

**FEATURES
SECTION**

How to ... manage the transition from functional to fixed appliances

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This paper presents the methods of transfer from functional to fixed appliances. The aim of transition should be maintenance of Class II correction in a time-efficient manner without compromising long-term patient co-operation.

Key words: Functional appliances, transition, fixed appliances

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Introduction

Functional appliances have been used in Europe for over 100 years being based on the 'bite jumping' principle introduced by Norman Kingsley in the United States.¹ The popularity of functional appliances increased throughout Scandinavia and Eastern Europe in the mid 20th century with the advent of activator appliances.² The introduction of the Clark's Twin Block appliance has resulted in sustained popularity in the United Kingdom³ and facilitated the emergence of functional appliances as a recognized method of Class II correction in the United States.

Considerable controversy has surrounded the mode of action of functional appliances.⁴ Recent randomized clinical trials have suggested the majority of overjet reduction is related to dento-alveolar effects, primarily involving tipping of teeth and differential eruption of the buccal segments.^{5–8} Specific dento-alveolar effects produced by functional appliances are uprighting or retroclination of the upper labial segment, proclination of the lower labial segment and a Class II effect on the maxillary dentition with distal tipping of the maxillary buccal segments (Figure 1).

Skeletal changes including acceleration and redirection of mandibular growth coupled with restraint of maxillary growth have a less significant and possibly transient role.⁹ Systematic review of the mandibular changes induced by functional appliances has suggested that supplementary mandibular growth is significantly

larger if treatment coincides with the pubertal peak in skeletal maturation.¹⁰

Irrespective of the precise nature of Class II correction, functional appliances offer a useful treatment modality in growing patients, producing desirable occlusal change, and making potentially difficult malocclusions more amenable to correction. Fixed appliance therapy typically follows functional appliances in a two-phase treatment approach to detail the occlusion. The major clinical decisions involved in overseeing transfer to fixed appliances are timing the transition, and selecting the best approach to consolidate Class II correction.

The relapse in the transition period is primarily postural with repositioning of the mandibular condyles; uprighting of the distally tipped maxillary dentition also contributes to relapse. Failure to manage either of these changes can result in a loss in the correction of incisor and buccal relationship soon after withdrawal of the functional appliance

Planning the transition

Post-functional records including study models and photographs should be obtained. A lateral cephalogram is often helpful at this point as it allows evaluation of the relative contribution of skeletal and dento-alveolar changes on overjet reduction and molar correction. The aims of further treatment need to be decided on and these will be dependent on several factors including the presence or absence of crowding and the relative position of the labial segments. A decision often has to

