Journal of Orthodontics/Vol. 27/2000/219–225

Class II Correction-Reducing Patient Compliance: a Review of the Available Techniques

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Abstract. *The correction of Class II malocclusions has been hampered by the use of appliances which require the patient to co-operate with headgear, elastics, or the wearing of a removable appliance. 'Non-compliance therapy' involves the use of appliances which minimize the need for such co-operation and attempt to maximize the predictability of results. This article reviews and describes the types of appliances used, and their mode of action-based on the current available research.*

Index words: Non-compliance Therapy, Review.

Introduction

Successful orthodontic treatment often relies heavily on patient co-operation in the wearing of headgear, elastics, or removable appliances. Compliance with headgear is rarely optimal (Cureton *et al*., 1994). Clinicians have concerns about the safety of headgear to cause eye and facial tissue damage (Samuels, 1996) The treatment of Angles Class II malocclusions where maxillary molar distalization is required, is traditionally especially dependent on patient compliance. Eliminating the need to use headgear, inter-maxillary elastics or removable appliances places the treatment result more under the control of the orthodontist. The appliances in 'non-compliance' treatment have a number of features in common. Forces are applied using fixed auxiliaries either intra-arch or between arches. Most often multi-banded fixed appliances are used with lingual arches or fixed palatal buttons to control anchorage. Much use is made of resilient wires such as super-elastic nickel titanium and titanium-molybdenum alloys (TMA).

Non-compliance treatment modalities are not necessarily to be reserved for the 'non-compliant' patient, but may well have useful application with 'compliant' patients also. Placing the treatment outcome under the control of the orthodontist is likely to produce more predictable results.

Classification

The appliances can be classified into those that derive their anchorage in an inter-maxillary, intra-maxillary, or absolute anchorage manner (Table 1). Summaries of the available appliances are shown in Table 2 and 3.

Intermaxillary Appliances

Herbst Appliance

The Herbst appliance (Dentarum, 10 Pheasant Run, Newtown, PA 18940, USA) is a fixed functional appliance which has been popularized by Pancherz (1979). Much of the research into this effects of this appliance on the occlusion and dentofacial system has been carried out by this author. It consists of a bilateral telescopic mechanism that maintains the mandible in a protruded position. The Herbst can be a banded, cast, acrylic splint (McNamara and Brudon, 1993) or cantilever bite jumper (CBJ) appliance (Ormco Corporation, 1717 West Collins Ave, Orange, CA 92867, USA). The cast appliance and bite jumper designs are cemented and worn full time negating the need for co-operation. However, McNamara and Brudon (1993) do not advocate the cementing of the acrylic design and only recommend cementation of the maxillary splint when retention is inadequate.

Effects of the Herbst Appliance

The Herbst appliance can have a restraining effect on maxillary growth and a stimulating effect on mandibular

TABLE 1 *A classification of the non-compliance appliances*

Inter-maxillary
Herbst appliance
Jasper Jumper™
Adjustable bite corrector™
Eureka Spring™
Saif Springs
Mandibular anterior repositioning appliance
Klapper SUPERSpring™
Intra-maxillary
Pendulum/Pend-X appliance
Distal jet
Modified Nance arch with nickel-titanium coils or wire
Magnetic appliances
Jones Jig™
Lokar distalizing appliance
Molar distalizing bow
Absolute anchorage
Palatal implants

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growth. Sagittal growth may be increased whereas the vertical growth is unaffected by treatment. Pancherz (1979) reported that, with the banded appliance, sagittal molar correction was 43 per cent due to skeletal changes and 57 per cent due to dentoalveolar changes. The overjet correction was 56 per cent due to skeletal changes and 44 per cent due to dento-alveolar changes. Dento-alveolar changes include lower incisor proclination and maxillary molar distalization and intrustion. The changes are similar to those produced by high pull headgear (Pancherz and Anehus-Pancherz, 1993). Vertically, the overbite is reduced. This occurs by intrusion of lower incisors and enhanced eruption of lower molars (Pancherz, 1995) The long-term effect on mandibular growth is uncertain and may only have a short-term effect on skeletal growth pattern (Pancherz and Fackel, 1990). Hansen *et al*. (1990) found that the appliance did not have any adverse effects on the temporomandibular joint (TMJ).

