Simultaneous intrusion and retraction using a three-piece base arch

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Although the correction of deep overbite is routinely achieved through orthodontic treatment, the need for careful diagnosis and a logically sequenced plan of treatment is critical for optimal results. Clinical situations involving flared incisors and the need for overbite correction can be particularly challenging, especially without a carefully designed mechanical plan.

In such cases, the incisors may be inadvertently flared even more during the initial phases of treatment and the deep overbite may remain, thus limiting the amount of anterior tooth retraction that can be achieved. It is therefore imperative to assess the problems, establish clear objectives of treatment, and develop adequate mechanics to achieve the established objectives.

This paper describes a method for the correction of deep overbite in patients with flared incisors, incorporating either extraction or nonextraction therapy. The focus is the biomechanics of the three-piece base arch and the principle of how an intrusive force may be used to help retract the anterior teeth.

Treatment options to correct a deep overbite

The correction of a deep overbite can be accomplished in a number of ways, depending on the initial diagnosis and the treatment objectives. Extrusion of posterior teeth may result in the correction of a deep overbite. This may be an acceptable treatment strategy for a growing patient presenting with short lower facial height and a profile that can afford some increase in convexity. But patients presenting with a convex profile will not benefit from the use of extrusive mechanics because their facial convexity will worsen, the occlusal plane will steepen, and the lower facial height will increase. The stability of such changes is questionable, especially if patients do not experience adequate growth.

The intrusion of anterior teeth may be very use-

Abstract

Flared incisors and deep overbite are challenging to treat orthodontically. This paper describes the use of a three-piece base arch and Class I elastics to correct deep overbite while simultaneously closing spaces. An analysis of the biomechanics and a discussion of the appliance design are presented to help understand how the incisor axial inclination can be corrected and controlled during orthodontic therapy. A clinical example illustrates the treatment sequence.

Key Words

Intrusion • Space closure • Biomechanics

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ful in correcting a deep overbite. In patients with excessive maxillary incisor display, intrusion of the maxillary anterior teeth will not only improve esthetics but also help in the correction of the deep overbite. Ideal maxillary incisor display (incision-stomion distance) of 3 mm is recommended for good esthetics;[2] the remainder of the overbite correction can be obtained by intrusion of the lower incisors. In some situations, a slight anterior curve of Spee may be maintained to assure adequate esthetics. Other advantages of intrusive mechanics include good control of the vertical dimension and forward rotation of the mandible, which may help correct the Class II relationship. The combination of extrusion of the posterior teeth and intrusion of the anterior teeth may be used to correct a deep overbite. This treatment approach should be carefully monitored according to the treatment objectives.

Commonly used mechanics for intrusion of anterior teeth

Utility arches are used to correct deep overbite in the Bioprogressive technique.[12,13] A 0.016" x 0.016" blue Elgiloy archwire is placed into the brackets of the four incisors, bypassing the canines and premolars. Tipback bends are incorporated mesial to the first permanent molars and are typically 45° to the horizontal plane. The resulting force system includes extrusive forces on the molars along with a tipback moment. The incisors experience an intrusive force with a counterclockwise moment, which tends to flare them. The anterior moment is primarily due to the full engagement of the square wire into the bracket of the anterior teeth.[10,11] The tipback moment at the molars is proportional to the amount of intrusive force and the distance to the point of its application. Typically, a force of 150 grams is recommended for intrusion of four incisors.[12,13] However, the exact amount of force delivered is unknown because the system is statically indeterminate.[3,4] The control of vertical dimension can be challenging, and high-pull headgear may be used when necessary. The anterior teeth usually experience relative intrusion, and their axial inclination will show more pronounced flaring. Although this treatment approach has considerable merit when used in cases requiring incisor flare, genuine intrusion may not always be predictably achieved.