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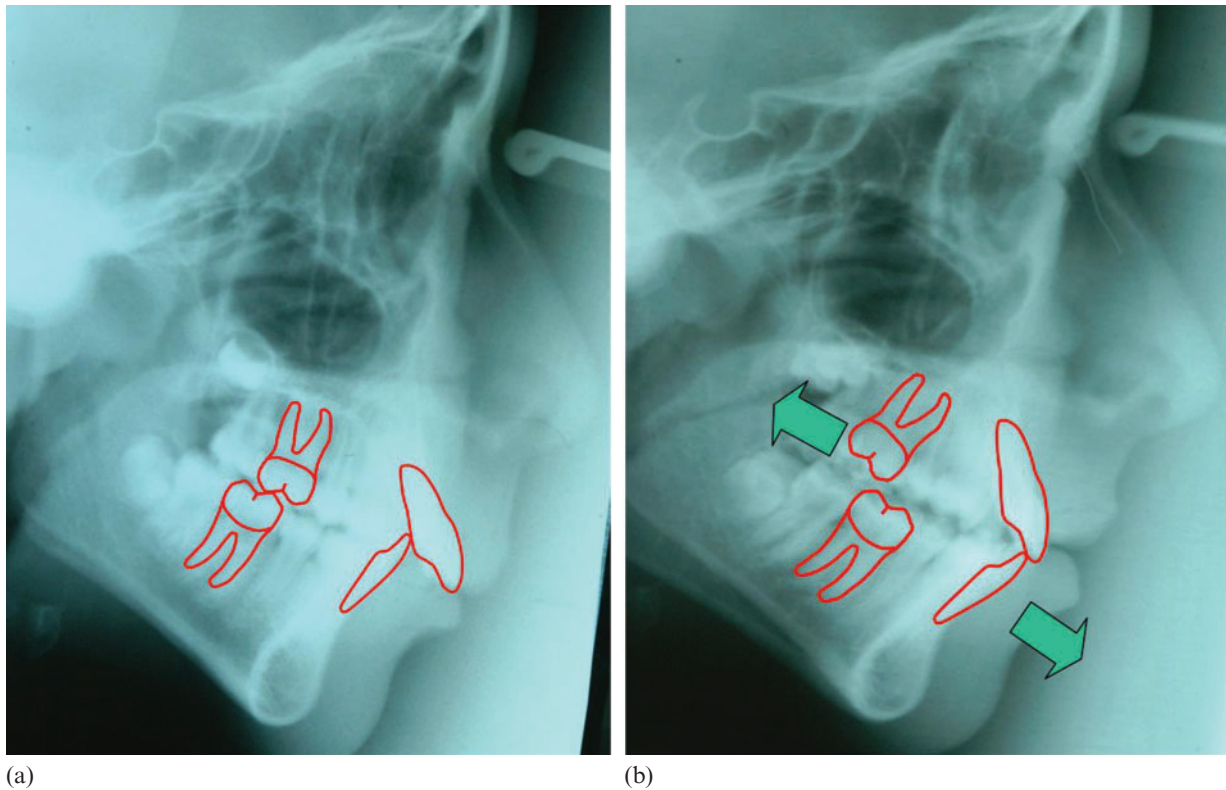


Figure 1 The effects of functional appliances. (a) Pre-functional appliance therapy lateral cephalogram. (b) Post-functional appliance therapy lateral cephalogram highlighting dento-alveolar effects of appliance

be made whether to upright the lower labial segment which is usually proclined following successful correction with functional appliances.

Timing

Unless earlier treatment has been undertaken early in the mixed dentition, by the time they reach the end of the functional phase of treatment, the majority of patients are in the permanent dentition and can progress directly into fixed appliances if appropriate. Contraindications to a fixed appliance phase are manifestations of poor compliance including:

- poor oral hygiene;
- active caries;
- repeated failed appointments;
- multiple breakages.

The transition to fixed appliances may be immediate, gradual, or delayed. Gradual transition involves a period of part-time appliance wear typically on a night-time basis. Complete withdrawal of functional appliances or other mode of Class II maintenance during the transition to the fixed appliance phase risks

relapse of Class II correction. Unwanted changes are likely to include increased overjet, proclination of the upper labial segment, uprighting of the lower labial segment, loss of molar correction and uprighting of the maxillary buccal segment. However, it is important to gauge whether changes are real and stable or merely transient and postural at the end of the functional appliance treatment, and unless the postural appliances are withdrawn for a period, this cannot be reliably assessed.

The relative merits of each approach are shown in Table 1.

Methods of consolidating Class II correction

Overcorrection

Ideally a degree of overcorrection of the excessive overjet should be produced during the functional phase to compensate for expected relapse. A Class III incisor relationship with edge-to-edge incisors or reverse overjet may be obtained with a 1/4–1/2-unit Class III molar relationship (Figure 2).



Figure 2 Overcorrection with functional appliances. (a) Pre-treatment. (b) Post-functional appliance. (c) Post-fixed appliance

Re-enforced anchorage

While mandibular retrognathia and reduced mandibular length usually accompany Class II division 1 malocclusion, maxillary protrusion occasionally contributes to the malocclusion.¹¹ Headgear is particularly useful where the malocclusion has arisen from a degree of maxillary protrusion.¹² Advantages of headgear use include:

- maintenance of molar correction and overjet reduction;
- allows immediate transition to fixed appliance phase as the maxillary buccal segment can be uprighted using fixed appliances without loss of the Class I correction. This is a major benefit of headgear over the use of other anchorage reinforcing devices such as palatal arches;
- Class III intermaxillary traction can be run supported by the headgear at night to retrocline proclined lower incisors;
- headgear with a high-pull force vector is of additional value in patients with high maxillo-mandibular plane angle (MMPA) and increased lower anterior facial height.

