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ORTHODONTIC TREATMENT WITH REMOVABLE APPLIANCES

SECOND EDITION

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ORTHODONTIC TREATMENT WITH REMOVABLE APPLIANCES

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PREFACE TO THE SECOND EDITION

THE AIM of this handbook is to provide a practical manual for the dental practitioner and student on the clinical management of removable appliances. In this edition we have taken the opportunity of expanding the text by the inclusion of chapters on the different classes of malocclusion and on adult orthodontics. The aim of these is to give more detailed guidance on treatment planning and the management of removable appliances, supported by examples of treated cases. The text concentrates on the practical details of appliance design and case management. Appendices deal with appliance construction in sufficient detail for most clinical requirements; and with the mechanical properties of removable appliance components in order to provide a scientific basis for a number of the recommendations made elsewhere in the text.

No claim is made for the universal application of removable appliances, and it is important that the practitioner should recognize both his own limitations and those of the appliances he is using. The latter are commented upon in the discussion of the treated cases which have been chosen to be representative of the results that should be expected by the general practitioner, rather than for their excellence. Many of the orthodontic problems encountered in general practice can be treated to a high standard with the types of appliance described in this text, provided that meticulous attention is paid to treatment planning, appliance design and case management. Given this care, removable appliances can provide a simple and cost effective way of dealing with a variety of occlusal problems.

Only a selection of removable appliances, which the authors have found to be simple and efficient in use, is described. Many other designs are available and each orthodontist will have his own preference. However, it is sensible for the practitioner to master the use of one design before experimenting with another.

We wish to record our appreciation for the helpful comments made by colleagues during the preparation of this book. We would also like to thank Miss A. Taylor for her invaluable secretarial assistance, Mr B. Webber for the technical work and the photographic departments of the Royal Dental Hospital and the Royal Berkshire Hospital for the photographs.

W. J. B. H.
K. G. I.

Note on Illustrations

In order to emphasize the important features of the appliances, the diameters of the wires shown in the diagrams are not to scale.

CONTENTS

CHAPTER 1

THE SCOPE OF REMOVABLE APPLIANCES

UNLIKE many fixed appliance techniques which are presented as complete systems for the treatment of all malocclusions, removable appliances are designed to produce specific tooth movements and the treatment plan must be formulated in detail by the operator for each patient. No claim is made for their universal application but they have an important place in the treatment of the simpler irregularities which form the great proportion of malocclusions requiring treatment.

It is emphasized that if good results are to be obtained, meticulous attention must be paid to case selection, treatment planning, appliance design and adjustment. While the clinical use of removable appliances is technically less demanding than use of fixed appliances, attention to detail must be quite as strict; and because the scope of removable appliances is more limited, case selection and diagnosis must be even more rigorous.

Advantages of Removable Appliances

1. The majority of malocclusions, which require simple tipping of the teeth, can satisfactorily be treated by removable appliances (*Fig.* 1).
2. Many tooth movements, especially tipping and overbite reduction, can be undertaken as readily with a removable as with a fixed appliance.
3. Removable appliances can incorporate bite platforms to eliminate occlusal interferences and displacement. This is not possible with fixed appliances.
4. Tooth movements undertaken are simple and only a few teeth should be moved at any time. This means that control is less complex than with a fixed appliance but careful attention to detail is still essential.
5. Simple malocclusions may be treated by the general dental practitioner who has received adequate training in diagnosis and treatment planning. With increasing demands for orthodontic treatment, this allows the specialist to concentrate on more difficult cases.
6. Removable appliances are manufactured in the laboratory and adjustments take less chairside time. This means the operator can increase his patient load.

a

b

Fig. 1

c

Fig. 1. A 14-year-old girl with a Class II, division 1 malocclusion with a 12 mm overjet. Treatment was based on the extraction of upper first premolars and the use of extra-oral anchorage and removable appliances *a*, Facial appearance before treatment. *b*, Facial appearance at the end of treatment. *c*, Fully reduced overjet.

7. They are relatively inexpensive to construct and the dental practitioner using only removable appliances does not need to stock a large range of expensive bands and attachments.

8. They can be removed by the patient for cleaning both the teeth and the appliance. Thus the difficulties of oral hygiene are not increased.

9. Should the appliance be damaged so that the patient is in pain, it can be removed for a short period of time until the operator can see the patient.

10. They are less conspicuous than banded appliances. With recent developments in directly bonded attachments, however, this is becoming a less important factor.

Limitations of Removable Appliances

1. With removable appliances, the force is applied to a single point on the crown and so the tooth tips about a fulcrum within the root (*Fig.* 2). This limits the malocclusions which can adequately be treated to those where tipping of the teeth is all that is required. Cases where teeth are unfavourably inclined must be treated with fixed appliances.

