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CLINICAL SECTION

The Dynamax System: A new orthopaedic appliance and case report

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The Dynamax appliance is a treatment modality for the correction of the Skeletal II malocclusion characterized by a mandibular retrusion. Progressive mandibular advancement, maxillary expansion, control of maxillary growth, incisor torque and control of vertical facial development are incorporated into a two-part appliance. The design facilitates laboratory construction, clinical handling and patient acceptability.

A prefabricated spring module forms the basis of the appliance, allowing both maxillary expansion and mandibular advancement. An easily adjustable progressive forward position of the lower jaw makes a construction bite unnecessary.

The spring module provides most of the structure of the appliance so that minimal acrylic is required and the appliance is fully contained within the freeway space. Contact between the upper and lower parts of the appliance occurs posteriorly in the lingual sulcus. Here the depth permits an extended vertical contact, to maintain a protrusive mandibular position throughout the range of mandibular opening, including during sleep. The lower portion of the appliance may be fixed or removable and multibracket treatment can be carried out in one or both arches at the same time as the orthopaedics.

Key words: Skeletal II malocclusion, Dynamax, orthopaedic, two-part appliance, progressive mandibular advancement, simultaneous multibracket treatment

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Introduction

In the correction of a Skeletal II malocclusion, the clinician has three choices to reduce the overjet; by bodily retraction of the maxillary incisors, bringing the lower incisors forward or a combination of both. However, simply tipping the lower incisors forward will generally result in an unstable situation and bodily retraction of the upper incisors, in most Skeletal II cases, leaves the upper labial segment too far back in the face for full exposure in the smile.[1,2] Additionally, the retrusive appearance of the chin will not be corrected.

In a growing patient, a better aesthetic result would ideally be obtained by using an orthopaedic appliance to accelerate the development of the mandible[3–10] by acceleration of growth at the condyles[11,12] and bone apposition in the condylar fossae.[13–17] This orthopaedic phase is generally followed by a separate stage of fixed appliance therapy to align the dentition and establish an optimal occlusion. Efficiency in treatment delivery is significantly improved by the ability to place a full multi-bracket fixed appliance to level and align the arches, concurrent with the orthopaedic phase. Not many orthopaedic appliances are able to achieve this objective, although the original Bass appliance system[5–7,17–19] does approach this. However, this system relies on hand-made modular components, requires a skilled technician in the laboratory and is not as patient-friendly as would be desirable. For these reasons, and to be cost-effective by using components manufactured to a consistent specification on fully automated machinery, the system has been redesigned to provide the new Dynamax appliance (Figures 1, 2 and 3) which is simple to construct and intuitive to use,[20] while still retaining the positive features of the old appliance.

From a clinical perspective, the Dynamax appliance offers the following advantages:

A. **The need for two separate stages in treatment has been eliminated.** Bracketed appliances can easily be utilized at the same time, either in one or both arches. (Figures 4 and 9).This allows the use of the Dynamax to be continued for several months after the initial orthopaedic correction has been achieved, either full-time or at night only. This is a significant feature and eliminates a major drawback in the use of many orthopaedic or functional appliances, where there is often a need for an additional interim stabilising phase, to avoid the relapse which may be seen if the orthopaedic phase is abruptly

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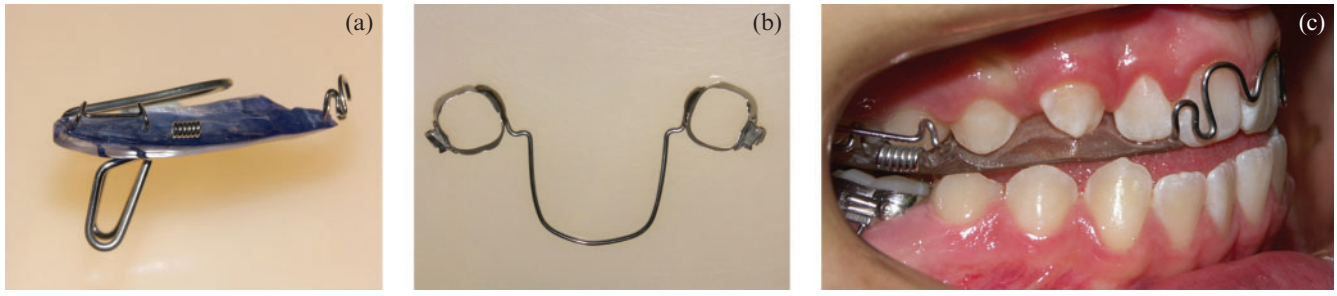

Figure 1 (a) The Dynamax appliance, upper component. (b) Lower component, fixed lingual arch with 'shoulders'. (c) Intra oral view of appliance

Figure 2 (a-c) The contact between the vertical portion of the spring and the shoulder on the lingual arch provides a protrusive mandibular position

Figure 3 Intra oral view of fixed lower component

discontinued. Extrapolation from experimental primate studies[16,21] to humans indicates that the newly formed cartilage in the joint begins to develop into immature woven bone only after at least 6 months of advancement therapy, continuing for 9 months or more. If the advancement therapy is discontinued too early, a partial relapse can be expected, due to the stretch of the anterior digastric muscles and perimandibular connective tissues tending to seat the condyles back in the fossae.[16] Maintaining mandibular advancement, while aligning the dentition with fixed appliances, gives time for the new bone to consolidate, without delaying the progress of treatment.

