchorage Need (Anteroposterior Plane)

1. **Absolute anchorage**: when all movement is needed only in the active unit with no movement in the anchorage unit.

2. **Maximum (high) anchorage (Type A)**: when the majority of movement is needed in the active unit with minimal movement desired in the anchorage unit.
3. **Moderate anchorage (Type B)**: when equal movement of active and anchorage unit is needed.
4. **Minimal (low) anchorage (Type C)**: when the majority of movement is needed in the anchorage unit.

Clinical experience suggests that, in the anteroposterior plane, if greater than 60% of the space created by dental extraction is required to complete the treatment, it may be considered a high anchorage case, if 30–60% it is medium, and if less than 30% it would be considered a low anchorage case.[23]

It is important to note that anchorage problems can occur not only from insufficient space for the active unit to move into but also from excessive residual space, which requires excessive anchorage loss.

Classification According to the Plane of Anchorage

1. Anteroposterior
2. Vertical
3. Transverse.

Anchorage Control with Fixed Appliances

During treatment with fixed appliances, anchorage can be controlled by affecting the different elements contributing to the anchorage value of both the active and anchorage unit. Different treatment techniques employ a combination of the following methods.

Intermaxillary Anchorage

Intermaxillary anchorage is provided by the opposing arch and can be achieved by the following methods.

Intraoral Elastics

Intraoral elastics can be used for treatment of anteroposterior vertical and transverse malocclusions (Figure 3.2). The anchorage provided by elastics can also be further classified into simple, compound, reciprocal and stationary anchorage. These elastics are usually worn on a full-time basis and changed every 24 hours, so rely on patient cooperation. An important and usually unwanted side effect of using intraoral elastics is their extrusive effect on molars and incisors, which might limit their use in high-angle open bite cases. In

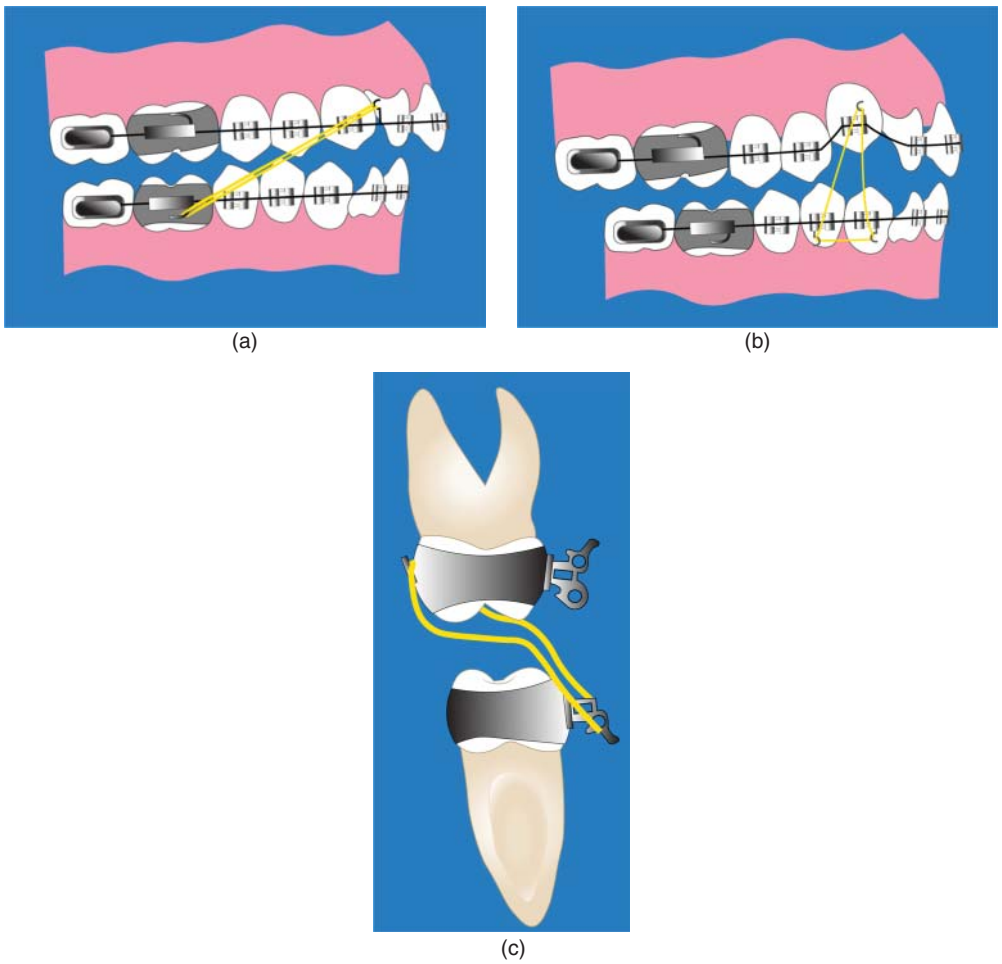

Figure 3.2 Intermaxillary anchorage can be achieved by using intraoral elastics for the treatment of (a) anteroposterior, (b) vertical and (c) transverse malocclusions.

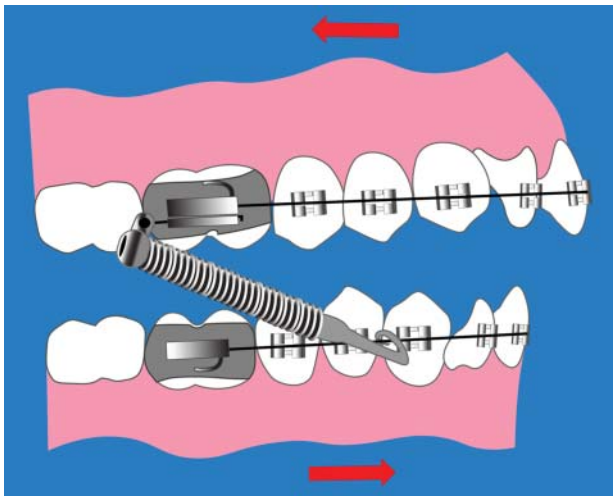

Figure 3.3 Forsus™ appliance, a non-compliance auxiliary, for the treatment of Class II malocclusion.

addition, Class II and Class III elastics can cause mesial tipping and lingual rolling of lower and upper molars, respectively. Prolonged use of Class II or Class III elastics could have adverse effects on the inclination of upper and lower incisors, introduce canting of the occlusal plane and cause root resorption of upper incisors.

Non-compliance Auxiliaries

These auxiliaries are usually indicated for treatment of Class II malocclusions and can be in the form of springs or pistons attached to fixed appliances (Figure 3.3). As their name suggests, they do not rely on patient compliance, contrary to intraoral elastics. These auxiliaries are usually prone to fracture and fatigue and are relatively expensive. However, like intermaxillary elastics, they also cause proclination of lower incisors.[24]

Functional Appliances

Although this subject is outside the scope of this textbook, functional appliances also rely on intermaxillary anchorage for their action. Initial successful treatment of Class II malocclusions with these appliances in growing children usually result in reduced anchorage demands during the second stage of treatment with fixed appliances.

Increasing the Number of Teeth in the Anchorage Unit

Increasing the number of teeth in the anchorage unit, thus increasing the total root surface area of the anchor unit, can be used to increase its anchorage value during the correction of anteroposterior, vertical and transverse malocclusions. There are many ways that this principle may be applied when using fixed appliances.

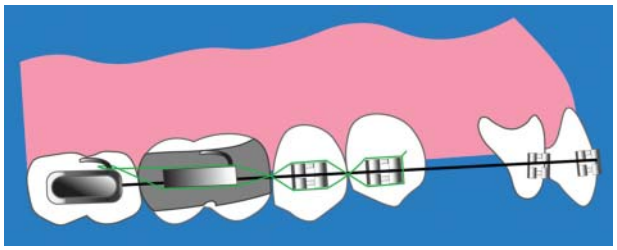

Figure 3.4 A stainless steel ligature wire (in green) can be used to increase the anchorage value of teeth by tying them together.

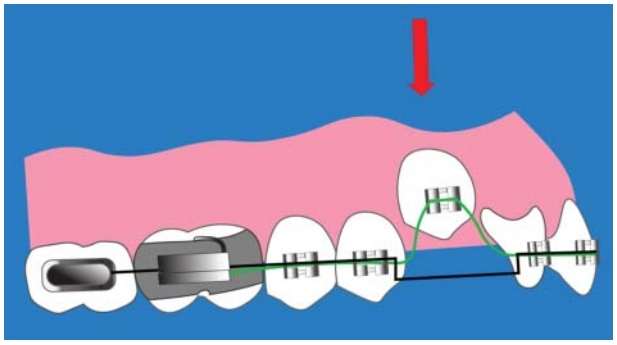

Figure 3.5 Piggyback NiTi wire (in green) to align upper canine.

1. Including the second molars in the anchorage unit.
2. Tying the anchor teeth together as a single unit using stainless steel ligature wires in order to increase their anchorage value (Figure 3.4).
3. Alignment of a severely displaced tooth using a flexible piggyback archwire over a rigid base archwire attached to the rest of teeth as a source of anchorage (Figure 3.5).
4. Using auxiliary wires over a rigid base archwire for tip or torque corrections (Figure 3.6).
5. Extraction pattern: the choice of extraction during orthodontic treatment can affect the number of teeth within both the active and anchorage units. For example, for treatment of Class II malocclusion, the extraction for upper first premolars will result in inclusion of the second premolars in the posterior anchorage unit, thus increasing their anchorage value during treatment. The extraction of lower second premolars will also help with treatment mechanics by limiting the retroclination of lower incisors and helping with correction of molar relationship by mesial movement of lower molars. The reverse extraction pattern (upper second premolars and lower first premolars) can be used in treatment of Class III malocclusions.
6. Subdivision of desired movements: a method of reducing strain on the anchorage unit is to move teeth within the active unit in more than one stage. One of the most common examples is the two-stage treatment of increased overjet starting with the retraction of

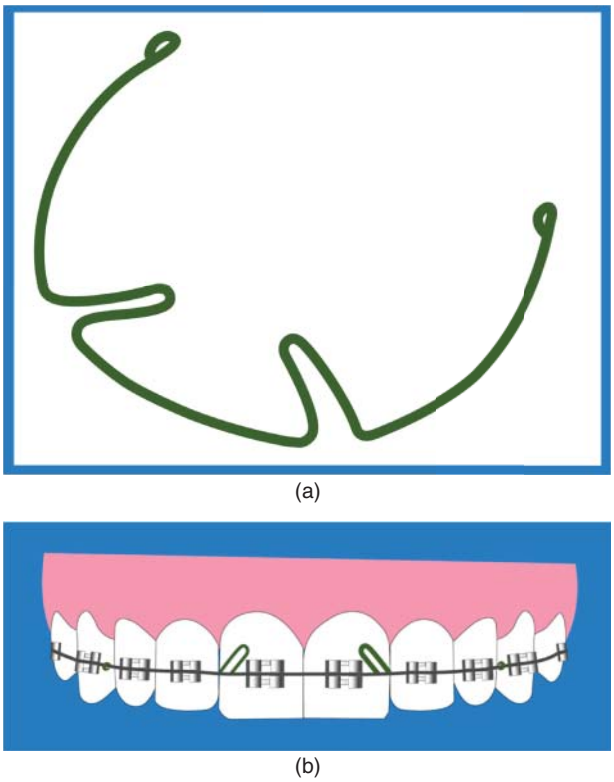

Figure 3.6 A two-spur torque auxiliary by TP Orthodontics™ (a) can be used to apply palatal toot torque on maxillary central incisors by placing it into bracket slots beneath the main archwire (b).

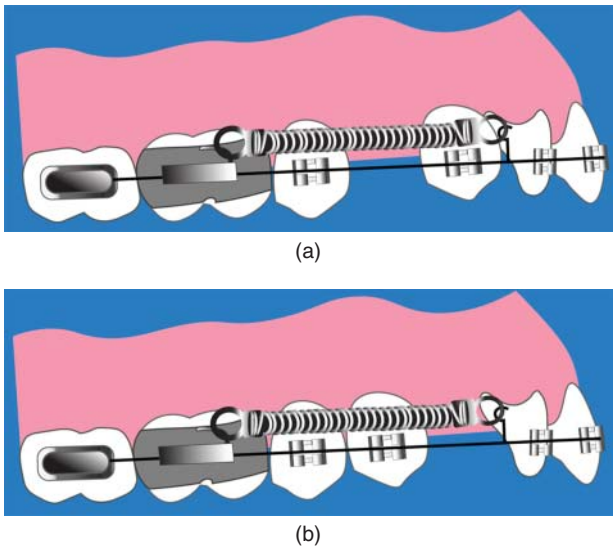

Figure 3.7 Retraction of upper anterior teeth: (a) en masse retraction; (b) two-step method where upper canines are distalised first.

maxillary canines as a first stage followed by retraction of the incisors. Although the theoretical principle behind this is sound, clinical studies have found no significant difference in anchorage loss with this two-step method compared with moving the canine-to-canine segment en masse (Figure 3.7).[25, 26] This concept is discussed further in Chapter 14.

Controlling Pressure Distribution in the Anchorage and Active Units

Controlling pressure distribution by intentionally angulating specific teeth within the anchorage unit can be used to make them better resist unwanted movement. This can be accomplished by introducing first-, second- or third-order bends in archwires or using specific bracket prescriptions.

First-, Second- and Third-Order Archwire Bends

As mentioned previously, more force is needed for bodily movement of teeth compared with tipping. Anchorage resistance of molar teeth can be increased by applying distal second-order bends (tip-back or anchor bends) thus committing them to moving only bodily while allowing anterior teeth to tip during space closure and overjet reduction using light forces for both sides (stationary anchorage). Anchorage support using this method, in addition to using intraoral elastics, is the heart of the treatment techniques of Begg and Tip-Edge appliances.

The use of tip-back bends was also an essential component of Tweed mechanics using edgewise brackets. Tweed used the term **anchorage preparation** to describe procedures during which the anchorage value of the upper premolars and molars was increased by tipping them distally before retraction of the anterior teeth. As a general guide, these bends should be very small, i.e. around 30°. It is also important to use light forces that cause movement of the incisors without causing movement of these molars. A common side effect of these bends is the extrusion and distal tipping of molars and proclination and intrusion of the incisors, which might not be desirable in patients with high angle and reduced overbite.

First-order bends can also be used for this purpose. Toe-in bends on molars can be used to prevent mesial rotation during space closure in addition to increasing their anchorage value.

Finally, third-order bends in rectangular or square archwires can also be used to increase the resistance of the anchorage unit. For example, during space closure in the lower arch, over-retraction of the lower labial segment teeth can be reduced by introducing labial crown torque for the lower incisors resulting in space

closure by more mesial movement of the buccal segment teeth.

Bracket Prescription

Changing the bracket prescription for individual teeth can be a valuable tool for anchorage control. For example, the MBT bracket prescription has reduced tip values for the upper incisors, canines and premolars compared with the Andrews prescription, in order to reduce strain on molars. This effect has been supported by a randomised clinical trial.[27]

Switching between right and left brackets can also change the second-order prescription of the same tooth. In Class III cases, using contralateral lower canine brackets will change the tip values from mesial to distal, making it easier to tip lower canine crowns distally, rather than distal root tipping, thus helping with lower incisor compensation using lower forces.

Based on the theory of anchorage loss explained earlier, Xu and colleagues have introduced a fixed appliance system called the Physiological Anchorage Spee-wire System (PASS).[28, 29] This system consists of two main components: a special crossed buccal (XBT) molar tube comprising a −7° main tube and a −25° tip-back tube crossing at the mesial end of the molar, and multilevel low-friction (MLF) brackets (Figure 3.8a). During the initial alignment stage using this system, the upper nickel–titanium (NiTi) wire is inserted into the tip-back tube generating a protective moment for the anchor molars from the beginning of treatment in addition to causing upper canines to tip distally at this early stage. According to the authors, this has a significant advantage over the traditional preadjusted edgewise appliance, where upper molars with low tip values were used. In this case, anchorage is usually lost early by their mesial tipping when incisors are engaged into the NiTi wires. By the time tip-back bends are used with stiffer archwires at a later stage, anchorage loss has already occurred, which might be significant especially in high anchorage cases. The other advantage of this system is the control of overbite with the initial archwire in contrast to the conventional system where incisor extrusion and increase in overbite are common side effects (Figure 3.8b). In order to study the clinical effect of the XBT tubes, Chen et al.[28] evaluated the records of 11 patients treated with this system. Linear and angular movements of upper first molars were evaluated via three-dimensional model analysis and cephalometric superimposition, respectively. The average movement of the upper first molars was 1.81° distal tipping and 2.38 mm mesial movement, which could meet the request of maximum anchorage. They concluded that application of XBT tubes could be an effective way to preserve molar anchorage without using additional anchorage enhancement appliances.

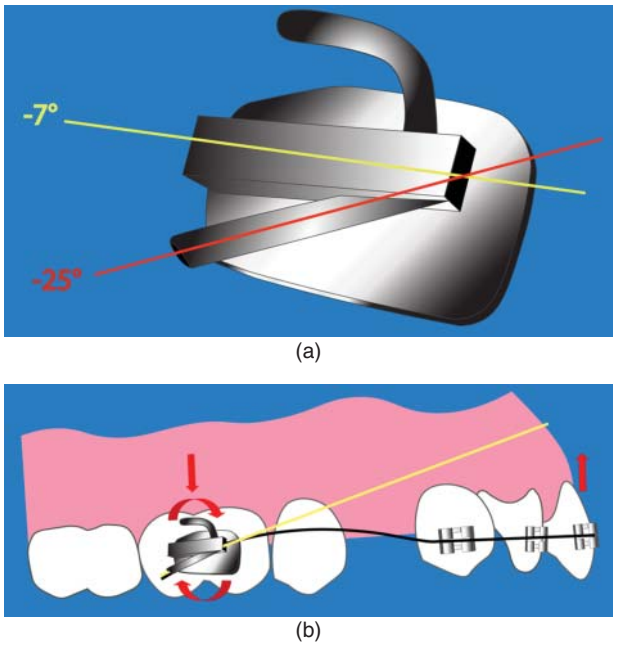

Figure 3.8 The PASS technique. (a) The cross buccal tube. (b) When the archwire is passively engaged into the tipback tube (yellow), it will lie above the anterior brackets. When the archwire is engaged anteriorly (black), a moment on the molar is created to prevent anchorage loss and anterior overbite is maintained.

Variations in bracket torque values can be used for resisting unwanted tooth movements. For example, increased labial root torque value for lower incisors with the MBT system can reduce their proclination when treating Class II malocclusions, especially when Class II elastics are being used. Also, during upper arch expansion using rectangular steel wires, brackets with greater labial root torque on the posterior teeth can be used in order to resist buccal crown flaring and hanging of palatal cusps.

