CLINICAL SECTION

Mini-implants for *en masse* intrusion of maxillary anterior teeth in a severe Class II division 2 malocclusion

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This case report describes the treatment of a 16-year-old post pubertal male patient with a severe Class II division 2 malocclusion and 100% deep bite. In the first phase of treatment, a 'Jones-Jig' molar distalization appliance was used to distalize the maxillary molars by more than 6 mm, to achieve a Class I molar relation. In the second phase of treatment, mini-implants were inserted between the roots of the maxillary lateral incisor and canine to intrude all the maxillary anterior teeth *en masse* in a single step. Four millimetres of intrusion was achieved. The implants remained stable throughout treatment. In the mandibular arch the incisors were proclined to alleviate the severe crowding. Good overjet and overbite was achieved and has been maintained one year after completion of active orthodontic treatment.

Key words: Deep bite, intrusion, mini-implants

Received 7th November 2007; accepted 21st January 2008

Introduction

Of the four main categories in Edward H. Angle's ubiquitous classification of malocclusions, the Class II division 2 type of discrepancy occurs the least often. In a study of 2758 White North American adolescents between 14 and 18 years of age, Massler and Frankel[1] found the prevalence rate of Class II division 2 to be 2.7%. In another study, Peck *et al.*[2] found a prevalence rate of 1.7% in a North American orthodontic population. According to the definition published by Angle in 1889, Class II division 2 malocclusions are characterized by posterior displacement of the mandibular dental arch, deep overbite and retruded upper incisors.[3] In growth patterns of the severe Class II division 2 malocclusion, it is essential to start orthodontic treatment at an earlier age to mollify some of the classic characteristics of this malocclusion. Once the majority of facial growth is complete, orthodontic solutions may become compensatory.

Class II division 2 patients have a more horizontal growth pattern with a clear-cut tendency towards increased overbite. Depending upon the diagnosis and treatment objectives, deep overbite can be corrected either by intruding the incisors or in growing patients also by extruding the posterior teeth and sometimes by a combination of both. Anchorage control, especially in the vertical dimension, is of paramount importance if bite opening has to be achieved by genuine intrusion of the anterior teeth. Numerous attempts have been made in the past to devise suitable anchorage methods; including intra-oral and extra-oral appliances. All intra-oral appliances show some degree of anchor loss while extra-oral appliances, although efficient, require extensive patient cooperation.[4] Aesthetics and social issues are also a matter of concern.

In the past decade, skeletal anchorage systems such as mini-plates, palatal implants, mini-implants and screws have revolutionized orthodontic anchorage and biomechanics by making anchorage more stable. Of those, mini-implants or screws have many advantages:[5] easy insertion and removal, immediate loading, placement at numerous anatomic locations including the alveolar bone between the roots of teeth and low cost.

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DOI 10.1179/146531207225022491

(a) (b) (c)

Figure 1 (a–c) Pre-treatment facial photographs

Creekmore and Eklund[6] were probably the first to report intrusion of maxillary incisors by using mini-implant anchorage. In 1997, Kanomi[7] was able to achieve more than 6 mm of lower incisor intrusion by using a screw 6 mm long and 1.2 mm in diameter. Recently, Ohnishi *et al.*[8] used a mini-implant to reduce a 7.2 mm overbite to 1.7 mm by upper incisor intrusion. In the case presented here, mini-implant anchorage was used to intrude all the six maxillary anterior teeth *en masse* in a post pubertal Class II division 2 patient showing 100% deep bite.

History

A 16-year-7-month-old male patient came to our postgraduate clinic with the chief complaint of irregularly placed front teeth. He also complained of excessive overlap of the upper and lower front teeth and was concerned about the possibility of long term damage to his gums.