In the Begg technique, bite-opening is usually achieved during Stage I using an Australian 0.016" stainless steel archwire with bilateral tipback bends anterior to the permanent first molars.[1] Intrusion of the incisors is obtained in clinical situations where the axial inclination of the incisors is such that the horizontal distance from the bracket to the center of resistance is minimal.[1] Simultaneous flaring of the incisors and relative intrusion occur when the horizontal distance from the bracket (point of force application) to the center of resistance increases. The molars usually experience considerable tipback moments and extrusion resulting in the linguoversion of these teeth. Posterior expansion incorporated in the wire may help control molar width and compensate, to some extent, for the linguoversion of these teeth.

A 2 x 4 appliance, consisting of an archwire connecting two molars with four incisors, is often used in the mixed dentition. Tipback bends are placed mesial to the tube of the molars and the archwire is tied directly into the brackets of the anterior teeth. Intrusion of the anterior teeth occurs with variable amounts of flaring, depending on the initial axial inclination of the incisors.[10,11] The posterior teeth extrude and their buccolingual position can be controlled with the use of a palatal arch. Vertical dimension can be maintained with the use of a high-pull headgear. The force system is statically indeterminate because the wire is inserted directly into the incisor brackets.

The use of J-hook and high-pull headgear associated with continuous archwires has been advocated for the treatment of deep overbite.[17] Although this treatment approach has considerable merit, a number of limitations are associated with the use of this appliance. The amount of force delivered to the maxillary anterior teeth is substantial and may result in significant resorption of the roots of the anterior teeth. The forces delivered by the headgear are also intermittent and the correction of the deep overbite is less efficient than with the use of continuous light forces. Considerable patient cooperation is generally required.

Continuous intrusion arches with the segmented arch technique may be used to obtain genuine intrusion of the anterior teeth.[4,5] A pure intrusive force is applied to the incisors using a 0.017" x 0.025" TMA (Ormco, Glendora, Calif) continuous intrusion arch tied to a rigid anterior segment of wire placed into the incisor brackets.[7,8] This mechanism assures a point contact of force application to the anterior segment of teeth. Pure incisor intrusion is obtained and flaring is controlled by tying back the intrusion arch at the molars. The posterior teeth tend to tip back and extrude. A rigid stainless steel palatal arch is usually placed to control molar position. Extrusive forces and molar tipback are controlled

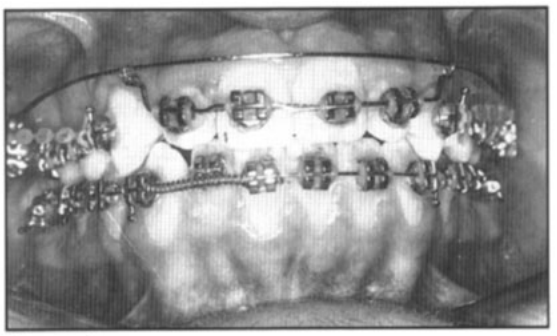

Figure 1

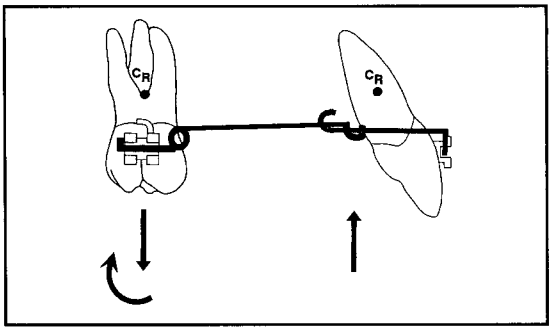

Figure 2

Figure 1
Frontal view of a continuous intrusion arch tied to the distal extensions of an extended anterior segment of wire.

Figure 2
Diagram showing a three-piece base arch from the sagittal aspect. The anterior segment of teeth is intruded while the posterior teeth experience a tipback moment and extrusion.

with rigid buccal wire segments and, perhaps, high-pull headgear. The headgear pull is usually directed above the center of resistance of the molar to encourage the molar roots to move distally, maintaining a good molar axial inclination.

