Early Treatment of Class II Malocclusion

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Abstract

An increased overjet in the primary or mixed dentition is a common reason to seek orthodontic treatment and is usually indicative of an underlying class II malocclusion. This can be due to a variety of factors, including digit sucking, a lip trap or an underlying skeletal II base relationship. Treatment timing has been controversial, with proponents of early treatment claiming it results in greater growth of the mandible and better outcomes for the patient. However, evidence from several large randomised clinical trials investigating early treatment for class II malocclusion have refuted this, essentially showing few clinical differences in outcome for patients who underwent an early course of treatment in the mixed dentition compared to those treated comprehensively in adolescence. However, patients treated early do seem to experience less dentoalveolar trauma than those treated later, although this is generally not severe, and it is debatable whether the slight reduction in risk justifies the cost and burden to the patient of early treatment. Another justification for early treatment is psychological outcome. An increased overjet has been shown to make a child a target for bullying, and there is weak evidence that early treatment can help these patients. If early treatment is embarked upon, there are several modalities that can be used, one of which is a functional appliance. These appliances primarily reduce an increased overjet by dental movement, retroclining the upper incisors and proclining the lowers. There is a small increase in mandibular length, but this disappears with normal growth. Most patients will need a further course of treatment, which will

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M.T. Cobourne (ed.), *Orthodontic Management of the Developing Dentition*,
DOI 10.1007/978-3-319-54637-7_9

mean maintaining overjet reduction in the transition from early mixed to permanent dentitions. In most cases, it is more efficient and less demanding on patient compliance to delay treatment until early adolescence in the late mixed dentition, as clinical outcome is likely to be the same.

Introduction

Class II malocclusion is very common in most developed countries, and the features can be seen even in the primary dentition. It usually presents as an increased overjet, which is often a cause of concern to the patient or their parents, and as a consequence, a specialist opinion is frequently sort. While it is possible to treat class II malocclusions in the mixed and sometimes even in the primary dentition, considerable discussion and debate has taken place as to the 'ideal timing' of treatment. This chapter will explore this controversial area.

Incidence

Class II malocclusions are common in Western societies and Caucasian patients of Northern European descent, with an incidence of up to 25% having been reported in 12 years old in the UK [1] and 15% of 12–15 year olds in the USA [2]. Class II is less common in Afro-Caribbean and East Asian populations and they tend to be a higher propensity to class III malocclusions.

The prevalence of a class II molar relationships is relatively high in the primary dentition [3]. This reduces in untreated subjects as they enter the mixed and early permanent dentition as the mandibular first molars migrate mesially with exfoliation of the second primary molars. This also reflected in a reduction in the overjet to a lesser extent, although this is less likely to occur if the overjet is over 6 mm [3]. Once a class II buccal segment relation has become established in the permanent dentition, it will tend to be maintained, even with good mandibular growth. This is because dentoalveolar compensation occurs thus maintaining the occlusion despite the growth [4]. As a consequence, class II malocclusions do not usually self-correct without active intervention.

Aetiology

Skeletal

The majority of class II malocclusions present with some degree of mandibular retrognathia [5]. Maxillary prognathism is much less common and is often associated with vertical maxillary excess. Vertical face type and growth are variable, ranging from patients with hypodivergent facial growth patterns and increased overbite to those who have a hyperdivergent pattern, an increased anterior low face height and a skeletal anterior open bite.

Soft Tissue

The teeth sit in a 'zone of balance' between the soft tissues of the lips and cheeks buccally and the tongue lingually. It is therefore unsurprising that the soft tissues have a significant influence on the position of the developing dentition. The position and competence of the lips has a bearing on the position of the labial segments. If the lower lip rests behind the upper incisors, these will be proclined and the lowers reclined, resulting in an increased overjet. This is known as a lip trap and the lip pattern described as potentially competent. If the lower lip position is higher, it can result in retroclination of the upper central incisors but still rest behind the lateral incisors allowing them to procline, resulting in the classic presentation of a class II division 2 incisor relationship.

