Class III Malocclusion

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Abstract

Interceptive treatment of Class III malocclusions is indicated if it reduces damage to the oral tissues, or prevents, or significantly reduces the amount, or severity, of future orthodontic treatment. Patients must be informed that the long-term success of interceptive treatment of Class III malocclusions cannot be guaranteed due to the unpredictability of future growth.

The choice of treatment depends on identifying the aetiology of the Class III malocclusion. The aetiology could be dental, a pseudo-Class III (which is due to a displacement of the mandible caused by a crossbite) or skeletal.

Simple anterior dental crossbites can be successfully treated with removable or fixed appliances in the mixed dentition.

Treatment with chin cup or functional appliances can correct a Class III incisor relationship, but any orthopaedic changes with these appliances are likely to be minimal.

Interceptive treatment with a protraction facemask treatment can reduce the need for future orthognathic surgical correction, when used on patients who are under 10, with a mild to moderate Class III and a retrusive maxilla, and with average or reduced vertical proportions.

Bone anchored appliances may offer the potential for more skeletal changes, but further research is needed in this area.

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Introduction

Class III malocclusion was originally defined by Edward Angle in terms of the occlusal relationship of the first permanent molars, with the lower molars mesially positioned relative to the upper molar. A more contemporary definition focuses on the incisors, describing a Class III incisor relationship as the lower incisor tips occluding anterior to the cingulum plateau of the upper incisors.

The prevalence and presentation of Class III malocclusion vary significantly with ethnic background. Prevalence in East Asian populations, such as Japan, Korea and China, can range from 4% to 19%, whereas in European populations the prevalence is much lower: 1–4% [1].

Aetiology of Class III Malocclusions in Mixed Dentition

It is important to identify the aetiology of Class III malocclusions in the mixed dentition as this will determine the most appropriate type of interceptive treatment. The aetiology may be due to skeletal and/or dentoalveolar components.

By definition, the lower incisors lie in front of the cingulum plateau of the upper incisors, often leading to an anterior crossbite of one or more teeth. An orthodontic assessment will help differentiate between a simple dental anterior crossbite, due to locally malpositioned teeth, and a true Class III skeletal discrepancy. Whenever an anterior crossbite is present, it is important to assess whether this is associated with an anterior mandibular displacement of the mandible, which increases the severity of the appearance of Class III. There is also often a skeletal component, with the mandibular dentition held more anteriorly than the maxillary dentition. This could be as a result of the size and position of either jaw: it is important to identify where the discrepancy lies as this may affect the choice of treatment.

In order to decide on the most appropriate interceptive approach, we must diagnose the contributing factors causing the Class III malocclusion. This can be done by: extra-oral assessment, intra-oral assessment (including assessing for any mandibular displacements as a result of anterior crossbites) and cephalometric analysis if required.

Extra-oral Assessment

A profile analysis will look at facial proportions, mid-facial position and chin position, as well as vertical proportions. This will help to determine the presence and location of any skeletal discrepancy. For patients with a retrusive maxilla, there may be increased sclera show below the pupil and flattening of the infraorbital rims in addition to flattening of the area adjacent to the nose.

Intra-oral Assessment

An anterior crossbite of one or more teeth is a common presentation in Class III malocclusions. Whenever there is a crossbite, it is important to look for an anterior mandibular displacement. This premature contact may lead to the mandible being positioning further anteriorly, to allow the patient to close into full intercuspation and obtain a more comfortable bite.

It is also important to look at the inclinations of the upper and lower incisors. In patients with skeletal discrepancies, the soft tissues may tilt the teeth towards each other to allow a lip seal to be achieved. This is known as dentoalveolar compensation, and the degree of existing compensation may dictate what is possible with orthodontic movements of the teeth alone or whether movements of the underlying bones are required.

Cephalometric Assessment

A cephalometric analysis may be required in addition to the clinical analysis to confirm the relative positions of the maxilla and mandible to each other and the base of the skull and to determine the inclinations of both the upper and lower incisors. The combination of clinical and cephalometric information will identify which type of Class III malocclusion can be treated in the mixed dentition and help decide the best interceptive approach.