2. While the rotation of one or two upper incisors can be dealt with, multiple rotations cannot readily be treated.

3. Multiple tooth movements have to be carried out a few at a time and this will prolong treatment in more complex cases.

4. When extractions are necessary but provide excess space, controlled forward movement of buccal segments to close residual spaces is difficult or impossible. However, in many of these cases, provided extractions have been correctly judged, spontaneous mesial

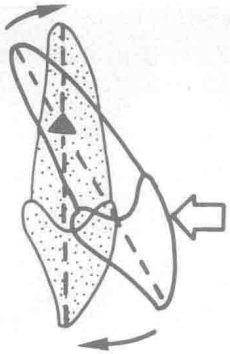

Fig. 2. Application of a force to the crown of a tooth results in a tipping movement.

drift of the buccal segments will occur after appliances have been discontinued.

5. The most successful removable appliance treatment in crowded cases follows extraction of first premolars. Where other teeth are missing or have to be extracted because of their poor condition or ectopic position, it is usually more difficult to obtain space closure and good approximal contacts between teeth adjacent to the extraction space.

6. Lower removable appliances are not well tolerated due to encroachment on tongue space and retention problems. Furthermore, because of space restrictions, lingual springs are rarely satisfactory. Only limited mandibular arch treatment is possible. However, in many simple orthodontic cases, the lower arch can be accepted or treated by extraction only.

7. The uncooperative patient may sometimes leave out his appliance. This will prolong treatment and uncontrolled drift of teeth may occur. Appliances are readily broken or damaged if they are not worn.

Case Selection

The Patient

It is important to restrict appliance treatment to the cooperative patient with good oral hygiene and whose dental condition is under control. Attempts to treat the uncooperative patient who does not wear the appliances as instructed are frustrating, and a poor result is almost certain. Unless oral hygiene is good, appliance wear will have a deleterious effect on oral health. Appliance treatment should not be commenced until the patient is dentally fit. If this rule is not observed, there may be a rapid deterioration in the dental condition during treatment, particularly in the adult with an untreated periodontal condition.

Patient cooperation can be difficult to predict. Poor oral hygiene and lack of dental care indicate poor motivation and orthodontic treatment should not be commenced until oral hygiene has been maintained at a good standard for several months. It is also helpful to discuss treatment with the child patient when the parents are not present. If the patient is unwilling to wear the appliances required it is wise to delay treatment until the attitude changes. The dental practitioner should not try to persuade the patient to have treatment, unless the malocclusion is traumatic. The need for active cooperation should be explained to the parent and the situation should be reviewed after six months or a year.

The Occlusion

The limitations of removable appliances have been outlined above. As a rule, the general dental practitioner should not attempt to treat the more difficult cases:

1. Severe Class II and Class III malocclusions, particularly where the dental base relationship is also adverse;
2. Where the Frankfort mandibular planes angle is very high or very low;
3. Where extensive lower arch treatment is required;

Fig. 3. A patient with a severely incompetent lip posture and an unfavourable dental base relationship, who would not be suitable for treatment with removable appliances.

4. Where teeth must be moved bodily or where there are multiple rotations;

5. Where the soft tissue pattern is unfavourable (*Fig.* 3).

Clearly, as with all orthodontic treatment, the practitioner must undertake removable appliance treatment only where a stable and worthwhile improvement (aesthetic or functional) in the occlusion can be anticipated.

Treatment Planning

Before treatment can be considered, a thorough diagnosis is essential because information is required on the dental base relationship, soft tissue pattern and activity, mandibular deviations and displacements, and the presence, condition, position and relationships of the teeth. It is not possible within the scope of this text to discuss the diagnostic procedure in detail. Outlines of treatment for the different malocclusions are given in Chapters 5–8. In general, lower arch treatment is limited to relief of crowding by extractions to allow natural alignment of the teeth. The form of the lower arch and position of the lower incisors has to be accepted and the upper arch is planned to match the lower.

CHAPTER 2

BIOMECHANICS

IN this chapter, the tooth movements produced by orthodontic forces and the nature of the tissue changes in the supporting structures will be discussed. When a force is applied to the crown of a tooth, it will be displaced slightly within the confines of the periodontal ligament. Depending on the type of force applied, the tooth may be tipped, moved bodily, or rotated about its long axis (*Fig.* 4). This small change in tooth position will set up areas of tension and compression within the periodontal ligament. Provided that the force is applied over a sufficient period of time, remodelling changes in the socket wall will allow the tooth to move further.

An understanding of these processes is of clinical relevance in that the rationale of appliance adjustment is based on our knowledge of them.