Lip incompetence and hypotonic activity, often associated with hyperdivergent facial growth, can result in the tongue having more influence on the incisors. Clinically this manifests itself as bimaxillary proclination and a reduction in the overbite. If this occurs with a class II skeletal pattern, an increased overjet can result as well as a reduced overbite or possibly an anterior open bite.

It has been argued that tongue position and poor lip posture are the primary aetiology of class II malocclusion in childhood [6]. The theory goes that due to nasal obstruction, oral breathing predominates, resulting in lip incompetence and an open mouth posture. The tongue position then drops and the maxillary arch narrows, resulting in crowding and a downwards and backwards growth rotation of the mandible. This in turn shortens the lower dental arch resulting in secondary crowding appearing in the mandibular dentition. There is limited evidence for this hypothesis from primate experiments and human studies looking at the effect of adenoidectomies on the growth in children and adolescents [7].

Advocates of this argument encourage early treatment for class II malocclusion usually consisting of a combination of myofunctional appliances and oral exercises designed to retrain the tongue and establish lip competence. By doing this, it is believed that greater anteroposterior mandibular growth will result, thereby correcting the class II malocclusion. There is however no scientific or clinical evidence to support this philosophy or to justify this type of early treatment. What is more, the treatment modalities advocated are extremely demanding on compliance, extend over many years and have by the clinicians' own admissions a very low success rate compared with other types of treatment.

Digit or Thumbsucking

Nonnutritive sucking habits are common in many societies but usually stop in the primary dentition [8]. If this persists into the mixed dentition, this can affect the dental arches and occlusion, the severity being dependent on the duration of the habit [9]. Clinically this often results in the development of a posterior crossbite and an increased overjet as the upper arch narrows, the upper incisors are proclined and the lower incisors retroclined [10]. This can also result in a reduced overbite or an anterior open bite [11].

Indications for Early Treatment

There has been much debate regarding the optimum time to start treatment for class II malocclusions, and early treatment has many advocates. The proposed advantages of early treatment are:

- Maximise growth potential
- Psychosocial benefits
- Reduce risk of dentoalveolar trauma
- Good compliance in younger patients
- Reduce need or complexity of second phase of treatment
- Better overall outcomes

However set against this are the following contraindications:

- Extended treatment time
- Retention problematic during transition of dentition
- Physiological cost of prolonged treatment
- Use up patient cooperation
- Cost to patient and parent—both economic and time

Many of the claims in favour of early treatment were based on retrospective research with small sample sizes, which were often compared to historic controls. In the 1990s, several large randomised clinical trials were set up to try and address the fundamental question of timing for the treatment of class II malocclusions: two in the USA and one in the UK [12–15]. The studies in the USA investigated the use of functional appliances, a Bionator, versus headgear or observation. They were based in dental schools with treatment carried out by a limited number of operators and sometimes involved patient incentivisation to comply with the study. They therefore investigated the *efficacy* of treatment, i.e. the provision of care under ideal conditions rather than its effectiveness. The UK-based study compared early treatment with a functional appliance, a Twin Block, to an observation group. Treatment in this study was carried out by numerous operators in hospital-based orthodontic departments in the UK. It therefore investigated the *effectiveness* of treatment, i.e. the provision of care under conditions that are more relevant to the setting where the proposed treatment is usually carried out. The studies initially reported following the first phase of treatment. The patients were then followed through comprehensive orthodontic treatment in adolescence [16–18]. Overall over 600 patients were initially enrolled in these studies with almost 500 completing them, and so to date, they provide the best evidence available on the outcomes and benefits of early treatment for class II malocclusions. So we need to look at the claims outlined above on the supposed benefits of early treatment in specific relationship to these studies.

