Orthodontic Retainers and Removable Appliances

Principles of Design and Use
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Why we need this book and who is it for?

This book aims to fill a gap in the literature that has existed for many years. Whilst it is a General Dental Council (GDC) requirement (quite rightly) to teach dental students orthodontic diagnosis and the principles of interceptive treatment (amongst other things), there seem to be no books that explain concisely, in practical terms (and in enough detail), what principles to apply when trying to design the appliances to enable this interceptive treatment to be undertaken. This book therefore sets out to address this.

Many books contain the principles but these are often obscured by excessive detail – or perhaps there is too much theory in the wrong place. Either way, things can get confusing. Alternatively, suggestions are made for ‘standard appliances’, but a one-size-fits-all approach is not always useful when it comes to working out when the ‘standard appliance’ is not appropriate. To reinforce this point, we also include a “Test yourself” chapter. Here, the reader can assess some patients for themselves and see whether or not a URA (upper removable appliance) would be appropriate or not.

In addition, in some cases, it may be necessary to refer a patient for specialist advice. For example, a patient may require initial, interceptive treatment but, in addition, may require referral for definitive treatment thereafter. It should be said that this would hopefully not be as a result of the interceptive treatment! Again, it is a GDC requirement that the dental graduate be competent at making appropriate referrals based on assessment. This is another aspect that this book gives advice on – what makes a good referral letter.

This book also includes a basic section on orthodontic retainers: current trends increasingly mean that patients wish to maintain their teeth as straight as possible following frequently lengthy, usually fixed, appliance treatment. Specialists performing orthodontic treatment must necessarily focus on the active treatment of the patients referred to them. Ultimately, such patients, if they wish to continue wearing retainers long term, need to be referred back to their own general dental practitioner (GDP) so they take over the responsibility of looking after their own patients and their patients’ retainers. However, there is little, readily available information for the GDP to enable them to perform this duty. Therefore, this book aims to provide some basic guidance to address this.
In addition, there are a limited number of lower removable appliances (LRAs) which may have a use in certain, somewhat restricted, circumstances. These will be referred to at appropriate points in relevant chapters. For reasons of completeness, the book also includes chapters, specifically for the specialist trainee, on some other uses of removable appliances. These cover basic aspects of functional appliance design and the use of vacuum-formed active appliances (VFAAs; also known as aligners).

This book is thus aimed at dental undergraduates who have received basic training in orthodontic diagnosis; have a reasonable level of understanding; and are familiar with the basic terminology. However, we also intend it to be useful to postgraduate students of orthodontics; orthodontic therapists; qualified GDPs; orthodontic technicians, and postgraduates in paediatric dentistry – all of whom require a knowledge of interceptive orthodontic treatment.

Friedy Luther
Zararna Nelson–Moon
We have written this book in the hope that it will be useful to future generations of students of orthodontics. We have tried to achieve this by illustrating it as well as we possibly could. To this end, we have been reliant on the goodwill of fellow colleagues, clinicians and postgraduate students to help us obtain photographs (often at short notice), when we have not been able to obtain them ourselves. Jay Kindelan, Consultant Orthodontist at York (York Teaching Hospital NHS Foundation Trust) also helped us greatly by writing Chapter 11 for this book. We hope everyone will forgive us for badgering them.

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Throughout this text, the following abbreviations have been used:

- **EOT**: extra-oral traction
- **FABP**: flat anterior biteplane
- **FMPA**: Frankfort–mandibular planes angle
- **GDC**: General Dental Council
- **GDP**: General Dental Practitioner
- **ICP**: inter-cuspal position
- **IOTN**: Index of Orthodontic Treatment Need
- **IPR**: interproximal reduction
- **LLS**: lower labial segment (usually taken to mean the lower incisors although some clinicians include the lower canines)
- **LRA**: lower removable appliance
- **MOA**: medium opening activator
- **PIL**: patient information leaflet

**RCP**: retracted contact position

**ss**: stainless steel

**ULS**: upper labial segment (usually taken to mean the upper incisors although some clinicians include the upper canines)

**URA**: upper removable appliance (not to be confused with upper right deciduous central incisor, see below!)

**VFAA**: vacuum-formed active appliance

**VFR**: vacuum-formed retainer

In addition, readers should note that the commonly used abbreviation for a supernumerary tooth, $, is used.