In the mixed dentition there are effectively three types of Class III malocclusions [1]:

- Dental: Incorrect inclination or position of maxillary or mandibular incisors
- Pseudo: Anterior positioning of the mandible as a result of premature dental contacts deflecting the mandible anteriorly to allow the patient to achieve full intercuspation
- Skeletal: True skeletal discrepancies in the maxilla and/or mandible

Indications for Interceptive Treatment of Class III

Although a Class III malocclusion may be identified in the developing dentition, a decision needs to be made whether it is better to treat at this stage or wait for further dental development and growth. Interceptive treatment of Class III malocclusions should be undertaken if it:

- Prevents damage to the oral tissues
- Prevents or significantly reduces the amount, or severity, of future orthodontic treatment

Damage to oral tissues may occur as a result of an anterior crossbite causing a displacement of the mandible. This may lead to localised attritional wear of the teeth that are in premature contact as the mandible slides forwards into a position where the patient can achieve a maximum intercuspation and a more comfortable occlusion. It is also possible for irreversible periodontal soft tissue and bony damage to occur. This is due to the lateral forces applied by displacing contacts associated with the anterior crossbites and is more likely to occur if there are problems with oral hygiene.

Additional benefits of interceptive treatment include improving occlusal function and improving the facial appearance. It may also reduce the risk of a developing an abnormal posterior occlusion. This abnormal posterior occlusion can be the result of habitual posturing of the mandible, as the patient finds a more comfortable bite to accommodate abnormal anterior occlusal contacts. It has also been suggested that interceptive treatment has the potential to reduce the need for future orthognathic surgery by causing favourable skeletal changes. This is controversial and will be discussed further in section "Growth Modification and Orthopaedic Treatment".

Interceptive treatment of Class III malocclusions is always challenging, due to the unpredictability of future growth. Although it may be possible to correct an anterior crossbite and improve dental arch relationships, the result may relapse as a result of future unfavourable mandibular growth. There have been attempts to develop techniques to predict future growth on an individual basis, but at the present time, it is still difficult to confidently predict the outcome of treatment of Class III malocclusions [2]. Patients should therefore be given a cautious prognosis for their corrected interceptive Class III treatment, due to the unpredictably of future growth.

The following sections will discuss the treatment of simple dentoalveolar anterior crossbites (section "Treatment of Simple Dento-Alveolar Anterior Crossbites") and the use of growth modification and orthopaedic movement for malocclusions with a larger skeletal component (section "Growth Modification and Orthopaedic Treatment"). In both cases, more favourable changes will be seen in patients who:

- Have a definite overbite at the end of treatment, which helps to maintain the correction of any anterior crossbite
- Present with an initial anterior displacement of the mandible due to the crossbite
- Are more compliant and will wear the appliances as directed

Treatment of Simple Dentoalveolar Anterior Crossbites

A simple anterior crossbite can be corrected using either a removable appliance or a fixed appliance. Success is increased if there is a minimal existing proclination of the upper incisors and there is adequate overbite to maintain the correction at the end of treatment.

A removable appliance has an active component anteriorly to procline the upper tooth or teeth to correct the anterior crossbite. This active component can either be a palatal spring, which is activated by the clinician, or a screw, which the

patient activates. The appliance also incorporates retentive components to keep the appliance in place and possibly posterior capping to disclude the occlusion to aid correction of the anterior teeth. A removable appliance can only tip the teeth, so it should only be used if simple tipping movements of the upper anterior teeth are required.

A fixed appliance can also be used (see Fig. 10.1) and is sometimes only bonded on the permanent teeth that are present in the mouth at this age. This appliance is often referred to as a "2 by 4" appliance as it is only bonded on the two upper first permanent molars and the four upper incisors. An active pushcoil, between the molars and the incisors, can be used to procline the incisors. Glass ionomer cement may be placed temporarily as a posterior fixed bite plane on the molars if disclusion is required. Fixed appliances allow bodily movement and correction of rotations. They also have the ability to increase the overbite to improve stability and reduce the compliance required by the patient.