Finally, first-order values of orthodontic brackets, such as anti-rotation values of molars, are helpful in reducing unwanted rotation and anchorage loss, to some extent, during space closure.

Orthodontic Auxiliaries

Different types of auxiliaries can be used to increase anchorage values of teeth, especially during space closure and midline correction. They are more commonly used with the Begg and Tip-Edge systems; for example, sidewinder springs used with the Tip-Edge system produce a mesiodistal root movement that can be used during space

closure and correction of midline shift. These are less relevant to preadjusted edgewise systems.

Extraoral Anchorage

Craniofacial and cervical bones can be used as sources of anchorage support during treatment of various malocclusions. The most commonly used extraoral appliances are headgears and facemasks.

Headgears

Headgears can be used to support anchorage of upper posterior teeth by maintaining the molar relationship usually during treatment of crowding and overjet problems. The variables controlling their effect are as follows.

1. **Force magnitude and duration**: anchorage support requires a force level of 250–350 g per side for a minimum of 10 hours per day.
2. **Direction of force in relationship to the occlusal plane**: all headgears have a distal direction of force; however, changing the direction of pull in relation to the occlusal plane will affect the direction of vertical forces on the molars. With **high-pull headgear** the direction of force passes above the occlusal plane and will have an intrusive effect on the upper first molars attached to the facebow via bands. This is usually indicated for high angle and anterior open bite malocclusions, and to resist the extrusive reaction of certain treatment mechanics. **Low-pull (cervical) headgear** has an extrusive effect on the upper molars as the forces will pass below the occlusal plane, and are thus indicated for deep bite, low angle malocclusions. **Straight-pull headgear** has a line of force that is approximately parallel to the occlusal plane and is indicated in malocclusions where no vertical forces on the molars are desired (Figure 3.9).
3. **Direction of force in relationship to the centre of resistance of molars**: bodily movement of molars will occur if resultant forces pass through the centre of resistance of molars, i.e. the trifurcation of their roots. If the resultant forces do not pass though their centre of resistance, tipping movements will occur. This can be controlled by altering the outer facebow length and inclination (see Chapter 14).

Headgear remains a valuable method for anchorage support when treating cases with high anchorage demands, especially in growing children where other effective methods such as direct bone anchorage devices cannot be used.[30] However, excellent patient cooperation is essential for their success. They are also socially limiting and not accepted by adults. More importantly, following the safety guidelines is vital during their wear as there are case reports of serious ocular and other extraoral or intraoral injuries due to the recoil of facebows in cases where these guidelines were not followed.

Facemasks

Facemask, also called reverse-pull or protraction headgear, uses the forehead and chin as a means of anchorage support (Figure 3.10). Although their main indication is the treatment of skeletal Class III malocclusion due to maxillary retrusion during the early mixed dentition stage by protracting the maxilla, they can be used in conjunction with fixed appliances by providing extraoral anchorage for protraction of posterior teeth, especially in hypodontia cases. Potential unwanted side effects of their use include posterior growth rotation of the mandible and the reduction of overbite due to the line of forces in addition to the retroclination of lower incisors. As with traditional headgear, it relies heavily on patient cooperation for success.

Avoiding or Reducing Forces on the Anchorage Unit

Anchorage loss can be minimised by attempting to avoid the application of force, or at least minimising forces, to the teeth that ideally should not move, or only move minimally during treatment. This may be accomplished as follows.

Avoiding Strain on Anchorage Units

This can be accomplished in several ways.

Bonding Rigid Wires Directly to the Anchorage Unit In high anchorage cases, Melsen and Verna[9] recommend delaying alignment of the anchorage unit during space closure. The theory behind this is that periodontal tissues around these teeth are stimulated to remodel long before space closure is initiated, which can result in anchorage loss. This can be done by using rigid wires inserted into molar bands and bonded directly to premolars to establish a passive unit.

Pull and Push Mechanics Applying push mechanics by using open coil springs is an effective method for anchorage preservation that can be used for incisor alignment and the correction of dental midline shifts (Figure 3.11).

Auxiliaries Several auxiliaries can be used for incisor alignment without the need for applying forces on the molars. For example, the Hugo space bar is an auxiliary that is placed on top of the mandibular base archwire and can be used to move the lower incisors laterally thus creating space for lower central incisor alignment (Figure 3.12).[31]

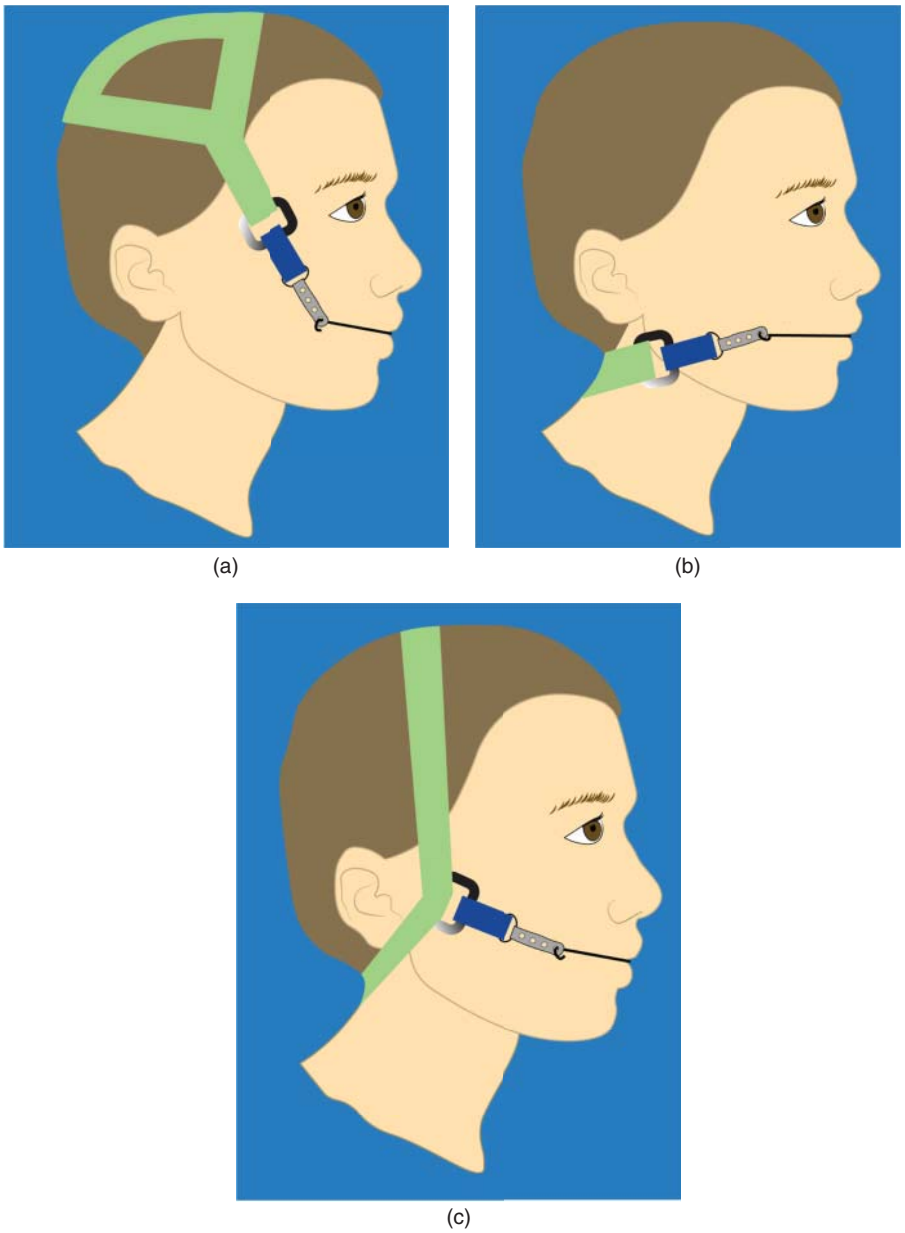

Figure 3.9 (a) High-pull headgear; (b) low-pull headgear; (c) straight-pull headgear.

Reducing the Force Level on the Anchorage Unit

The importance of using light forces for differential force mechanics has been explained earlier. With preadjusted edgewise mechanics, there are also several ways to reduce force levels and thus strain on the anchorage unit.

Reducing the Resistance to Sliding Sliding mechanics, which involves movement of brackets along the archwire, is used mainly in the edgewise technique. With this type of mechanics, forces are not only needed for bone remodelling necessary for tooth movement but also to overcome the **resistance to this sliding (RS)** that is generated at the bracket–wire interface. Increasing the force level will, in turn, have implications for orthodontic anchorage.

Resistance to sliding has been the subject of considerable debate among orthodontists. There is still a lack of understanding of this phenomenon despite a number of studies being published. The reason is the large number of variables affecting RS and the discrepancies among and between both *in vitro* and clinical studies. Savoldi et al.[32] were not able to perform a meta-analysis to study the variables affecting RS due to the incompatibility of experimental parameters, the lack of clear description of study design, materials, and experimental set-up, and the absence of consideration of the normal force (the force

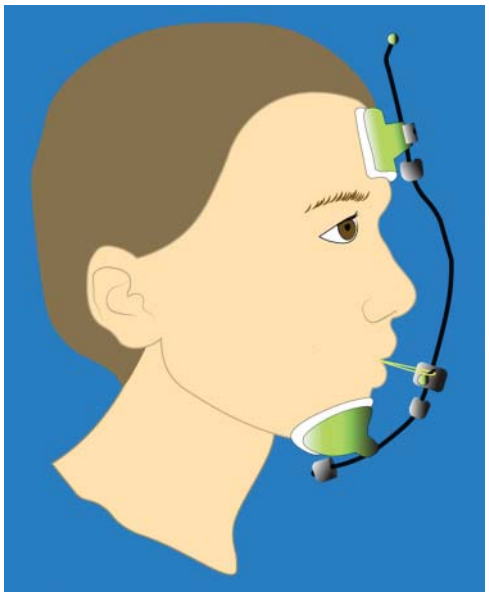

Figure 3.10 Facemask appliance.

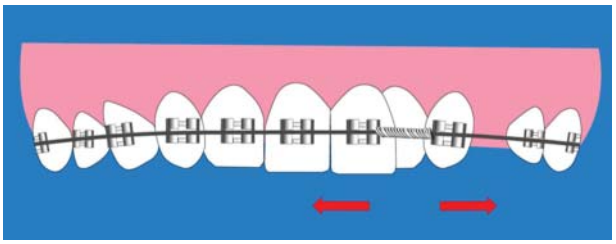

Figure 3.11 Push mechanics by using open coil spring to move upper left canine distally without putting any strain on the posterior anchor teeth.

perpendicular to the sliding) by most studies. They have suggested a protocol in order to achieve more objective evaluations and more relevant applications of *in vitro* findings to clinical treatments.

For a long time, friction has been considered the major cause of RS. **Friction** may be defined as the resistance encountered when one body moves relative to another body with which it is in contact. In clinical orthodontics, this relative movement of two contacting bodies produces a force resisting their relative movement in a direction tangential to the plane of contact. The magnitude of this force (F) is equal to the product of the normal force *FN* acting perpendicular to the contact surface, multiplied by the frictional coefficient μ ($F = FN \times \mu$). The frictional coefficient depends on the surface roughness and the combination of the materials involved; it is not, however, affected by the surface area of the contacting surfaces.

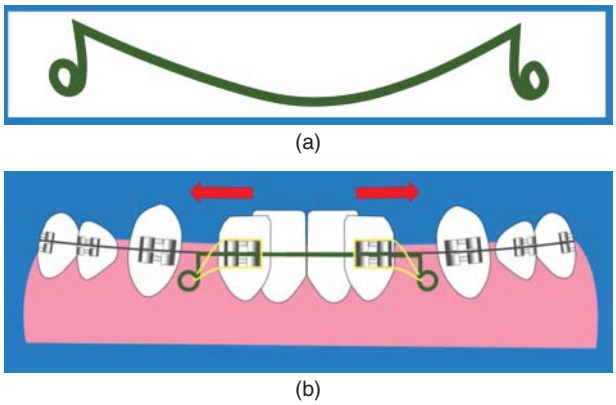

Figure 3.12 Hugo space bar auxiliary (a) can be used to create space for the lower incisors by tying an elastomeric thread from the lateral incisors to the circles of the auxiliary (b).

Several factors have been found to affect frictional forces between brackets and archwires.

Archwire

Material Several studies have shown that frictional forces are least when stainless steel wires and brackets are used together.[33–35] The highest resistance has been found with titanium molybdenum alloy (TMA) archwires. However, this increase in coefficient of friction is related mainly to surface chemistry rather than mechanical friction between the bracket and archwire. Although surface treatment and ion implantation have been suggested to reduce frictional resistance of this wire, this has been shown to be ineffective.[36]

Size and Cross-section Several studies have shown that frictional forces increase as the wire size increases for the same bracket and wire material. Rectangular wires were also shown to have higher values compared to round wires, especially for TMA and NiTi wires.[37, 38] For this reason, dual-geometry wires, such as the Hills dual-geometry wires used with the SPEED™ system, have been introduced by some companies. These wires have a rectangular anterior section that maintains the optimal torque and a round posterior section in order to reduce frictional forces during sliding. The same effect may be clinically performed at the chairside by thinning the sections of a rectangular wire where sliding needs to occur.

Bracket

Material Different brackets have shown variable frictional characteristics due to differences in their chemical and morphological structure. Although ceramic brackets are more aesthetic, studies have shown that they produce nearly twice the friction produced by stainless

steel brackets.[39, 40] Incorporating stainless steel slots into ceramic brackets was shown to be effective in overcoming this high frictional force.[41]

Manufacturing Technique Even within the same bracket material, friction differed according to manufacturing technique. Milled stainless steel brackets have been found to have higher friction than sintered and cast brackets.[42, 43] Among different types of ceramic brackets, a study by Cha et al.[44] found that frictional resistance of silica-insert ceramic brackets was comparable to that of conventional stainless steel brackets.

Ligation

Materials Stainless steel ligatures were generally found to cause less friction than elastomeric modules.[45] Several modifications of ligature materials have been suggested to reduce their frictional properties, such as surface coating. This kind of modification has been found to be effective with steel ligatures as Teflon coating was found to reduce their frictional forces.[46] However, contrary to the claims of manufacturers that it reduces friction, polymeric coating of elastomeric modules appears to produce more friction compared with conventional elastomeric ligatures.[47]

Tightness Increasing the tightness of both steel ligatures and elastomeric modules ligated to brackets has been shown to increase frictional forces between the brackets and archwires.[48, 49] Several studies have shown that new designs of non-conventional elastomeric ligatures had lower ligation forces compared to conventional ones.[50, 51]

Self-ligating Brackets Although self-ligation was introduced in 1935, it has gained more interest recently as a means to increase treatment efficiency. Self-ligating brackets have the ability to hold the archwire within the slot by an integral locking mechanism. There are two main categories of these brackets, classified according to their mechanism of closure and interaction with the archwire, i.e. active and passive. **Passive self-ligating brackets** have slides that can be closed without applying active force to the archwire. Conversely, **active self-ligating brackets** have spring clips that press against the archwire. Multiple studies have claimed that self-ligating brackets generate less friction during sliding mechanics,[50, 52, 53] while passively ligated brackets showed less frictional resistance compared with actively ligated systems.[54]

Biological Factors

Saliva There is some controversy in the literature about the effect of saliva on friction. Kusy et al.[55] suggested that the effect of saliva could promote both adhesive and lubricous behaviours depending on the archwire–bracket combination.

Occlusal Forces Occlusal forces during function have been suggested to have a positive effect on reducing friction, although this factor has been found to be inconsistent.[56]

Although the focus of orthodontic research for many years was on controlling friction in order to reduce RS, recent studies have been more doubtful about its impact, stating that it plays only a small role in RS.[57, 58] Researchers have questioned the methodology of previous work, especially since most of our knowledge on this matter is based on *in vitro* studies that do not accurately simulate oral conditions.

According to Kusy and Whitley, two other factors contribute to RS in addition to friction: **binding** and **notching**.[59] Binding occurs when the tipping of a tooth or flexion of the archwire creates contact between the wire and the corners of the bracket (Figure 3.13). This could act as a lock that prevents movement of teeth within the active unit, leading to unwanted movement of the anchorage unit instead. Binding may be affected by the force of contact between the bracket and archwire and the contact angle between them. Increasing bracket width will reduce the binding tendency, as this reduces both the force of contact and the contact angle with the archwire. However, increasing bracket width comes at the expense of reducing the interbracket span, which in turn increases the stiffness of the archwire in this span. However, some *in vitro* studies have reported that narrower brackets are associated with less RS as they offer more clearance for wires during tipping.[35, 60] The addition of rounded bracket slot

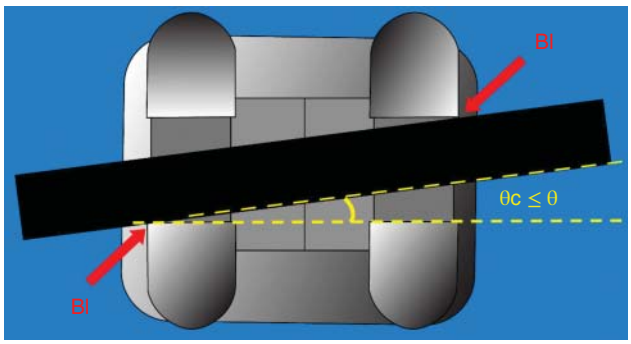

Figure 3.13 Binding of archwire (BI) with the bracket corners starts when the contact angle between the archwire and bracket slot (θ) is equal to the critical contact angle (θc). Binding forces increase further as θ increases.

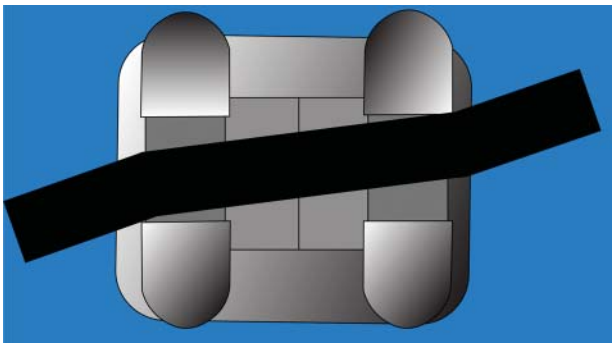

Figure 3.14 When θ is much greater than θc, sliding and tooth movement will stop due to notching of the archwire until this notch is released during function by masticatory forces.

walls has also been shown to reduce the impact of binding on RS but at the expense of control of root position.[61] Notching of wire edges refers to the permanent deformation which occurs at the wire–bracket corner interface (Figure 3.14).