B. **Incremental mandibular advancement.** This is carried out in small steps from an initial 3–4 mm protrusion, permitting the patient to easily hold the mandible forward of the protrusive contact. The appliance encourages the development of an 'avoidance reflex' and the mandible is held forward by the patient's own musculature rather than by the appliance. This is the opposite of most functional appliances, where considerable forces are developed in the dental arches as the musculature pulls the mandible back against the appliance.[22] When an appliance forces the protrusion of the mandible, only the retracting muscles are active and the mandibular protraction muscles appear to be inactive.[23] Stimulating the patient to position the mandible forward by an 'avoidance reflex' means that very little force, if any, is exerted on the lower dentition. In contrast, the forces generated by the retraction muscles can cause considerable proclination of the lower incisors. For example, in a

Figure 4 (a) With multibrackets in the lower arch to level and align. (b) The lingual arch integrates fully with the lower brackets. (c) Brackets are fully compatible with the orthopaedics. Note the extent of mouth opening required to disengage the vertical springs from the lingual arch

prospective study of 36 patients, the Twin Block appliance resulted in an average 8° proclination of the lower incisors.[24] Stepwise advancement has also been shown by some to promote skeletal change, rather than dento-alveolar change.[22,25,26] This approach is supported by experimental animal research.[27]

C. **Upper incisor inclination is controlled and tipping prevented.** A torque spring attached to the anterior part of the appliance (Figure 5) is a feature of the original Bass appliance[28] and has been shown to prevent unwanted retroclination of the incisors[9,17] avoiding any restriction to maximum forward development of the mandible.

D. **A modified fixed lingual arch as the lower component makes the appliance comfortable and convenient for the patient.** Patients who perceive an appliance to be bulky or uncomfortable are unlikely to wear it sufficiently for it to be effective. Studies have shown between 34 and 49% of patients failing to use removable functional appliances as directed.[29,30] During mixed dentition treatment, the modified lingual arch serves to maintain the leeway space, reducing the need for permanent extractions[31] and promoting treatment efficiency.

E. **Extra oral traction may be added, to control the growth of the maxilla.** This can be achieved both horizontally and vertically.[17,32,33] Control over the vertical dimension is an important aspect of orthopaedic therapy[34] particularly in a long-face case.

Figure 5 The torque spring controls the inclination of the upper incisors and prevents unwanted retroclination

Appliance design

The orthopaedic appliance consists of 2 parts (Figures 1 and 6). The upper is removable; the lower is cemented to the first molars (Figures 1, 2 and 3). A removable version of the lower can also be used (Figure 6). The fixed lingual arch is the preferred design as it allows the concurrent use of a multibracket appliance. It is also an advantage in the late mixed dentition stage, when loose deciduous teeth may create a problem with a removable appliance.

The maxillary part of the system (Figure 1) has the following features:

Retention

- Adams' clasps on the first molars. Clasps on the deciduous second molars or second premolars are optional.
- An anterior torque spring[4–6,28]
- Capping of the buccal segments and incisors may also be used for retention, particularly if a 'pull-down' construction process is used.

Expansion of the upper arch is often indicated to avoid the development of cross-bites and is achieved by the spring incorporated into the palatal part of the appliance. It also aids maxillary development, providing more space in the arch for dental alignment.

Mandibular advancement is stimulated by vertical spring projections in the first molar area, which come