Growth

There is no doubt early treatment is effective at reducing an increased overjet, and this is achieved by a combination of dental and skeletal effects. Therefore all three studies reported positive results following the initial treatment including a relative increase in mandibular length measured cephalometrically in the patients treated with the functional appliances and maxillary restraint in those treated with headgear. However once the patients were followed through to the end of the study, these differences had disappeared, and there was no difference skeletally between the patients who had undergone early treatment and those who had undergone later treatment. Therefore to date there is no evidence that early treatment for class II malocclusion has any lasting impact on growth, and therefore 'to achieve better growth' is not a reason to undertake early treatment.

Psychosocial Health

There is an increasing body of evidence that the presence of a malocclusion can have a negative impact on an individual's quality of life and psychological health. This is particularly relevant to class II malocclusions which can be particularly aesthetically conspicuous. Both in childhood and adolescence compromised aesthetics can make an individual more susceptible to teasing and bullying. Bullying is endemic within school populations in most countries. In the presence of a malocclusion, bullying has a negative impact on self-esteem and oral-health-based quality of life including lower levels of social competence, athletic competence, self-esteem related to physical appearance and general self-esteem [19]. In addition bullied individuals report higher levels of oral symptoms, functional limitations and emotional and social impact from their malocclusions. Combined, these factors can have a long-term negative impact on individuals and are associated with both poor psychological and physical health, including low self-esteem, depression, anxiety, poor academic performance, truancy, crime, mental health problems and suicide.

Despite no evidence of long-term impact of early treatment on self-esteem, it appears to result in a short-term increase in self-esteem and a reduction in the self-reported levels of bullying, as well as a positive impact on the oral health-related quality of life [13, 14, 20]. In certain well-motivated individuals, therefore, early treatment may well be very beneficial (Figs. 9.1, 9.2, 9.3 and 9.4). However this needs to be done on the understanding that ultimately it may result in extended treatment times and quite possibly a second course of treatment with no discernable difference in the final outcome, compared to one course of treatment in adolescence.

Fig. 9.1 8-year-old girl who presented with a 15 mm overjet who was being bullied at school about her dental appearance

Fig. 9.2 Patient from Fig. 9.1 in treatment with a Twin Block functional appliance

Fig. 9.3 Patient from Fig. 9.1 following early treatment

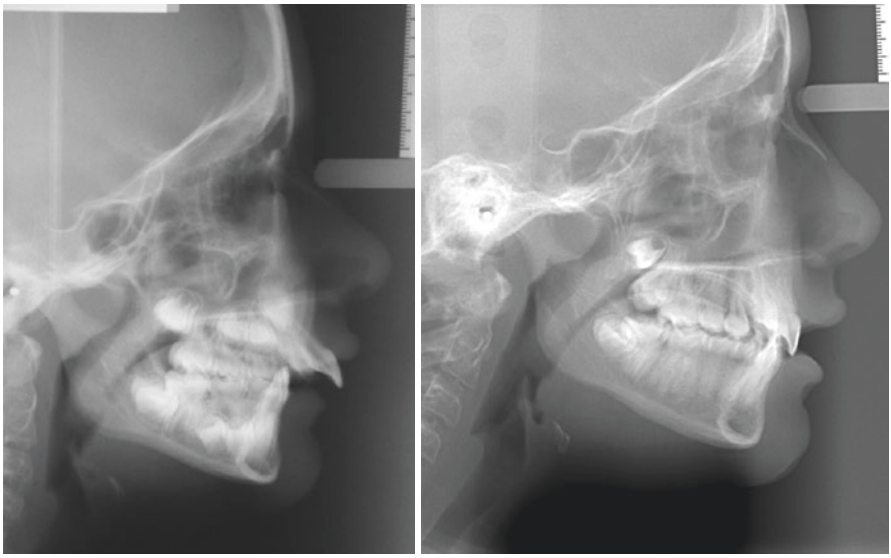

Fig. 9.4 Pre- and post-treatment lateral cephalograms for patient from Fig. 9.1

Prevention of Dentoalveolar Trauma

An increased overjet of over 6 mm has been associated with a higher incidence of trauma to the upper labial segment particularly when associated with lip incompetence [21]. The incidence is highest in children in the mixed dentition, i.e. patients aged 8–11 years old. While the trauma is usually mild, usually consisting of fractures within enamel, it can on occasion be more severe such as fractures into dentine and the pulp, root fractures and rarely avulsion resulting in complete tooth loss, all of which have long-term consequences in terms of treatment and cost.