The headgear should be fitted on withdrawal of the functional appliance directly to bands on the upper first molars and the patient instructed to wear it for 10–12 hours a night as ‘sleeping’ headgear. It is generally required only during the initial levelling and aligning

phase of fixed appliance therapy until the angulation of the fixed appliance has been expressed in the buccal segments and the permanence of the growth-related changes are established. At this stage the patient should be in rigid archwires allowing the use of Class II elastics if appropriate as discussed below.

The major drawback of this approach is compliance ‘burnout’ with sub-optimal compliance among patients wearing headgear as an adjunct to fixed appliances well documented.^{13,14} A prolonged functional phase followed by introduction of headgear is very demanding in terms of co-operation.

Maintaining postured bite

The rapid correction of the overjet by some functional appliances such as the Clark’s twin-block appliance does not usually allow time for compensatory growth of the condyles or eruption of the posterior dentition to close the resultant lateral open bites. Therefore maintaining a postured bite following the initial overjet correction can be beneficial. This can be achieved in several ways.

Part-time functional appliance wear. Maintenance of the functional appliance during the transition to fixed appliances keeps the mandible in a protracted position and even if worn only at night maintains the neuromuscular response and growth stimulatory effect.¹⁵

Table 1 Transition timing: advantages and disadvantages of the various options versus a ‘gold standard’.

Transition	Gold standard	Immediate	Period of night-time retention	Period of no appliance wear
Overall treatment length	Short	Short	May be increased	May be increased
Maintenance of Class II correction	Yes	Variable/ may be compromised	Yes	No
Prediction of relapse/anchorage demands	Yes	No	No	Yes
Spontaneous occlusal settling	Yes	No	Moderate	Yes
Allows condylar adaptation	Yes	No	Yes	No

