

IN BRIEF

- The correct appliance choice is essential for optimum treatment outcome
- Removable appliances have an important but limited role in contemporary orthodontics
- Fixed appliances are usually the appliance of choice
- Functional appliances are helpful in difficult cases but may not have an effect on facial growth
- Extra-oral devices include headgear, face-masks and chin-caps

Orthodontics. Part 5: Appliance choices

D. Roberts-Harry¹ and J. Sandy²

NOW AVAILABLE
AS A *BDJ* BOOK

There are bewildering array of different orthodontic appliances. However, they fall into four main categories of removable, fixed, functional and extra-oral devices. The appliance has to be selected with care and used correctly as inappropriate use can make the malocclusion worse. Removable appliances are only capable of very simple movements whereas fixed appliances are sophisticated devices, which can precisely position the teeth. Functional appliances are useful in difficult cases and are primarily used for Class II Division I malocclusions. Extra-oral devices are used to re-enforce anchorage and can be an aid in both opening and closing spaces.

ORTHODONTICS

1. Who needs orthodontics?
2. Patient assessment and examination I
3. Patient assessment and examination II
4. Treatment planning
5. Appliance choices
6. Risks in orthodontic treatment
7. Fact and fantasy in orthodontics
8. Extractions in orthodontics
9. Anchorage control and distal movement
10. Impacted teeth
11. Orthodontic tooth movement
12. Combined orthodontic treatment

There are four main types of types of appliance that can be used for orthodontic treatment. These are removable, fixed, functional and extra oral devices.

REMOVABLE APPLIANCES

In general these are only capable of simple tooth movement, such as tipping teeth. Bodily movement is very difficult to achieve with any degree of consistency and precise tooth detailing and multiple tooth movements are rarely satisfactory. These appliances have received bad press over the past few years because studies have shown that the treatment outcomes achieved can often be poor.^{1,2} In these studies as many as 50% of cases treated with removable appliances were either not improved or worse than at the start of treatment. When faced with evidence such as this, one might be justified in discarding removable appliances completely. However, provided they are used in properly selected cases they still can be very useful devices and the treatment outcome can be satisfactory.³ In general, removable appliances are only recommended for the following:

- Thumb deterrent
- Tipping teeth
- Block movements
- Overbite reduction
- Space maintenance
- Retention

Thumb deterrent

Digit sucking habits which persist into the teenage years can sometimes be hard to break and may result in either a posterior buccal cross bite or an anterior open bite with proclination of the upper and retroclination of the lower incisors. In general, if the habit stops before facial growth is complete then the anterior open bite usually resolves spontaneously and the overjet returns to normal.⁴

Figs. 1a-c show a case with an anterior open bite associated with an avid digit sucking habit. A simple upper removable appliance was used successfully to stop the habit. The appliance simply makes the habit feel less of a comfort and acts as a reminder to the patient that they should stop sucking the thumb. Complex appliances with bars or tongue cribs are rarely needed. In this patient once the habit had stopped the open bite closed down on its own without the need for further orthodontic treatment.

Tipping

One of the major uses of removable appliances is to move one incisor over the bite as shown in Figs 2a-d. A simple upper removable appliance utilized a 'T' spring constructed from 0.5 mm wire activated 1-2 mm which delivered a force of about 30 g to the tooth. After only a few weeks the cross bite was corrected without the need for complex treatment. Note the anterior

¹Orthodontic Department, Leeds Dental Institute, Clarendon Way, Leeds LS2 9LU;

²Division of Child Dental Health, University of Bristol Dental School, Lower Maudlin Street, Bristol BS1 2LY

Refereed Paper

doi:10.1038/sj.bdj.4810872

© British Dental Journal 2004; 196: 9-18



Fig. 1a-c A 9 year-old patient with an anterior open bite caused by a thumb sucking habit. Note the wear on the thumb as a result of this. She was fitted with a simple upper removable appliance and gently encouraged to stop the habit. She did so successfully and the open bite closed down spontaneously in 6 months



Fig. 2a an anterior cross bite involving the upper left and lower left central incisors