He had a history of generalized 'enamel hypoplasia', especially in the front teeth. On further investigation it was found that this condition was endemic in the area of residence of the patient and was possibly related to the water supply (mottled enamel).[9]

Diagnosis

The extra-oral clinical examination showed a symmetric face with a convex profile and normal lip competence at rest. The maxillary midline was shifted to the right by 2 mm relative to the facial midline. The pre-treatment intra-oral photographs and the study models demonstrated a full cusp Class II molar and 'end on' canine relation, bilaterally. The overbite was excessive (100%) with lingually inclined upper and lower incisors and over-erupted maxillary incisors. The curve of Spee was 2.5 mm. There was severe crowding in both the upper and lower arches with 8 mm in the upper and 7 mm in the lower (Figures 1 and 2). The patient had poor oral hygiene with amalgam restorations on LL6 and LR6 and a large restoration on UL6.

Cephalometric analysis revealed a skeletal Class II anterior–posterior discrepancy with an ANB angle of 5° and mandibular plane angle of 28° (Go–Gn–SN). The upper incisors were at an angle of 85° relative to the cranial base (S–N plane), while the lower incisors showed an angle of 89° (IMPA) relative to the mandibular plane (Figure 3). The panoramic radiograph showed the presence of the complete dentition, except for the upper right third molar. The overall alveolar bone was within normal limits (Figure 4).

As the patient did not report a significant medical history, the aetiology of the malocclusion was considered developmental, especially because of reduced mandibular growth. Functional assessment revealed that mouth opening and excursions were within normal functional limits with no signs and symptoms of a temporomandibular joint disorder.

(a) (b) (c)

Figure 2 (a–c) Pre-treatment intra-oral photographs

Treatment objectives

The treatment objectives based on the results of cephalometric and study model analyses were:

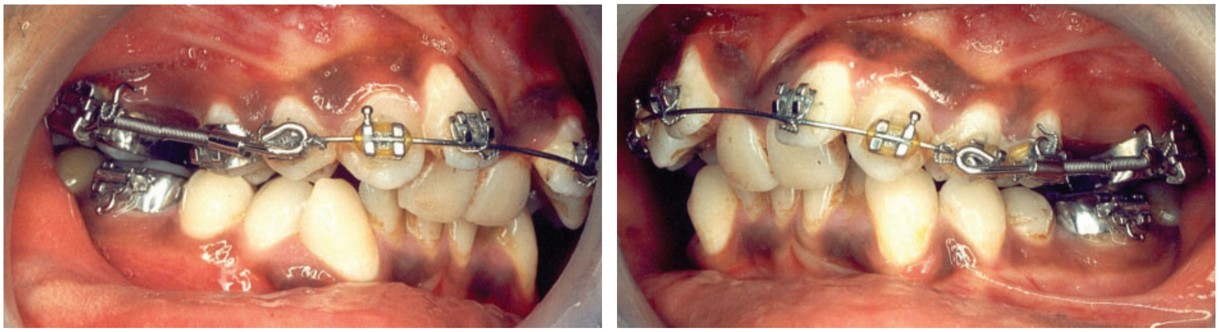
- To create adequate arch length in the upper and lower arches to decrowd and align the teeth.
- To correct the deep bite by intruding the maxillary incisors with minimal extrusion of the maxillary and mandibular molars so as not to cause any further rotation and distalization of the already retrusive mandible.
- To advance the maxillary and mandibular incisors to reduce the bimaxillary dental retrusion and establish an interincisal occlusal stop.
- Overall, to achieve a Class I molar and canine relation with normal overjet and overbite, together with a canine guided occlusion.

Figure 3 Pre-treatment lateral cephalograms

Treatment alternatives

The ideal treatment plan for this patient could have combined comprehensive orthodontic treatment with orthognathic surgery. Mandibular ramus surgery could rotate the mandible slightly forward and downward to increase the lower anterior facial height and at the same time achieve a Class I molar and canine relation. However such an approach appeared too aggressive and invasive. Besides, the risks and treatment expenses involved would be too high. The second option that was presented to the patient involved distalization of the maxillary molars, proclining the upper and lower incisors and intrusion of maxillary anterior teeth. Two alternatives were suggested to the patient; the first involved a cervical headgear to distalize the molars together with an intrusion arch for correcting the deep bite. The second option involved the use of an intra-oral distalization appliance for molar correction and skeletal