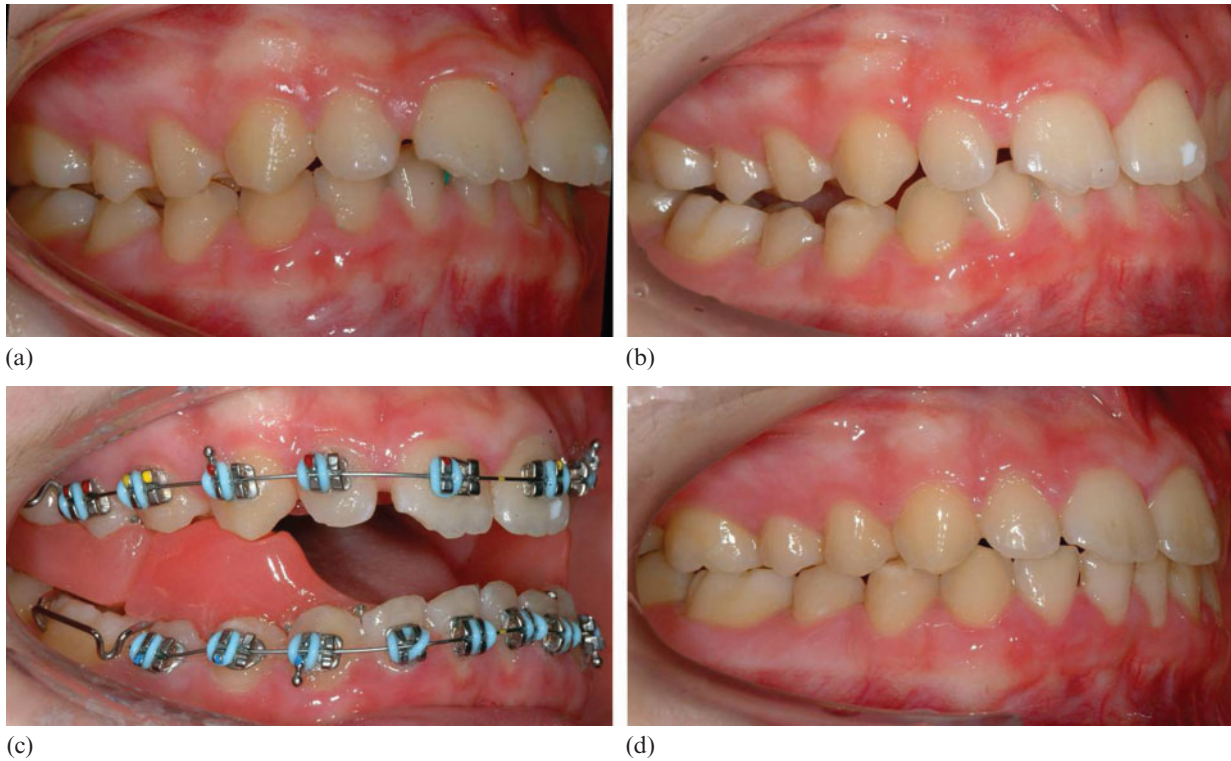


Figure 3 Cut-down twin-block to maintain postured bite into fixed appliances. (a) Pre-treatment. (b) End of functional phase. (c) Partial fixed appliance with cut back twin-block. (d) Finished occlusion

Advantages:

- resolution of lateral open bites and eruption of teeth;
- reduced compliance demand;
- overjet reduction and molar correction maintained;
- no additional appliances or expense.

Disadvantages:

- weakens appliance;
- adjustments may compromise retention.

Removable modified Clark's twin-block appliances may be adjusted to incorporate fixed appliances and worn nightly to retain Class II correction. To facilitate integration of fixed appliances, clasps may be removed and a partial bond-up carried out (Figure 3). Ball-ended clasps may be used in the premolar region to enhance retention without compromising bracket positioning and baseplates should be trimmed to allow the teeth to move. The aim would be to undertake the alignment of the upper and lower labial segments before removal of the functional appliance; at the point the functional appliance is discarded, the molars should be bonded. As such this approach is particularly suited to non-extraction cases with minimal crowding.

Fixed functional appliance. The possibility of running fixed appliances concurrent with the functional appliance allows the first phase of treatment to blend directly into the second, avoiding the problem of holding the Class II correction with the potential to result in more efficient treatment.

Potential advantages include:

- molar correction and overjet reduction maintained;
- rapid treatment progression;
- compliance demand on Class II correction reduced;¹⁶
- reduced likelihood of non-completion of treatment.¹⁷

Fixed functional appliances include:

- clip on functional fixed appliance; a fixed version of the twin-block appliance;¹⁸
- Herbst appliance. This fixed functional appliance has undergone a revival in recent years in Europe.¹⁹ The fragility of the appliance, frequent breakages and excessive chairside time to manage breakages has limited its popularity in the UK;
- Dynamax appliance.²⁰ This versatile appliance consists of an upper removable component combined with a lower lingual arch. A lower fixed appliance can easily be placed at any stage. Retentive components in

