An Orthopedic Approach to the Treatment of Class III Malocclusion in Young Patients

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JAMES A. MCNAMARA, JR., DDS, PHD

Most orthodontists are familiar with the difficulties associated with the treatment of Class III malocclusion, particularly when this condition is identified in patients in the late deciduous or early mixed dentition period. Such patients frequently present with maxillary skeletal retrusion, mandibular skeletal protrusion, or some combination of the two conditions. These patients also often exhibit maxillary constriction that is manifested as an anterior and/or posterior crossbite. Petit describes such patients as having a "prognathic syndrome" in which the underlying skeletal elements may be out of balance in all three planes of space.[1]

The treatment of this malocclusion raises the clinical dilemma: Is it better to intervene at an early age or to wait for craniofacial growth to be fully expressed?

Many clinicians have chosen to intervene early, using such appliances as the chin cup, reverse extraoral traction, or the function regulator (FR-3) of Frankel. Most cases of minimal to moderate severity are managed satisfactorily with these approaches, particularly if underlying etiological problems have been resolved. However, other cases, while improved, must be characterized as at best a compromised result at the end of the growth period. In these cases, the attainment of a Class I occlusion--if achieved at all--occurs very slowly, and the underlying skeletal discrepancy remains unresolved.

Because of a lack of success in certain early treatment cases, some clinicians have not initiated treatment until growth has been fully expressed. This approach almost always involves a combination of orthognathic surgery and orthodontic treatment. Although such an approach is generally effective in resolving the underlying skeletal and dental malrelationships and may be the treatment of choice in severe cases, the patient still faces the psychosocial problems during childhood that have been shown to be associated with this type of malocclusion.[2]

The purpose of this article is to describe a treatment approach that permits a rapid resolution of certain Class III malocclusions in young patients. The components of this treatment--a bonded rapid palatal expander and an orthopedic facial mask--are not new, but when they are used in combination they produce a more rapid treatment response than when either is used alone.

Components

Facial Mask

The facial mask was first described more than 100 years ago,[3] with other descriptions appearing early in this century.[4,5] Perhaps the individual most responsible for reviving interest in this technique is Delaire.[6-8] More recently, Petit[1] has modified the basic concepts of Delaire by increasing the amount of force generated by the appliance, thus decreasing the overall treatment time.

The Petit facial mask was originally constructed on a patient-by-patient basis, using .25" round lengths of stainless steel, to which pads for the forehead and chin were attached (Fig. 1). Later, several versions of the Petit facial mask became available commercially, reducing the amount of chair time needed to deliver the appliance.

The current version of the Petit facial mask (Fig. 2) is made of two pads that contact the soft tissue in the forehead and chin regions. The pads are made from acrylic and are lined with a soft closed-cell foam that is nonabsorbent, easily cleanable, and replaceable. The pads are connected by a midline framework made from a round, contoured length of .15" stainless steel with acorn nuts on each end.

In the center of the midline framework is a crossbar, made from .075" stainless steel, which is secured to the main framework by a set screw, thus allowing the position of the crossbar to be adjusted vertically. The crossbar ends are contoured for patient safety (Fig. 2).

Maxillary Splint

The second component of this orthopedic treatment is the maxillary splint (Fig. 3), an acrylic and wire maxillary expansion appliance that is bonded to the posterior dentition. The splint is similar in design to the maxillary portion of the acrylic splint Herbst appliance.[9,10] In mixed dentition cases, the splint usually covers the first and second deciduous molars. The upper canines may also be included in patients who present with complete deciduous dentitions.

The maxillary splint is made of a framework of .045" round stainless steel wire, to which an expansion screw is attached. If second molars are present, an occlusal rest is extended to the second molars to prevent overeruption of these teeth during treatment (Fig. 4). Two hooks, to which elastics are attached, are soldered to the wire framework. These hooks usually lie adjacent to the canines or first deciduous molars. A sheet of 3mm-thick splint Biocryl is heated and adapted to the framework and associated teeth using a

Biostar thermal pressure machine. The use of splint Biocryl less than 3mm thick can lead to problems in occlusal decalcification, because of abrasion of the appliance by the opposing dentition and the subsequent contact of tissue fluids with the occlusal surfaces of the involved teeth.