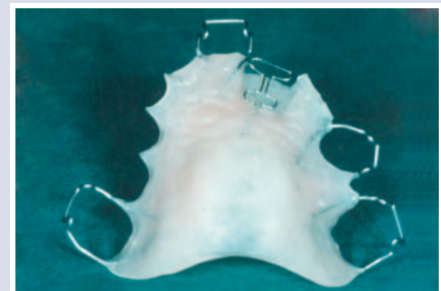


Fig. 2b An upper removable appliance with Adams cribs for retention made from 0.7 mm wire on the first permanent molars and the upper left central incisor. A 'T' spring made from 0.5 mm wire is used to push the tooth over the bite. The anterior retention is to prevent the front of the appliance being displaced as the spring is activated



Fig. 2c The appliance in place. The T spring is activated 1-2 mm every 4 weeks



Fig. 2d The completed case. Active treatment took 12 weeks

retaining clasp that prevents the appliance from displacing downwards when the spring is activated.

If teeth are to be pushed over the bite with removable appliances, a stable result is more likely to be achieved if the tooth is retroclined in the first instance, the overbite is deep and there

is an anterior mandibular displacement associated with a premature contact. Tipping teeth tends to reduce the overbite because the tip of the tooth moves along the arc of a circle as shown in Figure 3a. Excessive tipping may also make the tooth too horizontal which can be not only aesthetically unacceptable but may also

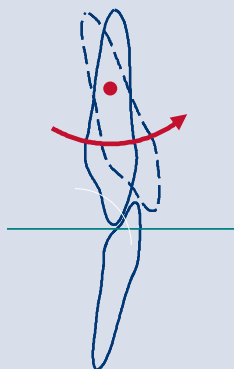


Fig. 3a The effect of tipping anterior teeth on the overbite. As the teeth move around a centre of rotation the incisal tip moves along the arc of a circle. By the laws of geometry, as the tooth is proclined the overbite reduces once it moves past the vertical

Fig. 3b Excessive tipping not only reduces the overbite but also makes the axial inclination of the teeth too horizontal. In these situations stability is reduced, the appearance is poor and the tooth may suffer from unwanted non-axial loading

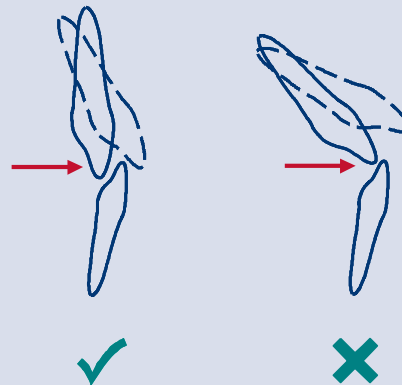


Fig. 4a Both the upper lateral incisors are in cross bite



Fig. 4b An upper removable appliance was used to tip the laterals over the bite



Fig. 4c The cross bites have been corrected. Note the reduction in the overbite



Fig. 4d 6 months later the upper right lateral has relapsed into cross bite due to the reduced overbite

result in excessive non-axial loading of the tooth as illustrated in Figure 3b.

Overbite reduction when teeth are over-proclined is illustrated in Figures 4a-d. In this case both the upper lateral incisors were pushed over the bite with an upper removable appliance. The cross bite was corrected but note the reduction in overbite on the lateral incisors. Six months after completion of treatment the upper right lateral had relapsed back into cross bite.

Block movements

If a cross bite involves a number of teeth, for example a unilateral buccal cross bite, removable appliances can be used to correct this. The

sequence of events is shown in Figures 5a-f. Adams cribs are generally placed on the first premolars and the first permanent molars and a midline expansion screw is incorporated into the base plate. This midline screw is opened 0.25 mm (one quarter turn) twice a week until the cross bite is slightly overcorrected. Posterior buccal capping can also be used to disengage the bite and prevent concomitant expansion of the lower arch. Once the cross bite is corrected the buccal capping can be removed and the appliance used as a retainer to allow the buccal occlusion to settle in. Occasionally two appliances will be needed if a considerable amount of expansion is needed.