The contribution of these factors on RS has been shown to depend on the stage of active movement of teeth. During the early stages, friction contributes significantly to RS as long as the wire–slot angulation is less than the critical contact angle for binding (θc). As this critical angle is exceeded, binding becomes the major factor affecting RS (Figure 3.13). If the wire–slot angle becomes steeper there will be a risk of wire notching, which, if it occurs, will become the prime source of RS and tooth movement will stop until this notch is released during function by masticatory forces (Figure 3.14).[59, 62]

This recent view may explain the lack of success of measures to control RS that have only targeted friction. Since RS appears to be predominantly due to binding and archwire notching, the use of self-ligating brackets may not be the solution to orthodontic anchorage problems.[63–65] A Cochrane review on the efficiency of self-ligation is currently in progress.

Different treatment methods have been suggested in order to avoid the anchorage problems related to RS, including the following.

1. Differential force mechanics, e.g. the Tip-Edge system.
2. Frictionless mechanics, relying on tooth/teeth movement along with the archwire rather than sliding mechanics. For example:
   (a) Non-sliding mechanics for continuous archwires, with use of closing loops for retraction of a single tooth (retraction spring) or for en masse movement of teeth (Figures 3.15 and 3.16).

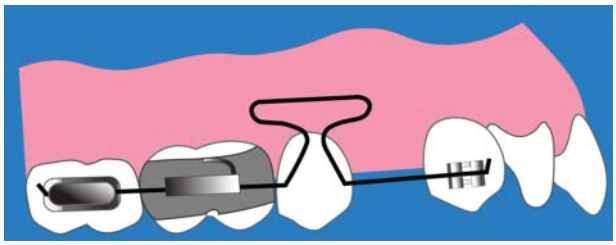

Figure 3.15 Non-sliding mechanics by using T-loop for retraction of upper canine.

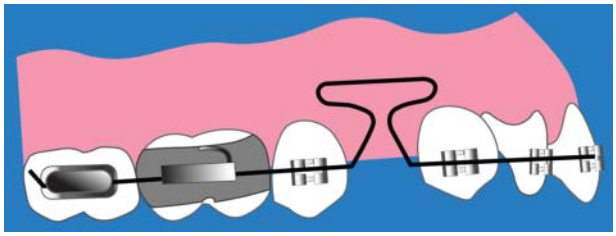

Figure 3.16 Non-sliding mechanics by using T-loops for en masse retraction of upper anterior teeth.

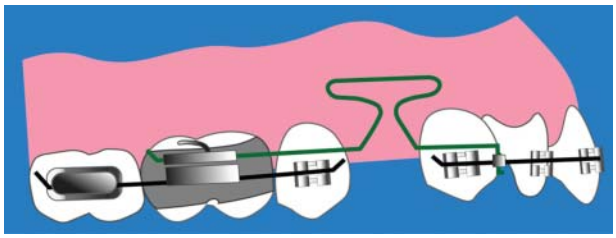

Figure 3.17 Segmental arch mechanics for retraction of upper anterior teeth.

   (b) Segmental arch mechanics, where the dental arch is split into two segments: active anterior and anchorage posterior segment. Different types of force systems can be generated by the use of various loops and springs (Figure 3.17).

However, these kinds of mechanics can be complicated, especially for segmental arch mechanics, which also requires more chair time for wire bending, is often more uncomfortable for patients and imposes oral hygiene issues.

Lacebacks Lacebacks are light stainless steel wires placed in the form of figure-of-eight ties that usually extend between the most distal attachments to the canines (see Chapter 14). One of the indications for their use is to apply a light distal force to tip canine crowns distally during the initial alignment stage, which in turn provides space for the alignment of incisors.[66] These forces are usually less than the forces applied by elastics.

Lacebacks are also commonly used during the initial alignment and levelling stage in order to control the arch length between the molars and canines, while the canine tip prescription is being expressed, thus minimising the proclination of incisors. This effect is especially seen in canines that have initial distal angulations. In a systematic review and meta-analysis, Fleming et al.[67] found that the use of lacebacks has neither a clinically nor a statistically significant effect on the sagittal position of the incisors and molars. They also concluded that there is no evidence to support the use of lacebacks for the control of the sagittal position of the incisors during initial orthodontic alignment. However, Long et al.[68] commented on this study: 'with regards to inappropriate statistical pooling and unclear risks of bias in included studies, an alternative conclusion – whether canine laceback is effective in controlling incisor proclination cannot be determined based on current evidence – would be more appropriate'.

Loose Engagement of Severely Displaced Teeth During initial alignment of severely displaced teeth using NiTi wires, loose engagement of the displaced tooth into the archwire, avoiding full engagement into the bracket slot, will reduce the unwanted reaction on adjacent teeth, especially when no rigid base archwire is being used. This is commonly applied during alignment of high upper canines, where NiTi wire is tied occlusal to the bracket (see Chapter 14, Figure 14.25).

Utilising Intraoral Musculature

The intraoral muscles have been used for anchorage support (Figure 3.18). Forces from lower lip muscles can be used by the lip bumper appliance for lower molar anchorage support. However, common side effects of this appliance include proclination of lower incisors and increase in intercanine width.[69]

Figure 3.18 Lip bumper appliance.

Occlusion

Occlusion can have both a positive and negative effect on anchorage when affecting the anchorage and active units.

Anchorage Unit

Fiorelli and Melsen[70] have presented cases where composites onlays have been bonded to the occlusal surface of teeth in order to increase their interdigitation, thus increasing their anchorage value.

Active Unit

The presence of occlusal interferences could impede or slow down the movement of the active unit and also increase the strain on the anchorage unit. Inaccurate bracket positioning can lead indirectly to this problem. A common example occurs during space closure when lower or upper canine brackets have been placed too far gingivally, resulting in their extrusion and interference with upper canine distalisation and overjet reduction. This effect can also be seen during upper arch expansion when no measures have been taken to disclude the upper posterior teeth by using fixed or removable bite planes. This could cause unwanted expansion of lower arch without improvement of the crossbite correction.

Maintaining the Arch Length

Lingual Arch

Lingual arches have been commonly used for mandibular anchorage support. Forward movement of lower molars can be prevented by maintaining the arch length through close contact of its anterior part with the lingual surfaces of the lower incisors (Figure 3.19). Clinical evidence has shown that they are of limited value for anchorage and could result in significant lower incisor proclination.[71]

Arch Stops

Maintaining arch length can also be accomplished by the use of arch stops in rigid orthodontic archwires (Figure 3.20). These are usually bent just mesial to the first molar bands in a passive manner. They may also be used in treating anterior crossbite cases, when they are used actively by placing the anterior part of the archwire around 2 mm in front of incisor bracket slots in order to provide a force to procline the upper incisors using the first molars as anchorage.

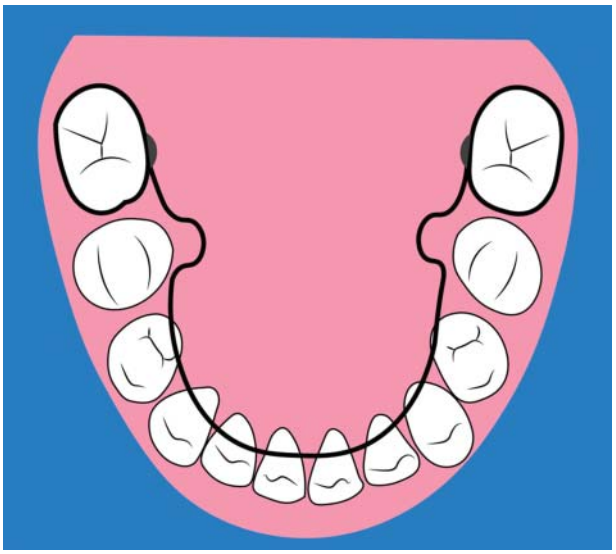

Figure 3.19 Lingual arch appliance.

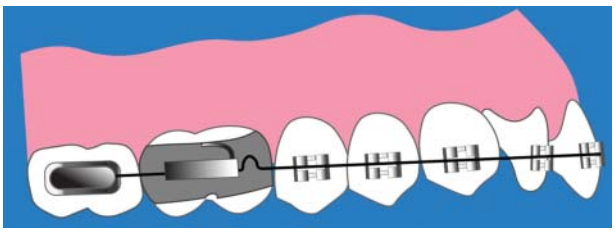

Figure 3.20 Arch stop.

Archwire Cinching

These are bends made on archwires just distal to the last attachment in order to maintain arch length by preventing unwanted proclination of incisors especially during initial alignment (see Chapter 14, Figure 14.26). However, they do not increase the anchorage value of molars.

Bone Anchorage

Indirect Bone Anchorage

Nance Palatal Arch The Nance arch, named after its originator, Hayes Nance, utilises the anterior palate as a source of anchorage (Figure 3.21). It can be most effective in patients with a high anterior palatal vault. Evidence suggests that it can be as effective as temporary anchorage devices and headgear in terms of anchorage support.[30] However, serious problems related to necrosis of palatal mucosa and susceptibility of periodontal disease for maxillary incisors can be found in patients with poor oral hygiene.[72] An important practical consideration is to remove this arch when upper incisors are being retracted during overjet reduction, otherwise the acrylic button can become embedded into the palatal tissues.

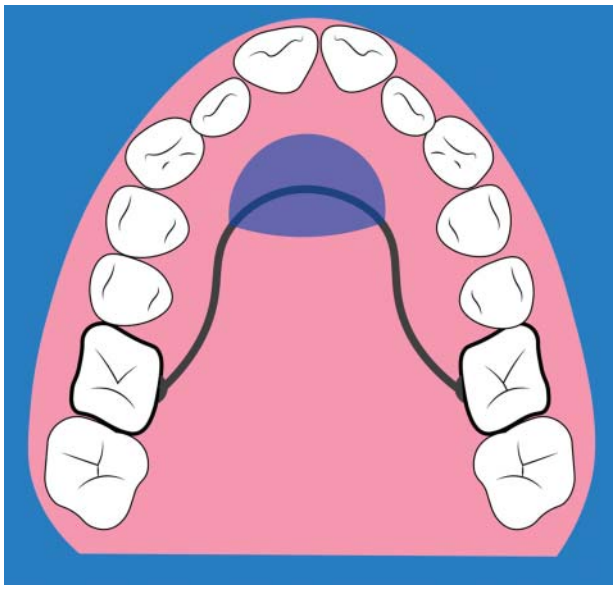

Figure 3.21 Nance palatal arch appliance.

Cortical Anchorage Ricketts popularised the concept of increasing the anchorage value of molars by torquing their roots against cortical bone. Using this method, tooth movement is slower because of the higher resistance of cortical bone to resorption compared to medullary bone. This technique is no longer recommended as it increases the risk of root resorption. However, reducing the contact of roots with cortical bone within the active unit can be used to reduce anchorage strain, e.g. Bennet and McLaughlin[73] recommend using brackets with reduced labial root torque (zero or +7°) on upper canines instead of −7° in premolar extraction cases.

The transpalatal arch (TPA) has been a very popular method for increasing the anchorage value of molars (see Chapter 14, Figure 14.47). In theory, the effect of a TPA is to prevent movement of molars anteriorly into the narrow part of the tapering palate by the contact of their roots with the buccal cortical bone (cortical anchorage). It also provides anchorage by preventing mesiolingual rotation of molars. However, clinical research has shown that a TPA is not a reliable source for anchorage support in the anteroposterior plane.[74] However, it can be used to provide horizontal and vertical anchorage during alignment of ectopic palatal canines and may be used together with temporary anchorage devices or headgears. The use of a chromosome arch, which is a TPA modified by soldering an extra arch to the second molars, has been claimed to be

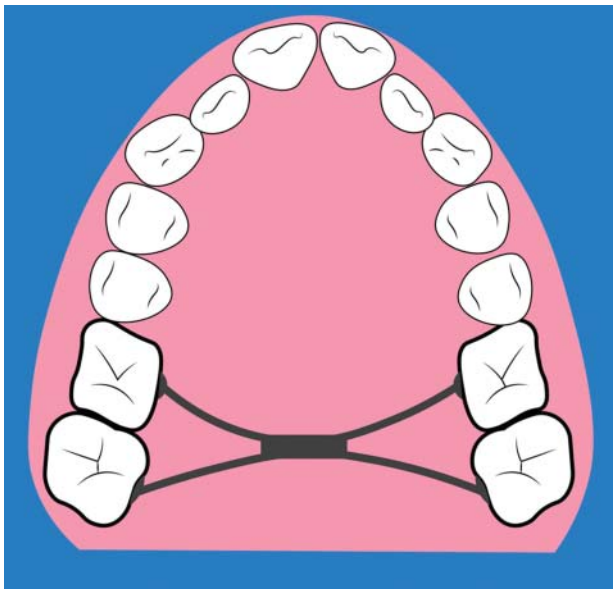

Figure 3.22 Chromosome arch.

much more effective than a TPA and can be used in high anchorage cases (Figure 3.22).[75]

Direct Bone Anchorage

Direct bone anchorage has become an extremely useful method for the management of various malocclusions, bringing orthodontics very close to realising the concept of absolute anchorage. There are advantages over other anchorage reinforcement methods. A more detailed account of orthodontic mini-implants can be found in Chapter 12.

Adjunctive Methods for Anchorage Control

Pharmacological Methods

There has been growing interest in recent years in anchorage management by local application of drugs that affect the activity of cells involved in bone turnover and tooth movement, and this may be a valuable adjunctive approach for orthodontic treatment in the future. Several drugs have been experimentally tested by local delivery adjacent to anchorage teeth to prevent their movement. A systematic review of these drugs found that osteoprotegerin (OPG), a glycoprotein involved in bone metabolism, was the most effective molecule in blocking the action of osteoclasts and thus preventing unwanted tooth movement. However, future studies are necessary to prove its effectiveness in humans.[76]

Surgical Procedures for Accelerating Orthodontic Treatment

Several adjunctive surgical procedures have been used to accelerate orthodontic tooth movement and shorten treatment time. Among these is the alveolar corticotomy procedure, which involves making full-length vertical cuts on the buccal and lingual cortical alveolar bone between teeth, after a mucoperiosteal flap has been lifted, without involving cancellous bone. Additional horizontal osteotomy cuts above the root apices are also involved. This technique has been modified over the years in order to reduce the surgical risks and damage to teeth and bone.[77] Another adjunctive surgical procedure is piezocision, a minimally invasive flapless procedure that uses an ultrasonic piezosurgical knife that makes micro-incisions in the gingiva and cortical alveolar bone.[78]

With regard to their effect on accelerating orthodontic tooth movement, current evidence shows that there is an absence of high-quality and long-term studies to support their claims. However, based on short-term studies, these procedures do appear to show promise as a means of accelerating tooth movement.[79, 80] As for their effect on anchorage, there is conflicting evidence whether they can be of benefit in reducing anchorage demands during orthodontic treatment.[81, 82]

In addition to these surgical procedures, adjunctive non-surgical methods that have been suggested for accelerating orthodontic tooth movement include low-level laser therapy and mechanical vibration. There is very little clinical research concerning their effectiveness for accelerating tooth movement and a literature search showed no data on their effect on anchorage.[83]

Anchorage Creation

In some cases, extraction of teeth and anchorage reinforcement will not be sufficient to achieve the desired treatment goal. In these cases, anchorage creation will be needed by distalisation of the upper posterior teeth. Several methods can be used for this purpose.

Headgear

Headgear can be used as an extraoral traction device of upper molars. This is the same appliance used for anchorage support discussed earlier but with wear time increased to a minimum of 12 hours and force level increased to around 400 g per side. The use of headgear for this purpose can be supported by adding a 'nudger' removable appliance, which includes a spring that prevents mesial movement of molars during the hours when the headgear is not being worn.

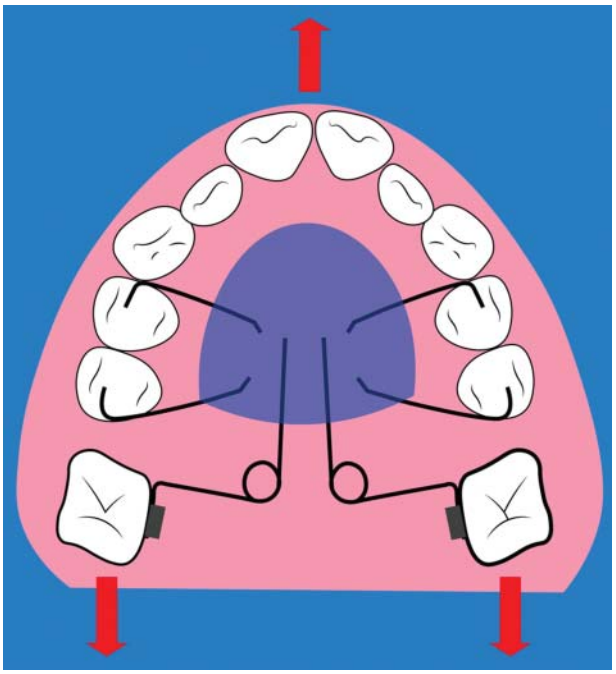

Figure 3.23 Pendulum appliance.

Intraoral Distalising Appliances

Intraoral distalising appliances include a large number of appliances that utilise the palate, teeth or other intraoral structures as the source of anchorage for upper molar distalisation. Commonly used appliances include the pendulum appliance, Jones jig and the distal jet appliances (Figure 3.23). The advantages of these appliances over headgear include less reliance on patient compliance, reduced risk of injury and full-time wear by patients. However, a Cochrane review comparing both appliances concluded that although intraoral appliances were more effective in distalising upper first molars, this effect was counteracted by loss of anterior anchorage, i.e. proclination of upper incisors, which was not found to occur with headgear.[84] However, the review acknowledged that the current evidence is of low or very low quality.

Direct Bone Anchorage

Using direct bone anchorage with implants, miniscrews or miniplates remains the most effective method currently available for distalisation for upper and lower molars. This method shares the same advantages of intraoral distalising appliances, whilst obviating the problems of anterior anchorage loss.[85] In fact, many of the intraoral distalising appliances have been modified to accommodate bone anchorage within their framework in order to overcome their limitations.

Anchorage Loss

It is usually not possible to accurately predict the response of teeth to treatment due to the complexity of the factors affecting the anchorage value of teeth with all the treatment mechanics and biological responses involved and the dependence of many of the anchorage reinforcement methods, such as headgear and elastics, on patient compliance. For this reason, it is essential that anchorage should be continuously monitored and managed during each visit. Anchorage loss occurs when there is undesirable or unexpected movement(s) of the anchorage unit. Failure to detect this at an early stage would usually reduce the scope for correction and leads to a compromised treatment outcome.