Figure 4 Pre-treatment panoramic radiograph



(a) (b)

Figure 5 (a,b) 'Jones-jig appliance' for bilateral molar distalization

anchorage to intrude the maxillary anterior teeth. An extraction treatment plan was not considered as the patient presented features of bimaxillary retroclination, and correction of their inclinations would in any case provide more space. There was also minimal upper arch crowding, and since the patient had a strong 'horizontal growth pattern', extractions might have further decreased facial height.

Due to aesthetic and social concerns the patient refused to wear a headgear and opted for the second alternative. The patient and his parents signed a consent form for this treatment plan.

Treatment progress

Because of poor oral hygiene and history of enamel hypoplasia, it was decided that fixed appliance treatment would be initiated only when the patient showed a significant improvement in his oral hygiene status. The patient was therefore instructed to follow a prescribed oral hygiene regime throughout the treatment. After six weeks of evaluation treatment was initiated.

In the first phase of treatment, maxillary first molars and second premolars were banded and a Jones-Jig appliance[10] was placed on the maxillary arch for bilateral distalization of the molars (Figure 5). A Nance palatal arch was soldered to the second premolar band for anchorage reinforcement. The rest of the arch, except for the central incisors, was bonded with a pre-adjusted edgewise appliance (0.022-inch Roth prescription, GAC International, Central Islip, NY, USA) and a 0.016-inch stainless steel archwire was inserted to initiate alignment. After five months of active distalization a Class I molar relation was obtained bilaterally. The molars were distalized by more than 6 mm on each side. Upper incisor flaring and bite opening due to molar extrusion were also noted.

In the second phase of treatment both the upper and lower arches were completely banded and bonded. Initial alignment and levelling was achieved with nickel–titanium archwires. Subsequently, the maxillary arch was divided into three parts, one anterior segment and two posterior segments. A pre-curved 0.021×0.025-inch stainless steel segmental wire was ligated to the six maxillary anterior teeth (UR3–UL3) while the posterior segments had 0.019×0.025-inch stainless steel wire. Self-drilling mini-implants (1.2 mm in diameter and 8 mm in length) were inserted into the buccal alveolar bone between the roots of the maxillary lateral incisor and canine. The implants were inserted under local anaesthesia using a low speed (400–500 rpm) contra-angle implant drill. A mid-treatment panoramic radiograph confirmed that no contact was made with the roots of the adjacent teeth (Figure 6). The implants were immediately loaded by applying elastomeric chains which exerted a force of 50 g, bilaterally for *en masse* intrusion of the six maxillary anterior teeth. Elastomeric chains were also extended from the distal end of the anterior segmental wire to the molar hook on both sides in order to prevent flaring of the anterior teeth and redirect the intrusive forces along their long axes (Figure 7). Four millimetres of intrusion was obtained in five months with this set-up (Figure 8).

In the lower arch, alignment and levelling was primarily achieved by proclination of incisors and some interproximal reduction. 0.019×0.025-inch TMA archwires were used for the final finishing and detailing for both the arches. After debonding, a removable Hawley retainer was placed on the upper arch, while for the lower a bonded lingual retainer made from 0.017-inch multi-stranded wire (Unitek, Coaxial, 3M/Unitek, Monrovia, CA, USA) was used. The mini-implants were removed under topical anaesthesia by unscrewing in the opposite direction.