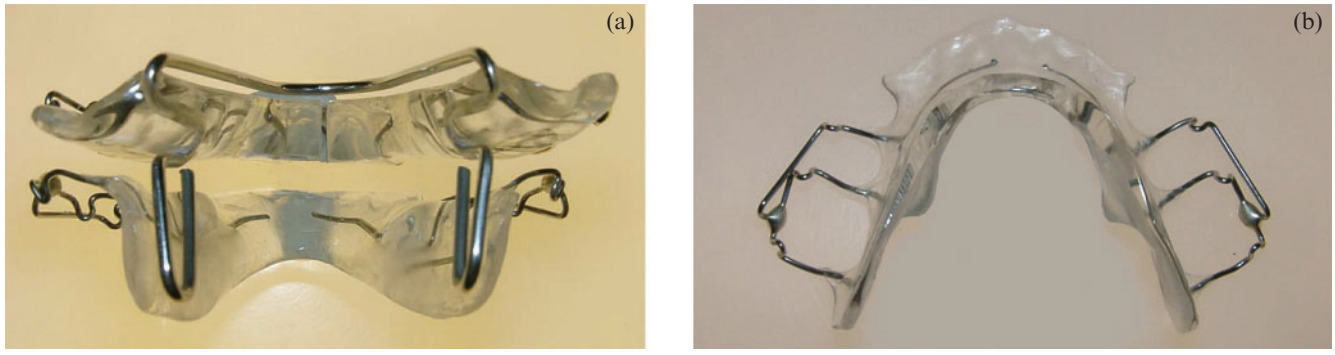

Figure 6 (a,b) A variation of the appliance with a removable lower component. The shoulders formed in acrylic extend 3 mm lingually and 3 mm down from the gingival margin (not the full depth of the appliance)

into intermittent contact with shoulders or steps formed on the lingual aspect of the mandibular part of the appliance (Figures 1, 2 and 6). The contact between the two prevents the mandible displacing backwards from the predetermined protrusive position, generally 3–4 mm forward of centric relation. The projections are on the lingual side of the teeth (Figures 2, 4 and 6) to avoid interference in the inter-occlusal space. This

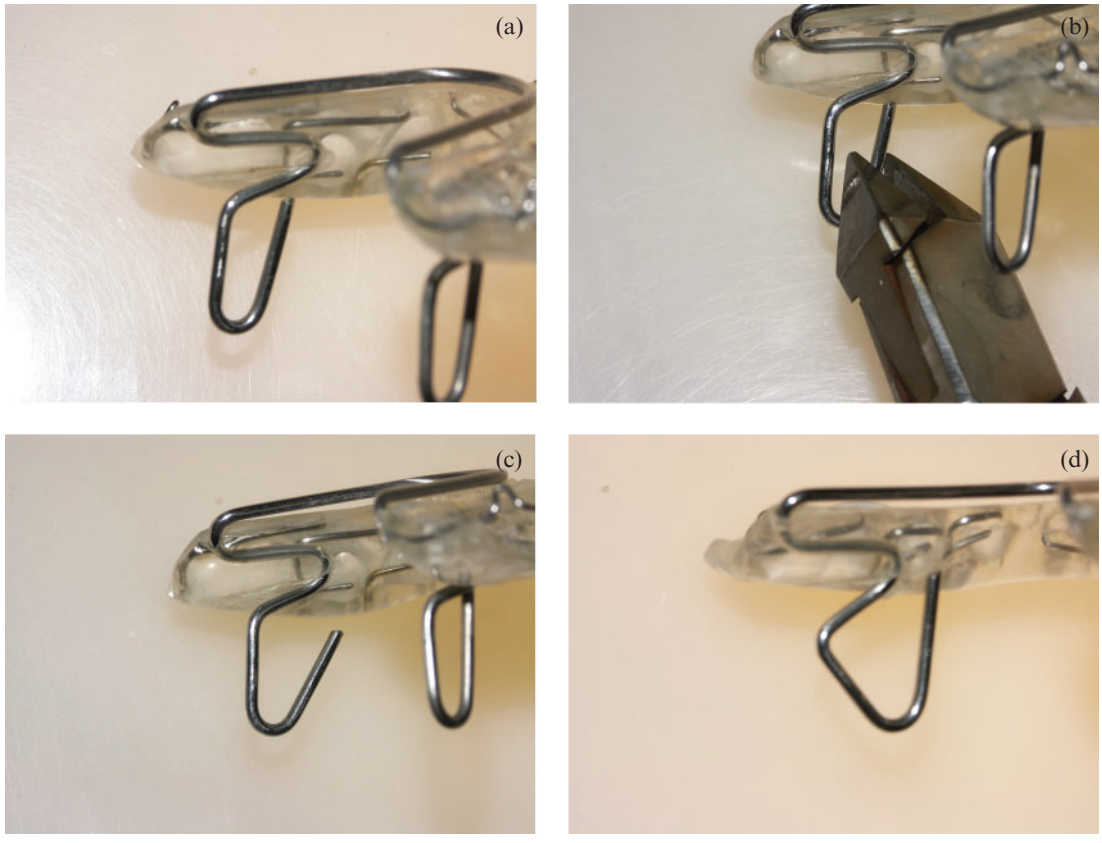

Figure 7 (a-d) Reactivation of the spring is carried out every 6–8 weeks, depending on progress. The 2 mm advancement is made by bending the front leg forward and then bending the rear leg forward until the front leg is parallel to its original slope. This can be checked by sighting across to the spring on the other side. It is important to leave the free end close to the acrylic to avoid the possibility of it snagging on the lingual arch. The same procedure is then repeated on the opposite side. To prevent fatigue fracture, the wire must be handled carefully and damage to the outer layer avoided. Flat beak pliers should be used on the flat part of the spring and not on the curved sections