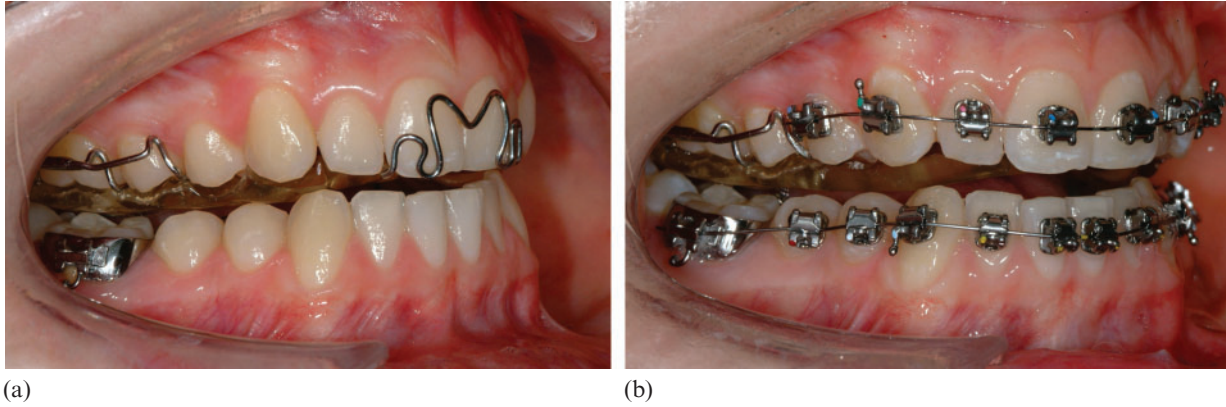


Figure 4 Integration of fixed appliance with a Dynamax appliance. (a) Dynamax appliance. (b) Cut-back upper removable appliance and fixed appliance

the upper removable appliance can be sequentially removed to permit placement of the upper fixed appliance while maintaining the postured bite (Figure 4);

- Jasper Jumpers;²¹
- mandibular protraction appliance.²²

Limitations of fixed functional appliances include:

- breakage of the constituent parts;
- additional expense and complicated laboratory techniques;
- premium on optimal oral hygiene and dietary control;
- more regular recall intervals are required to supervise plaque control and debride stagnation areas.

An outstanding fixed alternative is yet to emerge ensuring removable functional appliances form the mainstay of treatment of Class II division 1 malocclusion in growing patients.

Upper removable appliance with inclined biteplane. A steep anterior inclined biteplane as part of an upper retainer represents a simple method of retention of Class II correction.²³ The precise type of retainer used relates to the treatment goals; Begg type retainers are favoured if occlusal settling and closure of lateral open bites is necessitated. In cases where molar positions are acceptable and retention of the appliance is a priority, a Hawley type retainer may be used. If the plan is to transfer immediately to fixed appliances a 'clip-over' bite plane with Plint clasps on the first molars is recommended (Figure 5c). In all cases the bite plane needs to be deep and steep enough to ensure the patient occludes anterior to the plane as opposed to on or behind it. A bite plane at least 8 mm deep and at an inclination of 70° to the horizontal is recommended.²³ To ensure a positive bite is achieved, it is recommended that the bite

plane is constructed with the working models mounted on a simple hinge articulator such as a functional appliance would be made. The bite plane can also easily be adapted at the chairside using cold cure acrylic. The appliance should be fitted on withdrawal of the functional appliance and the patient instructed to wear it full time initially. If run concurrent with fixed appliances, it is maintained during the alignment phase of treatment until the patient is into heavy enough archwires to permit use of Class II inter-maxillary traction.

Advantages:

- worn in conjunction with fixed appliances integrating phases;
- fixed appliance placement unimpeded;
- allows closure of lateral open bites;
- time efficient;
- maintains Class II effect.

Potential disadvantages:

- retention of appliance if worn in conjunction with fixed appliances. This can be improved with use of ball-ended clasps but as the appliance has to allow tooth movement, retention is invariably compromised;
- proclination of the lower labial segment;
- insufficient depth of the plane may allow relapse of overjet;
- may allow differential eruption of second molars introducing anterior open bites in high Frankfurt–mandibular planes angle cases.

An inclined bite plane can also be incorporated into an active upper retainer during the retention period following treatment. This design of retainer may compensate for the tendency of the initial growth pattern to re-assert itself following treatment in skeletally immature patients.