Midfacial orthopedic expansion has in itself been shown beneficial in the treatment of certain Class III malocclusions. Haas has demonstrated that rapid palatal expansion can produce a slight forward movement of Point A and a slight downward and forward movement of the maxilla.[11-13] In the context of facial mask therapy, the effect of such expansion is to disrupt the maxillary sutural system, thus possibly enhancing the effect of the orthopedic facial mask by making sutural adjustments occur more readily.

Elastic Traction

The facial mask is secured to the face by stretching elastics from the hooks on the maxillary splint to the crossbow of the facial mask. Heavy forces are generated, usually through the use of 5/16", 14oz elastics bilaterally.[1] Lighter forces may be used during the break-in period, but forces should be increased as the patient adjusts to the appliance.

Clinical Management

Impressions

After the proper diagnosis has been established for the patient and the use of midfacial orthopedics is indicated, an upper alginate impression is taken for fabrication of the maxillary splint. A standard aluminum tray with average extensions is adequate. The impressions should be checked for proper reproduction of the teeth and associated soft tissue. A working model should then be poured and trimmed.

Splint Fabrication

The wire framework is formed from .045" round stainless steel wire that is contoured to the posterior teeth. Hooks facing posteriorly are soldered to the framework on each side in the region of the canine and first deciduous molar. An expansion screw is placed in the middle of the palate and soldered in place. Then a sheet of splint Biocryl is softened and formed over the framework and the work model using a Biostar. After cooling, the appliance is trimmed and polished with the acrylic extending to the gingival margins of the involved teeth.

Bonding Procedure

The maxillary splint is bonded to the posterior teeth in the following manner.

The appropriate maxillary teeth are cleaned with a rotating rubber cup and non-fluoridated pumice. The maxillary dental arch is then isolated, using cheek retractors that have extensions into the buccal vestibule but do not cross over the occlusal surface of the dental arches. Absorbent Dri-Angles are placed on both sides of the vestibule to block the secretion of the parotid gland.

The teeth are carefully etched using a dilute (37%) solution of phosphoric acid. The etching solution should be dabbed in place continuously, rather than being rubbed onto the teeth in a circular motion. Only the buccal and lingual surfaces of the teeth are etched. The occlusal surfaces are not etched, to facilitate removal of the appliance. Etching should last 60-90 seconds for the upper first molars and 90-120 seconds for the deciduous teeth.

After etching, the area is thoroughly rinsed with a continuous stream of water; each tooth should be rinsed for 10-20 seconds. The teeth are then air-dried and checked thoroughly to ensure that the etched areas have the appropriate chalky appearance.

At this stage of the procedure, a two-part sealant is used. After the two parts are mixed, the sealant is applied to the teeth, using only a thin coat. The sealant will ensure maximum bond strength as well as possibly help protect the teeth under the appliance from decalcification.

A bonding agent (such as Excel) specifically designed for the bonding of a large acrylic appliance is used at this stage. Such a product should be a two-part bonding agent (not one-step) with a low viscosity and a long working time--both of which are essential features for proper bonding of the maxillary splint.

A four-handed approach is advisable when bonding the splint. As the sealant is being applied by the clinician, an auxiliary applies plastic primer to the inside of the appliance and then begins mixing the two-part bonding agent. Then the auxiliary fills the maxillary splint completely and passes it to the clinician, who places the loaded acrylic splint on the maxillary dental arch and pushes the splint into place. Firm pressure is applied initially to force the excess bonding material out of the splint. In most cases, pressure can then be released from the splint and the clinician can begin the clean-up process using cotton applicators and a universal scaler.