One of the easiest methods for monitoring anchorage clinically is the use of pretreatment dental study models. These can be used as a reference for assessing changes in the space available, tooth alignment and occlusion. Study models can provide a more accurate picture of the anchorage situation when treatment involves a single arch only, using the opposing non-treated arch as a relatively stable reference for assessment. However, when treatment involves both arches, a supplemental cephalometric radiograph might be needed in order to accurately assess anchorage loss by comparing with the pretreatment radiograph for incisor inclination and other changes using stable structures for superimposition.

With the introduction of digital study models, there has been a growing interest in looking for stable structures within these models in order to assess tooth movement and occlusal changes, although their current use is mainly for research purposes. The use of the palatal rugae has been proposed for this purpose; however, their positions were found to be affected by facial growth,[86] and alternative methods were suggested for the upper models.[87] As for the lower arch, a recent study has found mandibular tori to be stable structures in adults.[88]

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4

Consent

Gavin J. Mack

CHAPTER OUTLINE

Introduction

The process of gaining consent from a patient prior to undertaking an investigation or treatment is an evolving and essential aspect of medicine and dentistry. In relation to consent, the medicolegal responsibilities of health professionals practising within the UK are clearly outlined in both the General Medical Council's *Consent: Patients and Doctors Making Decisions Together*[1] and the General Dental Council's publication *Standards for the Dental Team*.[2]

Preadjusted Edgewise Fixed Orthodontic Appliances: Principles and Practice, First Edition. Edited by Farhad B. Naini and Daljit S. Gill.

The professional guidance relating to consent has evolved. Previously there was a more paternalistic approach, with a patient discussing and agreeing to a clinician's prescribed course of treatment. Increasingly, consent is now more of a more patient-centred process, with the patient being empowered to make their own decisions regarding their preferred course of treatment (see Chapter 1).

This evolution in the consent process for treatment has been clearly represented by the legal requirements that have changed regarding the amount of information patients should be provided with regarding the possible treatment options and the attendant risks and benefits.

There has been a clear transition from clinicians informing patients of the more commonly associated risks and complications associated with a type of treatment, as outlined by the Bolam Test.[3] Currently there is a professional responsibility for clinicians to outline all known possible risks and complications associated with a type of treatment, particularly if the implications of the risk and complications materialising are significant. This change in the professional standards governing the information that should be provided to patients was introduced following the court ruling in the Montgomery versus Lanarkshire Health Board case in 2015.[4]

The principles of gaining consent for treatment are evolving in relation to professional standards and can be significantly impacted through rulings of individual case law. The general trend has been for clinicians to increasingly involve patients in the decisions regarding treatment options initially and thereafter throughout the process of delivering the treatment. The benefits of this evolution are thought to be increased patient satisfaction with the result of treatment and fewer complaints and litigation should an unfavourable outcome or complication occur.

Types of Consent

Implied Consent

Implied consent is demonstrated through the actions and behaviour of the patient. A simple example would be when a patient sitting in a dental chair opens their mouth to permit an intraoral examination to take place. This type of consent is appropriate for simple and routine assessment and interventions.

Verbal Consent

Verbal consent would be expected if a more significant investigation or procedure is going to be undertaken. In advance of a pretreatment lateral cephalometric radiograph or dental panoramic radiograph, a discussion with a patient or the parents is required. The discussion would allow the clinician to outline the indications for the radiograph, and the potential clinical benefits of the radiograph would be explained in relation to the associated level of exposure to the ionising radiation.

Written Consent

Written consent represents a more comprehensive approach to confirming that a patient formally approves of proceeding with an investigation or treatment. This would be appropriate for investigations that are more intensive or invasive and for treatments that are more complex or lengthy. Written consent is obtained through the use of a form or document that is amended, read through, discussed and signed by both the patient and the clinician who is responsible for delivering the treatment. These forms can be lengthy and may include numerous sections that relate to the proposed treatment, alternative treatment options, the associated risks and benefits of treatment, and the potential use and publication of images and records that will be collected during treatment.

The documents used for obtaining written consent for a course of treatment may take a significant amount of time to complete and may require the patient to consider a significant amount of complex clinical information before confirming the decision they make regarding the treatment. For this reason, a 'two-stage' approach to obtaining consent may be appropriate for patients. This allows patients to discuss, consider and sign the consent documentation over two separate appointments. This process is thought to allow the patient an increased amount of time to consider how they would like to proceed with their treatment and, importantly, some of this time would be outside the clinical environment and away from the clinical team. This hopefully allows patients ample time to discuss their treatment options with family and friends and reflect on how they truly wish to proceed without feeling under any pressure or influence from the clinical team.

Valid Consent

The concept of valid consent is important to ensure the consent process is effective. For consent to be considered valid, patients should be fully informed about their treatment options and the associated risks and benefits of all these options. Patients should also be competent and therefore able to fully understand the information that has

been provided regarding the available treatment options. And finally, it is essential that patients give their consent to treatment voluntarily, without feeling under pressure or influence from anyone else, which could potentially include members of the clinical team or the patient's family members or friends.

Withdrawal of Consent

It is extremely important to appreciate that consent is given by patients prior to starting a course of treatment, and thereafter this consent is reaffirmed and maintained throughout the treatment. For this reason, consent is more appropriately considered as an ongoing process that starts before treatment commences and is maintained during the treatment. This also means that a patient can withdraw their consent and discontinue treatment at any stage of the treatment process.

Treatment Options

For prospective orthodontic patients there can be a multitude of treatment options that relate to the agreed aims of treatment and the selection of appliances that are available. However, in relation to the possible aims of treatment the following options broadly apply to most patients.

Avoiding Orthodontic Treatment

The significant majority of orthodontic treatment undertaken is considered as elective and may not be essential to the future dental health of a patient. Even when a patient presents with an unerupted impacted tooth that is causing significant resorption to adjacent teeth, an orthodontic treatment option may be viable; however, an approach avoiding orthodontic treatment, possibly involving oral surgery and restorative treatment, may be a reasonable alternative.

This means that for some patients the option of accepting their existing alignment and occlusion or considering a different type of dental treatment to address their concerns may be a viable alternative option to orthodontic treatment.

For patients presenting with relatively mild malocclusions, the risk–benefit analysis for orthodontic treatment should also be openly discussed (see Chapter 1). This option also has the inherent benefit of avoiding the long-term burden of care that is associated with the long-term retention that is routinely indicated for most orthodontically treated patients.

Orthodontics with Limited Objectives

This approach to treatment may be appropriate for patients who present with localised dental irregularities that require some specific tooth movement. This would include a short course of treatment to upright a mesially tipped molar tooth in order to facilitate a future restorative intervention, such as the placement of a bridge or an implant.

Another example of an approach to orthodontics with limited objectives would be improving the alignment of the teeth for an adult patient presenting with an underlying skeletal discrepancy. This treatment approach may enhance the alignment of a patient's teeth but would not deliver an optimally functional occlusion.

When a course of orthodontic treatment with limited objectives is agreed between a patient and a clinician it is essential that the end result of the treatment is mutually appreciated and agreed upon. This is because when a course of treatment with limited orthodontic objectives is being proposed, there is often an element of compromise in the occlusion that has to be accepted. To ensure a patient has appropriate expectations for the treatment result, a full discussion regarding the occlusal result should be held prior to commencing the treatment. In addition, the further treatment that would be required to establish an ideal orthodontic treatment result should also be fully explored and discussed prior to the commencement of any active treatment.

Comprehensive Orthodontics for Occlusal Correction

For comprehensive orthodontic correction to be achieved on completion of treatment, static and dynamic occlusal goals should be explained to patients.

The static occlusal treatment goals are represented by the Six Keys to Normal Occlusion that were proposed by Andrews.[5] These ensure that on completion of treatment a patient's teeth are well aligned, with optimal intercuspation between the mandibular and maxillary dentition.

The dynamic occlusal goals for orthodontic treatment have also been well described by the dental profession and ensure that a balanced occlusion with anterior guidance, canine guidance or group function and an absence of non-working side interferences are established on completion of treatment.[6–8]

The ideal static occlusion is readily appreciable by patients and parents and is clearly demonstrated through the typodont study models that are very helpful in allowing potential patients an opportunity to touch and examine the braces prior to starting treatment (Figure 4.1).

Figure 4.1 Class I typodont models.

Key Factors to be Communicated with Patients

In addition to a clear agreement on the aims of treatment, there are other key factors that should be clearly communicated by the clinician prior to confirming a treatment plan.

Treatment Duration

Studies have demonstrated that the duration of a course of treatment can vary depending on many factors. These variables include the complexity of the presenting malocclusion, the compliance of a patient, and the expertise and number of clinicians involved in delivering the treatment.[9, 10] An estimation of the duration of active treatment is extremely helpful in allowing patients to prepare for orthodontic treatment. The burden of active treatment includes attending for regular appointments and modifying oral hygiene and dietary habits. It is therefore essential for patient compliance in the short term and patient satisfaction in the long term that a reasonably accurate estimate of treatment duration is discussed as part of the consent process.

Expected Compliance

Irrespective of the orthodontic treatment that is being proposed, for successful delivery of treatment in the short term and effective retention of the corrected occlusion in the long term, a good level of patient compliance is essential to achieve successful outcomes.

The requested compliance with removable appliances will involve a discussion covering the hours of wear and appliance care. For fixed appliance treatment, cooperation with the use of inter-arch elastics may also be required to achieve a good outcome. For all orthodontic treatments, cooperation with oral hygiene routines and dietary habits is also important.

Retention Protocol

On completion of every course of orthodontic treatment a prescribed retention regime is essential. For removable retainers this will include an explanation of the type of retainer that will be provided and the suggested hours of wear. The hours of wear that is requested from the patients typically reduces over a period of time, from a 'full-time' approach to a 'night-time' only level.

When the use of fixed wire retainers is planned on completion of treatment, patients should be given very clear instructions about the specific oral hygiene techniques that are required to maintain dental health.

The long-term use of retainers is considered to be extremely important to the long-term success of orthodontic treatment.[11] It is therefore essential to carry out a full discussion regarding the type of retainers to be used and their duration of use before active treatment has commenced. This is a key aspect of the consent process.

The Costs of Treatment

A clear explanation of the costs associated with the planned orthodontic treatment is a fundamental aspect of the consent process. This should include the varying costs associated with the different orthodontic treatment options that may have been discussed. All possible additional costs that may be incurred during active treatment or during the retention regime and beyond should also be explicitly outlined. In addition, the potential costs associated with the involvement of other dental professionals for non-orthodontic components of the treatment, such as hygiene therapy, extractions and temporary or permanent restorations and prostheses, should be outlined

during the pretreatment consent process. This helps to avoid patient dissatisfaction if unexpected and potentially hidden treatment costs are requested after treatment has started.

Treatment Benefits

The demand for orthodontic treatment continues to increase as patients and parents with increasing levels of dental awareness and improving standards of dental health seek to optimise their dental appearance and occlusal function. The demand for treatment has also increased as orthodontic appliances have become more easily tolerated by patients. The range of available appliances has also never been more diverse, with more aesthetically acceptable appliances available for older patients who request a more discreet orthodontic treatment approach.

As the demand for orthodontic treatment increases, it is important that a clear evidence-based explanation of the benefits of treatment is provided as part of the consent process. This ensures that patient expectations of treatment are realistic and are predictably aligned with the planned outcome. This ensures that patients are more fully aware of what the treatment will deliver and hopefully ensures future patient satisfaction.

Enhanced Smile Aesthetics

A major motivating desire for patients to undergo a course of orthodontic treatment is to improve the appearance of their smile. This often relates to the alignment of the upper and lower anterior teeth. This obvious aesthetic benefit to orthodontic treatment is easily understood by most patients.

A full discussion about the improvements to a smile that may be possible should include the benefits of achieving well-aligned anterior teeth but should also include possible limitations and compromises that may be required. Examples of this would be the pre-existing morphology of the teeth that would not be changed through orthodontic treatment. Anterior teeth that have a specific morphology, such as being tapered or barrel shaped, can still appear to have spaces present between adjacent teeth even when optimal interdental contact points have been established (Figure 4.2).

Similarly, the relief of anterior crowding and the alignment of anterior teeth may result in the establishment of spaces below the contact points of adjacent teeth. These spaces can result as a consequence of papillary eviction and the resulting ‘dark triangles’ between teeth at the level of the gingival margin can be a cause for concern for patients with high aesthetic expectations (Figure 4.3).

Figure 4.2 Incisors with tapered crown morphology.

Figure 4.3 Interproximal spaces, particularly evident between the lower incisor teeth.

Enhanced Dental Health

The theoretical health benefits of orthodontic treatment can be discussed with a potential patient and these would include reduced plaque and calculus accumulation around well-aligned teeth in relation to crowded teeth. This assumption would seem logical and obvious but is not clearly supported by clinical research. Clinical studies have found that the satisfactory maintenance of ideal oral hygiene is more closely related to the dexterity and diligence of the individual patient as opposed to the alignment of the teeth.[12]

The motivation and dedication of the individual patient to maintain an optimum standard of oral hygiene has been recognised as the key factor in improving gingival health in the short term and avoiding periodontal complications in the long term. This therefore precludes clinicians from making enhanced claims regarding the potential for a course of orthodontic treatment to have a long-term benefit on periodontal health for patients in the majority of cases.

A similar rationale would apply to the potential role orthodontic treatment may confer in reducing the risk of dental caries. It would be logical to assume that well-aligned teeth are at reduced risk of developing carious lesions than crowded and impacted teeth, but this claim

is also difficult to substantiate through reference to the available clinical research. Whilst plaque traps and stagnation areas may become established between crowded and impacted teeth, the development of caries in these areas can be effectively controlled through dietary and oral hygiene disciplines.[13]

A recognised and important dental health improvement that orthodontic treatment can deliver relates to the increased trauma risk that is associated with patients with increased incisor overjets. Studies have estimated that approximately 10% of 12-year-old children will have sustained some degree of trauma to their permanent incisors.[14, 15] For a patient with an overjet greater than 9 mm the associated risk of experiencing dental trauma is doubled.[16] This risk is further increased if a patient has incompetent lips.[17] The evidence to support the dental health benefits of reducing increased overjets is both logical and supported by the available clinical research. This is reflected in the weight given to increased overjets in the Index of Orthodontic Treatment Need (IOTN), where patients with overjets in excess of 9 mm are considered to have a 'very high need' for treatment.[18]

Enhanced Occlusal Function

Enhanced occlusal function may be a credible treatment benefit when patients present with severe malocclusions associated with underlying skeletal discrepancies, or anterior open bites related to digit-sucking habits. This can result in patients struggling to achieve incisal contacts that facilitate the biting and shearing components of masticatory function. Anecdotally, patients who cannot establish incisal contacts may avoid eating certain foods or adapt how they eat, particularly in social situations. For such patients, the orthodontic correction of the malocclusion would hopefully improve their ability to bite and chew food.

For less severe malocclusions, when the benefits of orthodontic treatment are related to relieving crowding or reducing a minimally increased overjet, it is unlikely that the treatment will predictably enhance a patient's experience of biting and chewing whilst eating.

Psychosocial Benefits

A major treatment benefit for orthodontic patients is the increase in confidence that can be delivered through optimising the dental appearance and smile aesthetics. This has been assessed and quantified over the years and in many countries.[19]

In addition to the internal benefit of an orthodontic patient feeling happier with their enhanced smile on completion of a course of treatment, there are also external benefits to presenting an aesthetic smile in social situations. Studies have demonstrated a more negative response from possible partners, teachers and employers when individuals present with obvious facial blemishes, including irregular or missing anterior teeth. Therefore, a possible benefit of orthodontic treatment may be that improving and normalising a patient's smile can avoid other people making negative assumptions about them, based on their dental appearance, throughout their lifetime.

Unfounded Claims for the Benefits of Orthodontic Treatment

Caution is advised when discussing the potential benefits of undergoing orthodontic treatment with prospective patients and, when applicable, their parents. The expectations of the patients should be carefully managed and guided with reference to the accepted clinical evidence and the established professional guidance.

The evidence to suggest that orthodontic correction of a malocclusion can relieve parafunction and symptoms of temporomandibular joint dysfunction is equivocal.[20] Similarly, claims to correct a speech impediment or to improve a patient's clarity of speech through a course of orthodontic treatment should be avoided as there is a similar lack of evidence to reliably support this aspiration.[21]

Treatment Risks

The majority of orthodontic treatment is generally considered to be associated with a low level of risk and harm. However, this does not mean that potentially adverse side effects and complications do not occur.

Damage to Teeth

Enamel Decalcification

This process can affect the enamel surrounding the components of a fixed appliance (Figure 4.4). Decalcification occurs during the early stages of progression of dental decay and occurs when poor standards of oral hygiene allow plaque stagnation areas to develop around the appliances. Coupled with a diet that includes cariogenic drinks and foods, this combination allows the enamel to become demineralised. At an early stage this can result in white spot lesions on the enamel surface and these have been shown to be reversible to some extent.[22] At a more severe level the lesions progress to brown spot lesions or cavitation of the enamel surface.

Figure 4.4 Enamel decalcification.

Enamel Fracture

This can occur when orthodontic appliances are bonded to, and then removed from, the surface enamel of the teeth. This occasional incidence of trauma to the teeth can be avoided by using the appropriate adhesives with relatively low bond strengths and careful application of force during the debonding process. Particular care should be taken when teeth are heavily restored and the enamel surfaces may be relatively unsupported and prone to fracture.

Another mechanism that can allow enamel fractures to occur is when the teeth from the opposing arch occlude on to the components of a fixed appliance. An example of this would be ceramic brackets on the lower teeth causing attritional wear to the enamel of the incisal edges of the upper teeth. This irreversible damage to the enamel of the teeth can be avoided by carefully sequencing the treatment process, appropriately positioning fixed appliances, and discluding the teeth for stages of the treatment if required. Particular care should be taken to avoid this type of attritional wear in patients who present with bruxist tendencies.

Root Resorption

Orthodontically induced inflammatory root resorption is a recognised risk of orthodontic treatment. This occurs when an orthodontic force is applied to a tooth, the periodontal ligament is both compressed and under tension, and inflammatory mediators stimulate the remodelling of the surrounding bone. This process can to some extent allow for resorption of the root surface to occur. Histological studies have reported a greater than 90% incidence of root resorption in orthodontically repositioned teeth.[23] In most cases this was minimal and of no clinical consequence to the patient in the short or long term and did not compromise the prognosis of the teeth (Figure 4.5).

However, patients may be inherently predisposed to experiencing root resorption to a more severe extent (Figure 4.6). The presenting morphology of the teeth has been described as a prognostic indicator for severe resorption, with short, blunted, curved and pipette-shaped roots being considered more at risk or undergoing significant resorption (Figure 4.7).

Figure 4.5 Mild root resorption.