(a) (b)

Figure 6 (a) Insertion of mini-implants. (b) Panoramic radiograph taken after mini-implant placement. The implants were inserted perpendicular to the cervical bone and were immediately loaded

(a) (b)

Figure 7 (a,b) *En masse* intrusion of maxillary anterior teeth

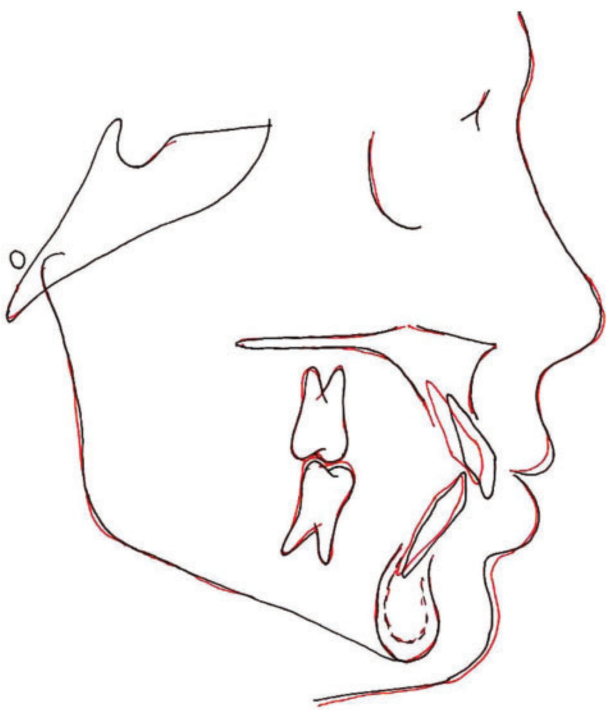


Figure 8 Pre-intrusion (black) and post-intrusion (red) cephalometric tracings, superimposed on sella–nasion plane at sella

Treatment results

An ideal display of maxillary anterior teeth with lips in repose and smiling helped to provide an aesthetically pleasing smile line. The midlines were aligned with each other and with the face (Figure 9). Intra-orally, a normal overjet and overbite was established. A well-seated buccal occlusion with Class I molar and canine relation was created. Canine guidance existed in both right and left excursive movements with no balancing interferences. Centric occlusion and centric relation were coincident (Figure 10).

Cephalometric analysis and superimposition showed 4 mm of maxillary anterior teeth intrusion (Figures 11 and 12). However because the maxilla descended vertically by about 3 mm as a result of growth during the early stages of the treatment, the vertical position of the maxillary incisor did not show a significant change in the overall superimposition. The SNA angle was reduced by 2° due to labio–lingual root torque of the maxillary incisors, while the mandibular plane angle increased by 2°. The interincisal angle was dramatically reduced by 32° due to proclination of upper and lower

(a) (b)

(c) (d)

Figure 9 (a–d) Post-treatment facial photographs

(a) (b) (c) (d) (e)