The Herbst appliance is indicated in Class II division 1 growing patients with well-aligned arches. Pancherz (1995) also recommends its use in post-adolescent patients, mouth-breathers, uncooperative patients, and those that do not respond to removable functional appliances. It can also be used as part of a two-phase treatment, the first step being the orthopaedic phase and the second an orthodontic phase involving correction of crowding and alignment with fixed appliances. McNamara and Brudon (1993) reported a rebound effect with the lower incisors retroclining after treatment with the Herbst appliance, although this data was unpublished. The optimal time for treatment is at or just after the pubertal growth spurt, and when the permanent dentition is established. Treatment in the mixed dentition is not recommended because of the difficulty with the primary molars being shed. The appliance is prone to breakage and is limited to use in patients who can tolerate proclination of mandibular incisors.

Indications.

1. Dental Class II malocclusion.
2. Skeletal Class II mandibular deficiency.
3. Deep bite with retroclined mandibular incisors.

Contra-indications.

1. Cases predisposed to root resorption.
2. Dental and skeletal open bites.
3. Vertical growth with high maxillomandibular plane angle and excess lower facial height.

Jasper Jumper™

The Jasper Jumper™ (American Orthodontics, 1714 Cambridge Ave, Sheboygan, WI 53081-1048, USA) consists of two vinyl coated auxiliary springs which are fitted to fully banded upper and lower fixed appliances. The flexible springs are attached to the maxillary first molars posteriorly and to the mandibular archwire anteriorly with the springs resting in the buccal sulcus. The springs hold the mandible in a protruded position. The appliance is said to produce rapid inter-arch changes similar to those produced by the Herbst appliance. The Jasper Jumper can be used for patients with Class II malocclusions with deep bites. Cope *et al*. (1994) quantified the action of the Jasper Jumper showing that the majority of the action was due to dental, rather than skeletal change, although the maxilla underwent significant posterior displacement and the mandible clockwise rotation.

The Jumper springs, are available in a number of pre-made sizes, paired left and right. They are attached to the maxillary first molar headgear tube with a soft wire with a ball on one end. The amount of mandibular advancement is adjusted by lengthening or shortening the maxillary connection wire. The jumper mechanism fits over the lower archwire. A lateral bayonet bend is placed distal to the lower canines and usually the brackets on the lower first premolars are removed. A jig is available which avoids the need for the bayonet bend and removing the bracket on the first premolar. A small acrylic ball is placed adjacent to the bayonet bend and then the archwire is placed through the hole on the anterior portion of the jumper (Blackwood, 1991).

A heavy archwire with lingual root torque is used in the mandibular dental arch in order to maintain lower anchorage. There also is a danger of lower incisor proclination if the archwire is not tied back. When fully extended, the jumper mechanism produces an anterior positioning of the lower jaw in a manner similar tot he Herbst appliance, but with more flexibility. Usually, 6–9 months of Jumper wear is necessary in order to correct a mild Class II problem in patients who still have some growth remaining. Additional treatment time may be required in patients with more severe problems.

Indications.

1. Dental Class II malocclusion.
2. Skeletal Class II with maxillary excess as opposed to mandibular deficiency.
3. Deep bite with retroclined mandibular incisors.

Contra-indications.

1. Cases predisposed to root resorption.
2. Dental and skeletal open bites.
3. Vertical growth with high mandibular plane angle and excess lower facial height.
4. Minimum buccal vestibular space.

The Adjustable Bite Corrector™

The Adjustable Bite Corrector™ (ABC) appliance (Ortho Plus Inc., 1275 Fourth Street, Suite 38, Santa Rosa CA) introduced by West (1995) functions in a similar way to the Herbst appliance and the Jasper Jumper. The advantages include universal left and right sides, adjustable length, stretchable springs, and easy adjustment of the attachment parts. No long-term studies have been carried out on this appliance in the present literature to date.