Figure 4.6 Severe root resorption.

In addition, other factors such as the duration of treatment, use of inter-arch elastics and the application of higher forces have also been considered as possible risk factors.[24]

Damage to the Periodontium

Mechanical Injury

The supporting periodontal tissues can also be damaged during a course of orthodontic treatment. This can occur through the injudicious insertion and removal of fixed appliances. An example would be over-seating a molar band around a molar tooth causing a traumatic injury to the periodontal tissues, or traumatising the gingival margin

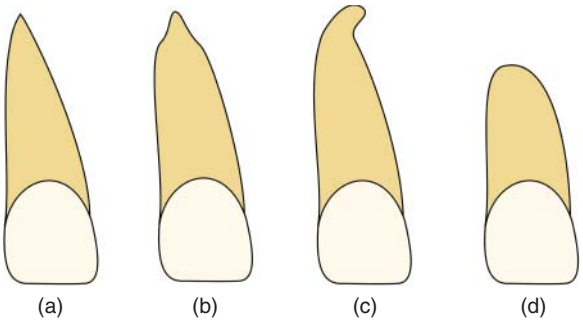

Figure 4.7 Susceptible root morphologies with a tendency towards external apical root resorption when undergoing orthodontic treatment include (a) triangular root morphologies, (b) pipette-shaped apical morphology, (c) roots with an apical bend, and (d) short blunt root apices.

Figure 4.8 Gingival recession.

around a molar tooth whilst applying force to the gingival margin of a band using band removing pliers.

Gingival Recession

Recession of the gingival margins and the associated attachment loss can occur as a consequence of periodontal disease and mechanical trauma. Gingival recession may also occur during the orthodontic repositioning of teeth. This may affect individual teeth that are crowded and significantly displaced from the line of the arch as the roots of these teeth may be positioned in or through the outer cortical margins of the maxilla and mandible. Recession can also occur when teeth are orthodontically repositioned and arch-form changes such as upper arch expansion and lower incisor proclination have been considered as potential causes of recession.[25] This recession can be unsightly and has the potential to be progressive unless meticulous and careful oral hygiene is maintained (Figure 4.8).

Gingivitis

The presence of orthodontic appliances can also be associated with the development of gingivitis and gingival hypertrophy. This is typically reversible and will settle on removal of the appliances but can further compromise the patient's

Figure 4.9 Gingivitis.

Figure 4.10 Periodontally compromised teeth.

ability to maintain a satisfactory level of oral hygiene and compromise the fit of retainer appliances (Figure 4.9).

Periodontal Disease

For all potential orthodontic patients, a comprehensive assessment of the periodontium should be included in a pretreatment clinical examination. The progression of active periodontal disease can be accelerated through the application of orthodontic forces and the use of fixed appliances.[26] It is for this reason that orthodontic treatment is contraindicated in patients with uncontrolled periodontal disease but can be undertaken carefully when the disease process has been stabilised. For periodontally susceptible patients considering undergoing orthodontic treatment, the risks of disease recurrence and progression should be discussed prior to treatment and signs of disease carefully monitored during the active treatment (Figure 4.10).

Pain and Discomfort during Treatment

Soft Tissue Irritation

The presence of fixed appliances in the oral cavity can cause traumatic irritation to and ulceration of the proximal

soft tissues. This is typically most pronounced when a fixed appliance has been recently fitted. The use of relief wax or similar products can help to prevent ulcers from developing during the time required for the local soft tissues to become more fibrous and resistant to the traumatic irritation. During the later stages of treatment, an appliance that has broken or partially debonded can also be an additional cause of trauma to the soft tissues and discomfort to the patient.

Dental Pain

During orthodontic treatment the application of forces to the teeth can lead to patients experiencing pressure and soreness in their teeth, with tenderness and discomfort when biting and chewing. This is often transient and is most commonly experienced after the braces have been initially fitted, and then subsequently adjusted and tightened. The pain experienced after the insertion of initial archwires has been reported to commence after four hours and then peak after 24 hours. This pain persists for three to four days before gradually declining.[27] This level of pain should be relatively tolerable for most patients and analgesics can be used to provide relief.[28] The use of light orthodontic forces can help to limit this type of discomfort that patients experience, and the pain threshold of individual patients can vary to the extent that very light forces may be required for certain patients (see Chapter 14).

Rare and Unusual Injuries

Whilst the majority of risks associated with orthodontic treatment can be considered to be of relatively low consequence to the long-term well-being of the patient, there are certain less commonly occurring risks that should also be considered.

Loss of Vitality of the Teeth

A tooth that is being repositioned as part of an orthodontic treatment plan can occasionally devitalise. This results in the tooth darkening in colour, developing a periapical lesion and requiring endodontic therapy (Figure 4.11). This can occur as a corollary to previous trauma or could be an iatrogenic change due to the application of excessive forces during treatment.

Allergic Reactions

Occasionally, an allergic reaction may develop as a consequence of orthodontic appliances causing hypersensitivity reactions in the adjacent tissues. This may be due to nickel-containing appliances irritating the skin or mucosa and is more likely to affect the extraoral tissues.[29]

Should an allergic reaction be experienced, a change to the treatment plan is likely to be required. Alteration of the prescribed appliances or the possible discontinuation of treatment may also have to be considered.

Figure 4.11 Non-vital tooth.

Penetrating Eye Injury

Rare and serious complications have been reported when penetrating eye injuries have occurred during treatment with headgear appliances.[30, 31] For all headgear appliances at least two safety features must be incorporated and appropriate patient selection and advice is also essential. As with all orthodontic appliances, patients should be appropriately trained in the safe and correct insertion, removal and use. All appliances must also be well fitting, correctly activated and routinely checked at every treatment appointment.

General Anaesthetic Complications

Some orthodontic patients may require surgery under sedation or general anaesthesia as part of a multidisciplinary treatment approach. It would primarily be the responsibility of the surgeon and anaesthetist to fully explain the potential risks and complications associated with the surgical procedure. The patients and parents should be fully aware of all the rare and potentially life-threatening complications associated with the surgery and the anaesthesia. Any presurgical orthodontic treatment should not be commenced if there are unresolved concerns about proceeding with the operation.[32]

Relapse

Prior to starting any course of orthodontic treatment, the risk of the teeth relapsing away from the agreed post-treatment position should be considered and planned for. Relapse can occur in the short term after completing the active orthodontic treatment, and tooth movement can also occur in the longer term as a consequence of the maturational dental changes that may take place over future decades.

Certain features of a presenting malocclusion have been identified as having a relatively high relapse tendency and these include diastemas, spacing and rotations of

individual teeth. The stability of upper arch expansion is also considered to be relatively low and prone to relapse.[33]

Although there is a lack of consensus and reliable evidence regarding an optimum retention protocol, an ongoing approach to using retainers is increasingly advocated to all patients (see Chapter 17). This is because orthodontic relapse may not be associated with the potential to harm or damage a patient's teeth or compromise dental health, but it can significantly affect a patient's satisfaction with the long-term result of the treatment.

Effective Communication

The process of consenting a patient for a course of orthodontic treatment is commenced at the initial appointments when treatment options and the associated risks and benefits of delivering the treatment are discussed. This typically results in a patient signing a consent form. However, this does not signify the end of the consent process as an ongoing dialogue between the clinician and the patient continues throughout the active treatment and retention phases. This dialogue includes a discussion regarding the progress towards the planned treatment result and the potential management of risks or complications that may exist or occur.

During the initial pretreatment appointments a considerable amount of information is exchanged between the clinician and the prospective patient. This information can be provided verbally through the clinical consultations, and adjuncts to the delivery of the relevant information have been developed to aid this process. These include the following.

Patient Information Leaflets

The use of relevant patient information leaflets can allow patients to be provided with clear information regarding specific aspects of their potential treatment. These leaflets can be discussed within the clinical setting, then taken home by the patients to allow for further reflection and consideration outside of the clinical environment. Typically, these leaflets are presented in a patient-friendly style and the use of clinical terminology is avoided, allowing for a clearer understanding of the treatment by the patients (Figure 4.12).

Websites

The use of interactive websites is increasingly helpful for patients to gain access to information regarding all aspects of orthodontic treatment. The multimedia potential of

Figure 4.12 Patient information leaflets. Source: British Orthodontic Society.

Figure 4.13 Kesling (diagnostic) set-up plaster models.

websites allows for written and visual information to be presented in an interactive format. This can be further supplemented with video footage of interviews with patients and clinicians. These websites can contain links to other sites that host videos and animated films that aid patient education regarding the risks and processes involved in different treatment approaches.

Clinical Predictions

To provide more customised, individual and option-specific aids to the consent process, and to aid treatment planning, clinical predictions of the treatment outcome can powerfully support the consent process.

A Kesling (diagnostic) set-up can allow patients to visualise and appreciate how teeth can be aligned within an arch and how the teeth can approximately occlude between the arches. A conventional Kesling set-up is provided when a technician repositions teeth on plaster study models (Figure 4.13).

Photographic and digital images, along with three-dimensional scans, can also be used to produce a predicted treatment outcome that allows patients to visualise and agree to a proposed treatment plan (Figure 4.14).[34]

Involvement of Family and Friends

In addition to excellent verbal and non-verbal communication and clinical adjuncts, encouraging the involvement of parents, family members and friends in the consent process can be highly effective. The involvement of a trusted friend or family member can ensure a patient feels supported during the consent process, has an advocate who can ask additional questions on their behalf and can be a reassuring influence throughout the decision-making process of gaining effective consent.

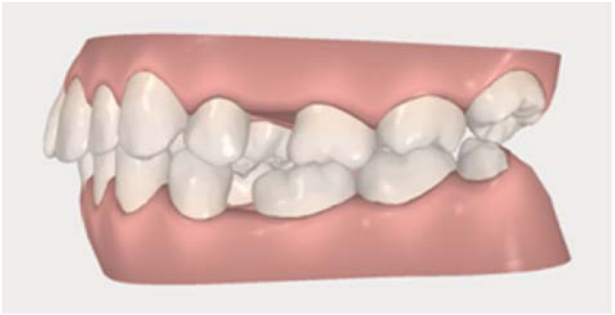

Figure 4.14 Three-dimensional images. Source: based on Barreto MS, Faber J, Vogel CJ, Araujo TM. Reliability of digital orthodontic setups. *Angle Orthod*. 2016;86(2):255–259.

In relation to family members supporting the consent process, it is important to consider that whilst patients over the age of 16 years are legally considered to have the capacity to give consent for their treatment, younger patients can also provide or withdraw consent for treatment if they are considered to be competent.[35] The Mental Capacity Act[36] provides the legal framework for adults who may lack the capacity to consent to treatment and this is explored in more detail in Chapter 5.

Occasionally, additional assistance may be required to facilitate the consent process and when language barriers are present the use of a professional interpreter can be invaluable. This can sometimes be preferable to relying on a patient's friend or family member to assist with the consent process and impartial assistance can be more confidently provided.

Conclusions

Clinicians should ensure that valid patient consent is provided for all treatment that is proposed and delivered. This is not just seen as good clinical practice, but is considered to be a legal requirement.

For orthodontic treatment, the range of options that may be available and the commitment to potentially lengthy treatment followed by the subsequent use of retainers means that the consent process can be complex. A considerable amount of information has to be presented by the clinician and comprehended by the patient. This process can be aided by the provision of relevant information leaflets and directing patients to other relevant sources of information and guidance.

To ensure patients are given an opportunity to reflect on how they would like to consent to treatment, ample opportunity must be given for patients to consider their options and ideally the consent process is managed over a number of pretreatment appointments and is continually reinforced as treatment is delivered.

Ensuring valid consent is given by all patients for their orthodontic treatment can be time-consuming and challenging. However, gaining valid consent from patients should be considered an essential requirement and a fundamental component of providing high-quality treatment, ensuring a high level of patient satisfaction during the active treatment and beyond.

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5

Dentolegal Aspects of Orthodontic Treatment

Alison Williams

CHAPTER OUTLINE

Introduction

From the point of view of most patients, routine orthodontic treatment is usually undertaken as an elective procedure to improve dental appearance. Therefore, complaints may be generated if a patient's expectations are not met. This is particularly so for adult patients, who often expect huge psychological rewards from going through lengthy and potentially obtrusive treatment.

All registered dentists in the UK are permitted to provide orthodontic treatment. As a consequence, orthodontic treatment systems have been developed specifically for use by general dental practitioners (GDPs), with the support of a third party. However, some dentists have been tempted into providing orthodontic treatment which is beyond their knowledge and training. If the treatment does not meet the patient's expectations, the dentist is vulnerable not only to a claim for a refund from the patient, but also a complaint that they have breached the General Dental Council (GDC) Standards,[1] because they have gone beyond their clinical competence. In the worst scenario, dentists providing orthodontic treatment have damaged the teeth and supporting tissues[2] and are liable to a claim of clinical negligence.

These factors have combined to produce a steady increase in the number of complaints that were received by Dental Protection Ltd about orthodontic treatment provided by members during the period 2011–2015 (Dental Protection Ltd, personal communication, 2016) (Figure 5.1). More recently, the Dental Complaints Service, which provides

Preadjusted Edgewise Fixed Orthodontic Appliances: Principles and Practice, First Edition. Edited by Farhad B. Naini and Daljit S. Gill.

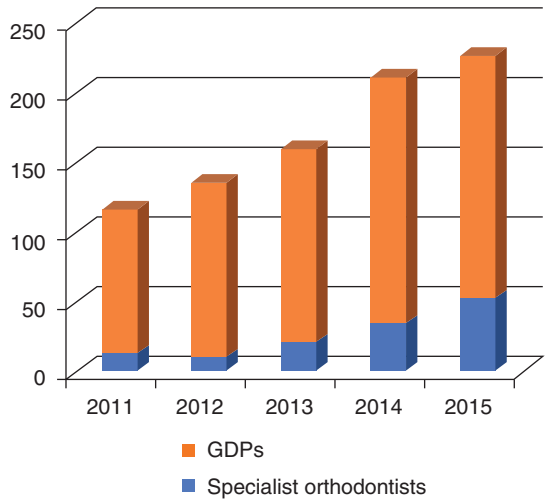

Figure 5.1 Complaints received about orthodontic treatment by members of Dental Protection. Source: Dental Protection Ltd, personal communication, 2016.

advice to patients who are dissatisfied with private dental treatment, has reported that the highest number of complaints that are discussed with them are about orthodontic treatment.[3]

This chapter discusses the dentolegal and ethical issues that may arise during orthodontic treatment and the professional standards that apply to clinicians providing orthodontic treatment. Measures that a clinician may put in place along the treatment pathway to reduce their risk of receiving a successful complaint from a patient or the GDC are suggested.

Advertising

Adult patients may self-refer for orthodontic treatment after reading an advert from the manufacturer of an orthodontic system. Advertising, including adverts that are sent electronically as a consequence of an individual's browsing history, is regulated by the Advertising Standards Authority.[4] A patient may also seek treatment after reading on a dental practice website that a particular system of orthodontics or bracket design is available at the practice. The content of dental practice websites is regulated by the GDC, which states, in Standard 1.3.3 of the GDC *Standards for the Dental Team*, 'You must make sure that any advertising, promotional material or other information that you produce is accurate and not misleading.'[1] The British Orthodontic Society (BOS) also publishes *Professional Standards for Orthodontic Practice*, which contains a section on advertising.[5]

Issues that may arise in relation to orthodontic treatment include dentists and orthodontists not making it clear, on their practice websites, that a particular orthodontic system may not be suitable for every patient and can only be provided after the patient has undergone a detailed orthodontic examination. It is also illegal, under the Dentists Act 1984,[6] to use the title 'orthodontist' or to state, in practice advertising, that you 'specialise' in providing a particular orthodontic system if you are not on the GDC's Specialist List for Orthodontics.

Another area that has been the subject of complaints by patients is the practice of offering patients 'free consultations' for orthodontic treatment, as practice-builders. The patient is examined briefly by the orthodontist who outlines, in general terms, the type of orthodontic treatment that might be appropriate for the patient. The patient then has a meeting with a treatment coordinator who outlines the costs of treatment. Patients have complained that they have been misled by the appointment being termed a 'consultation' because, without the availability of radiographs and the results of other special tests, for which a charge is then made, only generic advice can be provided about their suitability for orthodontic treatment. To avoid this type of complaint, it is important to include advice about what a 'free' consultation does, and does not, include on the practice's website.

The Initial Consultation

Recording the Patient's Concerns

For an elective treatment such as orthodontics, it is particularly important to have a detailed discussion with the patient and/or their parent regarding their concerns about their malocclusion before treatment begins, and to document these clearly in the clinical records. The old adage that 'if it isn't written down, it didn't happen' applies to all clinical practice.

It is also important to identify, at the outset, factors such as travelling time to appointments and work or school commitments, which may make it difficult for a patient to attend regularly. A discussion can then be had with the patient about the implications that this may have for their overall treatment time, rather than encountering these issues further along the treatment process.

There are some patients whose expectations of orthodontic treatment are unrealistic. It is possible that they may be suffering from undiagnosed body dysmorphic disorder (BDD)[7] and have a distorted body image. If BDD is suspected, the patient should be informed in a straightforward and polite manner, and advised to seek the help of a clinical psychologist or liaison psychiatrist with a special interest in BDD.[7] Alternatively, there may be aspects of their personality that make them crave attention or seek to control

a clinician. These traits are often well hidden and dentists are not trained in the diagnosis and management of personality disorders. Unless the patient decides to seek help themselves, there may be little that a clinician can do to help the patient receive the appropriate care.

However, a clinician is not compelled to provide elective treatment for a patient. If the clinician detects, during the initial consultation, that the treatment they are able to provide will not meet a patient's expectations, then it is better to discuss this with the patient and suggest that they seek treatment elsewhere, rather than to embark on treatment in the hope that the patient will become more realistic as treatment progresses. This can be a very difficult situation to manage if the patient has already sought opinions from several other orthodontists.

Pretreatment Orthodontic Examination

'Failure to undertake and record a sufficient orthodontic examination at the beginning of treatment' is an allegation that has been made frequently by the GDC, particularly, but not exclusively, against GDPs providing orthodontic treatment with limited objectives. Some GDPs mistakenly believe that, since they are only moving the anterior teeth, a full orthodontic examination and diagnosis is not required. The GDC disagrees. Furthermore, the BOS publishes *Professional Standards for Orthodontic Practice*, which states that 'All significant findings and diagnosis must be fully documented'.[5] These Standards, which the Court is likely to use as a benchmark for a reasonable standard of clinical practice, apply to all orthodontic treatment in the UK, not just that which is provided by Specialist Orthodontists. The list of what should be assessed and recorded during an orthodontic assessment, as outlined in the paper by Roberts-Harry and Sandy,[8] has been referred to by expert witnesses in GDC investigations and so can be considered a reasonable guide for what should be recorded during the orthodontic examination.