The bonding material is not viscous when it is first setting, and it is necessary to use cotton applicators to remove the excess material. The clinician can also use his or her fingers to clean around the outside of the splint. As the gel phase of the setting begins, the bonding material becomes much thicker and is easily removed from the appliance with a scaler. Particular attention must be paid to the part of the appliance that is distal to the last molar. Once the bonding agent has set, a bur in a handpiece is needed

to remove excess bonding material.

After the excess material has been cleaned from the splint, the splint is checked for voids, particularly along the gingival margin. A second application of bonding agent can be used to fill any voids. Failure to fill a void can result in decalcification of the associated teeth during treatment.

Activation of the Splint

The patient is usually instructed to turn the midline jackscrew of the appliance once daily, generally before bedtime. In the majority of Class III individuals in whom use of an orthopedic facial mask is indicated, some maxillary expansion is beneficial. In such a case, the maxillary splint is expanded until the desired transverse change is achieved. In instances in which no transverse change is necessary, the maxillary splint is activated once a day for eight days to produce a disruption in the sutural system that facilitates the action of the facial mask.

Delivery of the Facial Mask

The current version of the Petit facial mask is available In one size and is fully adjustable to fit the facial contours of any patient. The appliance is held against the face of the patient (Fig. 5), and the positions of the forehead and chin pads are adjusted by loosening the set screws (Fig. 6A). The position of the crossbar is similarly adjusted in the vertical dimension to allow the elastics to pass through the interlabial gap without producing discomfort to the patient (Figs. 5,6B).

The elastics are connected bilaterally from the hooks in the canine or first deciduous molar regions of the maxillary splint to one of the indentations produced by the contours of the crossbar (Fig. 7). The elastics travel in an inferomedial direction anteriorly from the hooks on the splint to the crossbar. Care must be taken that the elastics do not cause irritation to the corners of the mouth.

Optimally, the patient is instructed to wear the facial mask on a full-time basis except during meals. Young patients (5 to 9 years old) can usually follow this regimen, particularly if the patient is told that the full-time wear will last only three to five months. In older patients, full-time wear may not be possible, in which case the appliance should be worn at all times except when the patient is in school or participating in contact sports.

Patients should be instructed to rigorously maintain a high level of oral hygiene and to report immediately any indications that the bonded splint might be loosening in any area. The patient should be seen every three or four weeks to check the condition of the splint and to evaluate hard and soft tissue changes.

The facial mask is usually worn until a positive overjet of 2-4mm is achieved interincisally. At this time, part-time or night-time wear is recommended for an additional three to-six-month retention period. The maxillary splint is then removed (using a bracket-removing plier with a sharp edge such as the ETM 349 plier), and a removable palatal stabilization plate, with arrow clasps between the first and second deciduous molars, is worn full-time. In cases with profound neuromuscular imbalances, the FR-3 Frankel appliance[14,15] can be worn as an active retainer.

Case Reports

No prospective clinical trials on patients treated with this approach have appeared in the literature, although some cases treated with the Petit facial mask have been reported.[1] The following two case reports illustrate typical treatment responses in young Class III patients.

Case 1

A 9-year-old boy presented with a Class III malocclusion characterized by an anterior crossbite and a unilateral posterior crossbite.

The initial lateral headfilm (Fig. 8A) was evaluated according to the cephalometric analysis routinely used by the author.[16] The maxilla was located normally relative to the cranial base. Point A was at 0mm relative to the nasion perpendicular. The effective midfacial length (measured from condylion to Point A) was 82mm. In a balanced face, the corresponding effective mandibular length would be 101-104mm.[16] Because the effective mandibular length in this patient was 111mm, the patient had a 7-10mm imbalance between the effective lengths of the upper and lower jaws. The differential between Point A and Point B relative to the nasion perpendicular was +3mm; the normal range would be -8mm to -6mm.

The patient's lower anterior facial height was about 5mm greater than normal. However, the facial axis angle (4°) indicated a more horizontal position of the mandible. The mandibular plane angle (23°) was within normal limits.