Characteristics of intrusion and desired force system in cases with flared incisors

Pure intrusion is obtained when an intrusive force acts upon the center of resistance of a tooth or a group of teeth.[7,16] The intrusive force is commonly applied at the maxillary incisor bracket (i.e., anterior to the center of resistance of the incisor). When axial inclination of the incisors is within normal limits, a small counterclockwise moment is expressed at the center of resistance of these teeth. The intrusion base arch is usually tied back to the molars to prevent any flaring of the anterior teeth.[7]

In clinical situations where the incisors are flared, the application of an intrusive force at the bracket tends to exacerbate the axial inclination of these teeth. For a given amount of intrusive force, the perpendicular distance from the point of force application to the center of resistance increases and the resulting counterclockwise moment is considerably larger than in the situation described previously. The use of a continuous intrusion base arch is not recommended in such clinical situations and different designs have been developed to help control the side effects described here.

One way to direct the intrusive force through the center of resistance of the incisors is to extend the anterior segment distally to the lateral incisors and to tie the base arch at the anticipated mesiodistal position of the center of resistance (Figure 1). The vertical position of the distal extensions of the anterior segment of wire is generally positioned so that the line of action of the intrusive force is directed through the center of resistance of the anterior teeth.

The second appliance that allows intrusive force to be directed through the center of resistance of the anterior teeth is a three-piece intrusion base arch.[14] This arch consists of an anterior segment of wire extending distally to the lateral incisor and stepped around the bracket of the canine. As rigid a material as possible is used for this anterior segment of wire (preferably 0.021" x 0.025" stainless steel) to avoid any deformation when intrusive forces are applied. Bilateral tipback springs are extended from the auxiliary tube of the molar bends and are hooked anteriorly at the estimated position of the center of resistance (Figure 2). The tipback springs are generally fabricated of 0.017" x 0.025" TMA. The amount of intrusive force used for four maxillary incisors is typically 60 g at the midline (30 g per side). The three-piece mechanism also allows for redirecting the force parallel to the long axis of the incisor and varying the force, if indicated, from one side to the other.

Assessment of the position of the center of resistance

In order to develop a predictable and desirable force system to intrude flared incisors, it is critical to recognize and diagnose the clinical situation properly and localize the center of resistance of the anterior teeth precisely.

The decision to intrude maxillary and/or mandibular incisors should be based on the amount of maxillary incisor showing at rest, the length of the upper lip, the interlabial gap at rest, the severity of the curve of Spee, and the presence of palatal impingement. Visual treatment objectives are helpful in making treatment planning decisions concerning the vertical and anteroposterior positioning of the incisors and the level of the occlusal plane.

Lateral cephalometric films are routinely used in orthodontic treatment for diagnostic purposes and are helpful in determining the anteroposterior and vertical center of resistance of the anterior teeth. The center of resistance of the four incisors is usually estimated to be halfway between the crest of the alveolar bone and the apex of the lateral incisor root in the sagittal plane.[16] This information is used clinically to establish the