Specialist Orthodontists have also been criticised for not recording full details of their examination of the patient in the main clinical notes. For example, if details of the examination are entered on a separate screen in an orthodontic record software package, it is also necessary to record the fact that the examination was carried out, and the location of that electronic record, in the main clinical notes. The orthodontic diagnosis should also be recorded in the main clinical records. Failure to do so makes it difficult to defend an allegation that the assessment was made from dental study models, for example, after the patient had left the surgery, and so the patient was not informed of the outcome of the examination.

Dental Health Assessment

The BOS Professional Standards also state that 'other significant dental problems (other than orthodontic problems) must be documented and communicated with the patients' primary care Dental Practitioners'.[5] However, the extent to which a Specialist Orthodontist, taking a referral from a GDP, who is responsible for the patient's overall oral health, should examine the patient for oral disease during an orthodontic assessment is unclear.

Lesions of the oral mucosa and soft tissues of the mouth may arise within the time between referral from the GDP and the orthodontic consultation. A visual inspection of the oral mucosa and soft tissues is non-invasive. It would be hard to defend an orthodontist who failed to undertake a visual inspection of the oral soft tissues and record their findings, at the first consultation and during subsequent appointments, in a patient who is subsequently found to have a neoplastic lesion which would have had a better outcome if it had been detected earlier. It is therefore good clinical practice during orthodontic treatment, which tends to focus predominantly on the position of the teeth, to establish the habit of undertaking and recording an inspection of the oral soft tissues at every patient visit.

The presence of untreated dental caries, particularly if a tooth is unrestorable, may modify an orthodontic treatment plan. 'Occult' caries may also be detected on scanning radiographs. These findings, and clear instructions for restoring the affected teeth, or requesting an opinion about the long-term prognosis for a tooth affected by significant caries, should then be communicated to the patient's GDP in writing. If the caries has been detected on a radiograph, then a copy of the radiograph should be provided to the GDP. It is also good practice to undertake a clinical examination of the dental tissues for caries at every treatment visit. Issues have arisen in which the patient assumes that the orthodontist is responsible for their general dental care as well as their orthodontic treatment, resulting in dental caries going untreated. It is therefore important to emphasise to patients, at the beginning of orthodontic treatment, that they must continue to see their GDP for regular dental care throughout their orthodontic treatment, unless of course you are also the patient's GDP.

A more difficult issue is whether a Specialist Orthodontist, seeing a patient for a consultation who is under the regular care of a GDP, should undertake a basic periodontal examination (BPE)[9] as part of the orthodontic assessment. In the past, the majority of an orthodontist's caseload was children and adolescents and BPE screening was not recommended for patients aged under 18 years. However, orthodontists would be able to detect if their patient was

suffering from periodontal disease, which is a contraindication for orthodontic treatment if the disease is active, by visually inspecting periodontal bone levels in scanning radiographs taken for other clinical purposes.

The situation has now changed because not only are more adults, who may have active periodontal disease, seeking orthodontic treatment, but also because the British Periodontal Society (BPS) now recommends that a BPE screening is undertaken for adolescents from the age of 12 years,[10] the age when most orthodontic treatment begins for adolescents. As such, the BOS now recommends that 'it is good practice for a periodontal screening (BPE) to be undertaken, in particular of adult patients by the Orthodontist at new patient assessment, start of treatment visit and mid-way through treatment' (N. Atack, Chair of BOS Clinical Governance Committee, personal communication, 2016). A clinician undertaking a BPE screening would also be expected, under GDC standards,[1] to have the skills, knowledge and training to undertake the screening. Specialist orthodontists may wish to consider undertaking training in BPE screening if they have not used the index for some time.

Taking Radiographs as Part of the Orthodontic Assessment

Another area in which clinicians undertaking orthodontic treatment have been the subject of criticisms from the GDC regards the taking of pretreatment radiographs. The regulations for taking and reporting on radiographs are laid out in the recently updated Ionising Radiations Regulations 2017 (IRR17)[11] and the Ionising Radiation (Medical Exposure) Regulations 2017 (IRMER17).[12]

Under IRR17, a clinician must quality-assure or grade a radiograph that has been taken and record the grading in the clinical notes. IRMER17 states that a clinician must justify why she is exposing her patient to ionising radiation. The clinical reason for taking the radiograph and the clinical findings from that radiograph must be recorded in the clinical records, as evidence that the clinician has conformed with the regulations.

The radiographs that should be taken as part of an orthodontic assessment has been an area of disagreement. GDPs undertaking orthodontic treatment, with limited objectives, have argued that since only light tipping forces will be used, the risk of root resorption during orthodontic treatment is low. Furthermore, the Orthodontic Radiographs Guidelines, which have been produced by the BOS, advise that 'orthodontic treatment may be carried out without the need for radiographs' in patients in the 'adult dentition'.[13] It is important to appreciate, however, that these guidelines relate to taking screening radiographs to identify unerupted or impacted teeth.

Teeth with blunt or pipette-shaped apices are more vulnerable to root resorption. This resorption has been observed within the first six months of treatment,[14] i.e. within the time-frame of short-term orthodontic treatment. In addition, many adult patients requesting orthodontic treatment with limited objectives have previously undergone orthodontic treatment which has relapsed. Most fixed appliance orthodontic treatment is associated with some minor root resorption, typically blunting of the apices. It is therefore important to identify this during the pretreatment assessment and to advise patients of their increased risk of further root resorption during the consent process. This discussion suggests that it is possible to justify clinically undertaking a radiographic review of the roots and apices of the teeth as part of the orthodontic assessment in patients in the adult dentition. This is supported, in part by the BOS recommendation, that intraoral radiographs are justified 'in patients having a repeat course of treatment'.[13]

The radiographic assessment of root morphology should include all the teeth within the fixed appliance, not just the teeth which are being moved. Newton's Third Law of Motion states that for every action there is an equal and opposite reaction. Orthodontic forces are therefore being applied to all the teeth, within the appliance, during orthodontic treatment with limited objectives. The vulnerability to root resorption of every tooth included within the orthodontic appliance should therefore be assessed before treatment begins. The Faculty of General Dental Practitioners (FGDP) Guidelines on Selection Criteria for Dental Radiography recommend that no more than one scanning radiograph should be taken for a patient within a 12-month period.[15] Referring dentists should therefore be requested to provide copies of dental pantomograms taken within the previous 12 months when referring a patient for an orthodontic assessment.

For patients in the mixed and adolescent dentition, the BOS Guidelines[13] advise that if a non-extraction treatment is planned, then it is not necessary for radiographs to be obtained as part of the orthodontic assessment or before treatment begins. Again, these Guidelines are based on the assumption that radiographs are being taken to identify unerupted or impacted teeth, rather than to assess the vulnerability of the roots to root resorption during treatment. However, the Guidelines do advise that if a tooth is identified clinically to be excessively mobile, then 'intraoral radiographs may be indicated'.[13] Nevertheless, clinical experience suggests that teeth with resorbed roots often show no clinical signs of mobility until the root resorption is quite advanced. Similarly, for adult patients there appears to be a strong argument for undertaking a

radiographic assessment of the roots in adult and child patients before fixed orthodontic treatment begins to identify those at increased risk of root resorption. The BOS Guidelines[13] also recommend that if there is a long waiting list for treatment, then the scanning radiograph should be taken just before treatment begins. However, under these circumstances, it is important to advise the patient, and their parent or caregiver, that there is a possibility that when the radiograph is taken it might reveal issues that are contraindications to orthodontic treatment, thus reducing the risk of disappointment and a complaint.

The value of taking a lateral cephalometric radiograph, as part of the pre-treatment orthodontic assessment, is a contentious subject. In common law, the existence of a clinical guideline supporting their practice, can help a clinician justify the treatment that was provided. As such, the BOS[13] have provided guidance, in the form of flow charts, for when a lateral cephalometric radiograph should be taken, for a patient, as part of the orthodontic assessment. If, however, the clinician can argue why he or she did not follow the guideline for a particular patient, this may also be accepted by the Court.

When deciding whether to take a lateral cephalometric radiograph as part of the orthodontic assessment, the clinician must assess whether they are conforming to IRMER17 when prescribing the radiograph for this individual patient. Will they be able to ascertain any additional information from the radiograph to inform the treatment-planning process and thus benefit the patient? Alternatively, are they merely taking the radiograph to confirm the incisor inclination for example, which they have already assessed clinically?

To conform with IRMER17, and also to confirm that the clinician has undergone this thought process when prescribing the radiograph, the justification for taking a lateral cephalometric radiograph must be recorded in the clinical notes. The lateral cephalometric radiograph should also be traced and the measurements which have informed the treatment plan must be recorded in order to provide evidence of benefit to the patient of taking the radiograph.

Pretreatment Records

The BOS have produced advice about the records that may be collected as part of a course of orthodontic treatment.[16] However, the publication is not presented as clinical guidance. Lists of the types of records that could be collected during orthodontic treatment are provided, rather than recommendations for the records that should be collected. The lack of formal guidance about orthodontic records has led GDPs, in particular, to argue that there is no necessity to take three-dimensional (3D) records of the occlusion at the beginning of treatment.

However, a 3D record of the presenting malocclusion provides evidence of the clinical issues that were confronting the clinician at the beginning of treatment. This may help to justify the decisions that were made during treatment planning if the patient brings a claim against them. The existence of 3D records of the occlusion is also extremely helpful in the consent process (see section Obtaining Consent). They provide a means by which the clinician can explain and discuss their planned individual tooth movements with the patient.

For orthodontic treatments with limited objectives where the tooth movements may have been subtle, the existence of a 3D model of the starting occlusion provides evidence of the tooth movements that have been achieved by the operator. This provides a defence to the, not uncommon, complaint that the treatment has achieved nothing. It is important to appreciate, however, that without a wax bite or some other record of the teeth in occlusion, pretreatment 3D models have little value. Orthodontic treatment, even that with limited objectives, moves the teeth in three dimensions and so it is important that the records collected are able to provide evidence of this.

Intraoral clinical photographs of the presenting dentition and occlusion are frequently presented as an alternative to a 3D record. In my experience, however, these photographs either fail to show the buccal segments clearly or are taken with the patient posturing forward, and so are not a true record of the presenting malocclusion. Also, photographs can be manipulated after they have been taken.

The legal status of virtual models of the occlusion provided by manufacturers of aligner systems is not clear. The GDC have accepted these as records of the starting occlusion (Dental Protection Ltd, personal communication, 2016), but the clinician has no control over the production of the model and the manufacturers are usually based outside of British jurisdiction. It may be difficult, under these circumstances, to defend an accusation from a patient making a claim that the images of the occlusion at the beginning of treatment have been manipulated. Taking your own 3D records of the starting occlusion for these treatments could reduce your risk of a successful claim. Software packages are also able to provide an audit trail, and this can be provided to the Court, for example, to show that the images have not been tampered with after they have been collected. It is clearly important to check that these facilities are provided if you decide to invest in 3D imaging.

Intraoral and extraoral clinical photographs are universally taken at the beginning of treatment for patients undergoing aesthetic treatment, including orthodontics.

These photographs are often then used, with the patient's consent, in practice literature to inform other patients of what can be achieved by the treatments offered by the practice.

However, the main dentolegal value of taking intraoral clinical photographs at the beginning of orthodontic treatment is as a record of the health of the gingivae and of the structure and appearance of the dental enamel. Complaints have been received from patients that the dental enamel has been damaged during fixed orthodontic treatment. The existence of a high-quality intraoral photograph of the enamel of the teeth taken at the beginning of treatment may enable the clinician to show that the enamel defect was present before treatment began, if this was the case. Similarly, GDC case examiners have alleged that orthodontic treatment has been commenced for a patient with poor oral hygiene (Dental Protection Ltd, personal communication, 2016). A good-quality clinical photograph taken at the beginning of treatment showing that the gingivae were healthy at the beginning of treatment can be crucial in defending this type of allegation.

It is also necessary to take extraoral clinical photographs for patients who are about to undergo orthodontic treatment. This is particularly important for treatment that aims to change a patient's facial appearance, for example functional appliance and orthognathic surgical treatment. Extraoral photographs taken at the start of treatment are also very valuable for defending a claim from an adult patient that the orthodontic treatment they have received has 'ruined' their appearance. Such claims are not uncommon from adult patients with unrealistic expectations of treatment. These may be hard to defend if you have not taken a record of the patient's facial appearance at the beginning of treatment.

It is important that clinical photographs are taken with a dedicated clinical camera. You will be in breach of the Data Protection Act[17] (the UK's implementation of the European Union's General Data Protection Regulations) if you take clinical photographs using a mobile phone because the images will not be stored securely and can inadvertently be shared with your other electronic devices. GDC *Standards for the Dental Team*, Standard 4.2.7 states that 'if you want to use patient information such as photographs for any reason, you must: explain how the information will be used' and 'obtain and record the patients' consent to their use'.[1]

Storage of Records

One of the arguments against using dental study models as a 3D record of the occlusion has been the difficulties presented by storing the models. The Data Protection Act states that 'records must be stored safely and securely'. Clinical records are confidential, except to the patient or their representative, and members of practice staff who have been instructed in the security policy. A patient's clinical records, including dental study models and radiographs, are the property of the clinician who made the record. If the practice is subsequently sold and the new owners purchase the clinical goodwill of the practice, ownership of records pertaining to previous patients passes to the new owners.

Under the Data Protection Act[17], patients are able to obtain copies of their clinical records if they provide the clinician with a written and signed request for the records. A parent, or clinical guardian who has responsibility for the patient, is able to request the records for a patient who is aged under 18 years. If the patient is aged over 18 years, even if they were under age when the treatment was provided, they must make the written request for the records themselves or provide their written permission for another person (e.g. a solicitor) to request the records on their behalf. It is important to appreciate that the clinical records include not only the written or electronic record of the treatment that has been provided but also items such as laboratory dockets, NHS forms and consent forms.

There is provision within the Data Protection Act[17] for a clinician to request that the patient covers the cost of copying their records. Unfortunately, many requests for clinical records are made by patients who are considering making a complaint against a clinician. A request from the clinician for monies to cover this cost may be the final factor which persuades the patient to pursue their complaint. It is therefore worth thinking carefully before proceeding with such a request.

The rules about how long records should be stored after the patient's treatment has ended are less clear. The Data Protection Act states that personal data should be retained 'no longer than necessary'.[17] However, the Department of Health recommends that records are retained for 11 years if an adult patient was treated in primary care, or for eight years if they were treated in secondary care. For children, it is recommended that their records are retained until the age of 25 years.[18]

A claim of negligence must be made within three years of the plaintiff becoming aware of an issue that may be a consequence of treatment they have received. However, the Court does have the discretion to extend this period, and for children this clock does not start until they reach the age of 18 years. Potentially, therefore, an issue may arise from orthodontic treatment provided during adolescence, for example, excessive tooth wear as a consequence of the teeth being left in traumatic occlusion at the end of orthodontic treatment. Therefore, ideally, clinical records should only be destroyed on the death of the clinician (it

is not permitted in civil law to sue the deceased or their estate).

With the introduction of electronic patient records, it may be possible to store clinical records for the lifetime of the clinician, but clearly this is not practical for paper records and dental study models. Dental Protection advise their members to store clinical records of complex treatments for 30 years. Dental Protection also advise that you are unlikely to be criticised if 12 years have elapsed since you provided treatment for an adult patient and you have destroyed their records. Records should be destroyed in a manner that protects the patient's anonymity.[18]

Dentolegal and Ethical Issues that may Arise During Treatment Planning

GDPs undertaking short-term orthodontic treatment are particularly vulnerable to a complaint that has originated from the treatment-planning process. Specialists in orthodontics take three years to train and so it is clear that GDPs cannot be taught these skills in a short weekend course, for example. To overcome this problem, many of the orthodontic systems that have been developed for GDPs provide assistance with treatment planning. This treatment planning is often informed by artificial intelligence. Unfortunately, however, it is the GDP who provides the treatment, rather than the manufacturer of the system, who is liable if issues arise during treatment that are the consequence of an inappropriate treatment plan. It is therefore worth bearing in mind that if you are tempted to provide one of these treatments for your patient, and a problem occurs leading to a patient complaint to the GDC, you will be cross-examined about the process that you went through to plan the patient's treatment. It is worth spending time ensuring that you fully understand the biological and mechanical basis of the treatment that you are proposing before offering it to your patient.

Specialist Orthodontists may also receive a complaint or claim about their treatment planning, particularly if they have not paid attention during the examination process and have overlooked an issue, for example an impacted canine. The realisation that the surgical exposure of an impacted tooth is required is likely to result in treatment time being much longer than the patient anticipated, potentially generating a complaint. Similar issues may arise if the orthodontist has not fully appreciated the extent of a patient's skeletal discrepancy and it becomes clear, during a protracted treatment, that orthognathic surgery is ideally needed to fully correct the patient's malocclusion. The risk of these types of issues arising can be significantly reduced if the clinician adopts a systematic approach to the examination of the patient during the initial consultation.

Complaints may also occur as a consequence of poor communication between the specialist orthodontist and the referring GDP. If a patient presents with hypodontia, for example, and the orthodontist plans to create space for prosthetic replacement of teeth, this must be discussed with the clinician who will be providing the restorations before treatment begins. This is particularly important for child and adolescent patients, who may well be entitled to free orthodontic treatment under the NHS because of their hypodontia but, by the time they are of the ideal age to be fitted with a permanent restoration, are no longer routinely entitled to free dental treatment. A complaint is likely to follow if the patient or parent is informed at debond that they will have to fund the cost of a bridge or implant themselves. Furthermore, the child's GDP may not agree with your clinical suggestion for how the space should be filled or may not have the skills to provide the restoration that you discussed with the patient during treatment planning. An impasse may be reached, in which the patient is ready to have their final restoration but then has difficulty obtaining the last part of their treatment. A complaint is almost inevitable.

It is therefore important during the treatment-planning process for a hypodontia case that there is detailed consideration of the type of restorations that will be fitted at the end of treatment, when the restoration will be fitted, by whom, and how this will be funded. These points should all be recorded in the clinical notes, as part of the overall treatment plan, and then agreed with the clinician providing the restorations. Orthodontic treatment is often completed before the age when permanent restorations should be placed. Plans should therefore also be made for the temporary prosthetic replacement of the missing teeth. Again, these need to be agreed with the patient's GDP, or whoever will be managing the restorative aspects of the case, before treatment begins. As previously, the proposed arrangements should be carefully documented in the patient's clinical records.