The maxillary central incisors were in a slightly retruded position relative to the maxilla, and the upper first molar remained unerupted, apparently locked behind the upper second deciduous molar. The lower incisor was well situated relative to the symphysis of the mandible, and the lower molar had almost reached full occlusion.

Treatment Progress

A maxillary rapid palatal expansion appliance with facial mask hooks was bonded to the maxillary deciduous canine and the first and

second deciduous molars and was expanded once daily for 35 days. At two weeks after splint placement, the facial mask was delivered; it was worn by the patient on a full-time basis for four months. The facial mask was then worn at night for an additional three months, after which the maxillary splint was removed and records were taken.

Analysis of Treatment Results

The cephalometric tracing taken at 10 years, 0 months of age (Fig. 8B) indicates that the treatment produced both skeletal and dental changes in this patient. There was a 2mm forward repositioning of the maxilla relative to the nasion perpendicular and a 3mm decrease in the prominence of pogonion, resulting in a 5mm reduction in the A/B differential. Maxillary length increased by 3mm, while mandibular length increased by only 1mm. Lower anterior facial height increased from 64mm to 66mm.

Adaptations in the various regions of the craniofacial complex were analyzed according to the four-point superimposition method of Ricketts.[17]

Cranial base superimposition (Fig. 9A). Superimposing along the basion-nasion line at its intersection with the pterygomaxillary fissure indicates that the mandible was rotated downward and backward, while the maxilla moved anteriorly. The upper incisor erupted forward and downward, as did the upper first molar.

Mandibular superimposition (Fig. 9B). Superimposing on the internal structures of the mandible (e.g., the lingual aspect of the symphysis and the inferior alveolar nerve) indicates a slight backward tipping of the lower incisor and vertical eruption of the lower molar.

Maxillary superimposition (Fig. 9C). Superimposing on the internal structures of the maxilla shows a downward and slightly forward movement of both the upper first molar and the upper incisor. Some changes in the external contour of the maxilla are also evident.

Maxillary displacement (Fig. 9D). Superimposing along the basion-nasion line at nasion shows that the maxilla moved substantially forward during the treatment period--an adaptation that presumably would not have occurred without treatment. Relative to nasion, the upper incisors moved downward and forward, as did the upper molars.

Summary

This patient demonstrated both skeletal and dental adaptations during treatment. The maxilla and the upper dentition moved forward, while the mandible rotated downward and backward, with some lingual tipping of the lower incisor. In addition, there were favorable changes in the soft tissue contour.

Case 2

A boy age 8 years, 2 months, presented with an anterior crossbite, a short lower anterior facial height, and unerupted first molars.

Analysis of the initial headfilm (Fig. 10A) demonstrated a normal maxillary position. A similar amount of mandibular prognathism as in Case 1 was observed. However, the relatively short lower anterior facial height (56mm) resulted in a more forward position of the chin (5mm relative to the nasion perpendicular). The A/B differential relative to Point A was 5mm, which can be contrasted to the normal range of -8mm to -6mm for this age group.

The upper incisor was retruded relative to Point A, and the lower incisor was lingually positioned relative to the mandibular plane and to the mandibular symphysis.

Treatment Progress

A maxillary splint with facial mask hooks was bonded in place and expanded once daily for 30 days. Two weeks after splint placement, the facial mask was delivered, and the patient wore the appliance full-time for approximately six months. The patient then wore the appliance on a night-time basis for an additional six months.

Analysis of Treatment Results

During the 13 months between the first headfilm (Fig. 10A) and the second headfilm (Fig. 10B), significant changes occurred in the skeletal and dental structures of this patient. In contrast to Case 1, the maxilla remained in the same position relative to the nasion perpendicular, although the effective length of the midface increased by 2mm. Mandibular length increased by 3mm, an amount slightly above average.[16]

The largest skeletal change was the increase in lower anterior facial height. The distance from anterior nasal spine to menton increased from 56mm in the initial film to 60mm in the second film. The mandibular plane angle relative to Frankfort horizontal increased from 25° to 26°.