Tooth notation: the alpha numeric tooth notation system will be used, e.g. upper right lateral incisor would be UR2. An upper right deciduous central incisor is noted as UR A.
Assumptions: What You Should Know and Understand Before You Use this Book

As a reader of this book, it is only fair that you know what you are getting as the remit is certainly not to teach orthodontics! It concentrates on discussing the practical aspects of only two, relatively discreet, but important aspects of orthodontics:

• **Interceptive treatment** deals with the developing, childhood dentition at a time when decisions can strongly influence long-term outcomes. Identifying and explaining the principles of interception are among the learning outcomes identified by the General Dental Council.

• **Retention** is an increasingly important part of orthodontic treatment for many patients. More and more, patients may wish to maintain (for as long as feasible) their treatment result following what may often have been lengthy and complex treatment. It is thus likely that general dental practitioners will need to take over the care and responsibility for their patients’ retainer requirements. Incidentally, however, it should be noted that whilst upper removable appliances (URAs) are appropriate for childhood interceptive treatment, they are not often useful for adults. In contrast, retainers may be worn by children or adults.

This book will also give pertinent advice on:

• **What makes a good referral letter** (again in line with the General Dental Council outcomes), e.g. when a patient requires referral to a specialist for definitive orthodontic treatment.

• **What is required when and the reasons for taking over the care and responsibility of a patient’s retainer requirements**.

In addition, discussion of lower removable appliances (LRAs) is included where appropriate, as well as specific chapters for the specialist trainee.

The authors acknowledge that the practical advice given in this book will sometimes not exactly match that given by every clinician, but
subtle differences in approach are evident between clinicians in all specialties. The approach adopted here is one that we have found works for us. Furthermore, as this is essentially a practical guide based on clinical experience, it is not written nor intended as a fully-referenced academic text.

So, this book assumes a basic level of orthodontic knowledge of the sort you would hopefully receive from an undergraduate dental training. This means that it does not explain terms such as overjet, overbite, the different skeletal, incisor or molar classifications, etc. – it will assume you know these already. It will also not explain how to undertake an orthodontic diagnosis, only pointing out aspects of diagnosis that are relevant to the particular problem under discussion.

Also this book will not explain how to undertake all orthodontic treatment. That is a specialist area. However, what this book will do is give guidance on situations where interceptive treatment could potentially be considered and how. Yet, this can never be comprehensive since no two patients are ever entirely identical. Many aspects of diagnosis can influence a decision as to whether a treatment is reasonable, possible or even feasible.

In addition, this book does not discuss issues of consent, risks of orthodontic treatment and balancing the risk/benefit ratio. These are all vital issues, but again we assume a level of knowledge that basic undergraduate dental training should cover.

Lastly and obviously, this book provides no direct practical experience whatsoever!
Upper Removable Appliances: Indications and Principles of Design

Upper removable appliances (URAs) are ‘removable braces’ that fit on the upper arch only. In the past, URAs were used for many malocclusions, including severe Class II division 1 cases. However, this is no longer seen as appropriate because removable appliances can only achieve very simple movements, i.e. simple tipping of teeth, and the vast majority of malocclusions that warrant treatment require far more complex movements (using fixed appliances) to achieve an adequate outcome. Fixed appliances can also tip teeth, but in complete contrast to removable appliances, they can also achieve bodily movement (including rotations, intrusion and extrusion) as well as torque. Therefore, regarding active treatment, this book will mostly confine itself to interceptive treatment where the types of malocclusion to be intercepted are very limited; if tooth movement is required, it is confined to tipping movements. The exceptions are covered in Chapters 10 and 11.