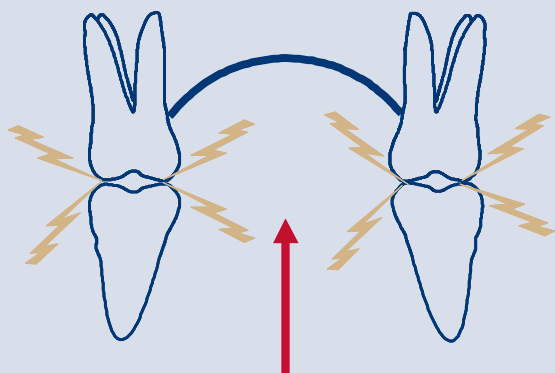


Fig. 5a Narrowness of the upper arch can produce a traumatic bite

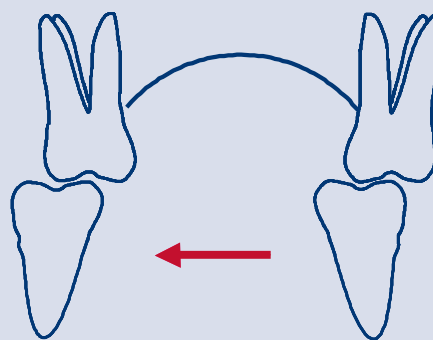


Fig. 5b To avoid painful cuspal contact the patient may move the mandible to one side producing a mandibular deviation and a cross bite

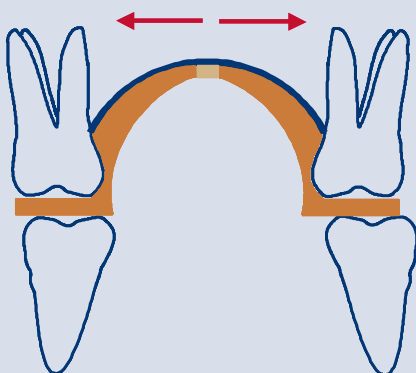


Fig. 5c An upper removable appliance with a mid line expansion screw can be used to correct the cross bite. The screw is opened one-quarter turn twice a week by the patient

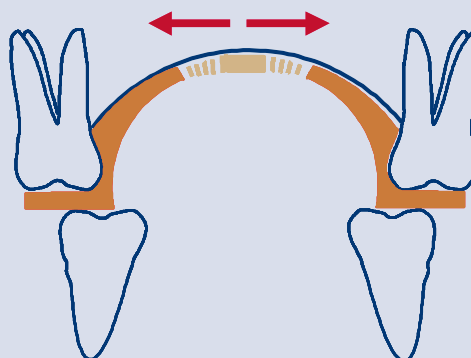


Fig. 5d The corrected cross bite. The treatment time varies with the amount of expansion needed but usually takes about twelve weeks

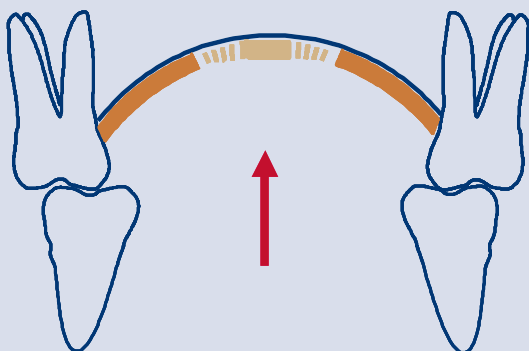


Fig. 5e Once active treatment is completed the appliance can be worn as a retainer. The posterior capping can be reduced to allow interdigitation of the buccal teeth thus helping to prevent any relapse

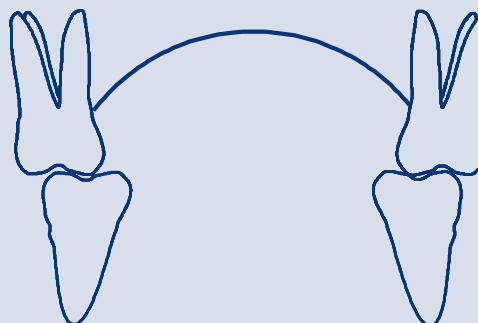


Fig. 5f The completed case

Overbite reduction

Removable appliances are very effective in correcting a deep overbite, especially in a growing patient. An upper removable appliance with an anterior bite plane is used which disengages the molars by 2–3 mm whilst at the same time establishing lower incisor contact with the bite plane (Fig. 6). Eruption of the posterior teeth produces a reduction in the overbite. It is essential that the inter-incisor angle is corrected at the completion of treatment so that an occlusal stop between the upper and lower incisors is produced preventing re-eruption of the incisors and a relapse of the overbite. Bite planes are usually used in conjunction with fixed appliances to help the overbite reduction (Figures 7a–d) or can be used as an aid to restoration of the anterior teeth. Figures 8a–d show a patient with a deep bite who had marked enamel erosion. Porcelain crowns were to be placed on the anterior teeth to restore them, but the deep bite made this technically difficult. The overbite