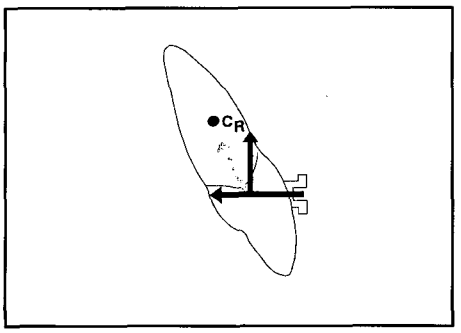

Figure 3

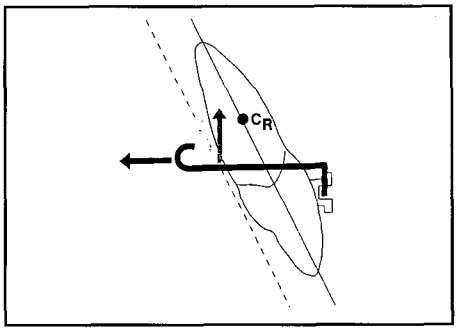

Figure 4

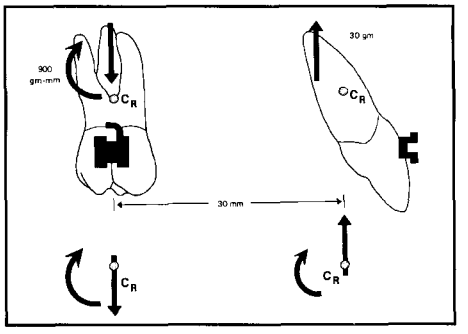

Figure 5A

Figure 3
When the intrusive force is moved mesially and a small distal force is added, the resultant force intrudes the incisors along the long axis.

Figure 4
The intrusive force may be moved lingually to the center of resistance of the anterior teeth and redirected parallel to the long axis of the anterior teeth using a small distal force. This creates a larger moment to tip the anterior teeth lingually.

point of force application during intrusive mechanics.

Intrusion retraction mechanics

In a number of clinical situations, a deep overbite with flared incisors is associated with the presence of generalized spacing that must be closed during nonextraction therapy. When crowding is present and extraction therapy is necessary, deep overbite correction must be achieved in addition to space closure. Traditionally, the overbite is corrected prior to space closure. However, it is possible to intrude flared incisors and retract these teeth simultaneously using a predictable and precisely analyzed force system.[15]

When an intrusive force is applied at the center of resistance of the incisors, pure intrusion of these teeth is obtained. If intrusion along the long axis of the incisors is indicated, the point of application of the intrusive force can be moved anteriorly and a small distal force will help redirect the intrusive force along the long axis of the incisors, thus intruding the incisors along this axis (Figure 3).

Applying an intrusive force parallel to the long axis of the incisors and lingual to the center of resistance of the anterior segment of teeth is a more efficient means of achieving simultaneous intrusion and retraction of these teeth. The anchorage requirement is not as critical as it is in clinical situations where the intrusive force is perpendicular to the occlusal plane. To obtain such a force system, the intrusive force is added lingual to the center of resistance of the incisors and an appropriate small distal force is applied. The resultant intrusive force is redirected parallel to the long axis of the incisors but in a more lingual position (Figure 4). As a result of the clockwise moment produced, the incisors will simultaneously intrude and retract. Analysis of the desired force system demonstrates that an intrusive force combined with a small distal force can be used to intrude and retract anterior teeth. Retraction of the anterior teeth occurs primarily as a result of the moment created around the center of resistance of the anterior segment. The overall force system includes an anterior intrusive force and a posterior extrusive force and tipback moment. When a small force is added between the anterior and posterior segments, a small anterior tipback moment and posterior tipforward moment are created (Figure 5A-B).

Clinical strategy to treatment

After a thorough study of the clinical situation and diagnosis, a treatment plan is developed. Visual treatment objectives, including the exact vertical and anteroposterior position of the incisors and molars, are defined and an appropriate mechanical plan is designed. Desired force systems are thoroughly analyzed to develop an appliance design. Although preliminary bracket alignment of incisors and posterior teeth can be obtained early in treatment, the incisor-canine discrepancy is maintained to allow intrusion of the anterior teeth.