Figure 10 (a–e) Post-treatment intra-oral photographs

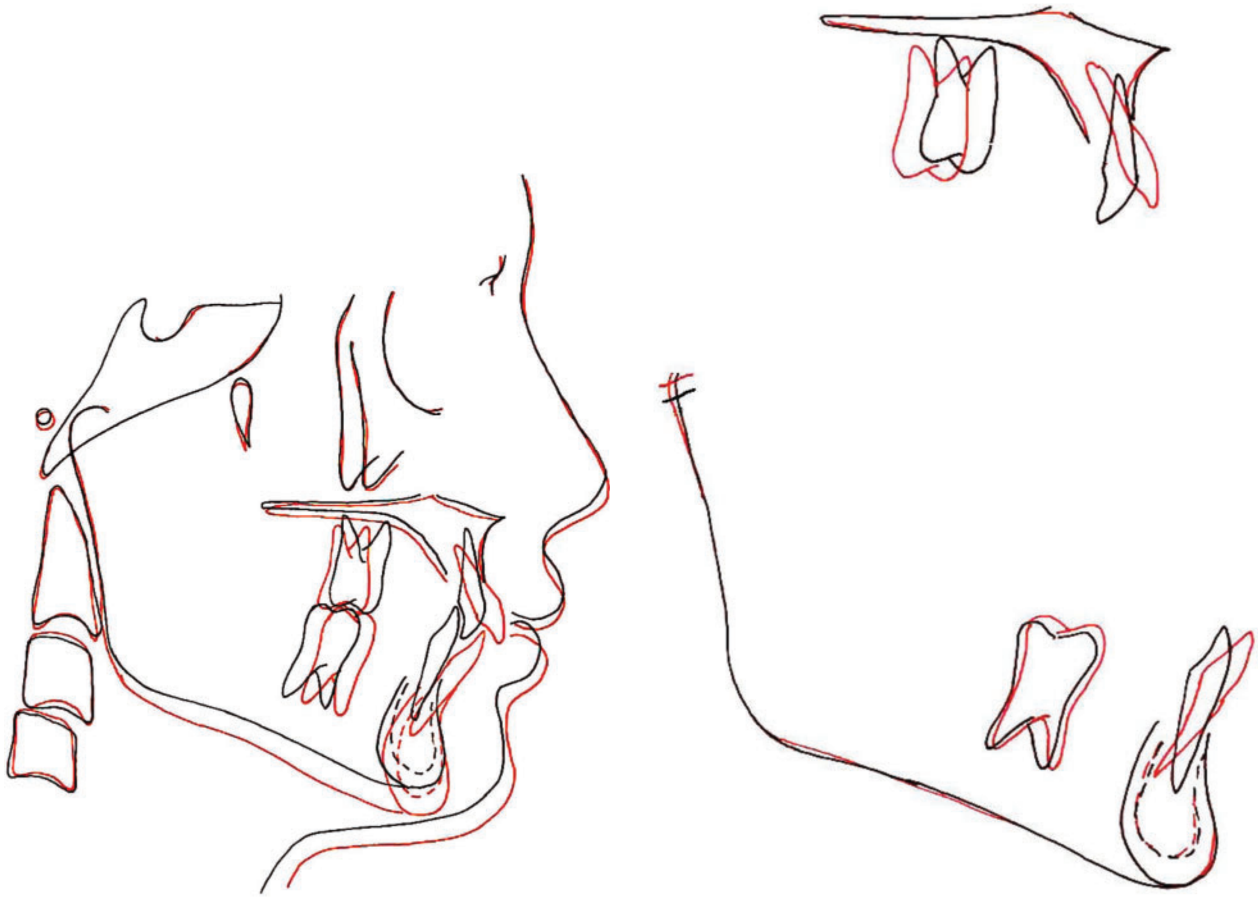
Figure 11 Post-treatment lateral cephalogram

incisors (Table 1). Post-treatment panoramic radiograph showed good root paralleling with minimal apical blunting of the incisor roots. Supporting tissues appeared healthy (Figure 13).

Total treatment time was 26 months. Although this was longer than usual, the patient was satisfied with the overall result. The mini-implants remained clinically

Table 1 Cephalometric data.

Measurement	Normal	Pre-treatment	Post-treatment
SNA (°)	82±2	81	79
SNB (°)	80±2	76	76
ANB (°)	2	5	3
NPg–FH (°)	89±3.9	85	84
Ar–Go–Me (°)	126±6	124	125
SN–GoGn (°)	32	28	30
UI–NA (mm)	4	2	6
UI–NA (°)	22	6	25
U1–SN (°)	102±2	84	104
LI–NB (mm)	4	3	5
LI–NB (°)	25	13	24
IMPA (°)	90	89	99
U1–L1 (°)	130±6	159	127
E line: U (mm)	–4	0	–2
E line: L (mm)	–2	–1	1
G–Sn–Pg' (°)	12±3	14	13



(a) (b)

Figure 12 Pre-treatment (black) and post-treatment (red) cephalometric tracings, superimposed on (a) sella–nasion plane at sella, (b) palatal plane at ANS and mandibular plane at menton

stable throughout treatment and were well tolerated by the patient without any complications. Because his third molars were still developing, he was referred to an oral surgeon for evaluation and possible extraction.

