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A Modification to Enable Controlled Progressive Advancement of the Twin Block Appliance

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Abstract. *A modification of the Twin block appliance has been developed to facilitate controlled gradual advancement of the mandibular position during the treatment of Class II division I malocclusions. This features the incorporation of stainless steel screws with conical heads into the blocks of the upper appliance to provide the inclined plane effect. Advancement is by the addition of polyacetal spacers between the screw heads and the upper blocks. The system is designed to improve the clinical flexibility of the appliance and to enhance patient acceptance in cases where mandibular protrusion is limited initially. Another possible application is gradual reactivation for Class III correction. Other advantages are reduced laboratory and clinical time during reactivation of the appliance, and perhaps a more physiological response to the growth modification process. The design and construction of the advancement system is illustrated, and its clinical use discussed.*

Index words: Functional Appliance Advancement, Twin Block Appliance.

Introduction

The Twin block appliance was introduced by Clark (1982). Since then, the original design has evolved with reduced emphasis on the need for headgear and intra-oral elastic wear (Trenouth, 1989; Clark, 1995). This system is currently one of the most popular functional appliances used in the United Kingdom, and recent evidence would suggest that it is probably the most successful in the treatment of Class II division 1 malocclusions (Chadwick *et al*., 1997).

One of the drawbacks of the original design was the inconvenience of reactivating the appliance to achieve an edge-to-edge protrusive position in some patients to enable full overjet reduction, or to allow a degree of overcorrection. In the treatment of patients with large initial overjets, the appliances usually require block augmentation or even appliance remakes, since many patients are unable to tolerate mandibular protrusion greater than 7 mm. Patients with dolichofacial patterns tend to have weak cranio-mandibular musculature and are less able to tolerate large initial protrusions, sometimes showing a tendency to bite the occlusal blocks one upon the other, instead of in the correct protrusive position. In such cases, Clark (1995) recommends gradual bite advancement. Woodside (1977) recommended bite registration for the Andresen activator in a position where the mandible is advanced approximately 3 mm distal to the most protruded position the patient can achieve, while vertically the bite is registered with the limits of the freeway space.

In Class III treatments using the Twin block, difficulty may be experienced with reactivating the appliance. In these cases, a gradual reactivation of the bite would facilitate better patient compliance and a more favourable treatment progression.

There has been more recent evidence that gradual incremental advancement of the working bite during treatment of Class II divisions 1 malocclusions may give a more favourable response to the growth modification process with a reduced effect on incisor tilting (Petrovic *et al*., 1981; Falck and Frankel, 1989; De Vincenzo and Winn, 1989). Compliance may be greater with small increments of mandibular advancement by reduction of tension in the cranio-mandibular musculature. It has been suggested that this improves patient comfort and speech (Bass, 1996) with greater likelihood of maintaining the correct appliance position during sleep.

Currently, reactivation of the Twin block appliance requires the addition of cold curing acrylic at the chairside or, alternatively, time-consuming laboratory modification. The former has the following disadvantages:

1. Unpleasant taste and smell for the patient.
2. Inaccurate due to polymerization shrinkage.
3. The use of methyl methacrylate monomer and its potential hazards.
4. Increased chairside time and inconvenience.

Light-cured acrylic may be used as an alternative as this may reduce chairside time. The appliance still requires finishing and dust extraction facilities are required during trimming for operator protection. Using laboratory re-advancement of the appliance means that the patient is without the appliance for some time, and further clinical and laboratory time is required to adjust and re-fit the appliance.

The advantages of chairside advancement of the twin

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block appliance with an adjustable screw mechanism are as follows:

1. Accurate measurable advance.
2. Quickly adjusted at the chairside.
3. Avoids the use of free monomer.
4. Laboratory support unnecessary.
5. Asymmetric advancement facilitated.
6. Smaller adjustments possible to allow stepwise advancement and improve patient tolerance.
7. Gradual advancement, particularly appropriate in Class III Twin block treatments.
8. Reversible if over-advancement is produced.
9. More gradual mandibular advancement may be more physiological and, therefore, produce improved mandibular response.

Principle of the Twin Block Advancement Mechanism

The appliance modification consists of the insertion of a screw into the mesial face of each block of the upper appliance. The 3 mm diameter 18/8 M3 stainless steel screws have slotted pan heads which are machined to a cone shape giving an included angle of 140 degrees. This means that when positioned longitudinally in the block the screw head will always present a 70-degree angle with the face of the lower block regardless of the rotational position of the screw (Figures 1 and 3a). The screws are available in 12- and 16-mm lengths (R. S. Components, PO box 96, Corby Northants NN17 9RS, U.K.). The longer screws are used for advancements greater than 5 mm. Advancement is achieved by adding cylindrical polyacetal co-polymer spacers, which have been used in 1-, 2-, 3-, 4-, and 5-mm lengths. The mechanism can also be used for gradual Class III correction with the Class III Twin block design, where screws are incorporated into the maxillary appliance. Bite reactivation is by small (1-2 mm) increments using the spacers.