Cranial base superimposition (Fig. 11A). Superimposing along the basion-nasion line at its intersection with the pterygomaxillary fissure indicates that, as in the previous case, the growth of the mandible was redirected toward a more vertical orientation. The facial axis was reduced from 5° to 3°, and the growth of the mandible was expressed only in a vertical direction. The upper incisors erupted forward and downward, as did the upper molars. Soft-tissue Point A moved forward 4mm, while soft tissue pogonion

remained relatively unchanged.

Mandibular superimposition (Fig. 11B). Superimposing on the internal structures of the mandible indicates that the lower incisor was tipped slightly lingually, while the lower molar erupted vertically. Some remodeling was observed in the symphyseal region as well.

Maxillary superimposition (Fig. 11C). Superimposing on the internal structures of the maxilla indicates that the upper incisor erupted along its long axis, while the upper molar tended to move mesially with little vertical movement. Forward movement of the upper second deciduous molar also occurred.

Maxillary displacement (Fig. 11D). Superimposing along the basion-nasion line at nasion indicates that in contrast to Case 1, there was little forward movement of Point A relative to nasion. However, there was substantial vertical movement of the maxilla and a downward and forward movement of both the upper incisor and the upper posterior segment.

Summary

This patient showed both dental and skeletal adaptation during the treatment period. The mandible rotated downward and backward, although no inhibition of mandibular growth was noted. The maxillary dentition moved downward and forward. Little change occurred in maxillary position.

Conclusion

This article has described the technique of combining a bonded rapid palatal expansion appliance, an orthopedic facial mask, and heavy-force elastics in the treatment of developing Class III malocclusions. The two case reports indicate that such treatment can be effective for those Class III patients who present with skeletal and dental imbalances. The possible treatment effects include:

1. A forward and downward movement of the maxilla.
2. A forward and downward movement of the maxillary dentition.
3. A downward and backward redirection of mandibular growth.
4. A lingual tipping of the lower anterior teeth.
5. An inhibition of mandibular growth.

Only a prospective clinical study with an adequate sample size can determine which of these treatment effects are observed on a routine basis.

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Figures

Fig. 1 Original facial mask designed by Petit (see reference 1). This type was constructed individually for each patient.

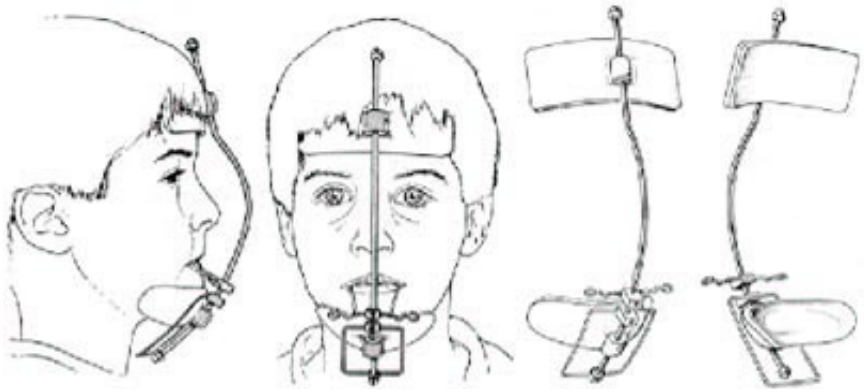

Fig. 2 Schematic illustration of facial mask currently available commercially.

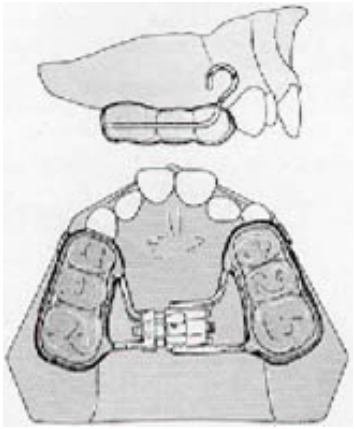

Fig. 3 Design of bonded maxillary occlusal splint used in early mixed dentition. First and second deciduous molars and first permanent molars are usually incorporated in the appliance. Facial mask hooks usually lie mesial to upper first deciduous molars.