The only small positive difference found in the class II RCTs was the slightly reduced incidence in dentoalveolar trauma in the patients who had undergone early treatment. This was not actually found in the individual studies, but when the results were combined in a meta-analysis, a difference between the early treatment group and late treatment group was found with less incidence of new trauma during the study period in the early treatment group [22].

The overall incidence of dentoalveolar trauma in childhood has been reported as 1–3%, and the cost of treatment has been reported to range from US $2 to $5 million per one million inhabitants with patients usually requiring 2–9 dental appointments to complete the treatment [23]. Most of the new trauma reported in the RCTs was mild in nature and clinically negligible not requiring treatment, and therefore it is debatable whether the extra cost related to early treatment could be justified. Also much of the trauma occurs in the early mixed dentition

as the permanent incisors erupt due to falls, sports or nonaccidental injury [23]. To have any really meaningful impact, therefore, treatment would need to be started soon after the permanent incisors erupt which may have an impact on compliance and overall duration of treatment, as well as cost. To prevent injury during sport, use of a mouthguard maybe more cost-effective and less demanding than early treatment. Finally even a slight increase in overjet of over 3–4 mm increases the risk of trauma by 21.8% (95% CI 9.7–34.5%) [3, 24]. This relatively would mean many more children would require early treatment, which is again neither cost-effective nor practical, particularly in a state-funded health system. However in certain children with very prominent maxillary incisors and lip incompetence who are particularly physically active and deemed at high risk of dentoalveolar trauma, early treatment can be justified (Figs. 9.4, 9.5, 9.6, 9.7, and 9.8).

Fig. 9.5 9-year-old male in mixed dentition with class II div 1 incisor relationship. Early treatment was carried out as there was gross lip incompetence increasing the risk of dentoalveolar trauma

Fig. 9.6 Patient from Fig. 9.5 in treatment with a Bionator functional appliance

Fig. 9.7 Patient from Fig. 9.5 at the end of the first phase of treatment showing reduction in overjet and improvement in soft tissue profile. The patient went on to have comprehensive treatment with fixed appliances and extraction of the upper left first molar which was hypoplastic

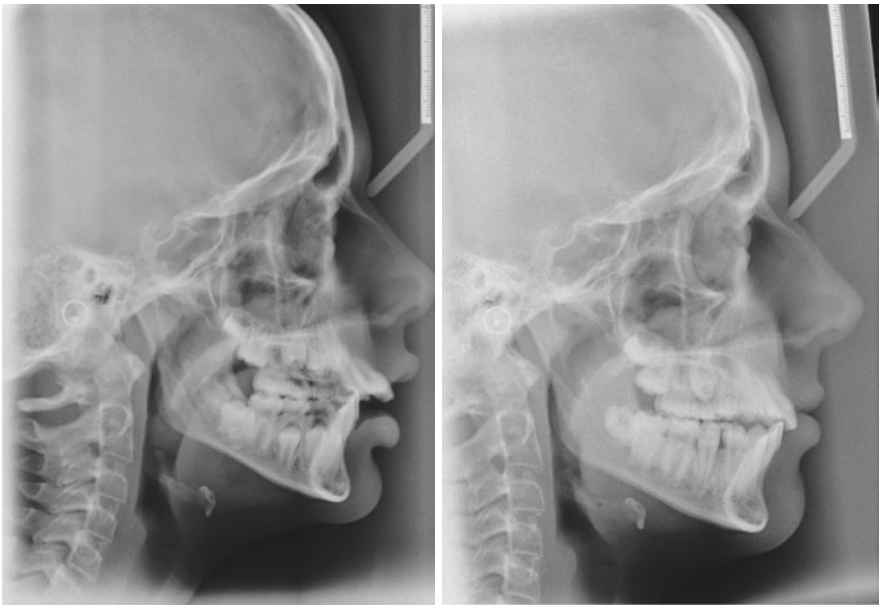

Fig. 9.8 Pre- and post-treatment lateral cephalogram from patient in Fig. 9.5 showing mostly dentoalveolar changes