Another area where poor communication between the specialist orthodontist and the referring GDP may lead to a complaint is in extraction cases. Many clinicians will be aware of instances when an unfortunate GDP has extracted the wrong tooth as part of an orthodontic treatment plan. Although it is ultimately the clinician who extracts the tooth who has the responsibility to identify the tooth, the orthodontist may be criticised if clear instructions have not been provided to the GDP about which tooth (teeth) are to be extracted and for what purpose. It is therefore good practice to write the notation of the tooth and also to describe the tooth (teeth) that are to be extracted in the

letter that is sent to the GDP to request the extractions. It is also good clinical practice to indicate in the letter that the teeth require extraction 'to facilitate orthodontic treatment'.

If a GDP has mistakenly extracted the wrong tooth, the way in which the situation is handled by the orthodontist is likely to have a significant impact on whether the patient or parent/carer decides to make a formal complaint against the GDP or not. Clearly, the GDP has a Duty of Candour[19] (see later) to inform the patient of their error. They should also contact the orthodontist as soon as they realise their mistake, for urgent advice. However, it is up to the orthodontist to act in the patient's best interests and to modify their treatment plan, if possible, to achieve the best possible outcome for the patient. If this increases treatment time or means that not all the original treatment aims can be achieved, then this should be discussed with the patient and/or their parent or carer. A specialist orthodontist would be severely criticised if, after the wrong tooth has been extracted, they make no attempt to consider a change to their treatment mechanics, where one exists, and lay the blame for a poor outcome solely on the GDP.

Obtaining Consent

Many complaints, particularly against specialist orthodontists, arise from the consent process. For an elective treatment such as orthodontics, gaining informed consent from a patient is particularly important. A patient and their parent/carer must clearly understand the risks and benefits and what will be involved for them in proceeding with a treatment that is not clinically necessary. Standard 3 of the GDC *Standards for the Dental Team*[1] provides Professional Standards for obtaining patient consent to dental treatment. The BOS have produced specific standards[5] for obtaining consent for orthodontic treatment. It is important to appreciate that the consent process must include a discussion of the potential risks and benefits of the whole orthodontic treatment pathway, including retention and interproximal enamel reduction. Complaints have arisen because patients have been unaware that after completing a gruelling course of orthodontic treatment, they then have a lifetime of wearing retainers and the ongoing costs of maintaining these.

For consent to be valid, details of what the patient has consented to should be documented, at the time that their consent was obtained, in the patient's main clinical records. The GDC also advise that 'a signature on a form is important in verifying that a patient has given consent'.[1] However, it is important to appreciate that if it later becomes apparent that the patient did not understand the treatment that they were providing their consent for, then a signed form will not provide a defence. Unfortunately, the opposite does not usually apply. The absence of a signed consent form tends to increase the clinician's vulnerability to a successful claim that the patient did not understand the treatment. Patients should be requested to provide separate written consent to having clinical photographs taken, if there is a possibility that their photographs will be used in the future for teaching or advertising purposes.

The Supreme Court ruling in Montgomery versus Lanarkshire Health Board[20] now provides the common law on consent in the UK. This ruling puts the issues that are important to the patient at the centre of the consent process by stressing that gaining consent should involve a dialogue between the clinician and the patient, in which 'the significance of a given risk is likely to reflect … the effect which its occurrence would have upon the life of a patient and the importance to the patient of the benefits sought to be achieved by the treatment' are paramount. The ruling in Montgomery versus Lanarkshire Health Board also states that 'The doctor is therefore under a duty to take reasonable care to ensure that the patient is aware of any material risks involved in any recommended treatment, and of any reasonable or variant treatments'.[20] This potentially provides a particular challenge in orthodontics, because there is often a range of different treatment options available for treating the patient's presenting malocclusion. For GDPs offering orthodontic treatment with limited aims, the challenge is greater because they are unlikely to have the training or experience to be able to advise the patient about the full range of treatment options. To satisfy the requirements of the ruling in Montgomery versus Lanarkshire Health Board, GDPs are now expected to include a discussion about the risks and benefits of treatment involving a referral to a specialist orthodontist, when obtaining a patient's consent for orthodontic treatment. For an elective treatment, such as orthodontics, it is also important to discuss the risks and benefits to the patient of remaining as they are, i.e. the option of no treatment. The details of these discussions must be documented in the clinical notes and also included in the written consent form that the patient signs.

There is an adage which suggests that 'if you provide ten orthodontists with a malocclusion, you will generate ten different treatment plans'. The ruling in Montgomery versus Lanarkshire Health Board therefore presents specialist orthodontists with the challenge of deciding how many treatment options to discuss with the patient and in how much detail. When deciding how many options should be discussed it is important to be aware of the second part of the ruling in Montgomery versus Lanarkshire Health Board, which states that:

> 'The test of materiality is whether, in the circumstances of the particular case, a reasonable person in the patient's position would be likely to attach significant significance to the risk, or the doctor is or should reasonably be aware that the particular patient would be likely to attach significance to it'.[20]

A pragmatic approach would therefore be to discuss, for example, the risks and benefits of an extraction versus a non-extraction approach to treatment, if this is a concern to the patient, or the risks and benefits of a compromise treatment compared to achieving an ideal result, if the patient indicates that they are only concerned about some aspects of their malocclusion. Clearly, the circumstances will vary from patient to patient, but you are unlikely to be criticised for not discussing the risks and benefits of extracting a second premolar versus a first premolar, for example, during the consent process, unless the patient professes a particular attachment to either tooth.

This part of the ruling in Montgomery versus Lanarkshire versus Lanarkshire Health Board illustrates the importance of spending time investigating the patient's concerns with their malocclusion and what they are hoping to achieve from orthodontic treatment during the initial consultation. If, as a clinician, you feel that the patient does not understand, and also, importantly, *accept*, that the only thing that orthodontic treatment is guaranteed to do (hopefully) is to improve their dental appearance, then you should discuss your concerns with the patient. The BOS recommend that 'All patients and guardians should be given a "cooling off" period to consider their options as part of the valid consenting process'.[5] This is particularly valuable for a patient who seems to have unrealistic expectations of what orthodontic treatment can do for their life.

The BOS also state that 'consent is an on-going process'.[5] This issue may arise during the orthodontic treatment of adolescent patients, because it is often their parents or carers who engage most in the consent process when the patient first attends for treatment. As treatment progresses it may become clear, as they become more Gillick-competent (see following section), that the patient would prefer to withdraw his or her consent to the continuation of treatment. This can present the clinician with a difficult dilemma if, for example, extractions have been undertaken and there are still spaces to close. It is not appropriate for a clinician to continue to provide treatment with the knowledge that the patient has not provided their full consent. The clinician will need to have a discussion with the patient about the advantages and disadvantages of continuing with treatment and document these. Rather than debonding the patient, it may be possible to adjust the treatment plan, with the patient's consent, to aim for a compromise result if this reduces overall treatment time. Wherever possible, efforts should be made to include whoever provided consent to the original treatment plan in these discussions. Alternatively, you could write to the parent or caregiver, with the patient's consent, explaining the reasons for the proposed change to the treatment plan and offering them the opportunity to ask questions.

If after discussion of the risks and benefits of stopping treatment, an adolescent is adamant that they want to stop treatment, then, although an active intervention is required to debond the appliances, they can be considered to have withdrawn their consent. A clinician could be criticised for refusing to remove the appliances. Some clinicians invite patients who wish to have their treatment terminated to sign a disclaimer to confirm that they understand the risks. However, the legal basis of such a document has not been confirmed. Another controversial area is whether retainers should be provided for a patient who has ended their treatment prematurely. It is important to be aware that, under the current NHS contract, most practitioners will have indicated that retainers will be provided as part of the orthodontic treatment plan. Retainers are also usually included with private orthodontic treatment contracts. Therefore, by not offering to provide retainers to a patient who has requested that their appliances be removed, you could be in breach of contract. If, by contrast, you offer to provide retainers to maintain the tooth movements that have been achieved but the patient declines to be fitted with retainers, then this should be recorded in the patient's clinical records.

Many clinicians have concerns that if they discuss a possible treatment option in general terms with a patient, then they are compelled to provide this treatment. However, GDC Standard 1.4.2 states that 'if their desired outcome is not achievable or is not in the best interest of their oral health, you must explain the risks, benefits and likely outcomes to help them to make a decision'.[1] For example, if it is your clinical opinion that a non-extraction approach will lead to long-term oral health consequences for a patient, then you would not be criticised if you decline to treat the patient on this basis. Therefore, it is crucial to clearly document the rationale behind your advice in the patient's records. It would also not be appropriate, under these circumstances, for you to then refer the patient to a clinician who you are aware is a 'non-extractionist'. The patient or their parent is entitled to make whatever decision they wish about their treatment. You could be criticised, however, for referring a patient for treatment which you are aware could be potentially damaging. Similarly, GDC Standard 7.2 states that 'you must work within your knowledge, skills, professional competence and abilities'.[1] If a non-extraction approach, say, would

involve the use of treatment mechanics which you do not feel confident to use –temporary anchorage devices might be an example – then, again, you are able to decline to treat the patient if you have explained and documented the reasons for your advice. In the latter example however, the GDC advises that 'you must refer the patient to an appropriately trained colleague'.[1]

Another issue that has arisen in discussions about possible treatment options for orthodontic patients regards the discussions that should be had with orthodontic patients about 'alternative' types of treatments, i.e. non-conventional treatments akin to 'alternative medicine'. These treatment modalities tend not to be accepted by the body of the orthodontic profession due to lack of evidence for their effectiveness. It has been argued, however, that these treatments should be included in the list of treatments discussed with patients as part of the consent process, although a GDC Fitness to Practice ruling did not support this view (Dental Protection Ltd, personal communication, 2016). However, in the spirit of the ruling in Montgomery versus Lanarkshire Health Board,[20] if a patient or parent raises this as a possible treatment option during the consent process, then the clinician would be expected to discuss the pros and cons of such a treatment in a measured way. Similarly, an 'alternative treatment practitioner' may be criticised for not discussing the pros and cons of conventional orthodontic treatment with the patient, if their treatment is aimed at correcting a malocclusion.

Who is Able to Provide Consent?

People over the age of 16 are entitled to provide consent for their own treatment. In cases where refusal to provide consent may lead to death or serious injury, this can be overruled by the Court of Protection, under the Mental Capacity Act 2005.[21] After the ruling in Gillick versus West Norfolk & Wisbech Area Health Authority,[22] a child aged under 16 who is considered to have enough understanding to fully appreciate what is involved in their treatment, i.e. they are **Gillick-competent**, may also provide consent for their own treatment.

A patient, or their parent or caregiver, is able to withdraw their consent to treatment at any time. For a long course of treatment, such as orthodontics, consent for each treatment visit is implied by the patient attending the appointment and sitting willingly in the dental chair. Issues may arise during treatment if the patient's parents become estranged and an irreversible procedure, for example, dental extractions, is required to which one parent does not agree. This type of scenario illustrates the importance of predicting, and incorporating, the whole treatment pathway into the original consent process, if at all possible. However, it is not unusual for an orthodontist to have to change a treatment plan in mid-course to include extractions, for example, if a patient fails to respond to an appliance or grows unpredictably.

The Children Act[23] provides the law about who should be involved in making decisions about a child. The Act states that 'when important decisions are made about the child', including consenting to 'a child's operation or certain medical treatment', then all those with 'parental responsibility' are allowed to have a say in that decision. Under the Act, mothers and married fathers automatically have parental responsibility for their child, even if they divorce. Unmarried fathers automatically have parental responsibility if the child was born after 1 December 2003 and the father's name is on the birth certificate or they have entered into a parental responsibility agreement with the mother. Grandparents have no parental responsibility for the child unless they were appointed as guardians, and the child's parents have died or they have obtained a Child Arrangements Order from the Court and the child lives with them. Similarly, step-parents have no parental responsibility for a child, unless they have entered into a parental responsibility agreement with everyone who has responsibility for the child and they are also married to one of these individuals.[23]

The Children Act states that if parents are unable to agree on a major decision for their child, which might include extractions for orthodontic treatment, then the parents should seek family mediation. Clearly, this would extend the length of the child's orthodontic treatment if it has already started, and if you are faced with a situation where parents are unable to agree a change in the treatment plan, for example, the need for extractions, you may consider providing information to each parent separately and then invite them to discuss this together in a side room. Similarly, if you are aware that a child's parents do not live together, then it would be wise to confirm with the parent attending with the child that the child's other parent is in agreement with the proposed change to the orthodontic treatment plan. Again, all these discussions must be documented in the child's clinical records.

Dentolegal Issues Arising During Active Orthodontic Treatment

For a claim of clinical negligence to be successful, the plaintiff must prove that:

1. the clinician has a duty of care
2. the clinician has breached this duty
3. an injury has occurred as a consequence of this breach.

If these three points can be proved, then the patient is entitled to obtain compensation through the civil courts.

A **duty of care** is a legal obligation placed on an individual whilst performing an act which could foreseeably harm the other person. All clinicians therefore have a duty of care towards their patients. The common law test for the standard of care that should be provided comes from the ruling in Bolam versus Friern Hospital Management Committee.[24] The **Bolam test** states that 'a doctor is not negligent if he has acted in accordance with a practice accepted as proper by a reasonable body of men skilled in that particular art'. A second test was added to the Bolam test after the ruling in Bolitho versus City and Hackney Health Authority.[25] The **Bolitho test** is that the standard which was considered to be proper should be able to 'withstand logical analysis'. Expert witnesses who provide advice to the Court about the standard of care that should have been achieved are now expected to produce clinical guidelines that have been developed after systematic review of the evidence of the effectiveness of a recommended clinical practice, where they exist, to demonstrate that their evidence will satisfy the test in Bolitho. Bolam sets out that 'the clinician is not negligent if they have acted in accordance with a responsible body of opinion'.[24] The ruling in Bolitho narrowed the scope of the Bolam test by stating 'that the court must be satisfied that the body of opinion relied upon has a logical basis'.[25]

It is also important to appreciate that, for negligence to be proved, 'a relationship of proximity must extend between the defendant and the claimant'.[26] This is relevant to treatments, including aligner treatments, which are planned by a third party. These third parties are usually considered not to be liable because they do not have a direct relationship with the patient. The clinician will therefore bear the total costs if negligence is proved.

An important aspect of the ruling in Bolam versus Friern HMC[24] is that the standard of care that is applied is that of the clinician's peers. This may raise issues if a claim of negligence is made against a GDP providing orthodontic treatment. Should the outcome of orthodontic treatment provided by a GDP be judged against those achieved by other GDPs, which have been reported to be low,[27] or against the results that are achieved by specialists? This has not yet been tested in the courts.

However, the GDC, which includes orthodontic treatment within the scope of practice for all registered dentists, states in Standard 7.2.2 that 'you should only deliver treatment if you are confident that you have had the necessary training and are competent to do so'.[1] GDPs undertaking orthodontic treatment, with limited objectives, sometimes encounter difficulties during active treatment if the teeth do not move as predicted or there are issues such as frequent breakages. Specialist Orthodontists encounter these problems too but they have the knowledge and range of skills to correct them. GDPs, however, may be vulnerable to an allegation that they were in breach of GDC Standard 7.2.1, which states that 'You must be sure that you have undertaken training which is appropriate for you and equips you with the appropriate knowledge and skills to perform a task safely',[1] if, having identified a problem, they do not have the skills to remediate it. It may also take some time for GDPs undertaking orthodontic treatment to realise that the treatment is not proceeding as anticipated. Treatment times will then be extended, which is a frequent source of complaints from patients.

Specialist Orthodontists, who have the training to adjust their own treatment plans, are vulnerable to a different issue that may arise during active orthodontic treatment. Most adult patients are engaged in the treatment process but, for some, this engagement becomes obsessive and they become their own 'experts', requesting frequent amendments to the treatment plan, often on a tooth-by-tooth basis. In an effort to appease the patient, the orthodontist will often go along with these 'tweaks' to the treatment plan but is then at risk of losing sight of the original aims of treatment. It is often impossible to satisfy these patients and eventually a situation is reached where neither the patient nor the clinician can see treatment being completed to the patient's satisfaction. The patient may then make a complaint against the orthodontist.

Although in retrospect there may have been clues to indicate the patient's obsessive personality during the initial consultation, unfortunately these patients can be difficult to spot before treatment begins. It is therefore important, for every patient, that the clinician formulates and gains consent for a very specific treatment plan at the start of treatment. It is also prudent that if the patient requests a change to the treatment plan during active treatment, that the new aims of treatment are documented and that the risks and benefits of the revised plan, however small the changes have been, are discussed with the patient and their formal consent to the revised treatment plan obtained. This process will appear to be very tedious in the busy clinical situation, but will help you to keep control of your treatment plan.

The clinical situations discussed here are unlikely to result in injury to a patient or a claim of clinical negligence. However, the patient would be able to make a claim of breach of contract if treatment is not completed. They may also be able to make a successful complaint to the GDC if they have doubts about your ability to complete their orthodontic treatment, or if they feel that their wishes have not been taken into account during the

treatment process. Fortunately, injury during orthodontic treatment, which could lead to a successful charge of negligence, is rare. Alani and Kelleher[2] have listed the dental issues which may arise during treatment. These include enamel demineralisation, gingivitis, exacerbation of periodontal disease, damage to restorations, tooth devitalisation, temporomandibular joint dysfunction, and external root resorption. Many of these conditions are either preventable or predictable. For example, a clinician providing orthodontic treatment who has not shown the patient how to care for their fixed appliances when they were fitted, not provided them with written instructions, and not documented this in the clinical notes may be vulnerable to a claim of negligence if the patient experiences significant enamel demineralisation or gingivitis during treatment. Similarly, if a patient presents with active periodontal disease and you do not take steps to ensure that this is under control before treatment begins and monitored throughout orthodontic treatment, and that these steps are documented, then you may be vulnerable to a successful claim if the patient's periodontal disease progresses. The GDC may also consider that you have not provided the expected standard of care when treating this patient.

A clinician's vulnerability to a successful claim of negligence if root resorption occurs during orthodontic treatment may be less conclusive. Blunting of the root apices is a common radiographic finding after orthodontic treatment with fixed appliances. Patients are usually warned about the risk of root resorption during the consent process for orthodontic treatment. Occasionally, however, root resorption during orthodontic treatment may be excessive, although there may be few, or no, clinical indicators that this is occurring during treatment. There is also rarely a clinical justification for taking a scanning radiograph during orthodontic treatment or at debond. The clinician may therefore be unaware that significant root resorption has occurred. The situation is further complicated because the prognosis for teeth with external root resorption is uncertain.[28]

Each case is different, but the issues which are likely to be taken into account when determining whether a clinician is negligent if external root resorption has occurred include the following. Were there radiographic signs at the beginning of treatment which indicated that the patient was particularly vulnerable to root resorption? If yes, and these were identified, was the patient warned of their increased risk? Also, did the patient report symptoms characteristic of root resorption to the clinician during treatment? If yes, did the clinician undertake the appropriate investigations? Similarly, were there any clinical signs of excessive root resorption present during treatment? If yes, did the clinician investigate these?