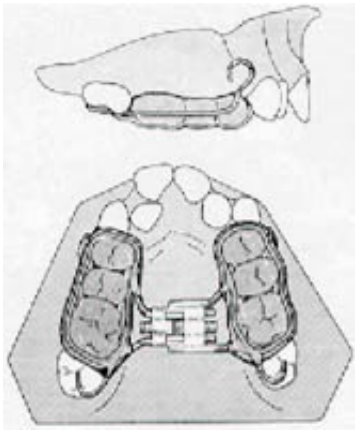

Fig. 4 Design of bonded maxillary occlusal splint used in permanent dentition. Wire extensions are placed on occlusal surfaces of upper second molars to prevent extrusion during treatment.

Fig. 5 Fitting the facial mask. A. Initial placement. Upper and lower pads can be adjusted by loosening set screw. B. Adjusting position of crossbar. Crossbar should be positioned so elastics pass from hooks on maxillary splint, through interlabial gap, and connect to crossbar without lip irritation.

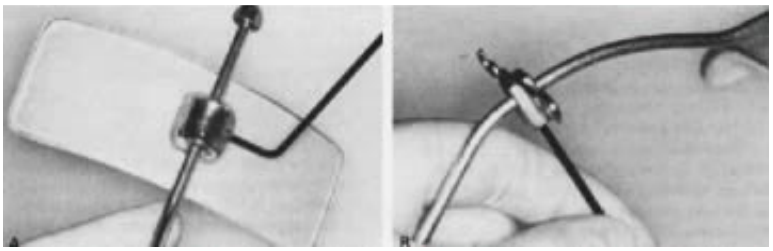

Fig. 6 A. Adjusting position of forehead pad. B. Adjusting position of crossbar.

Fig. 7 A. Attachment of elastic to facial mask hook. B. Elastic courses anteriorly and medially to attach to crossbar.

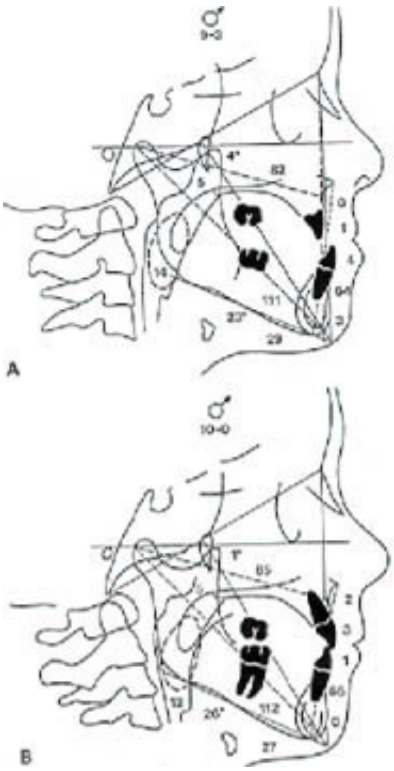

Fig. 8 Case 1. A. Tracing of initial lateral cephalogram. B. Tracing of cephalogram taken nine months later.