TOOTH MOVEMENTS

When a force is applied at a point on a smooth surface, it can be resolved into two components, one perpendicular to the surface and the other parallel to it (*Fig.* 5). Where the surface is curved, the force is resolved perpendicular and parallel to the tangent at the

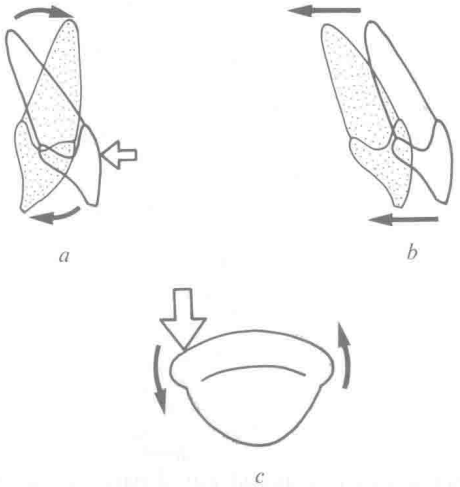

Fig. 4. Three kinds of tooth movement: *a*, Tipping, *b*, Bodily movement, *c*, Rotation about the long axis.

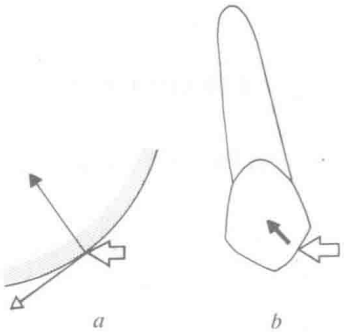

Fig. 5. *a*, When a force is applied to a curved surface, the direction of the resultant movement is at right angles to the tangent at the point of contact. *b*, A partially erupted tooth will be intruded if a spring is applied to the cuspal incline.

point of contact. If the force is applied at an angle to the surface, tooth movement will be produced by the perpendicular component. Thus the tooth will not move in the direction of the applied force.

Although the initial movement must be considered in three dimensions, it is convenient to discuss it in the two planes which span the space: first the plane through the long axis of the tooth and in the direction of tooth movement, and, second, a plane of cross-section.

Movements in the Plane of the Long Axis

When a force is applied to the crown of a tooth, movement is resisted by the periodontal ligament.

TIPPING MOVEMENTS: A force applied at a single point on the crown will tip the tooth about a fulcrum. Although many texts suggest that tipping takes place about a fulcrum within the apical third of the root, both on theoretical and practical grounds it can be shown

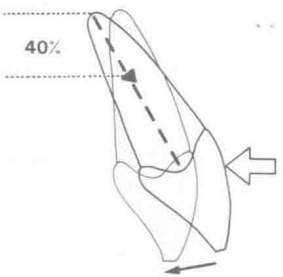

Fig. 6. When a tooth is tipped with a removable appliance, the fulcrum of rotation is approximately 40 per cent of the length of the root from the apex.

that the centre of rotation is usually about 40 per cent of the length of the root from the apex (Christiansen and Burstone, 1969). This means that while the crown moves in one direction, the apex moves in the opposite direction (*Fig.* 6). The exact level of the fulcrum depends on a number of factors which are not under control of the orthodontist: these include root shape and the distribution of fibre bundles within the periodontal ligament.

BODILY MOVEMENTS: If a tooth is to be moved bodily a couple of forces must be applied to the crown in conjunction with the original force (*Fig.* 7). The use of a couple of forces allows precise control over the position of the fulcrum. This is not normally a practical undertaking with removable appliances but is possible with fixed appliances and to a limited extent with fixed components used in conjunction with removable appliances (*see* Chapter 11).

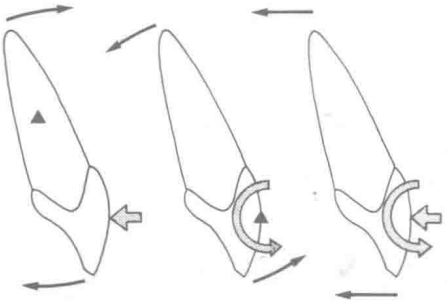

Fig. 7. Bodily movement of teeth: *a*, A force applied at a single point on the crown results in tipping. *b*, A force couple applied to a crown will cause rotation of the tooth about a fulcrum. *c*, An appropriate combination of a force couple and a palatally directed force will give bodily tooth movement.

INTRUSION: When a bite plane is incorporated in an appliance, an intrusive force is applied to the teeth which occlude with it. However, the amount of intrusion is usually small and overbite reduction with removable appliances is largely the result of eruption of the posterior teeth (*Fig.* 8). Where an incisor does not occlude perpendicular to an anterior bite plane, it may be tipped as well as intruded.