There is evidence to suggest that both types of appliances work and the results are equally stable. Fixed appliance treatment is quicker and cheaper and has less

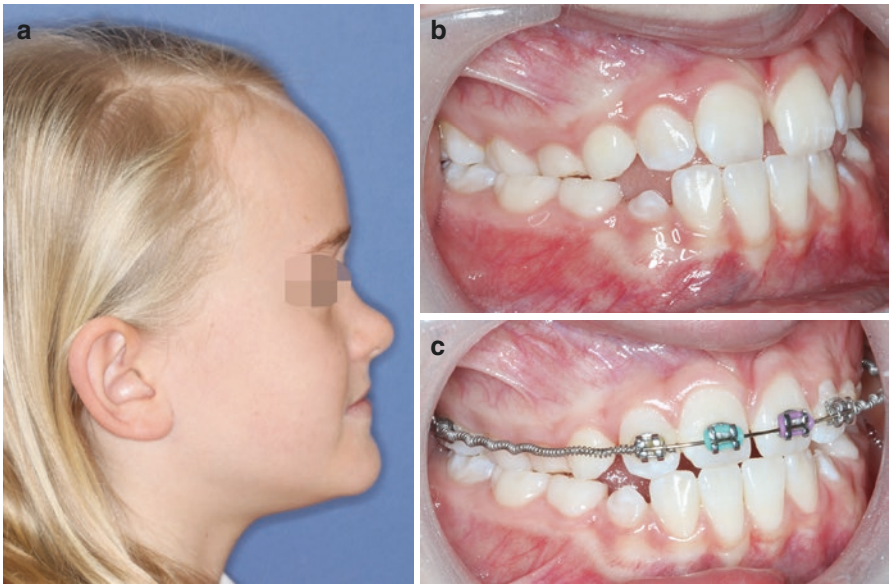

Fig. 10.1 Case demonstrating simple correction of anterior crossbite with 2 × 4 fixed appliance. (**a**) Start extra-oral lateral view demonstrating Class III skeletal pattern (partly retrognathic maxilla and slightly prognathic mandible). (**b**) Start intra-oral view demonstrating Class III incisor relationship and anterior crossbite upper right central and lateral incisor. There was a slight anterior displacement of the mandible caused by this crossbite, leading to a "pseudo-Class III". (**c**) Fixed "2 × 4" appliance with pushcoil proclining the upper incisors. The patient wore the appliance for 5 months. (**d**) Final extra-oral lateral view, showing Class I skeletal pattern as a result of the correction of the crossbite, which removed the anterior displacement of the mandible. (**e**) Final intra-oral view showing correction of the anterior crossbite, with an overbite present to maintain the correction. Future stability will depend on future mandibular growth

Fig. 10.1 (continued)

effect on the patient's speech than a removable appliance, but patients may complain of slightly more difficulty in chewing and biting initially with the fixed appliance [3–6].

Growth Modification and Orthopaedic Treatment

It has been suggested that it is possible to intercept a developing Class III skeletal malocclusion by using growth modification, leading to orthopaedic treatment. This approach aims to correct the skeletal discrepancy or at least improve it sufficiently to allow treatment with orthodontic camouflage in the future and avoid orthognathic surgery. This orthopaedic approach has been attempted using a variety of approaches, including functional appliances, chin cup therapy, protraction facemask and bone-anchored appliances. The evidence to support each of these approaches will be briefly discussed.

Functional Appliances

Functional appliances have been used to try and modify the skeletal pattern by enhancing the growth of the maxilla and restricting or redirecting the growth of the mandible. Examples include Fränkel functional regulator III appliance (FR III) and reverse twin-block appliance.