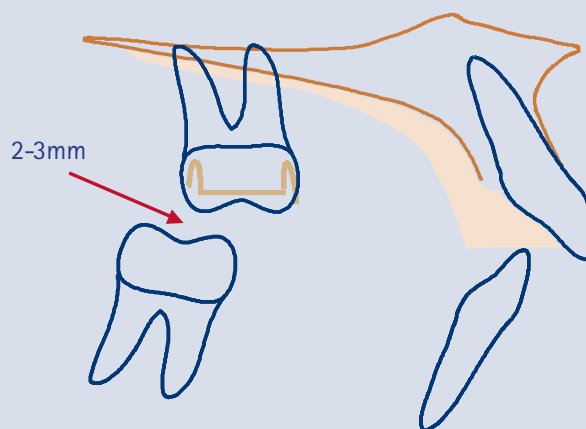


Fig. 6 Overbite correction with a removable appliance. The posterior teeth should be separated by about 2–3 mm



Fig. 7a A case with a deep bite and retroclined upper incisors



Fig. 7b An upper removable appliance is used to help the overbite reduction whilst palatal springs simultaneously move the first permanent molars distally



Fig. 7c Once the overbite is fully reduced the upper fixed appliance can be placed



Fig. 7d The completed case with good overbite reduction

was therefore reduced with a bite plane to make room for the crowns.

Space maintenance

Space maintainers are rarely indicated in orthodontic treatment but occasionally can be used, particularly if the upper canine is buccally crowded. Whilst the extraction of the first premolars will often create space for the canines, there is a danger that the space will close before the canine erupts as the buccal teeth drift mesially. Figures 9a–e illustrate such a case where the fit-

ting of a space maintainer proved useful. The appliance was fitted just prior to the emergence of the permanent canines. The four first premolars were then extracted and the appliance left in position until the canines erupted. This took about 6 months and saved a considerable amount of extra treatment for the patient by allowing spontaneous alignment of the canines.

Retention

Many orthodontists use various types of removable appliances to act as retainers, usually at the



Fig. 8a, b A patient with severe erosion of the teeth



Fig. 8c A bite plane was used to reduce the overbite



Fig. 8d Strip crowns were placed on the incisors once the overbite was reduced



Fig. 9a, b A case with severe upper arch crowding. The upper permanent canines were unerupted, buccally positioned and very short of space

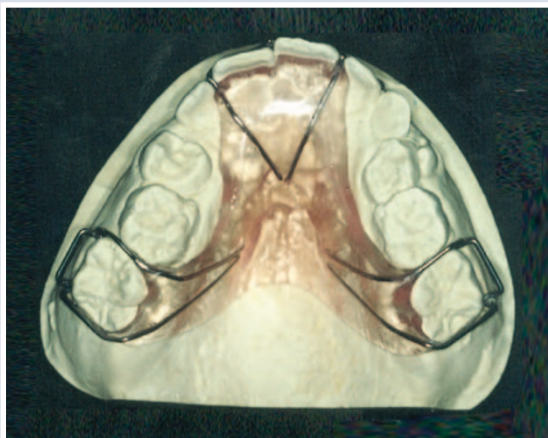


Fig. 9c An upper removable space maintainer. Adam cribs have been placed on the first permanent molars and a Southend clasp on the upper central incisors



Fig. 9d,e The first premolars have been extracted and the upper canines are erupting into a good position

completion of fixed appliance treatment. Removable retainers are usually held in position with Adams Cribs on the first permanent molars with a labial bow and possible acrylic coverage of the anterior teeth (Fig. 10).