Intrusion of teeth may also be produced unintentionally by the incorrect application of a spring. Where for example a spring to retract a canine is applied to the cuspal incline (*Fig.* 5*b*), the tooth will be intruded as well as retracted. This most often happens when attempts are made to retract a canine which has only partially erupted. For this reason, it is preferable not to attempt to move a tooth until it has erupted fully.

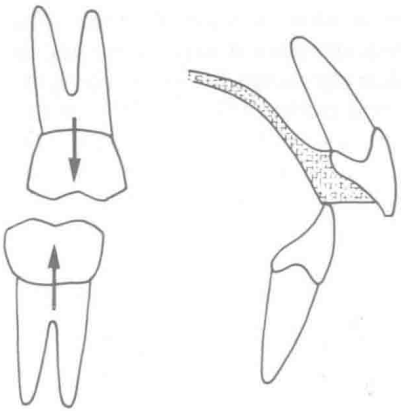

Fig. 8. An anterior bite plane allows vertical development of the posterior teeth.

Movements in the Plane of the Occlusion

The example selected in this discussion is the retraction of an upper canine but the argument applies equally to other situations.

The tooth will move in the direction of the component of force perpendicular to its surface. This is of particular importance when considering tooth movement in this plane. It is common to find that the spring is positioned too far posteriorly (*Fig.* 9) so that the resultant force does not lie in the required direction along the line of the arch but is directed buccally. Thus the tooth will move buccally as well as distally. The unwanted buccal movement is particularly difficult to avoid when the tooth is buccally positioned in the first place. In these circumstances, a buccal spring which can apply a force at the required point is essential.

If the resultant force does not pass through the long axis of the tooth, a rotation will be induced. Rotations of this sort may be particularly difficult to avoid if the tooth is already slightly rotated (*Fig.* 9*c*). Teeth in this position must be controlled by a spring which can apply the force from a buccal direction.

ROTATIONS: While rotations may inadvertently be introduced as described above, the controlled rotation of a tooth can only be undertaken with a couple. With an upper central incisor, it may be possible to correct a rotation with a couple between a labial bow and a palatal spring at the baseplate (*see Fig.* 26, p. 30) but this requires skilled management. A fixed attachment used with a removable appliance will give better control (*see* Chapter 11).

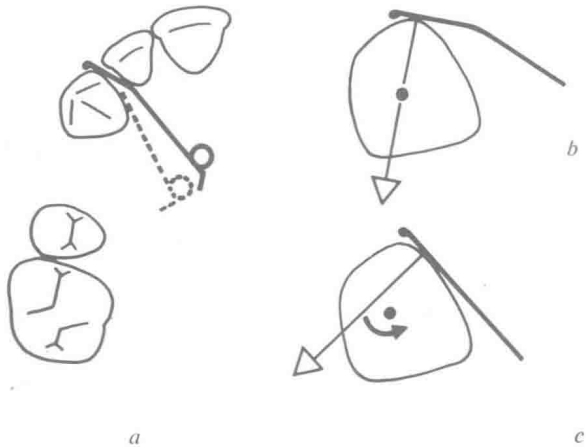

Fig. 9. Application of force to the crown of a tooth: *a*, If a palatal cantilever spring is positioned too far distally, the tooth will be moved buccally. Correct position is shown by the solid line. *b*, Correct application of a palatal finger spring to a canine. *c*, Incorrect application results in unwanted rotation of the canine.

TISSUE CHANGES DURING TOOTH MOVEMENT

As a result of the initial tooth movement described above, areas of compression and tension are set up within the periodontal ligament. The distribution of these areas depends on the nature of the initial tooth movement. If the tooth tips, the pressure varies along the root, being greatest at the alveolar crest and apex (*Fig.* 10*a*). It should be remembered that the pressure at any level will vary with the width of the periodontal ligament and around the circumference of the root (*Fig.* 10*b*). With bodily tooth movement, which is not possible with simple removable appliances, the distribution of pressure is more uniform along the root length but still varies around the circumference. The more uniform distribution of pressure with bodily tooth movements means that for a given force applied to the crown of a tooth, the maximal pressure (and tension) within the periodontal ligament will be less than with tipping movements.

In response to these changes in pressure induced in the periodontal ligament, tissue changes take place. The nature of the changes depends on whether the area in question is one of compression or tension and whether capillary blood pressure is exceeded locally.

Areas of Compression

WHERE CAPILLARY BLOOD PRESSURE IS NOT EXCEEDED: There may be local changes in blood flow but the capillaries remain patent. An increase in cellular proliferation takes place, both in the fibroblasts