The Eureka Spring™

Devincenzo (1997) described the Eureka Spring™ (Figure 1) (Eureka Spring Inc., 1312 Garden St, San Luis Obispo, CA 93401, USA), which is a fixed inter-maxillary force delivery system. The main component of the spring is an open wound coil spring encases in a telescoping plunger assembly. The springs rest in the buccal sulcus and attach posteriorly to headgear tubes on the upper first molars, and

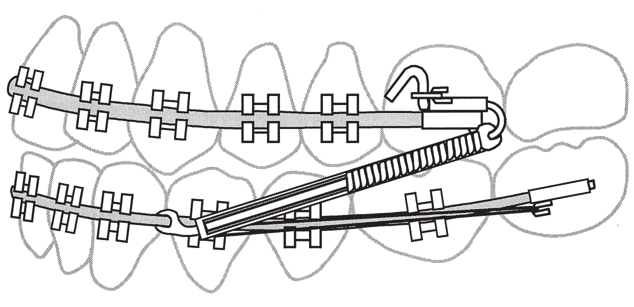

FIG. 1 The Eureka Spring.

anteriorly to the lower archwire distal to the cuspids. A triple telescoping action allows opening of the mouth to 60 mm before disengaging. The spring exerts 16 g for every millimetre of ram compression (J. Devincenzo, personal communication). The appliance is designed to be used in conjunction with fully banded upper and lower fixed edgewise appliances with heavy rectangular lower arch in place. Labial root torque to the lower incisors needs to be applied to match the anchorage requirements and buccal root torque should be applied to the upper first molars. The appliance should only be used in conjunction with a transpalatal bar. The mechanics of the appliance has the opposite effect to that of Class II elastics in that it acts to intrude both the lower incisors and the upper molars. The effects of this appliance are entirely dentoalveolar, and no orthopaedic or bite jumping effects are claimed by the clinicians who have developed the appliance. The dento-alveolar effects achievable with this appliance include maxillary molar distalization or advancement of the lower anterior teeth in Class II cases. A recent study carried out on 37 consecutive class II treatments was reported to produce an antero-posterior correction of 0·7 mm per month with equal amounts of maxillary and mandibular movement (J. Devincenzo personal communication).

Indications.
1. Dental Class II malocclusion.
2. Deep bite with retroclined mandibular incisors.

Contra-indications.
1. Class III with anterior open bites.
2. Procumbant lower incisors.
3. Deep buccal overbites or posterior crossbites.
4. Extremely tight buccal musculature.
5. Minimal buccal vestibular space.

Saif Springs

These are long nickel-titanium closed coil springs that are used to apply Class II inter-maxillary traction when fully banded fixed appliances are in place (Saif Springs, Pacific Coast Manufacturing Inc, 18506 142nd Ave, NE Woodinville, WA 98072, USA). The springs are tied in place with steel ligatures and are worn in place of inter-maxillary elastics. The springs are available in two lengths 7 and 10 mm. No longitudinal research studies on this auxillary are available in the literature to date. Starnes (1998) recommends that for successful treatment to be carried out the prerequisites are as follows:

- prior correction of deep bites;
- stabilization of each arch with a large rectangular archwire;
- direction of force as horizontal as possible;
- sufficient resistant torque (lower incisor lingual crown torque);
- perfect fit of bands;
- proper placement of hooks for spring attachments.

The Mandibular Anterior Repositioning Appliance

The Mandibular Anterior Repositioning Appliance (MARA, Allesee Orthodontics Appliances, PO Box 725, Sturtevant, WI 53177, USA) MARA (Figure 2) consists of cams made from 0·060 square wire attached to tubes (0·062 square) on upper first molar bands or stainless steel crowns. A lower first molar crown has a 0·059 arm projecting perpendicular to its buccal surface, which engages the cam of the upper molar. The appliance is adjusted so that when the patient closes, the cam on the upper first molars guides the lower first molars and repositions the mandible forwards into a Class I relationship. There have been no studies to date documenting results achieved with this appliance. The developers of the appliance recommend a 12-month treatment time to achieve a bite jumping or orthopaedic effect. Stabilization of the lower molars is assisted by the fitting of a lingual arch and on the upper arch a transpalatal bar to stabilize the upper molars is placed. This appliance does not require the placement of attachments on teeth other than the first molars.

Indications.
1. Skeletal Class II with mandibular deficiency.

Contra-indications.
1. Dolichofacial growth pattern.
2. Cases predisposed to root resorption.
3. Dental and skeletal open bites.
4. Vertical growth with high mandibular plane angle and excess lower facial height.