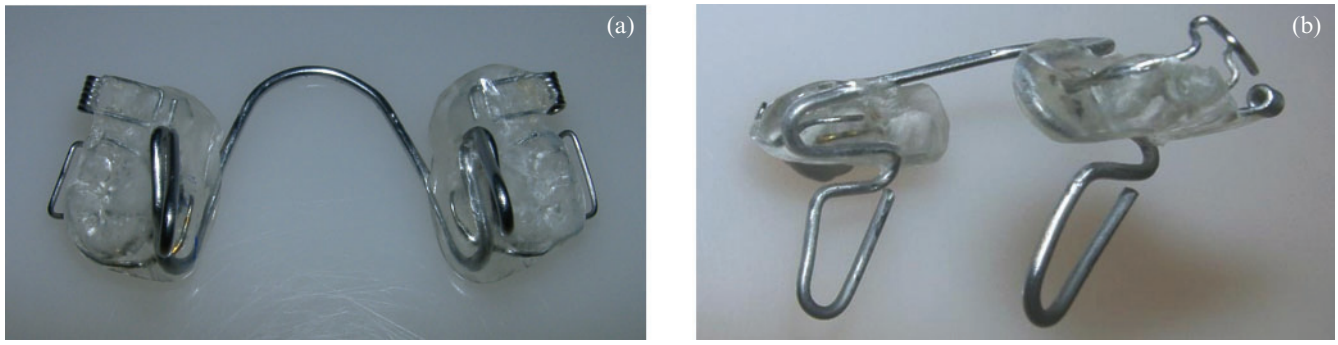

Figure 8 (a,b) The appliance is trimmed down in the later stages of treatment and is retained only on the first molars

reduces the possibility of an unwanted increase in lower face height, which may accompany the use of appliances such as the Activator or Twin Block.[24,35] The sulcus depth between the tongue and the mandible permits the use of 14 mm vertical springs, which allow the protrusive action of the appliance to act over the range of mandibular opening (Figures 4 and 9). This overcomes the problem of loss of activation which occurs when the mandible drops back as the mouth is opened.[35] A majority of children sleep with the mouth open,[35] losing the protrusive action of an orthopaedic appliance. The Dynamax design maintains mandibular advancement throughout the night and during speech, this contrasts with appliances that only hold the protruded mandibular position over a range of a few millimetres of mandibular opening.

The contact between the upper and lower parts of the appliance acts as a stimulus for an 'avoidance reflex'. This may have the additional effect of strengthening the masticatory muscles,[18] an advantage in the high angle case. The vertical projections have some flexibility which act as stress breakers, with the intention of avoiding the fatigue fractures which could occur with a rigid system. (Additionally, springs are heat treated during manufacture to remove tensions induced as a result of forming, which potentially give rise to stress concentration and failure.) The original Dynamax spring design[20] has been modified to provide additional flexibility but it is still important to provide 1.5 mm of space each side for small lateral movements to take place without flexing the wire. Omitting to provide this lateral freedom may result in fracture of the spring. Chairside repair with rapid cure acrylic is possible but preferably avoided.

Progressive advancement of the mandible

In an endeavour to develop the mandible forward at the maximum rate of growth of the condyles and fossae, progressive incremental advancement of the mandible is carried out, rather than one large activation.[22] This also ensures that the musculature supporting the mandible is not over-stressed, making the appliance more comfortable for the patient and promoting compliance.

The design of the vertical springs permits uncomplicated forward reactivation at the chairside, using standard orthodontic pliers (Figure 7).

Extra-oral traction may be utilized by adding a short facebow and posterior highpull headgear to tubes in the second premolar region. The acrylic capping of the buccal segments allows heavy forces up to 1500 g per side to be used without any discomfort to the patient, in order to establish control over vertical and horizontal development of the face. A facebow with a built in safety catch[36] provides effective security against accidental detachment and is efficient and simple for the patient to use.

Posterior capping

The occlusal surfaces of the upper posterior teeth are covered with a 1 mm thickness of acrylic (Figure 1), to give the following effects:

- Unlocking the occlusion, permitting the mandible to develop, without interference from the cusps of the posterior teeth.
- Heavy extra-oral force is distributed more evenly throughout the arch, reducing it to a comfortable level on individual teeth.
- Vertical forces can be applied to the maxilla, which may inhibit its normal downgrowth, promoting mandibular advancement by allowing the mandible to hinge forward.