FIXED APPLIANCES

These appliances are attached to the crowns of teeth and allow correction of rotations, bodily movements of teeth and alignment of ectopic teeth. They have increased in sophistication enormously over the past 10–15 years and together with advancements in arch wire technology are capable of producing a very high level of treatment result. Simultaneous multiple

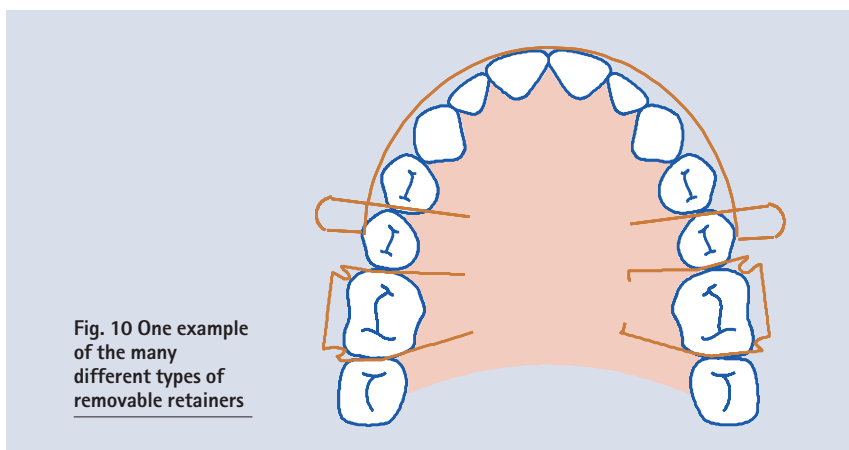


Fig. 10 One example of the many different types of removable retainers

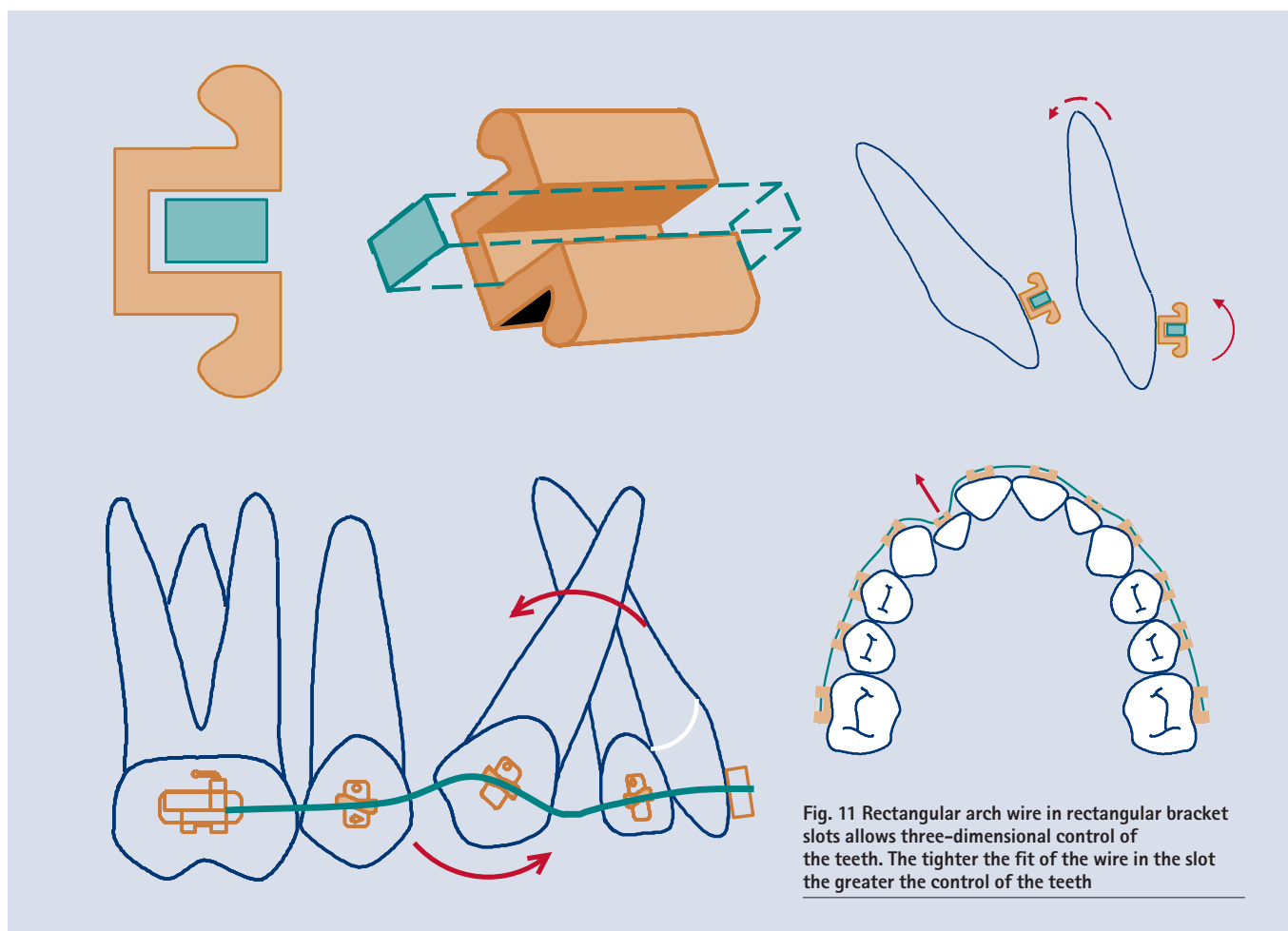


Fig. 11 Rectangular arch wire in rectangular bracket slots allows three-dimensional control of the teeth. The tighter the fit of the wire in the slot the greater the control of the teeth

tooth movements can be achieved, invariably creating a better treatment outcome than can be achieved with removable appliances. Although there are a variety of fixed appliances available they all operate in a similar way producing a fixed point of attachment to control the position of the teeth. Brackets are attached to the teeth and wires (arch wires) are placed in the bracket slots to move the teeth. The closer the fit of rectangular arch wires in a rectangular slot on the bracket the greater the control of the teeth (Fig 11). As treatment progresses, thicker rectangular wires are used to fully control the teeth in three dimensions. Fixed appliances are the appliances of choice for most orthodontic treat-

ment because the results are far more predictable and of a higher standard achieved than by other means. However, they are relatively complex appliances to use and further training in these devices is essential. An example of a case treated with fixed appliances is shown in Figure 12a–j. The anchorage requirements for the bodily movement of teeth are considerably greater than for tipping movements (Fig. 13).

FUNCTIONAL APPLIANCES

These are powerful appliances capable of impressive changes in the position of the teeth. They are generally used for Class II Division I malocclusions although they can be used for the



Fig. 12c Upper first and lower second premolars were extracted and the canines surgically exposed



Fig. 12d A tri-helix was used to expand the upper arch and a sectional fixed appliance used to pull the canine into the line of the arch