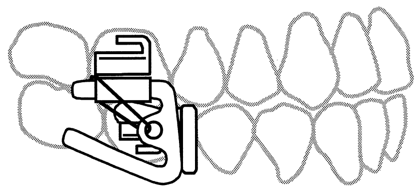

FIG. 2 The mandibular anterior repositioning appliance (MARA).

The Klapper SUPERspring™

This appliance is an auxiliary which is fitted to fully banded upper and lower fixed appliances (Figure 3) (ORTHOdesign, 744 Falls Circle, Lake Forest, Illinois 60045, USA. The appliance consists bilaterally of a length multi-flex nickel-titanium which is bent back on itself attaching to the upper first molar tube and attaching to the lower archwire by means of a helical loop. The springs lie in the buccal vestibule. The effect of the spring is to place a distalizing and intrusive force to the upper first molar. The appliance comes in two sizes, a 27-mm primarily designed

TABLE 2 *Summary of the inter-maxillary appliances*

	Indication	Contra-indications	Mechanics	Anchorage	Effect upper molar	Manufacturer
Herbst	Dental Class II malocclusion Skeletal Class II mandibular deficiency Upper molar distalization Lower incisor advancement	Cases prone to root resorption Dental and skeletal open bites Vertical growers	Bilateral telescoping mechanism advancing the mandible into new position	Lower lingual arch or lower acrylic splint	Distalizing, intrusive, expands laterally	Dentaurum Inc. and others
Jasper Jumper™	Dental and Skeletal Class II malocclusion with maxillary excess deep bite with retroclined incisors	Root resorption Open bites Vertical growers Minimal vestibular space	Inter-maxillary springs in compression	Fully banded lower arch with torque control	Distalizing, intrusive, expands laterally	American Orthodontics
MARA	Skeletal Class II with mandibular deficiency. Lower incisor advancement	Root resorption. Dolicofacial growth pattern	Bilateral cams fitted to molar stainless steel crowns to advance mandible	Lower lingual arch and transpalatal arch	Distalizing	AOA Laboratories
Saif Springs	Class II traction	Deep bite cases	Class II coil springs in tension	Fully banded lower arch with torque control	Extrusive to lower molar	Pacific Coast Manu. Ltd
Klapper Springs™	Upper molar distalization. Lower incisor advancement	Open bites. Vertical grower. Minimal vestibular space	Intermaxillary spring in torsion	Fully banded upper and lower arch with torque control with trans-palatal arch	Distalizing, intrusive, expands laterally	ORTHOdesign
Eureka Spring™	Dental Class II malocclusion. Upper molar distalization Lower incisor advancement	Class III with open bites. Procumbent Class II incisors. Deep buccal overbites or posterior crossbites	Telescopic rods with integral light force compression springs	Fully banded upper and lower arch with torque control with transpalatal arch	Distalizing, intrusive, expands laterally	Eureka Spring Inc.

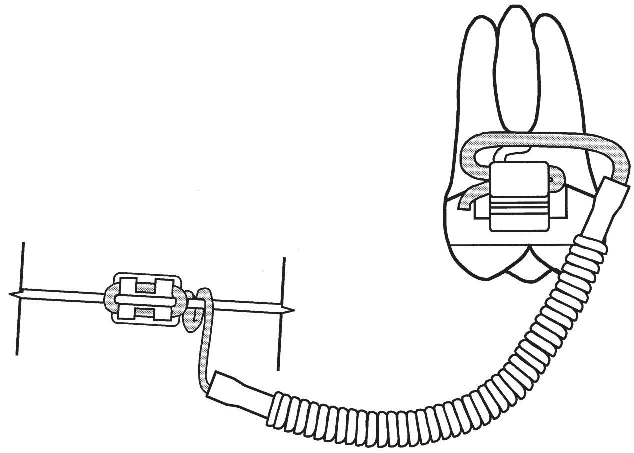

FIG. 3 The Klapper SUPERspring.

for extraction cases and 40-mm for non-extraction cases. The springs are paired for left and right sides. The latest design of the spring requires a special oval tube to be fitted to the upper first molars. This facilitates buccolingual adjustment of the springs in the vestibule and aids patient comfort. The springs can be readily removed for adjustment or activation. There have been no studies to date documenting results achieved with this appliance.

Indications.
1. Dental Class II malocclusion.
2. Deep bite with retroclined mandibular incisors.