Anterior torque control

The torque spring fitted to the original Bass appliance[5–7] has been modified to lie flat against the surface of the incisors (Figure 5) increasing patient comfort.

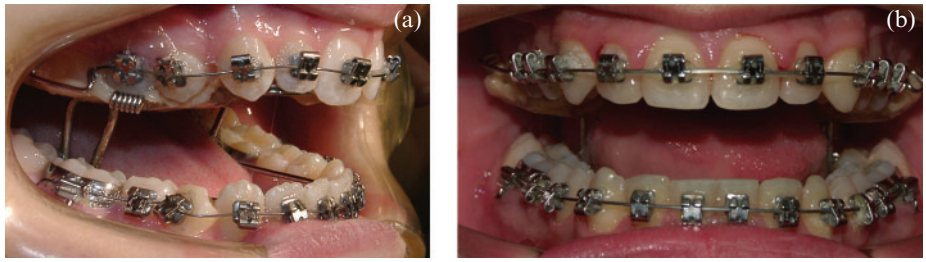

Figure 9 (a,b) Cutting down the appliance allows concurrent use of brackets in the upper arch

Anterior Bite Plane

This is usually placed 2 mm short of the level of the incisal edges, to control eruption of the lower incisors and contributes to levelling of the curve of Spee.

Mandibular Appliance

The fixed mandibular appliance (Figures 1, 2 and 3) is made in a similar manner to a standard lingual arch with 1.0 mm wire, modified with 3 mm 'shoulders' in front of the bands. The shoulders should be at right angles to the mid-line. Occasionally, where more anchorage of the lower dental arch is needed or soft tissue modification is desirable, a lip bumper may be added to the lingual arch.

Alternatively a removable type of lower appliance (Figure 6) can be used if the clinician prefers.

Appliance construction

Laboratory construction is based around a prefabricated wire form (Forestadent, 21 Carters Lane, Kiln Farm Milton Keynes MK11 3HL). This wire form provides the vertical springs, the expansion element and the framework for the acrylic baseplate (Figure 10). Adjustment is simple and generally only the width requires adaptation. In most cases, the technician does not require a construction bite or articulator mounting. The models generally only require marking for centric occlusion. The exception is with a high angle malocclusion, where a posterior contact with the appliance occurs. A construction bite in these cases will avoid the need to trim the posterior capping at the chairside.

The initial forward activation is standardized at 3–4 mm from centric and the indication for this measurement is readily transferred to the lower model during construction, to mark the position of the 'shoulders' on the lower appliance.

Clinical procedure

Alginate impressions are taken, with a wax bite in centric occlusion. For the fixed lower component, molar bands are selected and placed in position, before the impression is taken. To avoid the possibility of bands splitting, these should preferably be 0.007-inch thickness (e.g. Forestadent)

Fitting the appliance in the clinic

The upper and lower parts are placed together by hand to check that the width of the vertical springs has been correctly adjusted; there should be approximately 1.5 mm of space each side, to allow for lateral movement without flexing the wires. If a lingual arch has been made, this is cemented into place. The upper component is then fitted and the patient will automatically close comfortably into the protrusive position in response to the action of the vertical springs.

Reactivation of mandibular protrusion

This is generally required about every 8 weeks, depending on progress. It is essential to maintain a constant 4 mm of forward protrusion. Reactivation is carried out at the chairside by bending the vertical springs, as shown in Figure 7. The free ends of the spring should remain in close proximity to the acrylic to avoid any possibility of catching on the lingual arch or the tongue.

More than 4 mm of protrusion is inadvisable as this will strain the patient's musculature and lead to the patient resting the lower component against the vertical springs. This will result in continuous pressure being transmitted to the lower part of the appliance and may result in forward movement of the mandibular dentition or cause fatigue fracture of the vertical spring.

After one to two weeks using the appliance, the patient will usually position the mandible forwards most of the time to avoid contact with the vertical springs,. The appliance acts as a stimulus for a learned 'avoidance reflex' and activates the protrusive musculature, rather than placing the mandible in a strained position that would activate the muscles of retrusion. Contact with the vertical springs will be intermittent and brief and serve only to maintain the 'avoidance reflex'. Generally, there is a slight space between the springs and the lower

Figure 10 The appliance is built around a prefabricated and heat treated wire

component of the appliance during use. In some instances the patient may posture so that the space may be as much as 3–4 mm and they may be initially unaware of the difference when the springs are reactivated 2 mm forward. The clinician should avoid the temptation to advance the springs again in these circumstances.