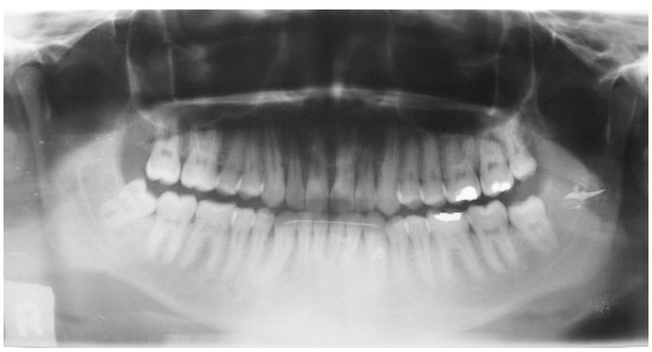


Figure 13 Post-treatment panoramic radiograph

Discussion

Skeletal growth modification is perhaps one of the primary considerations in determining the appropriate treatment plan for a skeletal and dental Class II deep-overbite malocclusion. However, it is appropriate to attempt growth modification treatment only if the patient appears to be in the early stages of his pubertal growth spurt, otherwise a camouflage treatment plan should be considered. In the case discussed, the patient was assessed as post-pubertal and further support of this assessment was provided by the fact that cervical vertebrae C2, C3 and C4 showed vertical elongation and pronounced concavities in their bases. Class II correction was primarily achieved with differential tooth movement, although some amount of residual growth also contributed. Several investigators in the past have made it apparent that craniofacial growth may extend beyond puberty in both males and females.[11,12]

The basic treatment format followed in the correction of Class II division 2 malocclusion is the relief of maxillary crowding, the development of maxillary arch length for incisor root torque, alignment, crown advancement and proper torque of the maxillary incisors. Once the maxillary incisors are placed in proper axial inclination in medullary bone and away from cortical bone, maxillary intrusion can be accomplished. Alignment of the buccal segments is achieved with distalization of the maxillary buccal dentition for the correction of the Class II malocclusion.

It is a well-known fact that correction of deep bite by extrusion of posterior teeth is difficult to accomplish in non-growing individuals having a hypodivergent skeletal pattern than on those with 'appreciable' growth remaining.[13,14] Also, the results might not be stable as the tooth extrusion is counteracted by posterior occlusion and muscle stretching unless suitable growth occurs.[15] Conventional appliances frequently use posterior teeth for facilitating anterior teeth intrusion. This system creates a force to elongate the molars. Although a headgear can be used to control the elongation, it requires excellent patient cooperation. Recently, skeletal anchorage has been the focus of much attention in orthodontics when absolute anchorage is needed. Mini-implants can solve some problems associated with conventional intrusion devices, besides having other advantages. Their simple design makes them comfortable to the patient; side effects, such as extrusion of adjacent teeth, are minimized, so that results are more reliable; and the implantation technique is relatively simple, as is controlling the direction and amount of force. Additionally, the small size of the implants ensures that they can be inserted in most of the anatomic locations of the oral cavity, including the alveolar bone between dental roots. However extreme caution needs to be exercised while placing the implants at these sites so as to avoid inflicting injury on delicate anatomic structures such as vessels, nerves or dental roots. When sufficient interradicular space is not available for implant placement, additional space can be created by intentional separation of the dental roots during the initial stages of orthodontic treatment.

In this case, the implants were custom made. They incorporated modifications of surgical micro-screws routinely used to stabilize plates in the facial bone and fracture reduction surgeries. In order to adapt these screws to the needs (i.e. for attachment of elastics or elastomeric chains), we modified the shape of the head and made the neck slightly longer. Previously Kim *et al.*[16] showed segmental intrusion of only the maxillary incisors using skeletal anchorage by placing a mini-implant between the central incisors below the ANS. In the case presented mini-implant anchorage was used to intrude the maxillary anterior teeth *en masse* by 4 mm using a segmented archwire. Availability of sufficient interdental bone, less soft tissue irritation and a larger anterior segment which required greater control were some of the factors that prompted us to use mini-implants between the roots of the canine and lateral incisors, bilaterally. The selection of the point of application of the intrusive force with respect to the centre of resistance (Cres) of the anterior segment was also an important consideration in the placement of the implants so that the nature of tooth movement that would occur could be predicted more accurately. The Cres of the six anterior teeth was estimated to be halfway between the Cres of the four incisors and canines.[17] True intrusion without axial inclination change can only be obtained by directing the intrusive force through the Cres of the anterior teeth. In this patient, a light distal force (r) was delivered by an elastic chain to the anterior segment to alter the direction of the intrusive force (i) so that true intrusion of the anterior teeth could be achieved along their long axes (Figure 14). The distal force used was of very low magnitude, primarily to redirect the line action of the intrusive force.