Contra-indications.
1. Cases predisposed to root resorption.
2. Dental and skeletal open bites.
3. Vertical growth with high mandibular plane angle and excess lower facial height.
4. Minimum buccal vestibular space.

Intramaxillary Appliances

Pendulum Appliance

This appliance first described by Hilgers (1992) uses a large Nance button in the palate for anchorage and 0·032-inch TMA springs (Ormco Corporation) that deliver a distalizing force to the upper molars. The springs insert into lingual sheaths on the palatal surface of the band. The anterior portion of the appliance is retained with premolar bands, which are joined to the appliance using a retaining wire. Occlusally-bonded rests on the primary molars or second premolars add to the retention. If expansion of the upper arch is indicated, then a midline screw can be added to the appliance. This version of the appliance is known as the Pend-X appliance.

Byloff and Darendeliler (1997) showed that the appliance moved molars distally without creating bite opening, but the molars did tend to tip. At the incisal edge was the anchorage loss was measured at 0·92 mm (SD ±0·67). Second premolar anchorage loss was measured at a mean of 1·63 mm (SD ±1·23), but distal movement of the molar represented 71 per cent of the space opened. If molar uprighting bends were incorporated into the appliance it reduced the tipping, but increased the anchorage loss at the premolars by 0·61 mm and the incisal edge by 0·62 mm (Byloff *et al*., 1997).

Ghosh and Nanda (1996) also found that the pendulum appliance is a reliable method for distalizing maxillary molars at the expense of moderate anchorage loss. The advantages of the appliance lie in its minimal dependence on patients compliance, ease of fabrication, one time activation, adjustment of the springs if necessary to correct minor transverse and vertical molar positions, and patients acceptance. The mean maxillary molar movement was 3.4 mm with a distal tipping of 8.4 degrees. There was, however, 2.5 mm mesial movement of the first premolar, which represents some anchorage loss. Thus, for every millimetre of distal molar movement, the premolar moved mesially 0·75 mm.

Hilgers (1992) reports that when the appliance is placed before the eruption of the second molars, two-thirds of the tooth movement is molar distalization, one-third is experienced as forward shift of the anchor bicuspids. If placed after eruption of the second molars, the experience tends to be reversed, one-third distal movement of the first molar, and two-thirds anchorage slip.

Indications

1. Distalization of upper first molars before eruption of second molars.

Contra-indications.

1. Lack of teeth anterior to the first molars to retain the appliance.
2. Upper second molars have erupted.

Jones Jig™ and Lokar Distalizing Appliance

These appliances use open coil nickel-titanium springs in compression to deliver 70–75 g of force over a compression range of 1–5 mm to the upper first molars, and use a Nance button attached to the upper first or second bicuspids or the primary molars (Jones and White, 1992). There are two variations of the Jones Jig (American Orthodontics; Figure 4), one being used when the second premolar is available for anchorage, the other when it is not available. A similar mechanism, called the Lokar distalizing appliance, has been developed by Ormco Corporation. It has reported advantages of ease of insertion and ligation. To date, no published clinical trials have emerged on either of these appliances.

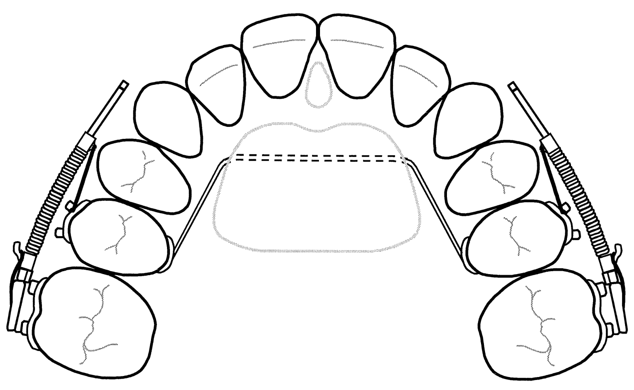

FIG. 4 A modified Nance button banded to the second premolars with Jones Jig assemblies tied in place.