Fig. 12a, b Pre treatment photographs of a patient with palatally impacted canine, a buccal cross bite, an increased overjet and crowding in both arches



Fig. 12e Full fixed appliances were then used to reduce the over bite and overjet, move the apex of the canine into the line of the arch and correct all the other features of the malocclusion. The initial arch wire was a very thin flexible wire. If a thick wire is used at this stage excess force will be applied to the teeth that can produce root damage and be very painful for the patient



Figs 12f,g Once initial alignment of the teeth is produced progressively thicker, stiffer wires are employed. Because these fit the bracket slot more closely they control tooth position more precisely than the thinner aligning wires



Fig. 12h,i The completed case. The canine is fully aligned and the overjet reduced without any unwanted tipping of the teeth



Fig. 12j Appropriate extractions and treatment mechanics have not been detrimental to the facial appearance

correction of Class II Division II and Class III malocclusions on occasion. They are either removable from the mouth or fixed to the teeth, and work by stimulating the muscles of mastication and soft tissues of the face. This produces a distalising force on the upper dentition and an anterior force on the lower. Whilst they are capable of substantial tooth movement, like all removable appliances they are not capable of precise tooth positioning and cannot deal effectively with rotations or bodily tooth movement.

There is some controversy as to the precise mode of action of functional appliances. Some clinicians feel they have an effect on this facial skeleton, promoting growth of the mandible and/or maxilla. Others feel that the effects are mainly dento-alveolar and that the results achieved are accomplished by tipping the upper and lower teeth. Unfortunately many of the studies relating to functional appliance treatment have been poorly constructed and their conclusions should be treated with caution. A large-scale, prospective, randomized clinical trial currently being undertaken in United Kingdom strongly suggests that 98% of the occlusal