Compliance

Good patient cooperation is fundamental to successful orthodontic treatment. This is often extremely difficult to gauge, and there appears to be no psychosocial parameters that can predict this. An assessment of potential cooperation can be made by observing the initial patient behaviour and in particular the relationship with the orthodontist or treating clinician [25]. Poor oral hygiene, repeated breakages, failure to wear appliances as instructed and a poor patient/clinician relationship are often indicators of poor overall outcome [26, 27].

Preadolescent children generally make very good patients as their behaviour is more affected by figures of authority such as their parents or the orthodontist. As long as instructions are not abstract or relate to long-term outcomes, compliance levels are generally very good. As a child enters adolescence, their behaviour becomes more influenced by their peer group, and they tend to rebel against authority. Successful treatment therefore involves empowering the patient, so that they feel the treatment is being done for them as opposed to them. This again involves including them in decision-making and developing a good patient-clinician relationship. Fortunately acceptance of treatment in this age group has become easier by the more universal availability of orthodontic treatment in most developed countries and the greater awareness of malocclusion and overall body image, plus the undeniable benefits of orthodontic treatment.

A problem with early treatment can be compliance ‘burn out’ as early treatment in the majority of cases will extend overall treatment time dramatically, and we know that extended treatment duration has a negative influence on cooperation [28]. Therefore there is a risk that the compliant eight year old will become a disgruntled 12 year old after 4 years in treatment. As no study to date has shown convincingly any major benefits in early treatment, particularly in relation to better outcomes, the argument of better compliance of younger patients cannot really be used to justify it as ultimately the majority of patients will still further treatment in adolescence.

Second Phase of Treatment

The majority of patients undergoing early treatment for class II malocclusion will require a further course of active orthodontic treatment according to the three RCTs previously discussed. This need for treatment can be for a variety of reasons but usually involves relieve of crowding and alignment of the teeth, detailing the occlusion or to fully reduce a residual increased overjet. Furthermore the extraction rates and the duration of any subsequent treatment, usually with upper and lower fixed appliances or the percentage of patients requiring orthognathic surgery, appear to be no different between the patients that underwent phase 1, early treatment and those

patients that waited and had comprehensive treatment at the more usual time in early adolescence. The early treatment of class II malocclusion therefore can also not be justified to reduce the need or duration of second phase of treatment, based on the current scientific evidence available.

Better Outcomes

In the three RCTs critically assessing early treatment for class II, the occlusal outcomes of the treated groups after the initial phase with both functional appliances and headgear were better than those in the control group: both modalities were demonstrated to be effective at reducing an increased overjet. Following comprehensive treatment, however, these differences disappeared. Indeed, overall the patients in the early treatment groups reported significantly longer treatment times overall, had a greater number of visits and, in the UK study, had a poorer occlusal result as measured by the Peer Assessment Rating (PAR) [17]. On the current evidence, therefore, it is not possible to justify early treatment for class II malocclusion on an expectation of a better occlusal result, compared with comprehensive treatment started in the late mixed or early permanent dentition.

Mechanics for Early Treatment of Class II Malocclusion

So overall, while early treatment using the methods outlined later in this chapter can certainly be effective, it is questionable whether it is the most efficient way to treat class II malocclusions. If it is decided, however, that a course of early treatment is justified, and in the patient's best interests, there are a variety of ways that it can be carried out.