The FR III (see Fig. 10.2) has maxillary vestibular shields in the depth of the sulcus. These shields are placed away from the maxilla to stretch the periosteum and

Fig. 10.2 Fränkel functional regulator III appliance (FR III)

encourage anterior development of the maxilla. The lower part of the appliance attempts to restrict mandibular growth or redirect it posteriorly. Research would suggest that it can improve the occlusal relationships, but this is principally due to dentoalveolar changes, proclining upper incisors and retroclining the lowers incisors [7]. The FR III can be challenging for patients to wear and subject to breakage, and as the changes are principally dentoalveolar, there may be simpler ways to correct the malocclusion by orthodontic camouflage.

The reverse twin-block (see Fig. 10.3) is a modification of the traditional twin-block, which was originally designed for treatment of Class II. In the reverse twin-block, the blocks are positioned so that there are posterior forces on the mandible and anterior forces on the maxilla. Once again the effects appear to be dentoalveolar, rather than skeletal [8].

It would appear therefore that functional appliances can successfully correct a Class III malocclusion, but this is principally by dentoalveolar changes, with minimal or no effects on the underlying skeletal pattern.

Chin Cup

Chin cup therapy is orthopaedic treatment aimed at modifying the growth of the mandible. The patient is asked to wear the chin cup for over 14 h a day, with forces of 300–500 g directly through the condyle or just behind it. It would appear that it

Fig. 10.3 Reverse twin-block

may redirect the mandible growth vertically, causing a backward rotation of the mandible [9], but often these changes are not maintained in the long term and the normal growth pattern re-establishes itself [10]. This is the principal appliance aimed at the correction of Class III malocclusions that are the result of prognathic mandible. However, as it seems to work by causing a backward rotation of the mandible, with disappointing long-term results, then patients who present in the mixed dentition with marked mandibular prognathism, particularly if associated with increased vertical proportions, are often best treated later with surgery, when their growth is complete.

Protraction Facemask

Protraction facemask, sometimes referred to as reverse headgear, applies a forwards and downwards force to the maxilla and has been shown to be successful in correcting reverse overjets in the developing dentition [11]. The appliance is composed of two components: an external framework that fits on the face and an internal attachment to the maxillary dentition (see Fig. 10.4). The two components are connected by elastics providing forces of 300–500 g per side in a forward and slightly downward vector. The external framework is made up of two pads (one that sits on the forehead and one that sits on the chin), which provide anchorage. There is also a middle bar for the connection of the elastics to the intra-oral attachment to the maxillary dentition.