Distal Jet

Carano *et al*. (1996) described the design and use of this appliance (American Orthodontics; Figure 5). They claim that it overcomes the disadvantages of other appliances for distalizing molars by reducing the tendency for the teeth to tip. Bilateral tubes of 0·036-inch internal diameter are attached to an acrylic Nance button. A coil and screw clamp are slid over the tube. The wire from the acrylic ends in a bayonet bend and inserts into a palatal sheath on the molar band. The force acts through the centre of resistance of the molar and thus is said to translate the tooth. The Nance button is also attached to a premolar band via a connecting wire. The appliance is activated by sliding the clamp closer to the molar and can be converted to a conventional Nance by severing the attachment to the premolar bands. The authors claim that the rate of movement is comparable to the Jones Jig or magnets, and is achieved by bodily translation. No clinical trials have been published on this appliance.

Nance Arch and Coil Springs

Several authors have described the use of a modified Nance arch with coils to distalize molars. Open coil springs are commonly used in orthodontic practice, but there have been few experimental studies on their clinical effects. Gianelly *et al*. (1991), obtained an average of 1–1·5 mm molar distalization in 1 month by 8–10 mm activation of super-elastic nickel-titanium coil springs. To maintain anchorage, a modified Nance appliance was cemented to the upper first premolars. An additional means of anchorage reinforcement involved the incorporation of uprighting springs to tip the crowns of these teeth. Pieringer *et al*. (1997) found it to be an effective method of moving molars posteriorly requiring minimal co-operation. Gianelly (1998) describes the distalization of molars using rectangular Neosentalloy wire (G.A.C. International, 1850 val Drive, Central 9 sl. p, NY 11722) using a similar mechanism.

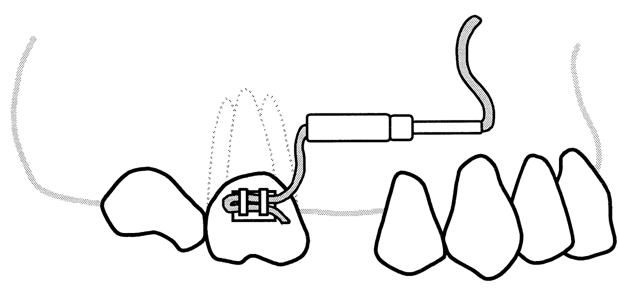

FIG. 5 Distal jet: a wire from a Nance button ends in a bayonet bend in the palatal molar sheath. A stainless steel coil exerts a distalising force against the first molar.

TABLE 3 *Summary of the intra-maxillary appliances*

Appliance	Anchorage	Force delivery to upper 1st molar	Manufacturer
Pendulum appliance Pend-X	Bonded to upper first premolars	TMA 0·027 wire	Ormco Corp
Distal jet	Nance button	Palatal Ni-Ti coils	American Orthodontics
Nance with Ni-Ti coils	Nance button	Neosentalloy coils	GAC
Jones Jig	Nance button	Ni-Ti coils	American Orthodontics
Lokar	Nance button	Ni-Ti coils	Ormco Corp
Molar distalizing bow	Thermoplastic splint	Ni-Ti coils or loops	
Palatal implant	Palatal implant	Various	Straumann Inc.
Repelling magnets/Magnaforce™	Nance button	Repelling magnets	Ormco Corp

Repelling Magnets

Gianelly *et al*. (1989) achieved molar distalization using repelling magnets. They suggested weekly activation of the magnets in order to maximize the force and stated that in cases with second molars in complete occlusion, distalization took longer. Anchorage loss in this study was calculated at 20 per cent. Itoh *et al*. (1991), also have used repelling magnets for molar distalization; they recommended activation of the magnets at intervals of 2 weeks and reported an anchorage loss of 30–50 per cent.

Erverdi *et al*. (1997) compared two different methods of molar distalization using nickel-titanium and repelling magnets finding that the nickel-titanium to be more effective in terms of the movement achieved. It was found that the first molars moved a mean of 2.1 mm with tipping of 7.6 degrees using repelling magnets. With the coil springs, the amount of distalization was 3.8 mm with 9.9 degrees of tipping. Bondemark and Kurol (1992) reported effective molar distalisation, together with distobuccal rotation using magnetic force. Bondemark *et al*. (1994) found that when comparing magnetic force to super-elastic force to distalize molars that distal movement was greater for the supercoils (3.2 versus 2.2 mm). Recently, Ormco Corporation have marketed a new appliance the Magnaforce™. Doĝanay *et al*. (1998) examined the effects of magnetic versus the Wilson bimetric distalizing arch finding that no bodily movement occurred in either group, but that significant tipping occurred, which may result in stability problems.