Thumb Deterrents

A digit sucking habit should ideally stop before eruption of the permanent incisors; otherwise it can result in long-term dental and skeletal changes, as outlined previously. If persistent into the early permanent dentition, the child should be actively encouraged to stop, and numerous techniques have been described to assist in this. If the child struggles to break the habit on their own, a passive device such as a palatal arch incorporating a thumb or tongue crib can be effective [29] (Fig. 9.9).

Fig. 9.9 An anterior open bite and increased overjet as a result of thumbsucking. A palatal arch with spurs was used to break the habit, and there was an improvement in the incisal relationship

Removable Appliances

A removable appliance with an activated labial bow can be used to reduce an increased overjet in the mixed dentition. This is only appropriate if the upper incisors are proclined and spaced, as the appliance will simply retrocline them by tipping of the teeth. An anterior bite plane can be incorporated to help reduce an

increased overbite, and headgear can also be used as outlined below. It is an inappropriate treatment in patients with a mark skeletal II base relationship, and mandibular retrognathia as simple dentoalveolar tipping is unlikely to produce a satisfactory result.

Functional Appliances

An extremely effective way of reducing an increased overjet in the mixed dentition is with the use of functional appliances. These are a class of orthodontic appliances originally developed in Europe in the early twentieth century that were believed to have an effect on facial growth. While many different designs and systems have been described the basic premise on which they all work is by posturing the mandible forward. This achieves several things: it changes the soft tissue environment and as a result alters forces that influence the position of the dentition. It exerts direct force on the teeth via the appliance, from the forces generated by the stretch of the muscles controlling the mandible trying to return to their resting length. In most cases, this results in a distalising force being transmitted to the upper jaw and the maxillary dentition and a mesialising force being transmitted to the mandible and the lower dentition. It has also been suggested that there is some bony remodelling at the condyle and glenoid fossa. Combining all of these influences is very effective at reducing increased overjets via:

Retroclination of the upper incisors
Proclination of the lower incisors
Distal tipping of the maxillary dentition
Mesial eruption of the mandibular dentition
Some small but worthwhile restriction in maxillary growth
Repositioning of mandible anteriorly with some remodelling of glenoid fossa.

Whether functional appliances have a lasting effect on facial growth has remained one the most hotly debated topics in orthodontics, with passionate supporters of both opposing viewpoints. Advocates claim that the use of a functional appliance results in a significant improvement in appearance as a result of an increase in mandibular growth. Unfortunately many of these claims were based on case reports or retrospective studies, often comparing a small treated group to a historic sample. There was also some evidence from animal studies that mandibular hyperpropulsion with a fixed splint did result in bony change at the condyle and glenoid fossa. Whilst animal models are interesting, these experiments imposed treatment regimes on either rodents or primates that would just not be tolerated clinically. Also while these experiments show histological changes, as class II malocclusions do not exist in the animal models used, it is difficult to imagine how these changes would relate to a meaningful clinical difference in a patient.

With the publication of the large RCTs over the last two decades, it has become apparent that the early use of functional appliances, while very effective at reducing

an increased overjet, appears to have little or no long-term impact on facial growth. This is not to say that by doing nothing, an increased overjet and class II malocclusion will correct spontaneously. Indeed an untreated class II malocclusion will almost certainly persist into adolescence and adulthood due to maintenance of the occlusal relationship irrespective of growth [4]. The clinical effect of these functional appliances therefore appears to be early establishment of a class I occlusion, while then allowing normal condylar growth to consolidate this. And herein lies one of the major problems of early treatment. The most effective time to use these appliances is during the adolescent growth spurt [30]. In females this starts around 10 years of age with the peak at about 11.5 years. In males the growth starts between 11 and 12 years and peaks between 14 and 15 years. If early treatment is undertaken, therefore, it does not coincide with the growth spurt, particularly in males. Treatment will be less efficient than if undertaken in the late mixed or even early permanent dentition. Also unless the achieved results are effectively retained, the beneficial clinical effects will be lost as the patient enters the growth spurt, thus necessitating a second course of functional appliances.