Learning outcomes

After reading this chapter you should know:

- The indications for the use of URAs
- The importance of anchorage
- The advantages and disadvantages of removable appliances
- What the components of URAs are
- What the components of URAs look like
- The design principles and steps to consider when designing URAs
- The importance of the timing of appointments

Prerequisites for orthodontic treatment

It must be understood that for any patient seeking any form of orthodontic treatment, dental health (including dietary control) and oral hygiene must be excellent prior to treatment.
Therefore, before any referral is made, the referring dentist must ensure that their patient is dentally fit, i.e. no active caries, gingivitis or periodontal disease, and that they have a standard of oral hygiene that is excellent – this is the level required to support appliance therapy. A number of recent audits in the UK have indicated that 30% of patients have undiagnosed/untreated caries on referral to an orthodontist. This wastes a great deal of everyone’s time as, obviously, the orthodontist cannot accept a patient for treatment if the patient is not dentally fit and/or has poor oral hygiene/diet control. This is because significant damage, e.g. caries, will be caused to the teeth and supporting structures by any appliance used under the wrong conditions. Damage will also occur far more quickly and severely than under normal conditions. Furthermore, restoration of teeth is more difficult once appliances are in place.

If, as the referring clinician, your patient cannot meet these conditions, but wants orthodontic treatment, you will need to explain to the patient/carers why referral is inappropriate and what the consequences of poor dental health are for their orthodontic treatment prospects. Treatment may be harder or more complicated if treatment has to be delayed until growth is (nearly) completed. Indeed, treatment may not be feasible unless dental health improves.

Oral hygiene that is less than optimal may lead to demineralisation of the enamel surface around or under any appliance, including the attachments of a fixed appliance. Such demineralisation can actually occur within a few weeks of an appliance being placed and, if severe, can lead to cavitation. The benefit of orthodontic treatment in providing a good occlusion and smile aesthetics is thus undone by the marking on the labial surfaces of the teeth in the case of fixed appliances (see Figure 5.20). However, around URAs damage may be hidden palatally from the patient and unwary clinician.

Moving teeth through bone in the presence of gingival inflammation and/or active periodontal disease will lead to very rapid destruction of the alveolar bone. Therefore, tooth movement should never be undertaken until the disease has been successfully treated; there is no bleeding from the gingival margins or the base of the periodontal pockets, and the patient has demonstrated that they are able to maintain the necessary level of oral hygiene.

It should be emphasised that before any appliance is fitted, a full orthodontic assessment (including appropriate radiographs) and diagnosis must have been performed. A problem list derived from the case assessment will then form the basis of a proper treatment plan. It is assumed that readers are able to undertake these tasks appropriately and the details of these steps are not covered here. To refresh your memory on any aspects of assessment, diagnosis or treatment planning, readers are referred to other textbooks.

Anchorage

Before discussing how to design URAs, we need to briefly remind ourselves about one very important aspect of orthodontic treatment – anchorage. Unless anchorage is given appropriate consideration, orthodontic treatment cannot only easily fail, but the original malocclusion can be made much worse.

What is anchorage?

Anchorage is most easily defined as the resistance to unwanted tooth movement. In other words, it is what stops the wrong teeth from moving. Newton’s Third Law of Motion states that: ‘To every action there is an equal and opposite reaction’.

In orthodontics, because of Newton’s Third Law, we can all too easily find that unwanted tooth movement takes place. In order to minimise such movement, it is generally accepted
that during URA treatment, only one or two teeth should be moved at a time. This means that the movement of a few teeth (or a tooth) is being pitted against the movement of many or the majority of teeth. This works because generally, the larger number of ‘anchoring’ teeth will have a larger root surface area than the smaller number of teeth to be moved (see Figure 2.1 for examples). Whilst the equal and opposite reaction will be ‘experienced’ by all the teeth in contact with the appliance, this force will be distributed according to root surface area. Thus, large rooted teeth will ‘experience’ a larger force than small rooted teeth, but if there are many teeth in contact, then each tooth will ‘experience’ relatively low force levels – levels that will not lead to significant tooth movement. Pitting a larger number of teeth against a smaller number of teeth actually being moved, thus provides increased anchorage. However, where for example a crossbite is to be corrected, it may be appropriate to pit one upper quadrant (e.g. URCDE6) against the opposite buccal quadrant using a screw as the active component. Turning the screw results in equal buccal movement of both sets of upper buccal teeth in a reciprocal movement since the root surface areas of both sets of teeth are roughly equivalent.