A transpalatal arch, custom-made with 0.036" stainless steel, or a preformed precision palatal arch (0.032" x 0.032" stainless steel or TMA), is placed between the right and left permanent first molars to control molar width as well as axial inclination in the frontal plane.[9] Passive segments of wire are placed from the molars to the premolars on both sides to form rigid posterior units. In extraction cases, canines are usually partially retracted and included in the buccal segments of teeth on each side of the arch to allow space for intrusion.[6,8]

Intrusion retraction mechanics may be initiated at this point. A three-piece base arch is fabricated as follows: A rigid anterior segment of wire (0.021" x 0.025" or larger stainless steel) is placed into the brackets of the four incisors and extended distally to the mesial aspect of the canines. This anterior wire is stepped up around the canines to avoid any interferences with the brackets on these teeth during intrusion and simultaneous retraction. Typically, this anterior segment extends 2 or 3 mm distal to the center

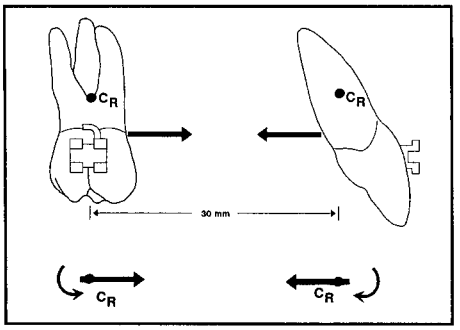

Figure 5B

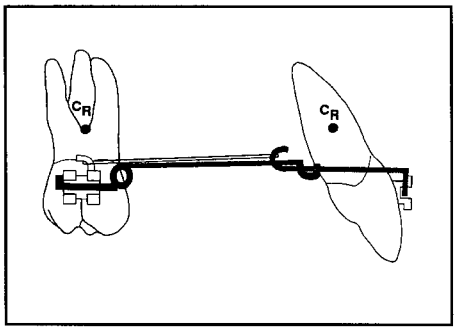

Figure 6

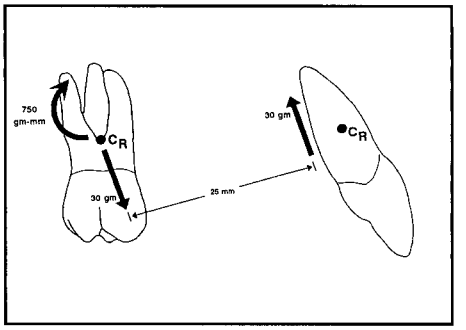

Figure 7

of resistance of the anterior segment of teeth. Bilateral tipback springs fabricated with 0.017" x 0.025" TMA are placed to deliver the intrusive force on each side. The point of force application of the intrusive force is distal to the estimated position of the center of resistance of the anterior segment of teeth (distal to the lateral incisor). Thirty grams of intrusive force are applied on the right and left sides and a small distal force is added by placing an elastomeric chain extending from the molars to the anterior segment of wire on each side (Figure 6). This small distal force directs the intrusive force so its line of action is lingual and parallel to the long axis of the incisors. A tipback moment is generated on the posterior segment as well as a small tip-forward moment. The anterior segment of teeth will be retracted as a result of the small tipback moment created.

Posterior anchorage control usually does not include the use of a headgear. The posterior tipback moment is reduced as a result of the redirection and distal movement of the intrusive force, thus reducing the tendency for the occlusal plane to tip (Figure 7).

The force system must be carefully monitored and altered as required at each appointment. The axial inclination of the incisors must be reassessed regularly and the estimated position of the center of resistance of the anterior teeth reevaluated.

Case Report

The following clinical example shows the sequence of treatment that is usually followed.

A 37-year-old Caucasian female came to the consultation with a chief complaint concerning the lingual position of the lower left second premolar. She had a secondary concern about her maxillary front teeth. The initial interview revealed that she was satisfied with her profile and general facial appearance. Her past and present medical and dental histories were noncontributory.

The extraoral examination revealed a convex profile and a long lower facial height. Intraorally, the patient presented with an Angle Class I malocclusion in the permanent dentition with maxillary and mandibular crowding. The right and left first molars, right premolars, and right canines were Class I and the left premolars and canines were Class II (Figure 8A-C). The overjet was 8 mm and the overbite was 40%. She presented with a lingually tipped lower left second premolar and a mesially tipped lower right second premolar. The maxillary and mandibular dental midlines were coincident and 2 mm to the left of the facial midline. A 2 mm apical base midline discrepancy was present between the maxilla and the mandible. Generalized periodontitis was present and the patient was under care for her periodontal condition.