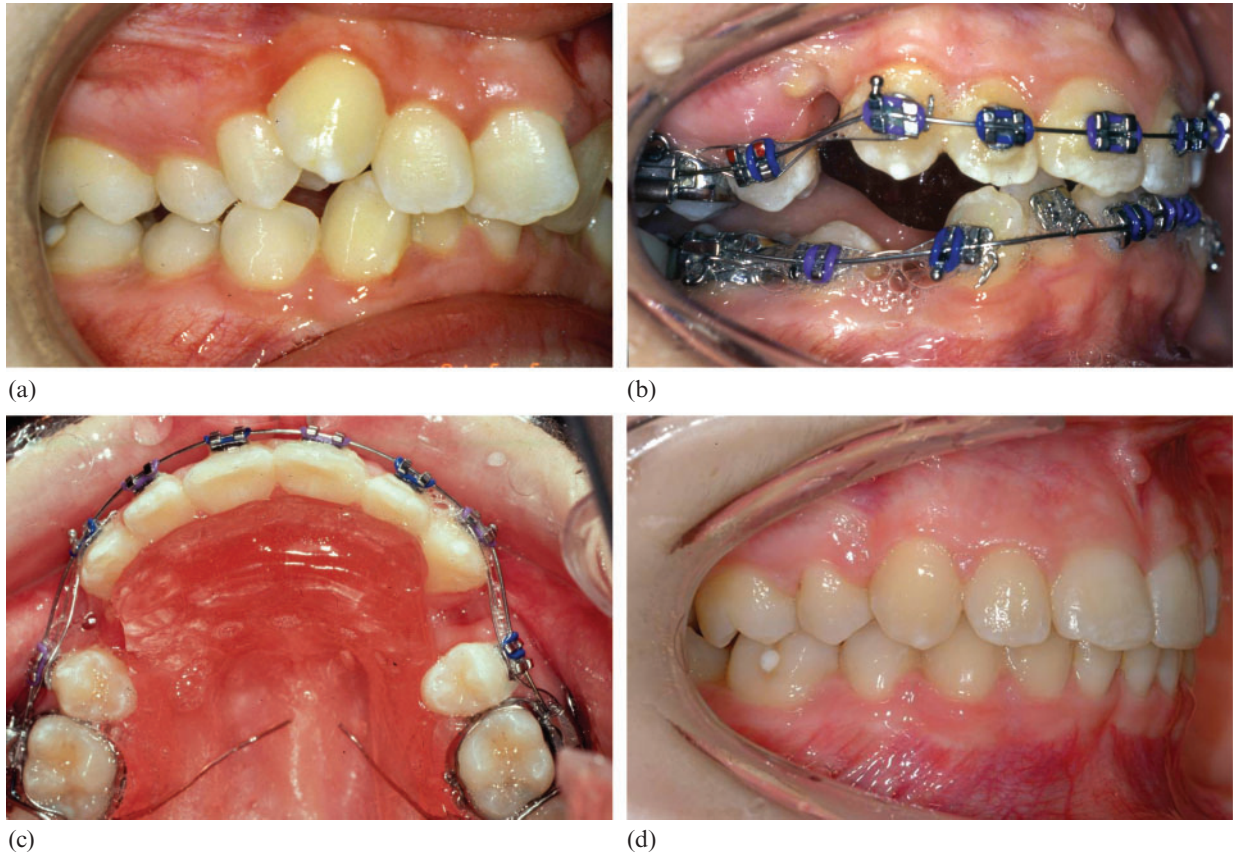


Figure 5 Use of inclined bite plane to maintain mandibular advancement in transition stage into fixed appliances. (a) Pre-treatment. (b) End of functional phase with fixed appliance and clip-over bite plane in place. (c) Clip-over bite plane with plint clasps. (d) Final occlusion

Early use of Class II elastics. Light Class II elastics used in round wires may re-enforce the dento-alveolar changes achieved during functional treatment and encourage the patient to maintain a postured bite. This is particularly a feature of the Begg and Tip Edge appliances.

Advantages:

- lower molar extrusion may be favourable in low angle cases and help close lateral open bites;
- low demand on compliance.