Molar Distalizing Bow

Jeckel and Rakosi (1991) described the use of an intra-oral removable appliance which consists of two components. First, a 0·8–1·5 mm thick thermoplastic splint extending into the buccal sulcus. A distalizing bow fits into the anterior slot and carries coil springs to apply a force to the molars. The amount of distal movement can be regulated with adjustable stops. To activate the appliance the central section of the bow must be fitted in the anterior slot by manual pressure against the elastic resistance of the springs or loops so that the force is generated to the molar tubes. No clinical trials have been published on this appliance.

Palatal Implants

Wehrbein *et al*. (1996) described the use an endosseous implant (Straumann AG, CH-4437, Waldenburg, Switzerland) inserted into the palate, which acts as anchorage for retraction of the anterior teeth. The implant is inserted into the palate and consists of a transmucosal fixture with a clamping cap fixed by an occlusal screw. A transpalatal bar is attached to this implant and the system used as the anchorage control unit for retraction of anterior segments. The advantages over the use of headgear are obvious. Problems include cost, failure of implant, difficulty of removal, and no long-term trial results are available. Glatzmaier *et al*. (1996) described the use of a biodegradable implant for orthodontic anchorage in a laboratory study. The authors suggested that the stability of this implant it may be clinically sufficient. Block and Hoffman (1995) described the use of onplants for absolute orthodontic anchorage. The onplant has an internal thread for placement of a transgingival abutment. The abutment is designed to receive a 0·051-inch wire. The onplant has the advantage that it is relatively easy to place and recover.

Conclusions

The need for patient compliance is achieving Class II correction is often the most limiting factor in determining the duration of treatment and the quality of result achieved. Non-compliance therapy aims to remove some of these patient determined variable factors. While this type of treatment may be useful in the non-compliant patient, reducing the need for compliance in all our patients may be advantageous. In the case of the inter-maxillary appliances the lower arch is used as anchorage. In the intra-maxillary appliances the upper anterior teeth, premolars, and the palatal vault/palatal bone are used for anchorage control. Anchorage loss can occur in either the inter-maxillary appliances or intra-maxillary appliances resulting in lower incisor proclination or overjet reduction, respectively. Other disadvantages include the rate of breakage and relatively high cost of these appliances.

References

Blackwood, H. O. (1991)
Clinical management of the Jasper Jumper,
Journal of Clinical Orthodontics, **25,** 755–760.

Block, M. S. and Hoffman, D. R. (1995)
A new device for absolute anchorage,
American Journal of Orthodontics and Dentofacial Orthopedics, **107,** 251–258.

Bondemark, L. and Kurol, J. (1992)
Distalisation of maxillary first and second molars simultaneously with repelling magnets,
European Journal of Orthodontics, **14,** 264–272.

Bondemark, L., Kurol, J. and Bernhold, M. (1994)
Repelling magnets versus superelastic NiTi in simultaneous distal movement of maxillary first and second molars,
Angle Orthodontist, **64,** 189–198.

Byloff, F. K. and Darendeliler, M. A. (1997)
Distal molar movement using he pendulum appliance, Part 1: clinical and radiological evaluation,
Angle Orthodontist, **67,** 249–260.

Byloff, F. K., Darendeliler, M. A., Clar, E. and Darendeliler, A. (1997)
Distal molar movement using the pendulum appliance, Part 2: the effects of maxillary molar root uprighting bends,
Angle Orthodontist, **67,** 261–270.

Carano, A., Testa, M. and Sicikliana, G. (1996)
The lingual distaliser system,
European Journal of Orthodontics, **18,** 445–448.

Cope, J. B., Buschang, P. H., Cope, D. D., Parker, J. and Blackwood, H. O. (1994)
Quantitative evaluation of craniofacial changes with Jasper Jumper therapy,
Angle Orthodontist, **64,** 113–122.

Cureton, S. L., Regennitter, F. J. and Yancey, T. M. (1993)
The role of the headgear calender in headgear compliance,
American Journal of Orthodontics and Dentofacial Orthopedics, **104,** 387–394.

Devincenzo, J. (1997)
The Eureka Spring: a new interarch force delivery system,
Journal of Clinical Orthodontics, **31,** 454–467.