Skeletally, the patient had increased facial convexity, primarily contributed by a retrusive mandible. Lower facial height was slightly increased and the maxillary and mandibular incisors were flared. Soft tissue facial convexity was high, with increased procumbency of the lips.

The treatment plan included extraction of four first premolars to correct the protrusion. Maximum anchorage would be required during retraction of the anterior teeth. Treatment was discussed with the periodontist, who recommended a three-month recall during the course of orthodontic therapy.

Orthodontic treatment was initiated with the placement of brackets and bands following extraction of the premolars. A transpalatal arch (0.030" stainless steel) and a passive lingual arch were placed in the maxillary and mandibular arches, respectively.

After rotation of the maxillary first molars and alignment of the lower left second premolar with a rectangular loop, separate canine retraction was initiated using segmented T-loops in all four quadrants. An anterior bypass archwire was placed in the canines to control rotation. After full retraction of the canines, buccal segments

Figure 5A-B
A: Force system developed between the incisors and the molars when using a three-piece base arch. The intrusive force is applied lingual to the center of resistance of the anterior teeth.
B: Force system developed between the incisors and the molars when a Class I elastic is used.

Figure 6
Diagram representing a three-piece base arch and a Class I elastic extending from the distal aspect of the anterior segment of wire to the molar.

Figure 7
Analysis of the force system developed between the incisors and the molars when the intrusive force applied is parallel to the long axis of the anterior teeth and lingual to the center of resistance of the anterior teeth.


Figure 8A

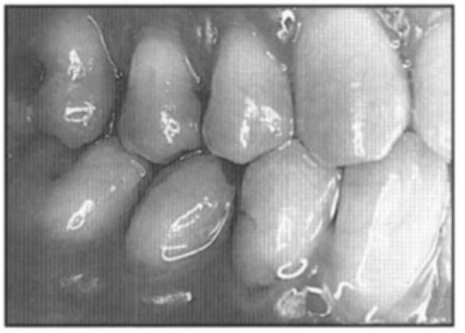
Figure 8B


Figure 8C

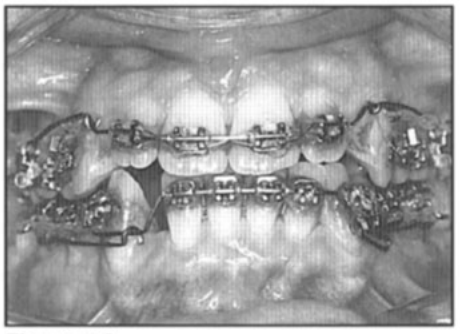
Figure 9A

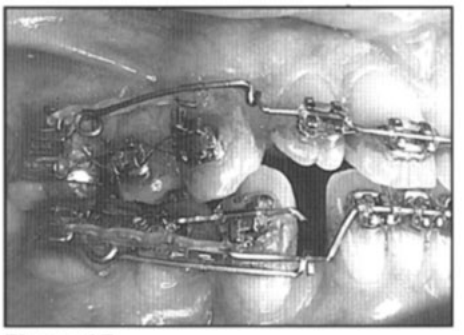
Figure 9B

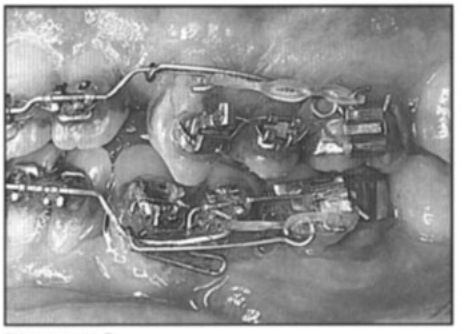
Figure 9C


Figure 10A


Figure 10B


Figure 10C

Figure 8A-C
A: Frontal view of the malocclusion prior to treatment.
B-C: Right and left views of the buccal occlusion prior to treatment initiation.