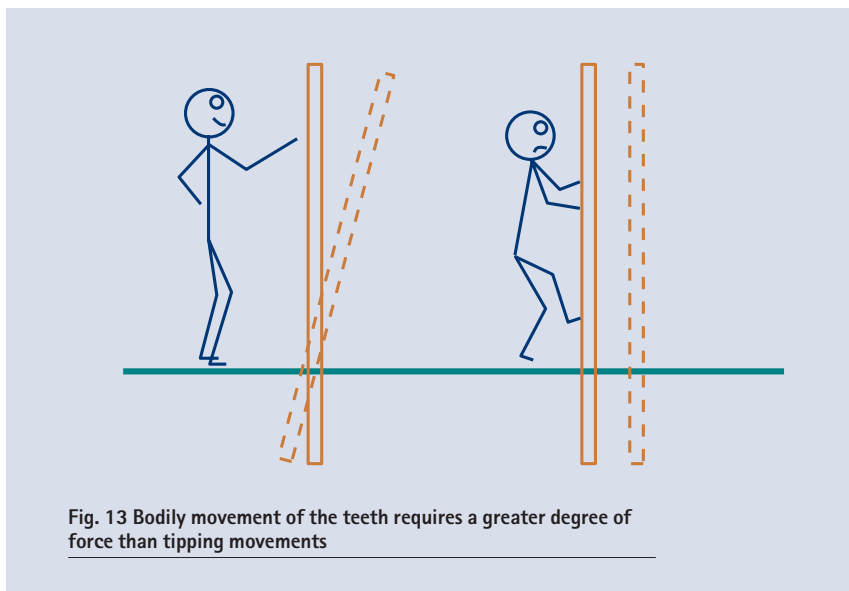


Fig. 13 Bodily movement of the teeth requires a greater degree of force than tipping movements



Fig. 14a,b Pre-treatment photographs of a 12-year-old girl with an increased overjet and a class II skeletal pattern associated with a retrognathic mandible



Fig. 14c A functional appliance was used to correct the sagittal relationship



Fig. 14e,f The facial appearance following treatment



Fig. 14d The final result after detailing of the occlusion with fixed appliances



Fig. 15 Extra-oral traction applied via an Interlandii headgear

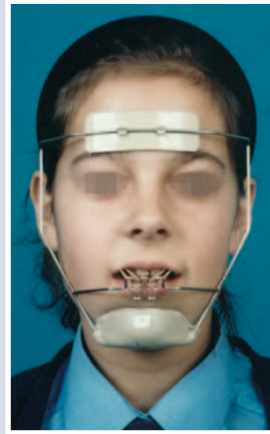


Fig. 16a,b A facemask or reverse headgear

correction is by tipping of the teeth with an almost negligible effect on the skeletal pattern.⁵ Nevertheless, dramatic occlusal changes are possible with these appliances and they can aid the correction of some quite severe malocclusions. Figures 14a–f show a case treated with a functional appliance that had a marked effect not only on the occlusion but also on the patient's facial appearance.

EXTRA-ORAL DEVICES

These are headgear devices, chin caps and face masks, which are used to provide an external source of anchorage or traction for teeth in one or both arches. The commonest type is headgear for the distal movement of the buccal teeth. A metal face bow is attached to either a removable or a fixed appliance inside the mouth and elastic traction applied to it. As well as force being applied distally to either the maxilla or the mandible it can be applied mesially via a facemask. This is typically used in Class III cases to correct an ante-

rior cross bite or in cases where the buccal segments are being moved forward to close spaces in the arches. Examples of extra oral traction devices are shown in Figures 15, 16a and b. Chin caps have been used to try and restrain mandibular growth in Class III malocclusions. However, the evidence from the literature suggests that they are not terribly effective and their use has declined in recent years.

1. Richmond S, Shaw W C, O'Brien K D *et al.* The development of the PAR index (Peer Assessment Rating): reliability and validity. *Eur J Orthod* 1992; **14**: 125-139.
2. Richmond S, Shaw W C, Roberts C T, Andrews M. The PAR index (Peer Assessment rating): methods to determine the outcome of orthodontic treatment in terms of improvements and standards. *Eur J Orthod* 1992; **14**: 180-187.
3. Kerr W J S, Buchanan I B, McColl J H. The use of the PAR index in assessing the effectiveness of removable orthodontic appliances. *Br J Orthod* 1993; **20**: 351-357.
4. Leighton B C. The early signs of malocclusion. *Trans Europ Orthod Soc* 1969; 353-368.
5. O'Brien K, Wright J, Conboy F *et al.* Effectiveness of treatment for Class II malocclusion with the Herbst or twin-block appliances: a randomized, controlled trial. *Am J Orthod Dentofacial Orthop* 2003; **124**: 128-137.