Figure 11 Significant expansion can be obtained, either parallel or with more expansion posteriorly

Expansion of the maxillary arch is obtained by pulling the two halves of the upper appliance apart by approximately 2–3 mm at the posterior edge. Activation can be parallel, with expansion of the canines as well as molars, or non-parallel with more expansion at the posterior of the arch. Lateral adjustment of the vertical springs will be required if the maxillary arch is widened significantly. If this adjustment is not made, the

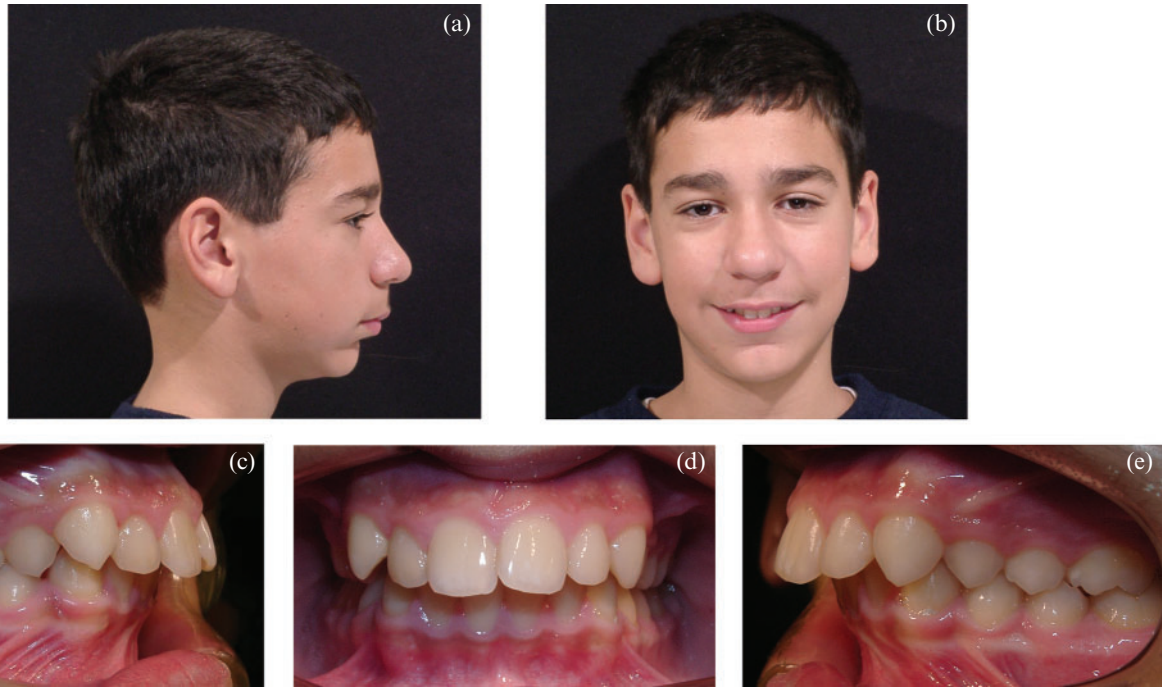

Figure 12 (a,b) Patient age 12 years 10 months. Note significant mandibular retrusion and abnormal lower lip function. (c-e) Permanent dentition fully erupted into one unit Class II molar occlusion. Overjet is increased and the overbite is increased. (f,g) Upper arch is crowded and the lower incisors are tipped labially