Another factor which may be taken into account is the time that the fixed appliances were in place and also the tooth movements that were undertaken. The risk of root resorption is correlated with treatment duration and bodily movements of the teeth, particularly those which move the root apices close to the cortical plates.[28] If it can be shown that treatment time was significantly longer than average or there were unnecessary root movements (e.g. 'round-tripping'), again the clinician may be vulnerable to a successful claim of negligence. However, it is important to appreciate that all orthodontic treatment applies forces to the periodontium that may lead to external root resorption. It is no defence to suggest that since you were only applying, say, tipping forces to the teeth in orthodontic treatment with limited objectives, there was no need to radiographically assess the vulnerability of the roots of the teeth to external resorption at the start of treatment.

Injury may also occur during orthodontic treatment, for example, if part of an orthodontic appliance is swallowed or inhaled. It is not practical to fit a rubber dam when fitting or adjusting a fixed orthodontic appliance, and so there is always a risk that a patient may swallow or, worse, inhale a piece of the appliance. The BOS have produced advice about the steps to take under these circumstances.[29] For example, if a complaint is made following the loss of a bracket down the patient's throat, the following factors may be taken into account: Did the clinician notice that part of the appliance had been lost? Was the clinician working with a trained dental surgery assistant? Was adequate suction available? Did the clinician inform the patient/parent and provide appropriate advice? Were the steps that were taken documented in the clinical notes? Was a clinical incident recorded? Did the clinician contact the patient at home to check that all was well? Accidents do happen during clinical practice but if you are able to show that you have taken steps to remediate the damage and have always put the patient's interests first, then you will reduce your risk of a successful investigation by the GDC. However, you could still be found negligent by the Court if it is found that your actions have caused injury to the patient. Most lost brackets, for example, are swallowed and pass through the gut uneventfully, i.e. no physical injury can be proven. Unfortunately, some plaintiffs are now claiming psychological injury, from worrying about the possible consequences of an untoward event during treatment. It is therefore worthwhile seeking advice from your indemnifiers if any type of untoward incident occurs during clinical practice.

Clear advice should also be provided to patients about the action they should take if their fixed appliance breaks. The main clinical concern with debonded brackets or lost archwires tends to be the impact that these may have on

treatment progress. However, a case has been reported in which a patient swallowed a section of archwire that had become detached from a recently fitted fixed appliance.[30] The wire then became embedded in the wall of the gut and needed to be surgically removed. It is likely that this patient contributed to the loss of the archwire by tampering with the appliance. Patients should therefore be warned, in a non-alarmist way, about the possible consequences of interfering with their fixed appliances.

Transfers

Orthodontic treatment can be a lengthy process and sometimes it becomes necessary to transfer a patient to another clinician during active treatment. The BOS report that, on average, treatment times are six months longer in patients who transfer during treatment.[31] To avoid a complaint, it would be wise to discuss this issue with the patient and to suggest ways for them to continue under your care if possible.

If a transfer is unavoidable, then the best way to facilitate this process is to provide them with copies of their clinical records, including radiographs and study models, to inform their new clinician of their presenting malocclusion; this is not mandatory but would be considered to be in the patient's best interests. However, it is important to remember to keep the original records and archive these carefully. Unfortunately, clinicians are most vulnerable to a complaint when a patient transfers to another clinician. It is therefore very important to be able to quickly retrieve the documentation regarding the treatment you have provided.

Non-compliance

Another issue that arises during treatment is non-compliance. This may be non-compliance with oral hygiene measures or non-compliance with treatment, for example the wearing of removable appliances or elastics. It is almost always adolescent patients who fail to comply with treatment. As previously discussed, this raises the issue of consent for treatment. Non-compliance is almost always a sign that the patient has decided that orthodontic treatment is no longer for them. However, it is very important to rule out other issues, such as lack of physical dexterity, before raising your concerns with the patient about their consent to treatment. If the patient is unable to physically tolerate an appliance or elastics, for example, it may be possible to amend the treatment plan or to reduce the aims of treatment. As discussed previously, these revised aims should be documented and consent obtained from the patient and their parent/caregiver.

More difficult issues arise when the decision to stop treatment has to be made by the clinician, for example due to continued poor oral hygiene or repeated breakages. In each of these situations, if the patient or their parent/caregiver makes a complaint to the GDC, the clinician will need to be able to show that they have put the patient's best interests first when terminating treatment. The patient should be informed of your concerns immediately they arise and efforts should be made to identify why the patient is struggling and to assist the patient to care for their appliances. The GDC is likely to take a dim view if you remove the appliances without giving the patient the opportunity to improve their ways. If poor oral hygiene is the issue, then intraoral clinical photographs will not only provide evidence of the clinical situation that you as a clinician were managing, but they can also be used to inform the patient of your concerns. Start clinical photographs can also form a baseline for comparison. The only exception to removing an appliance without giving the patient a warning would be when there has been a significant loss of tooth tissue due to caries or erosion and there is a significant risk to the dentition of leaving the appliance in situ. Again, good-quality intraoral photographs should be taken to document the clinical situation. Arrangements should also be made for the patient to receive urgent restorative care.

Non-attendance

A patient may also show their lack of consent for continuing with orthodontic treatment by failing to attend for appointments. If this is an intermittent pattern, once again the clinician should show that they are acting in the best interests of the patient by discussing the impact that failed attendance will have on treatment progress and the potential for unwanted side effects to occur if the appliance is not monitored. As ever, these discussions must be documented. Efforts should also be made to identify the issues that are making it difficult for the patient to attend and, if possible, to make arrangements to assist the patient to attend. Sometimes, the situation will be impossible to correct. This highlights the value of discussing the importance of regular attendance, and also the surgery hours, with patients and their parents/caregivers during the initial consent process. Similarly, if the practice operates a policy in which patients are discharged after a minimum number of failed appointments, this must be drawn to the patient and parent/caregiver's attention during the initial consent process.

Often the patient fails to attend for any further appointments. Again, the GDC will want to see evidence that you have continued to act in the patient's best interests and that efforts were made to contact the patient to arrange an appointment to discuss treatment/debond. Clearly

you cannot impose treatment on a patient who has withdrawn their consent by not attending. The BOS advises that 'efforts should be made to inform the patient that wearing an unsupervised appliance carries risks for the dentition'.[32] A non-compliant patient may be nervous of attending again for fear of rebuke; adding a line to a letter informing them that you are keen to find a solution, including possibly removing the braces, may encourage them to attend.

Non-payment of Fees

Orthodontists often arrange for private patients to spread the cost over the course of treatment. Issues may arise if treatment is continuing but patients are not keeping up with their payments. The clinician may be tempted to suspend treatment until further payments are made. Wearing an appliance that is either inactive or is not being regularly monitored is clearly not in the best interests of the patient. The clinician could be criticised for this if the patient makes a complaint to the GDC.

Non-payment of fees therefore needs to be regarded as a separate issue to the clinical treatment, which must continue as planned. It is not strictly necessary to wait until treatment has been completed to put debt recovery measures in place. Clearly, however, this has the potential to impact on the relationship with the patient and so discussions should be had, out of the surgery, with whoever is paying for the treatment to find a sensitive solution to the problem.

Supervision of Orthodontic Therapists

In the UK, orthodontic treatment is increasingly being delivered by orthodontic therapists. The clinical procedures which may be performed by orthodontic therapists are laid out in the GDC's *Scope of Practice*.[33] Orthodontic therapists are only able to undertake clinical procedures that are prescribed by a registered dentist. This includes both GDPs and specialist orthodontists. The BOS has produced Professional Standards for Orthodontic Practice which state that 'patients should not be seen and/or treated by Dental Care Professionals (DCPs) without direct supervision on at least every other appointment by a General Dental or Specialist Practitioner with adequate orthodontic competency'.[34] An expert witness will use these standards as evidence of the standard of care that should have been provided if a patient makes a complaint about an issue that has occurred during active orthodontic treatment provided by an orthodontic therapist. To reduce your risk of an allegation that you have breached this standard, it is worthwhile checking that systems are in place to record that you have seen the patient and provided a prescription to the orthodontic therapist, if you are the supervising clinician.

Retention

Issues with retainers are a common source of complaint in orthodontics. Orthodontists now routinely recommend that patients wear their retainers for the life of their dentition. However, patients or their parents/caregivers may complain that they were not made aware of the long-term implications of wearing retainers, particularly the cost of maintaining them, before treatment began. It is therefore important that the retention which is planned for a case is included in the initial consent process.

Some patients or their parents/caregivers have preconceptions that fixed retainers are superior to removable retainers. It is not unknown for fixed retainers to be requested by parents/caregivers at the end of orthodontic treatment, because they have little confidence in their child's ability to wear their removable retainer. This raises two issues. Firstly, there are long-term oral health implications associated with fixed retainers and so the clinician could be vulnerable to criticism if there were no good clinical reasons for fitting the fixed retainers. Secondly, many clinicians now recommend that patients wear their removable retainers at night, as an adjunct to the fixed retainers. This may come as an unwelcome surprise to a parent who has paid extra to have a fixed retainer fitted. Clearly, it is better to have these discussions before treatment begins rather than to be confronted, at debond, by the patient or parent/caregiver feeling unable to provide their consent for your recommended retention regimen.

Another issue that frequently arises in orthodontic clinical practice is the long-term cost of maintaining retainers and also who will provide this. Under current NHS regulations,[35] patients are entitled to a 12-month period of supervision of retention, but there is a charge for a lost retainer. Charges for NHS treatment for children are very rare and so most parents/caregivers will be taken aback if they are suddenly presented with a bill for a lost retainer. They will also probably feel that they have no choice but to pay the charge, rather than jeopardising their child's orthodontic result. These feelings could lead to a complaint. Consequently, NHS patients, and their parents, should be informed of the possibility of additional charges before they commit to orthodontic treatment and this advice documented in the clinical notes. This advice should be repeated when the retainers are fitted. If the patient is being treated under private

contract, then the fact that lost retainers will incur additional charges, and the level of those charges, should be clearly stated in the contract, if this is your practice's protocol.

For NHS patients, once the 12-month retention is over, orthodontists are entitled to charge patients for review appointments. Alternatively, the patient's GDP may review the patient's occlusion and their retainers. For specialist orthodontists who take referrals, it is worth confirming the arrangements for the ongoing maintenance of retainers with your referring dentists. Complaints have arisen when patients or parents have sought advice about a broken or lost retainer from a GDP, only to be informed that it is the orthodontist's responsibility to maintain these, and vice versa. Not all GDPs will feel confident to monitor or repair a fixed retainer. Furthermore, fixed retainers have the potential to retain plaque and calculus and so require regular review. It is ultimately the responsibility of the clinician who fits a retainer to ensure that arrangements are in place to ensure that no harm will come to the patient from wearing the retainer.

Issues may also arise when an orthodontist leaves his or her practice or retires. Many orthodontists are in the habit of making running minor repairs to a previous patient's fixed retainers, at little or no charge, if they attend with a breakage. The incoming orthodontist may not be willing to provide this type of care at low cost to the patient. Complaints have arisen because a patient has been presented with a large bill for what is often a relatively quick procedure. If the practice is being sold, it is important for an arrangement to be made for the ongoing maintenance of patients wearing fixed retainers, in particular, as part of the sale of the practice. Monies will usually need to be left by the outgoing orthodontist to cover these costs. Similarly, if an orthodontist leaves a practice, these issues should be discussed before they leave.

When removable retainers are fitted, it is important that the patient is given clear instructions about their wear and maintenance. In the UK, it is also important to be aware that if you make your own vacuum-formed retainers on site, then you must register with the Medicines and Healthcare Products Regulatory Agency (MHRA).[36] It is good practice to support the verbal advice that is given to patients with written instructions. The advice that is given to patients, particularly about when they should wear their removable retainers and how to clean them, should be documented in the clinical notes. These instructions should provide clear advice about the patient's responsibility for attending review appointments and also the action that the patient should take if they identify a problem with a retainer. If the number of hours that removable retainers should be worn is reduced during the retention period, this advice should be clearly recorded in the clinical notes. Patients should also be provided with clear instructions about the action they should take if a retainer is lost or broken.

Relapse

Orthodontic treatment requires a significant investment of time and money from the patient or their parent or caregiver. If changes then occur in the occlusion after the appliances have been removed, the patient is likely to be extremely disappointed. If their issues are not addressed by the clinician to their satisfaction, they may make a formal complaint. A patient may also complain if their fixed retainer requires frequent repairs.

It is not uncommon for an adolescent patient in particular to fail to wear their removable retainers as directed. If clear instructions have been given to the patient and their parent about when they should wear their retainers, and these have been documented in the clinical notes, it is unlikely that the patient will be successful in their complaint about relapse if this is a consequence of lack of retention. An exception to this may be when a clinical reviewer is of the opinion that the teeth have been placed in an extremely unstable position at the end of treatment, and that the patient was not warned about this risk during the initial consent process.

Similarly, if a patient continually presents with a broken fixed retainer, rather than continually repairing it, it is worth spending time considering whether the retention that has been provided is adequate. Fixed retainers do fail due to bond failure but repeated failures should draw the clinician's attention to the possibility of relapse of individual teeth attached to the retainer. GDPs providing fixed retainers at the end of short-term treatment are particularly vulnerable to a complaint about a frequently debonding fixed retainer because they may not be able to convince the Court, or the GDC, that they have sufficient knowledge and skills to understand and remedy this type of clinical situation.

Duty of Candour

If you have identified an issue with a fixed retainer that you have fitted, or some other problem with part of the orthodontic treatment process, it is important that you inform the patient of what has occurred as soon as you become aware of it. All clinicians working within the regulated healthcare professions in the UK now have a Professional Duty of Candour.[19] The GDC states that:

this means that healthcare professionals must:

- Tell the patient (or their carer, if the patient does not have capacity) when something has gone wrong;
- Apologise to the patient;
- Offer an appropriate remedy or support to put matters right (if possible); and
- Explain fully to the patient the long and short-term effects of what has happened.[19]

It is important to appreciate that the Duty of Candour was introduced to increase transparency within the delivery of healthcare and also to increase patient engagement with the treatment process. Many clinicians are very worried about the obligation to apologise to the patient if treatment has not gone to plan, because they are under the impression that this will be taken as an admission of negligence if the patient makes a complaint or claim. However, the purpose of the apology in the Duty of Candour is to show empathy towards the patient about their feelings of disappointment and concern that something has gone wrong with their treatment. The Court will not use a record of an apology from a clinician, on its own, as evidence that he or she has been negligent. Similarly, being candid and apologising to a patient is no defence for providing clinical care that your peers would consider to be substandard.

Responding to a Complaint

Unfortunately, despite one's best efforts to avoid them, it is almost inevitable that, as a clinician, you will receive a complaint from a patient, about the orthodontic treatment that you have provided, during your practising lifetime. However, your risk of receiving a complaint can be significantly reduced by developing a good relationship with your patient and listening to them, so that issues can be discussed as soon as they arise. Nevertheless, it is not unknown for a patient who appeared to have been reassured when they left your surgery to then go home and be encouraged to make a formal complaint by a third party.

The GDC *Standards for the Dental Team*, Standard 5.1.1 states that 'It is part of your responsibility as a dental professional to deal with complaints properly and professionally'.[1] If the patient makes a complaint to the GDC, the manner in which you and your practice have handled the complaint will be examined as part of the GDC's investigation of the complaint. All the indemnifiers in the UK provide advice for their members. It is very worthwhile contacting your indemnifiers for advice as soon as you become aware that a patient is dissatisfied with the orthodontic treatment you have provided.

Circumstances vary but, in general terms, it is probable that if you have received a verbal complaint, you will be advised to arrange a meeting with the patient and their representatives to discuss their concerns. This can be a daunting prospect for the clinician but will demonstrate to the patient that you are taking their concerns seriously and wish to work with them to find a solution. As such, it is important to give sufficient time for the meeting, rather than squeezing in the complainant between other patients. Although you should never compromise your safety, it is also important to consider that a patient may feel intimidated if you are accompanied to the meeting by a third party, for example, your practice manager.

If a verbal meeting is not sufficient to resolve the complaint, then it may be necessary for you to invite the patient to put their concerns in writing. Again, it is extremely important that you seek advice immediately you receive a written complaint. It is also important to comply with GDC Standards[1], i.e. the patient is sent a written acknowledgement of their complaint within the time limits set out in your practice's complaints protocol, together with a copy of the protocol. The latter should also be displayed in the practice where patients can see it.

Some clinicians working in private practice have been tempted to simply give the patient their money back 'as a gesture of goodwill', if the patient has made a complaint about orthodontic treatment which has not gone smoothly. Although this may seem like an effective way to bring the matter to a close, it may be considered that you were not taking the patient's issues seriously and were merely paying them to go away. It is entirely possible that after reviewing your clinical records, your indemnifiers may be of the opinion that the patient has some grounds for a successful complaint or claim and that a refund is recommended to dissuade the patient from taking their complaint further. Your indemnifiers will be able to assist you to write a letter, to accompany the refund, that provides your response to the issues that the patient has raised and explains the reason for the refund. This will reduce your risk of an allegation that you have not responded to the patient's complaint professionally.

Although receiving a complaint from a patient is an extremely unpleasant experience for a clinician, it is worth keeping uppermost in your mind that the proportion of patient complaints that are taken forward by the GDC to a Fitness to Practice (FTP) Panel hearing, for example, is very small (Dental Protection Ltd, personal communication, 2016). If you are unfortunate enough to be referred to a FTP hearing, the GDC panel's main concern is about your current practice and whether you are a risk to patients. If you are able to demonstrate that you have insight into the deficiencies in your practice that have led to the patient

complaint and can provide evidence that you have taken steps to remediate these, then this is likely to be considered favourably by the Panel.

The GDC are also concerned about dishonest practice and the impact of this on the reputation of the dental profession. If an allegation of dishonesty is proven against a clinician, this is likely to have consequences for their registration. However, the GDC are realistic that clinical treatment does not always go to plan and patients do not always understand the consequences of their decisions. If, as has been emphasised throughout this chapter, you have documented your discussions with your patient, and also the treatment that you have provided, carefully and **contemporaneously**, then this will demonstrate to the GDC that you have been open and honest about the care you provided even if the patient is dissatisfied.

This is not to say that providing a poor standard of care or a treatment that you do not have the knowledge, skills or experience to undertake is acceptable, even if you have made good clinical notes of what you have done. The patient may still be able to make a successful claim of negligence against you for the treatment that they themselves received, even if the GDC do not consider that your current practice is impaired. It is therefore very important to always work within your clinical competency and to maintain your continuing professional development.

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