Disadvantages:

- although retroclination of upper incisors and proclination of lower incisors favours overjet correction, lower incisors are often already proclined following functional appliance therapy. Therefore further proclination is to be avoided. This is especially relevant in non-extraction cases where there is less facility to upright proclined incisors;
- in high-angle cases and in patients with vertical maxillary excess an unfavourable downward–backward

mandibular rotation will occur with excessive use of Class II elastics;

- unwanted lingual tipping and rotation of lower molars may occur with excessive force in NiTi wires, and as such the use of intermaxillary elastics is not recommended during the levelling and aligning phase with pre-adjusted edgewise appliances. Once working steel archwires are in place, inter-maxillary traction can be used as appropriate i.e. 0.019 × 0.025-inch steel wires when a 0.022 × 0.028-inch slot is being used.

Extraction pattern. Extractions may be necessitated in the post-functional phase. In the study by Tulloch *et al.*, extractions were carried out in 30% of patients after the functional appliance phase.⁶ The decision to remove teeth in this situation is made by assessment of space requirements and space availability.²⁴ The chosen extraction pattern depends on a number of factors including:

- presence of teeth;
- health of teeth;

- degree and location of crowding;
- soft tissue profile;
- overbite;
- vertical growth pattern;
- lower incisor inclination. Significant proclination of the lower labial segment has been shown with twin-block²⁵ and Herbst appliances,²⁶ with a resultant space requirement.

The planning of extractions can be difficult following successful functional appliance therapy as the true anchorage requirement in the upper arch may be hidden. Desirable overcorrection of the presenting Class II malocclusion often produces a Class III incisor and buccal relationship with residual crowding and proclination of the lower labial segment. Extraction of upper first premolars and lower second premolars facilitates and helps to maintain molar correction in Class II cases, and may simplify the mechanics needed for differential space closure. However, this can also create excessive space in the upper arch and potentially result in undesired retraction of the upper labial segment. As such it is often advisable to plan the extraction pattern around the space requirements at the end of functional appliance therapy and to use one of the other methods listed to maintain the Class II correction during the alignment phase with fixed appliances.

Fixed appliance prescription. Specific bracket prescription can promote conservation of molar correction and overjet reduction by counteracting potentially unstable dento-alveolar effects of the functional phase.

- *Torque values:* increased palatal root torque of the MBT prescription (17°) of the upper incisors will counteract retroclination of the upper incisors that tends to occur with functional appliances but will also put a greater demand on anchorage in the upper arch. Similarly the reduced labial crown torque in the lower incisors (-6°) may upright the lower labial segment which tends to be proclined following the functional appliance phase. Buccal root torque (14°) of the upper molars in the MBT prescription corrects buccal flaring caused by expansion with the functional appliance.
- *Tip values:* in the upper arch 0° mesial tip in the maxillary first molars and premolars is desirable to limit anchorage requirements and the tendency for overjet relapse. This option is available in both MBT and Roth prescriptions. A reduced tip maxillary canine MBT prescription (8°) also limits increases in maxillary arch length conserving anchorage and overjet correction.

Conclusions

In managing the transition to fixed appliances the effects of the functional phase of treatment must be critically assessed along with the residual malocclusion that is to be corrected. The beneficial dento-alveolar and skeletal changes (if any) introduced in the functional appliance phase should be retained while allowing treatment to proceed in a time-efficient manner. The authors make the following recommendations.

- Overcorrect with functional appliance aiming for a Class III incisor and buccal segment relationship.
- In non-extraction cases especially with increased MMPA headgear may be helpful and excessive use of Class II elastics should be avoided.
- In patients with a reduced MMPA and deep overbite, inclined bite planes with early use of Class II elastics may be preferable.
- The use of functional appliances with which fixed appliances can run concurrently can facilitate a smooth transition.

To try and ensure success, the orthodontist must use their clinical skills and invention when managing the transition from functional to fixed appliances. It should be remembered that each case is different, and therefore one stock approach will not fit all scenarios.

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