Construction

Original Prototype Appliances

These were made by drilling a 2·3-mm diameter hole along the length of the maxillary appliance blocks followed by cutting a square seating for the screw head and tapping using a 3-mm diameter plug tap. All later appliances were made by forming the blocks directly around the screw thread with the head of the screw retained by wax during build up of the baseplate (Figure 2a). These techniques had a number of disadvantages. It was difficult to achieve a consistent friction fit on the thread and some screws were found to be very right as a result. Positioning the screws had to be done by eye with increased likelihood of errors in alignment. Occasional cracking of the blocks occurred along the line of the screw, although this was alleviated by the use of higher quality self-cure acrylic and the incorporation of a wire support/strengthener. It was not possible to process the screws into the appliance using a heat cure technique. No grinding of the blocks could be carried out without seriously weakening the acrylic around the screws.

Screw Thread Housing

The above problems were overcome by the development of an injection moulded screw thread housing made from acetal resin (R. S. Components, PO box 96, Corby Northants NN17 9RS, U.K.), although any material with similar strength and frictional properties would be satisfactory. The housings have extended lateral tags moulded which serve both as a means of retaining the screws during processing (Figure 2b and c) and facilitate screw alignment by the temporary fitting of alignment rods during waxing up. These rods magnify the alignment of the screws both in relation to the occlusal plane and to the line of the arch. The housings prevent fracture propagation by strengthening the blocks laterally and provide a consistent fit on the screw threads. Limited grinding of the blocks may be carried out distal to the screw after advancement. A block height of 6 mm between the second premolars will be required to accomodate the screws. The following construction procedure has been adopted successfully:

The advancement screws are positioned using wax, either by inserting the tags through a wax dam on the buccal aspect for self-curing acrylic (Figure 2b), or by waxing directly onto the occlusal surface before building up the blocks in the usual way for heat cured acrylic. The screws

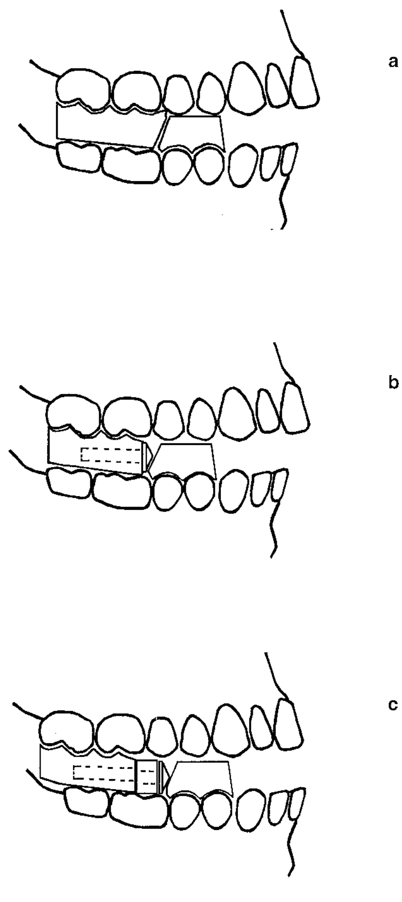


FIG. 1 Diagrammatic illustration of the principle of the Twin block advancement modification. (a) Conventional 70-degree inclines of the standard Twin block appliance. (b) Twin block modification incorporating advancement screws in the maxillary blocks which maintain the inclined plane effect with the mandibular appliance. (c) After re-advancement by insertion of spacer between screw head and maxillary block surface.

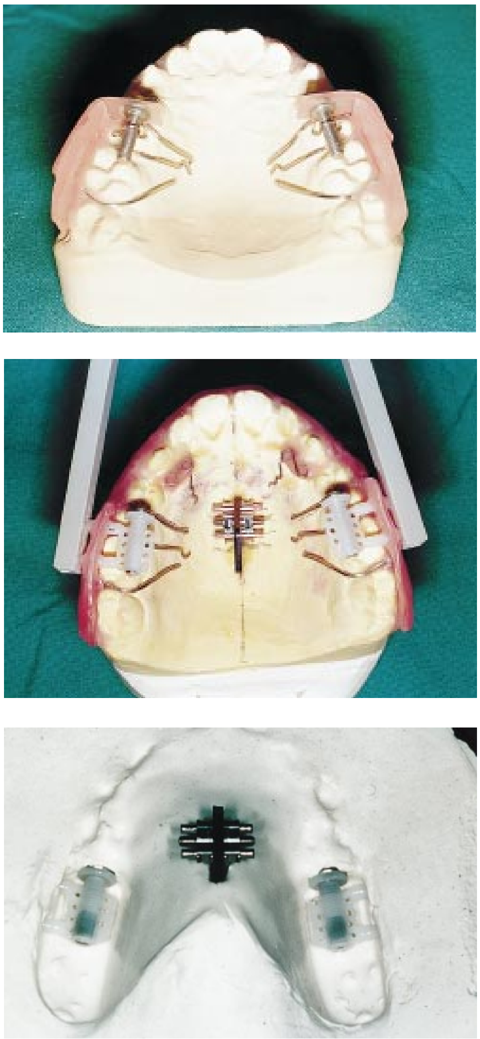
are aligned relative to the occlusal plane and to the midline. It is essential that the screws are positioned to prevent collision with the cusps of the maxillary first premolars on screw advancement.