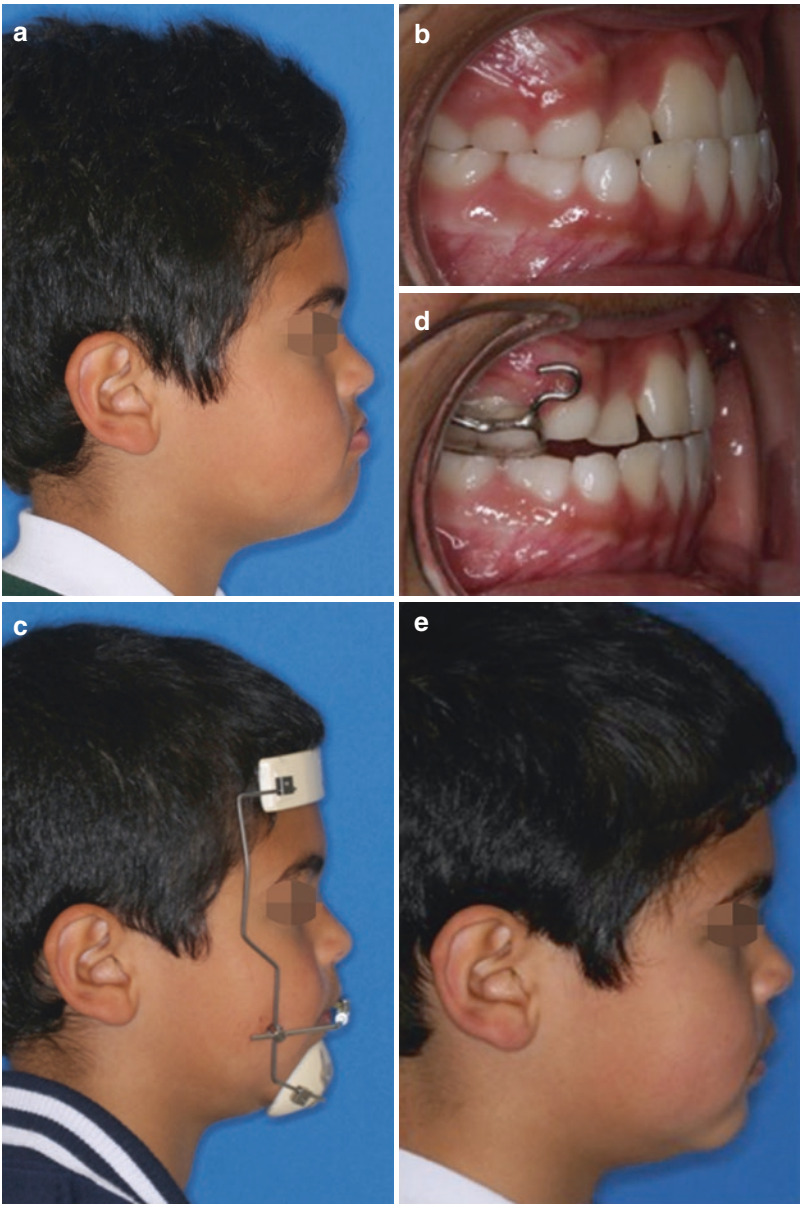

Fig. 10.4 Protraction facemask case. (**a**) Age 8.5 years pretreatment facial view. (**b**) Age 8.5 years pretreatment intra-oral view. (**c**) Facial view of protraction facemask during treatment. (**d**) Intra-oral view during treatment of bonded RME with hooks for attachment of elastics. (**e**) Facial view at end of 6 months of treatment. (**f**) Intra-oral view after 6 months of treatment. (**g**) Age 11, facial view 2 years after treatment. (**h**) Age 11, intra-oral view 2 years after treatment

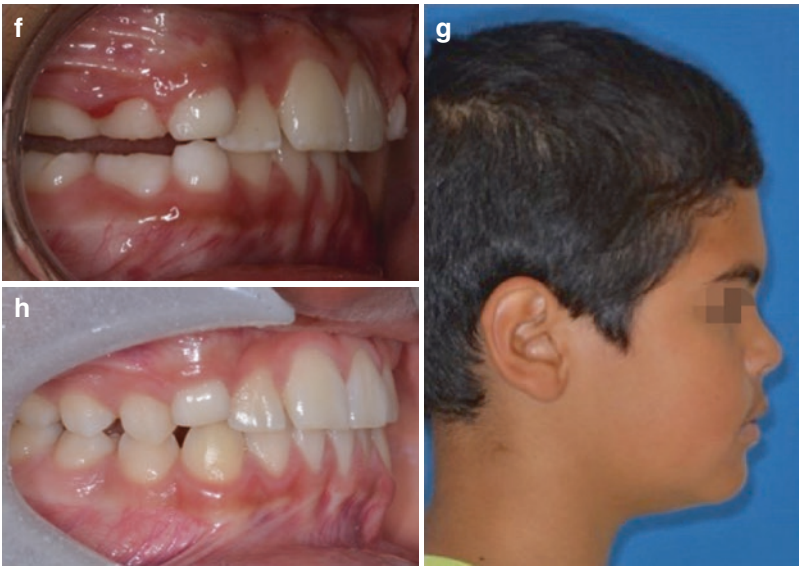

Fig. 10.4 (continued)

There are various designs of attachment to the maxillary dentition, including removable, banded and acrylic-bonded versions. They all incorporate some sort of hooks positioned above the roots of the first deciduous molar (the centre of rotation of the maxilla), for attachments of the elastics. The elastic forces are typically 300–500 g per side and need to be worn 12–14 h per day. The total treatment time is usually 6–9 months.