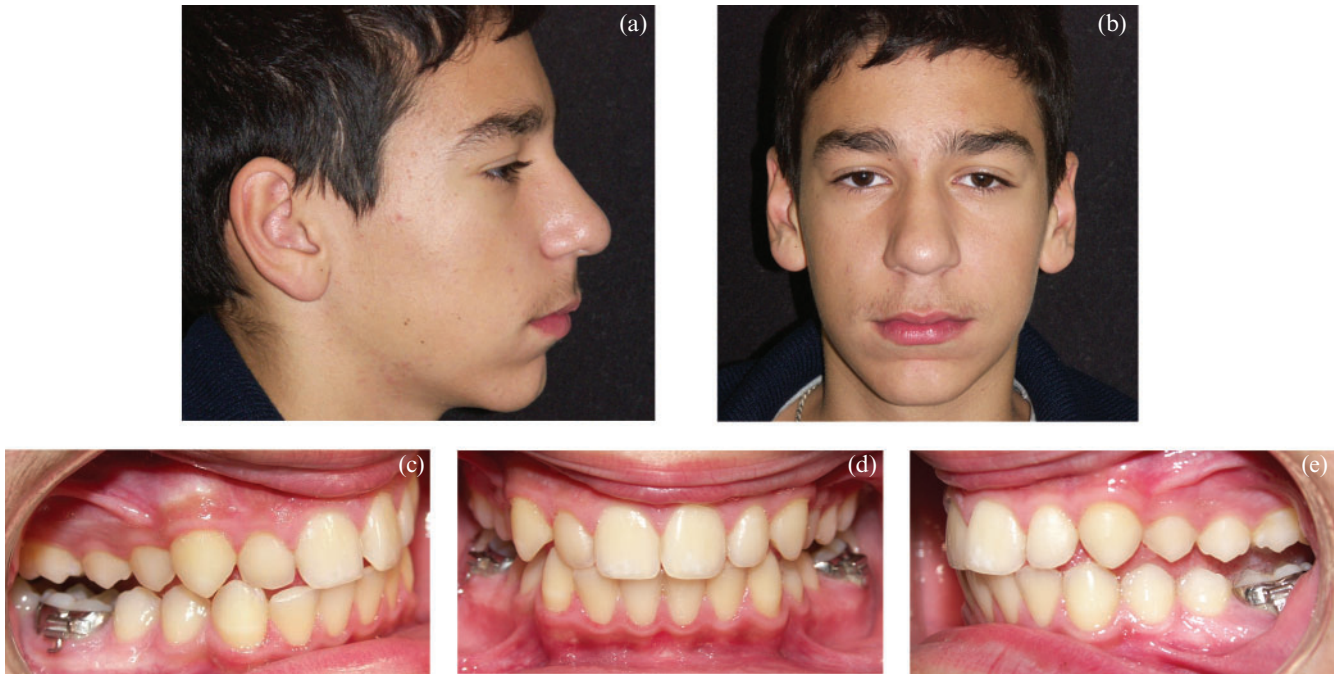

Figure 13 (a,b) Age 13 years 7 months. After 9 months of treatment with the Dynamax appliance. The facial profile is improving well and the soft tissue function now harmonised with the dentition. (c-e) After 9 months treatment. Canine occlusion is now Class I. The buccal segments at this stage still require more time to erupt

appliance may become unwearable or possibly cause fracture of a vertical spring. If further expansion is required and mandibular advancement is complete, the vertical springs may be removed altogether (Figure 11).

Co-ordination with multibracket treatment

With a fixed lingual arch in place, brackets can be bonded on the lower arch and levelling and alignment carried out at any time during the orthopaedic phase (Figure 4). The lower incisors may be actively intruded to avoid an increase in lower face height as the curve of Spee is levelled.

If there is significant irregularity of the upper teeth, particularly if a lateral incisor is instanding, the torque bar may be omitted from the construction and brackets can be placed from the premolars forward, from the start of treatment. Generally brackets are placed in the upper arch towards the end of the orthopaedic phase. The front part of the appliance is removed and the appliance retained with the clasps on the first molars only (Figures 8 and 9). The reduced appliance is usually worn at night for several months after the orthopaedic correction has been achieved, in order to enhance stability and during this time fixed appliance therapy is carried on as normal. Generally, torque of the upper incisors is not required, except in Class II division 2 cases, and the first molars are only banded to finalize levelling and rotations at the end of treatment. This simultaneous use of orthopaedics and fixed appliance therapy allows maximum Skeletal II correction without extending treatment time.

Case report

A case report is shown in figures 12–19 and demonstrates the use of a Dynamax appliance in a 12 year old boy. This patient presented with a skeletally-based Class II division 1 malocclusion. Treatment was undertaken with the Dynamax appliance combined with fixed appliances to obtain final alignment and maximal interdigitation.

The total treatment time was 24 months. A maxillary wrap around retainer was used for six months full-time followed by six months nighttime wear. A mandibular 3-3 fixed retainer is in place.

Conclusion

The Dynamax orthopaedic appliance features:

- straightforward construction around a prefabricated spring component.

Figure 14 (a-c) 3 months later, the buccal segments are now erupted into occlusion. Lower arch is bonded and the orthopaedic correction stabilized with appliance used at night only. Expansion of the upper arch is continued, to provide space for alignment

Figure 15 (a-c) After 15 months treatment, the upper arch is bonded for final alignment. The appliance is reduced in size and now contacts only the upper molars

Figure 16 (a-c) Molars are now bonded for final adjustments in rotation and levelling

Figure 17 After 22 months, immediately prior to debond

- a fixed lingual arch allows concurrent use of a multibracket appliance to align and level the lower arch. The lingual arch also maintains the leeway space from deciduous second molars, reducing the need for the extraction of permanent teeth.
- control of maxillary development by means of extra-oral traction, expansion of the maxillary arch, control of molar eruption and torque control of the maxillary incisors.
- brackets may be placed on the upper arch at any stage of treatment and the orthopaedic therapy can be maintained for as long as necessary, to allow stabilisation of the new mandibular position.
- the appliance is comfortable and unobtrusive for the patient, with minimal speech interference. The design of the vertical spring eliminates loss of forward activation during sleep or speech.
- readily adjusted at the chairside to progressively advance the mandible.
- correction of the Skeletal II malocclusion can be carried out at any stage in the dental development of a growing individual.

The author acknowledges a financial interest in the Dynamax appliance.