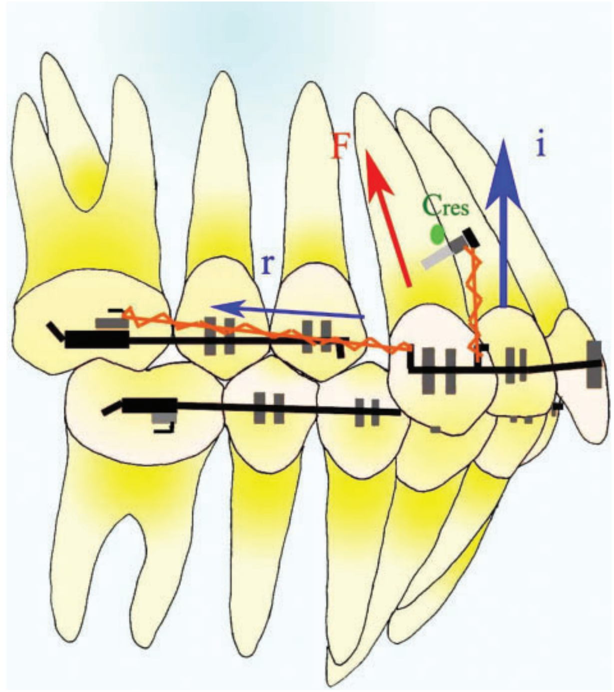
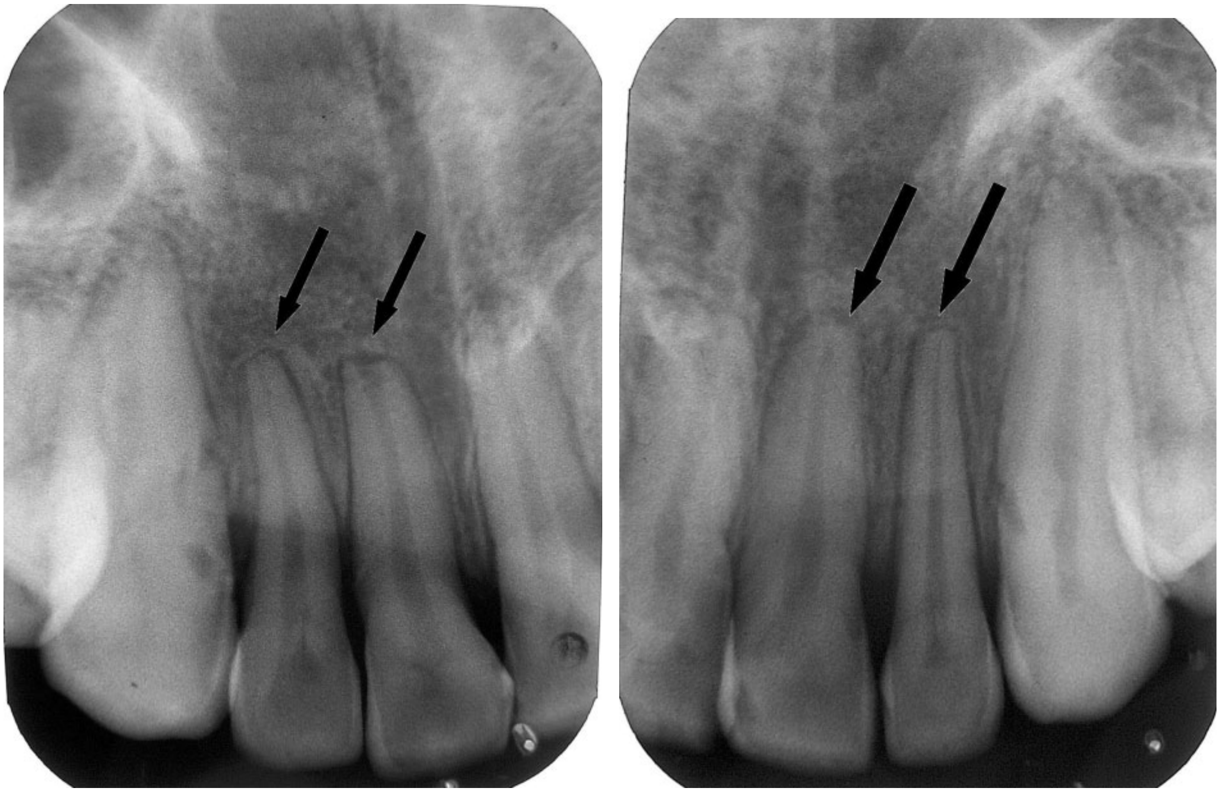