Any mesial convergence of the screws will be cancelled out by the opening of the midline expansion screw, if fitted. It is preferable, however, to position the screws as parallel to the midline as possible. This ensures that they will act against the centre of the lower block faces when advanced. A large angle of convergence reduces the effective advancement of a given spacer length.

Housing tag extensions are cut off during finishing and the ends are polished flush with the buccal surface of the blocks (Figure 3c). After finishing the maxillary appliance (cold cure technique) the screw faces and blocks are waxed over leaving only the working facet exposed. The lower appliance is then formed against this and the resulting facets serve as a guide for finishing the block faces to the correct angle. For the heat cure technique, the lower block angle is determined during waxing up from the working face of the screw. It may not be possible always to get the screws precisely parallel with the occlusal plane, but provided that the screws are aligned in the same plane and that the lower block faces are complementary, a few degrees variance from the 70-degree ideal has proved to be perfectly satisfactory.

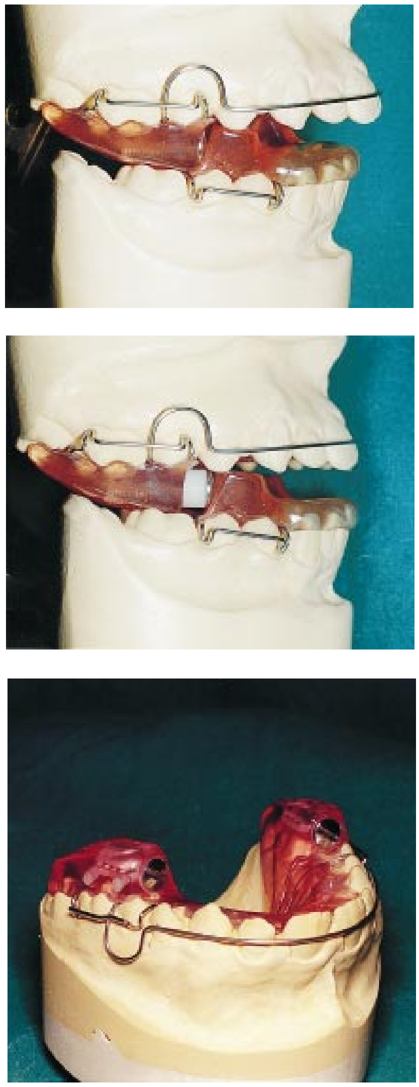
The Advancement Spacers (Fig. 3b)

These measure 6 mm in diameter and are constructed from polyacetal co-polymer resin (also known as acetal resin or polyoxymethylene). This is a modern thermoplastic produced by the polymerization of formaldehyde. It is highly crystalline in structure with linear unbranched chains of up to 75 per cent crystallinity. It has been used for dental applications for about 10 years, but due to the complexity of processing (it can only be injection moulded or machined from larger pieces) and the cost of the equipment required, its use in the UK has been limited largely to aesthetic clasps



(a) (b) (c)

FIG. 2 (a) Construction stage of modified maxillary appliance with direct screw insertion. (b) Construction stage using screw thread housing before self cure acrylic processing. Alignment rods allow accurate screw positioning and the housing enables heat cure or self cure acrylic processing. (c) Advancement screws with housings invested before heat cure acrylic processing.



(a) (b) (c)

FIG. 3 (a) Finished appliance (direct screw insertion) showing 70-degree block and screw inclines. (b) After appliance advancement with spacers. (c) Finished upper appliance incorporating screw thread housings.

for chrome partial dentures. The spacers are currently machined from 6 mm diameter pre-formed rods (R. S. Components, PO box 96, Corby Northants NN17 9RS, U.K.). It is envisaged that these would be injection moulded in a commercially-produced version of the system.