One controversial area is the use of rapid maxillary expansion (RME) used at the same time as the protraction facemask. Often patients with a Class III skeletal pattern have a small maxilla in the transverse dimension as well as the anteroposterior dimension, so this expansion is a helpful component to the treatment. It has been suggested that this may loosen the circummaxillary sutures and increase the forward movement of the maxilla, although the results of higher quality research seem to suggest that the effects of the RME are minimal [12]. This principle has been taken further by using a technique known as Alt-RAMEC (alternating rapid maxillary expansion and contraction) [13]. The Alt-RAMEC protocol describes alternative weeks of rapid maxillary expansion and constriction, to disarticulate the maxilla without over-expanding. Further high-quality research into RME with protraction facemask is required to determine if this is an appropriate approach.

In a randomised controlled clinical trial comparing protraction facemask with no treatment, it was shown that successful correction of the reverse overjet will happen in 70% of patients, with an average increase in overjet of 4 mm, and a significant skeletal change, principally due to forward movement of the maxilla. The ANB

angle (relating the maxilla to the mandible) improved 2.6° compared to the control at the end of treatment [14]. There were no detrimental effects on the TMJ. Although it was successful skeletally and dentally, there were no detectable psychosocial benefits for the patients who wore the protraction facemask.

These patients were followed up 6 years later to see if the favourable changes were maintained towards the end of growth and in particular to assess whether the interceptive use of a facemask in the developing dentition can help to reduce the need for orthognathic surgery [15]. Of the patients that wore protraction facemask, 36% needed orthognathic surgery at the age of 15, whereas 66% of patients in the control required orthognathic surgery. Encouragingly 68% of patients who wore the protraction facemask had a positive overjet after 6 years. Interestingly, the initial early protraction facemask treatment improvements in the skeletal parameters were not maintained at 6 years follow-up. The reduction in the need for surgery may be as a result of rotational changes in the maxilla and mandible. It may also be due to the accumulation of multiple effects on the occlusion and skeletal pattern, which on their own are insignificant, but collectively reduce the need for orthognathic surgery.

So it would appear that the use of protraction facemask in the developing dentition will correct the Class III malocclusion and reduce the need for orthognathic surgery in the future in the following types of cases:

- Child under the age of 10
- Mild-moderate Class III
- Retrusive maxilla
- Average or reduced vertical proportions

While interceptive treatment of Class III malocclusions can be beneficial in these particular cases, it has been suggested that because the appliances used are tooth-borne, they may lead to less orthopaedic change and unwanted dental changes such as:

- Buccal flaring of molars and extrusion lead to increase in vertical dimensions.
- Arch length decrease due to mesial migration of molars leading to crowding.

In an attempt to overcome the limitations of tooth-borne appliances in the interceptive treatment of Class III malocclusions, bone-anchored appliances have more recently been used.

Bone-Anchored Appliances

As well as trying to overcome some of the unwanted dentoalveolar effects of tooth-borne appliances discussed above, there may also be the potential for bone-anchored appliances to offer greater skeletal changes [16]. These appliances typically involve the use of Class III elastics attached between plates placed in

the mandibular symphyseal region and the infrazygomatic crest (see Fig. 10.5). The success of these mini-plates is related to the surgical technique and the thickness and quality of the bone. Particularly in the maxilla, the bone quality is often not as good until the patient is at least 11 years old, so this interceptive technique tends to be used in slightly older patients than the tooth-borne appliances. The results of initial studies into this bone-anchored approach suggest that it has the potential to offer greater skeletal changes, with less unwanted displacement of the dentition. However, there are unpredictable variations in individual outcomes, and further high-quality research is needed to investigate this technique further.