Doĝanay, A., Kucukkeles, N., Koyutuk, O. and Erverdi, N. (1998)
Comparison of two intraoral molar distalization methods: magnets versus bimetric distalization arches,
European Journal of Orthodontics, **20,** 467–468 (Abstract).

Erverdi, N., Koyuturk, O. and Kucukkeles, N. (1997)
Nickel-titanium coil springs and repelling magnets—a comparison of two different intra-molar distalization techniques.
British Journal of Orthodontics, **24,** 47–53.

Ghosh, J. and Nanda, R. (1996)
Evaluation of an intraoral maxillary molar distalisation technique,
American Journal of Orthodontics and Dentofacial Orthopedics, **110,** 639–646.

Gianelly, A. A. (1998)
Distal movement of maxillary molars,
American Journal of Orthodontics and Dentofacial Orthopedics, **114,** 66–72.

Gianelly, A. A., Vaitas, A. S., Thomas, W. M. and Berger, D. G. (1989)
The use of magnets to move molars distally,
American Journal of Orthodontics and Dentofacial Orthopedics, **96,** 161–167.

Gianelly, A. A., Bednar, J. and Deitz, V. S. (1991)
Japanese Ni Ti coils used to move molars distally,
American Journal of Orthodontics and Dentofacial Orthopedics, **99,** 564–566.

Glatzmaier, J., Wehrbein, H. and Diedrich, P. (1996)
Biodegradable implants for orthodontic anchorage—a preliminary biomechanical study,
European Journal of Orthodontics, **18,** 465–469.

Hansen, K., Pancherz, H. and Petersson, A. (1990)
Long-term effects of the Herbst appliance on the craniomandibular system with special reference to the TMJ,
European Journal of Orthodontics, **12,** 244–253.

Hilgers, J. J. (1992)
The pendulum appliance for Class II non-compliance therapy,
Journal of Clinical Orthodontics, **26,** 706–714.

Itoh, T., Tokuda, T., Kiyosue, S., Hirose, T., Matsumato, M. and Chaconas, S. (1991)
Molar distalisation with repelling magnets,
Journal of Clinical Orthodontics, **25,** 611–617.

Jeckel, N. and Rakosi, T. (1991)
Molar distalisation by intraoral force application,
European Journal of Orthodontics, **13,** 43–45.

Jones, R. D. and White, J. M. (1992)
Rapid Class II molar correction using an open coil jig,
Journal of Clinical Orthodontics, **26,** 661–664.

McNamara, J. A. and Brudon, W. L. (1993)
Orthodontic and orthopedic treatment in the mixed dentition, Ann Arbor, USA. Needham Press.

Pancherz, H. (1979)
Treatment of Class II malocclusion by jumping the bite with the Herbst appliance, a cephalometric investigation,
American Journal of Orthodontics and Dentofacial Orthopedics, **76,** 423–442.

Pancherz, H. (1995)
The Herbst appliance,
Editorial Aguairam Sevilla Espana.

Pancherz, H. and Anehus-Pancherz, M. (1993)
The headgear effect of the Herbst appliance: a cephalometric long term study,
American Journal of Orthodontics and Dentofacial Orthopedics, **103,** 510–520.

Pancherz, H. and Fackel, U. (1990)
The skeletofacial growth pattern pre- and post-dentofacial orthopaedics. A long-term study of Class II malocclusions treated with the Herbst appliance,
European Journal of Orthodontics, **12,** 209–218.

Pieringer, M., Droschl, H. and Permann, R. (1997)
Distalisation with a Nance appliance and coil springs,
Journal of Clinical Orthodontics, **31,** 321–326.

Samuels, R. H. A. (1996)
A review of orthodontic facebow injuries and safety equipment,
American Journal of Orthodontics and Dentofacial Orthopedics, **110,** 269–272.

Starnes, L. O. (1998)
Comprehensive Phase 1 treatment in the middle mixed dentition,
Journal of Clinical Orthodontics, **32,** 98–110.

Wehrbein, H., Merz, B. R., Diedrich, P. and Glatzmaier, J. (1996)
The use of palatal implants for orthodontic anchorage,
Clinical Oral Implant Research, **7,** 410–417.

West, R. P. (1995)
The Adjustable bite corrector,
Journal of Clinical Orthodontics, **29,** 650–657.