Figure 9A-C
A: Frontal view of the malocclusion during retraction of the anterior teeth.
B-C: Right and left views of the buccal occlusion.

Figure 10A-C
A: Frontal view of the occlusion at the completion of treatment.
B-C: Right and left views of the buccal occlusion.

were extended to these teeth and intrusion with simultaneous retraction of the anterior teeth was initiated using a three-piece base arch in the maxilla and mandible (Figure 9A-C). Careful control of the axial inclination of maxillary and mandibular incisors was achieved and space closure was completed with overbite correction using a three-piece base arch in both arches. The patient was debonded and debanded (Figure 10A-C) and upper and lower Hawley retainers were placed for retention. Superimposition of tracings showed the movement of the maxillary incisors (Figure 11). Intrusion and retraction were achieved with simultaneous correction of the axial inclination.

Conclusion

In this paper, the treatment of malocclusions with deep overbite associated with flared incisors has been discussed. The use of a three-piece base arch to achieve orthodontic correction as-

sures the attainment of a predictable, reproducible, and statically determinate force system.

The precise determination of the point of application of the intrusive force as well as its direction are critical in the simultaneous intrusion and retraction of the anterior teeth. Loss of anchorage is seldom observed because of the tipback moment on the posterior teeth. Another advantage of intrusion mechanics is the control of the vertical dimension. The design of the appliance also allows the clinician to deliver a well-controlled force system with minimal chairside adjustments.

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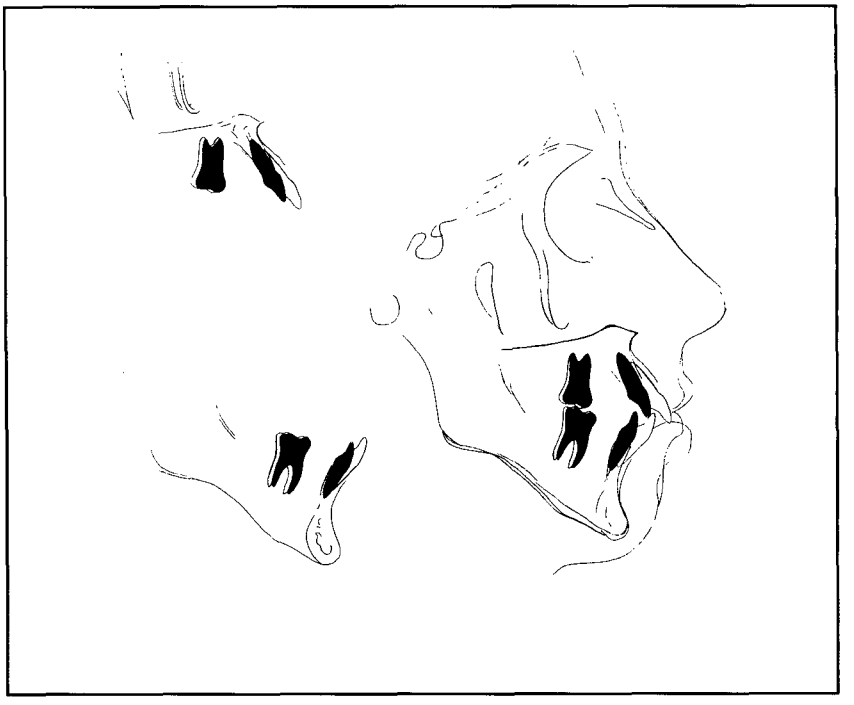

Figure 11

Figure 11
Superimposition of tracings before initiation of treatment and after completion of treatment. The movement of the maxillary incisors can be clearly observed. Retraction and intrusion of these teeth were achieved during treatment and their axial inclination was simultaneously corrected.

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