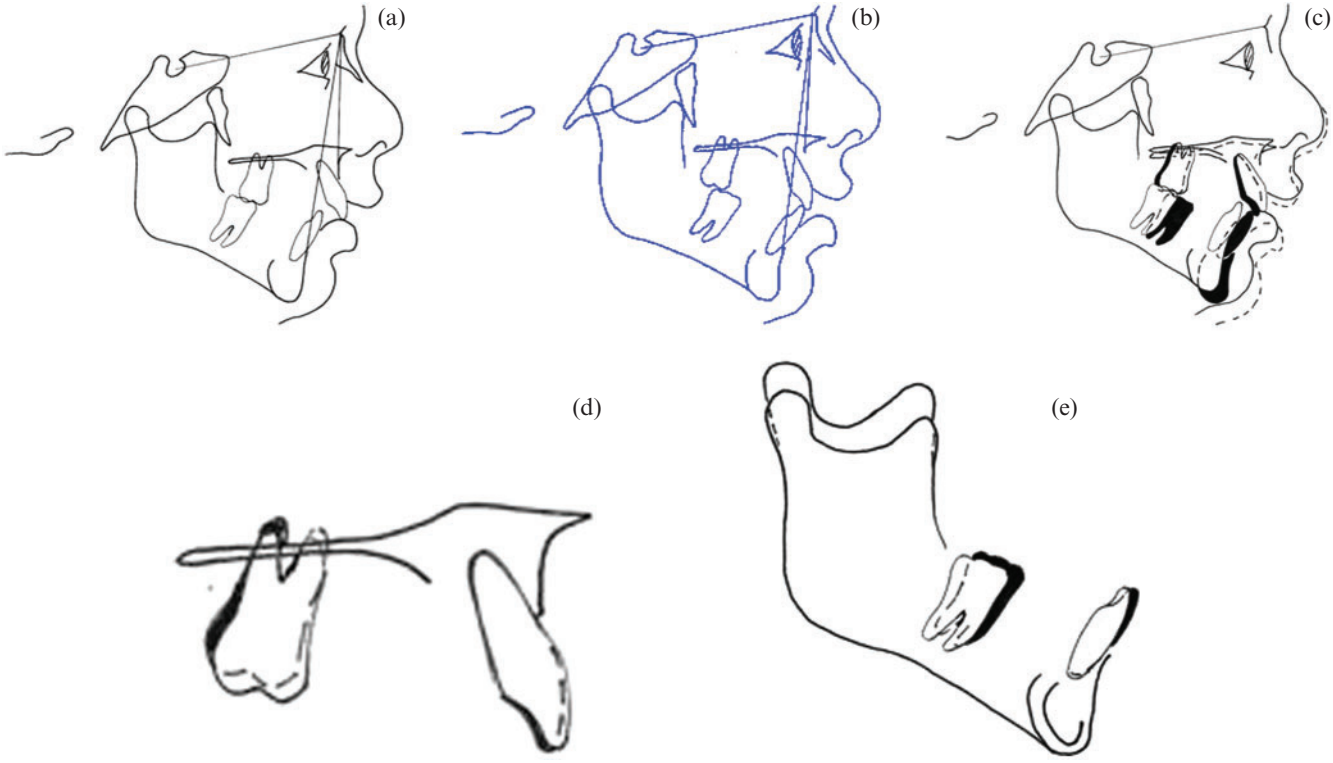

Figure 18 (a) Cephalometric tracing prior to treatment. Age 12 years 10 months SNA 82° SNB 74° ANB 8°. Upper Incisor inclination 110° to maxillary plane. Lower incisor inclination 110.5° to mandibular plane. MMPA 25°. (b) After 11 months orthopaedic treatment and 3 months night-time stabilisation. Age 14 years 0 months SNA 81° SNB 76° ANB 5°. Upper Incisor inclination 110° to maxillary plane. Lower incisor inclination 110° to mandibular plane. MMPA 25°. (c) Superimposition on cranial base at S point. Initial tracing solid line, dashed line indicates post-orthopaedic treatment. Change with 11 months full time appliance wear and 3 months night-time stabilisation. Accelerated mandibular growth has enhanced the skeletal correction in this case. The new mandibular position improves the facial profile, corrects the Skeletal II malocclusion and allows the lower lip to function normally. (d) Maxillary superimposition on best anatomical fit. Incisor position and torque are fully controlled. (e) Mandibular superimposition on stable structures (Bjork). The improvement in the overjet is almost entirely due to skeletal change in this case

Figure 19 (a-c) One month after treatment completion. The occlusion is well settled. (d-g) Facial appearance following 24 months treatment. Note the harmonious soft tissue profile and the dentition well placed in the face. The advancement of the mandble has avoided the need for incisor retraction in the correction of the malocclusion

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