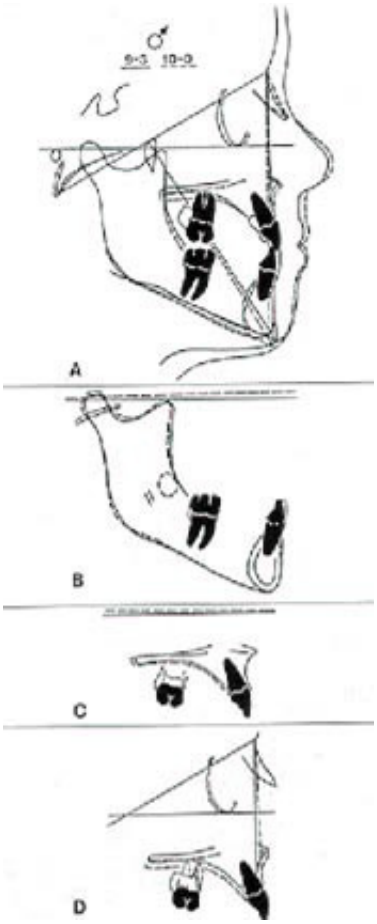

Fig. 9 Case 1. Superimpositions of tracings in Figure 8. A. Cranial base superimposition along basion-nasion line at pterygomaxillary fissure. B. Mandibular superimposition on internal structures. C. Maxillary superimposition on internal structures. D. Maxillary displacement--superimposition along basion-nasion line at nasion.

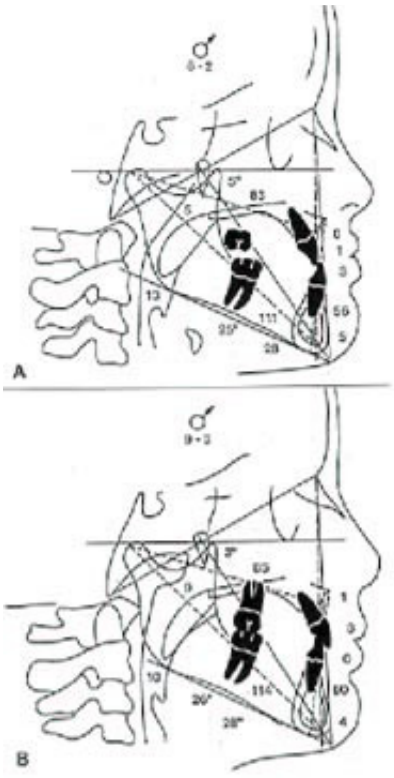

Fig. 10 Case 2. A. Tracing of initial lateral cephalogram. B. Tracing of cephalogram taken 13 months later.

Fig. 10 Case 2. A. Tracing of initial lateral cephalogram. B. Tracing of cephalogram taken 13 months later.

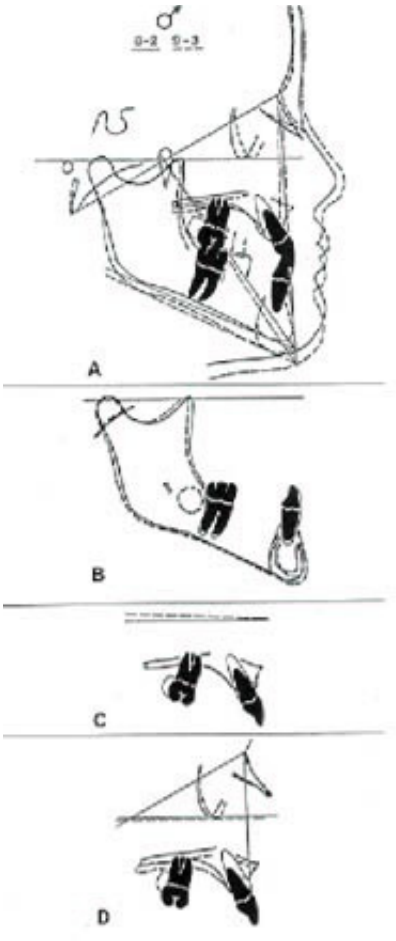

Fig. 11 Case 2. Superimpositions of tracings in Figure 10. A. Cranial base superimposition along basion-nasion line at pterygomaxillary fissure. B. Mandibular superimposition on internal structures. C. Maxillary superimposition on internal structures. D. Maxillary displacement— superimposition along basion nasion line at nasion.

Fig. 11 Case 2. Superimpositions of tracings in Figure 10. A. Cranial base superimposition along basion-nasion line at pterygomaxillary fissure. B. Mandibular superimposition on internal structures. C. Maxillary superimposition on internal structures. D. Maxillary displacement--superimposition along basion-nasion line at nasion.

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Footnotes

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2. Excel: Reliance Orthodontic Products, Itasca, IL.