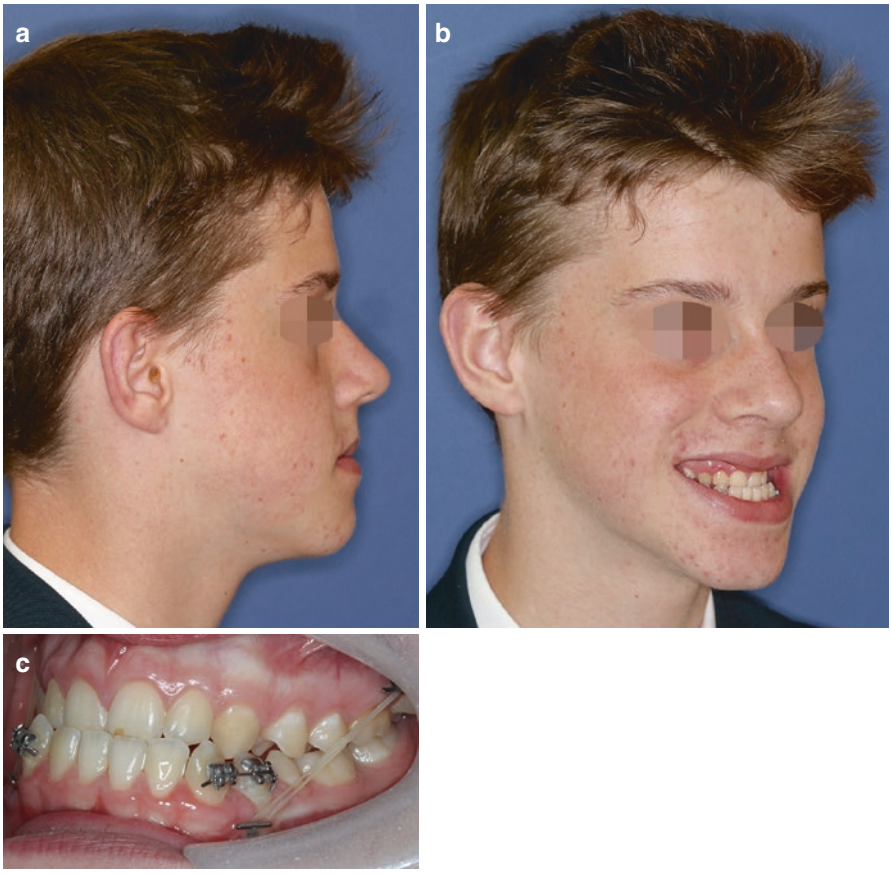

Fig. 10.5 Case demonstrating the use of bone-anchored mini-plates with Class III elastics. (**a**) Start extra-oral lateral facial view. (**b**) Start extra-oral three-quarter facial view. (**c**) Intra-oral view of Class III elastics attached to mini-plates that were placed 2 weeks previously. (**d**) Four months into treatment extra-oral lateral facial view. (**e**) Four months into treatment extra-oral three-quarter facial view. (**f**) Four months into treatment showing intra-oral improvement in occlusion. Use of full-time Class III elastics is ongoing

Fig. 10.5 (continued)

Conclusions

1. Interceptive treatment of Class III malocclusions may be undertaken if it prevents damage to the oral tissues, and/or prevents, or significantly reduces the amount, or severity, of future orthodontic treatment.
2. The long-term success of interceptive treatment of Class III malocclusions cannot be guaranteed due to the unpredictability of future growth.
3. It is important to determine the aetiology of the Class III incisor relationship before deciding on any interceptive treatment. The aetiology could be dental, a pseudo-Class III (which is due to a displacement of the mandible caused by a crossbite) or skeletal.
4. Treatment is more likely to be successful if there is a definite overbite at the end of treatment to maintain the result, in the presence of an initial anterior

displacement of the mandible due to the crossbite and in patients who are more compliant and will wear the appliances as directed.

5. Simple anterior dental crossbites can be successfully treated with removable or fixed appliances in the mixed dentition.
6. Treatment with chin cup or functional appliances can correct a Class III incisor relationship, but any orthopaedic changes are likely to be minimal with these appliances.
7. Interceptive treatment with a protraction facemask treatment can reduce the need for future orthognathic surgical correction, when used on patients who are under 10, with a mild to moderate Class III and a retrusive maxilla and with average or reduced vertical proportions.
8. Bone-anchored appliances may offer the potential for more skeletal changes, but further research is needed in this area.

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