A practical problem with the use of removable functional appliances in the mixed dentition, particularly a largely tooth-borne appliance such as Twin Block, is retention of the appliance in the mouth (see Figs. 9.1, 9.2, 9.3, and 9.4). Primary teeth are generally not ideal teeth to attach a crib to, due to their conical shape and lack of natural undercuts. These teeth can also become mobile as they begin to exfoliate thus further reducing their function for retention. This problem can sometimes be overcome by the addition of composite to create an undercut or by the use of cemented functional appliances such as a Herbst. Finally there is the option of using non-tooth-borne or partially tooth-borne removable appliance such as a functional regulator or Balter's Bionator. The former is not an easy to appliance to wear and is prone to distortion or breakage while the later has the potential advantage of allowing the natural shedding of the primary molars. In a child for whom early treatment is being advocated on psychosocial grounds due to bullying and teasing, the Bionator also has the advantage of them not having to wear the appliance to school, thus avoiding making them more of a target for abuse by their peers (see Figs. 9.5, 9.6, 9.7, and 9.8).

The final problem with early treatment with a functional appliance is knowing what to do once the overjet is reduced to maintain this reduction as the patient enters their adolescent growth spurt and while the permanent dentition establishes itself. Ideally the patient enters a period of retention while the appliance is worn at night, although this may be for several years depending on when treatment was started, which can put a strain on future compliance. Also it may necessitate the use of a further appliance such as a removable retainer with headgear added at night. The second option is to give the child a break from treatment by stopping appliance wear; however this runs the risk of relapse and reappearance of the overjet as the class II malocclusion re-establishes itself. Either way the patient and their carers should be fully informed of these potential outcomes before early treatment is started.

Headgear

Headgear for the treatment of class II malocclusion can be used with a removable or functional appliance, or on its own, and it has been shown to be effective at overjet reduction in the mixed dentition. Classically headgear can be run to maxillary molar bands while the patient wears an ACCO (acrylic cervical occipital) appliance to reduce the overbite and distalise the maxillary molars correcting the buccal segment relationship. In the two RCTs looking at early treatment for class II carried out in the USA, headgear was compared to an observation group and a group treated with a functional appliance [12, 15]. Both in terms of morphological traits and dentoalveolar trauma, there was no difference in the outcomes for the headgear patients compared with the patients treated with a functional appliance after the initial phase of treatment, i.e. both modalities of treatment essentially did the same thing, and both were effective at reducing overjets. As with the patients treated with functional appliances, however, these differences disappeared in the headgear patients compared with the observation group at the end of comprehensive treatment.

Practically, the use of headgear with or without a removable appliance also has the problems of retention and what to do during the transition from the mixed into the permanent dentition.

Fixed Appliances

Similarly to the use of a removable appliance, if space is available with the dental arch, a fixed appliance can be used to reduce an increased overjet. The main problem with the use of fixed appliances in the mixed dentition is bonding brackets and attaching wires to the primary teeth, as this may increase their mobility and thus hasten their loss. This is usually why the use of removable or functional appliances is often preferred.

Conclusions

Class II malocclusion is extremely common and is usually evident in the mixed dentition when it can effectively be treated using a variety of treatment modalities. There is however no evidence that treatment at this stage is superior in terms of morphological outcomes to comprehensive treatment carried out once the permanent dentition has become established. Indeed early treatment will result in an overall greater treatment time, a larger number of appointments and higher cost to the patient or state, depending on who is paying. It can perhaps be justified in terms of risk-benefit analysis in patients with very prominent maxillary incisors with lip incompetence who have an active lifestyle are considered more at risk of dentoalveolar trauma. Similarly early treatment is worth considering in patients with very prominent upper incisors who are experiencing sustained bullying specifically due to their dental appearance. Before treatment is started, however, the patient and their parents or carers need to be fully aware that this course of early

treatment will not result in a better outcome nor will it reduce or eliminate the need for further orthodontic treatment to be carried out at a later stage when the full permanent dentition is established.

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