Figure 14 Biomechanical design for the *en masse* intrusion of the maxillary anterior teeth, where i=intrusive force, r=distal force, F=resultant force and *Cres*=Centre of resistance of the anterior teeth)



(a) (b)

Figure 15 (a,b) Periapical radiographs of maxillary anterior teeth after treatment (black arrows show resorption of the apical root tips)

Regarding the optimum force for intrusion, Burstone[18] suggested 20 g of force for intruding anterior tooth and Gianelly and Goldman[19] recommended 15–50 g of force for small teeth. We used elastic chains to exert 50–60 g of intrusive force on each side which is approximately 16–20 g of force/tooth. Although the forces were extremely physiologic, some root resorption was detected in the periapicals taken at the end of treatment (Figure 15). Early investigators[20,21] of this phenomenon found maxillary incisors to be the teeth most susceptible to root resorption. At this time evidence indicates that a typical course of orthodontic treatment will lead to an average apical resorption of 1–2 mm for the upper incisors.[22]

The interincisal angle was reduced by 32°. Riedel[23] suggested that a large interincisal angle at the end of treatment was associated with relapse of deep overbite. Therefore it is important to establish effective incisal stops and guidance between the maxillary and mandibular incisors by reducing the interincisal angle so that stability can be achieved in overbite correction. Superimposition of the lower incisors at protruberance menti point shows a labioversion of 10°. An archwire with a reverse curve of Spee placed an intrusive force on the mandibular incisors anterior to the centre of resistance, resulting in labial proclination. The mandibular incisors can be proclined more in patients with hypodivergent skeletal patterns and prominent chins.[24] However excessive labial movements can also result in progression of mucogingival problems and loss of alveolar bone support.

At the end of active orthodontic treatment the patient maintained a straight profile and the overall aesthetics improved. Some overbite rebound seems to be inevitable in the Class II division 2 deep-bite orthodontic patient.[25,26] A post-treatment increase in the overbite can provoke a reduction in the mandibular intercanine width and subsequent mandibular incisor crowding. Therefore, it might be prudent to place fixed lingual retention on the mandibular anterior teeth in such patients. The mandibular retainer might also help to maintain the overbite correction by not allowing mandibular anterior arch width collapse.

Conclusion

This case report demonstrates the utility of mini-implants in carrying out *en masse* intrusion of the maxillary anterior teeth without relying on patient cooperation. Clinically, 100% anchorage was maintained during intrusion with no extrusion of the posterior teeth. Controlling the direction and amount of force also contributed to the overbite correction. The implants remained stable throughout treatment and showed no associated soft tissue complications. As long term monitoring of the periodontal health and stability is critical (especially when the patient has 'enamel hypoplasia'), the patient has been kept on recall visits.

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