Acetal resin has a number of properties which can be exploited for orthodontic use. However, this use can only be viable if the products can be mass produced instead of individually custom made. The authors believe that this material has great potential for future use in orthodontic applications as preformed items. The following properties of acetal resin are of significance in this application:

1. It is non-toxic (Gandini *et al*., 1994) and non-allergenic (Caraffini and Calandra, 1990).
2. It is up to 10 times stronger than acrylic resin with a high elastic modulus and exhibits very low water absorption.
3. It has a high resistance to surface wear, but may be trimmed using standard dental rotary instruments.

Clinical use of the Advancement Mechanism

The twin block appliance is constructed by taking a protrusive wax bite with a degree of advancement which remains comfortable for the patient. In some cases this may be to an edge-to-edge bite, but in others as little as 2–3 mm may only be possible. Initially, the screws are inserted into the upper blocks without the addition of any advancement spacers. Once the appliance has been worn sufficiently to achieve the initial degree of overjet reduction, additional advancement can be made at subsequent visits by simply removing the advancement screws, and inserting spacers between the screw heads and the block faces (Figure 1c, 3b). In this way, a gradual reduction of the overjet can be achieved and a degree of over-correction obtained if required. The degree of each subsequent advancement can be individualized for each patient. In most cases 2–3 mm is suitable. For patients with mandibular dental asymmetry, it is possible to advance one side more than the other to obtain centre line correction. Advancements up to 9 mm have been achieved using the longer 16-mm screws.

In brachyfacial patterns with deep overbites, overbite reduction may be more problematical using this modification as the advancement screws reduce the potential for block trimming during the retention stage. Where a fixed appliance is planned to follow the functional appliance phase, overbite can be successfully managed with this. Where no fixed appliance is planned, several options exist for overbite control:

1. Use of an initial upper removable appliance (Phase 1 appliance, Trenouth, 1989, or ELSAA, Orton, 1990). This achieves overbite reduction and expansion before the Twin block appliance phase, and obviates the need for both block grinding and subsequent fitting of an inclined bite plane for this purpose during retention. It also makes the incorporation of a midline expansion screw into the Twin block maxillary appliance unnecessary, and often provides 2–3-mm overjet reduction from the retroclination of spaced, proclined incisors. During retention, gradual reduction of Twin block wear allows subsequent settling of the posterior open bites. This is the approach favoured by the authors.
2. Once an edge-to-edge occlusion has been achieved using the Twin block appliance, wear is gradually reduced during the retention period to allow settling of the posterior open bites.
3. Use of an upper removable retainer with an anterior inclined bite plane after the Twin block phase (Clark, 1995).

In dolichofacial patterns, overbite reduction generally is not necessary and all stages can be carried out using the Twin block appliance.

Discussion

The modification of the Twin block appliance has proved effective in over 70 Class II division cases, and no major problems have been experienced. Occasional cracking of the blocks overlying the screw threads has occurred after advancement. This has occurred in only two instances and in both cases the screws were inserted retrospectively and block heights were felt to be inadequate. In appliances which were constructed with the screw incorporated initially, few problems have been noted. Larger advancements by insertion of spacers of up to 9 mm have been successfully achieved by the use of the longer 16-mm screws.

Stainless steel used for the screws is tried and tested intra-orally, and has sufficient strength in small cross-sections to withstand distortion or fracture from occlusal forces. Acetal resin is used for construction of the advancement spacers and screw housings, and is a relatively new material in the dental field. Its use normally requires injection moulding and it may be known better for use in aesthetic clasps on chrome partial dentures. This resin is 10 times stronger than acrylic, but can be trimmed and polished in the same way making it ideal for use in this application.

Minor improvements to the system have been considered, for example, the use of screws with tamper-proof heads to prevent patients from interfering with the appliance. The screw thread housing is now used routinely as it facilitate chairside removal of the advancement screws, as direct insertion of the screw threads into acrylic has occasionally produced difficulty in screw removal. The housing also facilitates heat curing of the appliance if this is preferred, although the authors routinely use high quality self-cured acrylic which has proved very satisfactory. Although it has not been tried by the authors, the modification would lend itself to use in Class III Twin block appliances, where small increments of reactivation are necessary.

The main disadvantage of the system is the reduced facility for block trimming in the retention phase of treatment. As discussed above, however, this can be overcome in a number of ways, and the advantages of the system would appear to outweigh greatly the disadvantages. Since some of the components require injection moulding, mass commercial production is the only way to enable widespread availability of the system. This is currently being investigated.

Apart from the practical advantages of the modification, it is possible that greater clinical success may result from gradual bite advancement, both in terms of improved patient acceptance and also from a more favourable growth modification response. A randomized clinical trial is currently underway to clarify this.

Conclusions

A simple effective and reliable modification has been developed to facilitate incremental chairside advancement of the Twin block appliance. Currently, 70 appliances have been constructed in this manner with few problems arising. Commercial production is being investigated to enable the system to become widely available for clinical use. A clinical trial is in progress to compare the effectiveness of modified appliances with those of conventional design.

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