**Causes of anchorage loss**

In circumstances where anchorage is not controlled, it can be lost very easily.

**Operator factors**

- Incorrect diagnosis/treatment plan
- Over activation of springs
- Incorrect URA prescription, e.g. if wire dimensions are too thick, these apply too much force when activated
- Inappropriate spring design or inadequate/ambiguous spring prescription on the laboratory card

*Figure 2.1* Anchorage. Larger teeth have larger root surface areas than smaller teeth. The groups of teeth that are pitted against each other will determine the anchorage balance. (Reproduced from Nelson-Moon ZL (2007) Craniofacial growth, cellular basis of tooth movement and anchorage. In: L Mitchell (ed) An Introduction to Orthodontics, p. 46, Figure 4.20, by permission of Oxford University Press.)
Patient factors
- Failure to wear appliance as instructed
- Distortion of spring(s) causing excessive force to be applied
- Appliance breakages, allowing uncontrolled tooth movement
- Failure to return for appliance checks, allowing uncontrolled tooth movement

Laboratory factors
- Failure to follow prescription
- Prescription unclear, leading to errors in manufacture

Results of anchorage loss
In the worst case scenario, treatment can make the original malocclusion far worse. For example, if one or more teeth is/are retracted distally along the arch using excessive forces, the other teeth, via the equal and opposite reaction, will move mesially. Especially if the force levels are sufficient to reach optimum levels (25–50 g), the ‘anchorage’ teeth will ‘experience’ forces leading to forward movement of all the anchorage teeth. This will appear as a visible and measurable increase in overjet. This increase in overjet will continue for as long as the excessive force is applied. In other words, it is possible for a patient who has a normal overjet to end up with an increased overjet as a result of poor management or incompetence by the dentist. To put it bluntly, they could end up complaining of ‘goofy teeth’ – a problem caused by orthodontic treatment. Such problems can be very hard to correct. As can be seen from the lists above, operator causes of anchorage loss outnumber those caused by patients.

Sources of anchorage
Anchorage is gained from all teeth in contact with the URA and from contact with the palate. Well-fitting appliances are thus crucial. Rarely, anchorage can be reinforced using extra-oral sources, i.e. headgear. In addition, in a relatively new development that is beyond the remit of this book, anchorage may be gained in some circumstances using temporary anchorage devices (TADs; also known as mini-screws). These are now being used in conjunction with fixed appliances.

The remit of this book is limited. Therefore, readers are strongly advised to consult other textbooks for more detailed discussions of how anchorage can be gained and its management. However, anchorage will be discussed briefly in connection with the examples of appliance design given in Chapter 3.

Components of URAs
URAs always comprise an acrylic baseplate with various stainless-steel (ss) wire components. These wire components may have the following functions:
- To retain (or ‘clip’) the appliance to the upper teeth. All URAs will have these.
- To move the teeth. These active components are springs. Only active appliances will have these.
- To prevent movement of some teeth. These passive components simply hold the teeth still. These may be made of wire or acrylic and, whilst they will always be present on passive appliances, they may also be present on active appliances.

For some URAs, active components may use a screw rather than a spring to move teeth.

An example of a URA is shown in Figure 2.2. URAs are orthodontic appliances which, if active, only tip teeth or, if passive, maintain tooth position. That is all they do. This is in contrast to fixed appliances which, as we have already said, can perform all tooth movements (including tipping of teeth).

Passive URAs are of two types:
- Space maintainers: these aim to prevent the movement of teeth into a space where another tooth is to erupt.