Journal of Orthodontics, Vol. 34, 2007, 158–167

CLINICAL SECTION

Mini-implants for retraction, intrusion and protraction in a Class II division 1 patient

M. Upadhyay and S. Yadav
Department of Orthodontics, KLES Institute of Dental Sciences, Belgaum, India

This case report demonstrates the clinical utility and versatility of mini-implants in carrying out different types of tooth movement in a 14-year-old boy with a 'severe' Class II division 1 malocclusion. Mini-implants were placed for 'en masse' retraction and intrusion of maxillary anterior teeth and for lower molar protraction. More than 11 mm of maxillary incisor retraction was achieved together with 3 mm of intrusion. There was significant reduction in the dentoalveolar protrusion and retraction of the upper lip, which resulted in decreased mentalis strain and improved chin projection. Cephalometric superimposition and panoramic radiographs showed no anchorage loss and good occlusion at the end of treatment.

Key words: Mini-implants, en masse, intrusion, retraction, protraction

Received 9th December 2006; accepted 19th February 2007

Introduction

Anchorage control is one of the most important aspects of orthodontic treatment. Although extra-oral anchorage can be used to supplement tooth borne anchorage, patients often reject the use of a headgear because of aesthetic and social concerns.[1] There are also safety concerns about headgear. Lack of cooperation with headgear can result in anchorage loss and poor treatment results.

To obtain anchorage without patient cooperation, endosseous implants,[2] miniplates,[3] mini-implants[4] and screws[5–7] have been used as orthodontic anchorage. Of those, mini-implants or screws have many advantages:[8] easy insertion and removal, immediate loading, placement at numerous anatomic locations including the alveolar bone between the roots of teeth and low cost.

In the case presented here, mini-implants were used for 'en masse' retraction and intrusion of upper anterior teeth and for protraction of lower right first molar. One hundred per cent anchorage was maintained throughout treatment.

Case report

History

A boy aged 14 years and 5 months presented at the Department of Orthodontics at KLE University, Belgaum with the chief complaint of an unattractive smile with forward placement of the upper front teeth. He showed good general health with no history of trauma or serious illness.

Diagnosis and aetiology

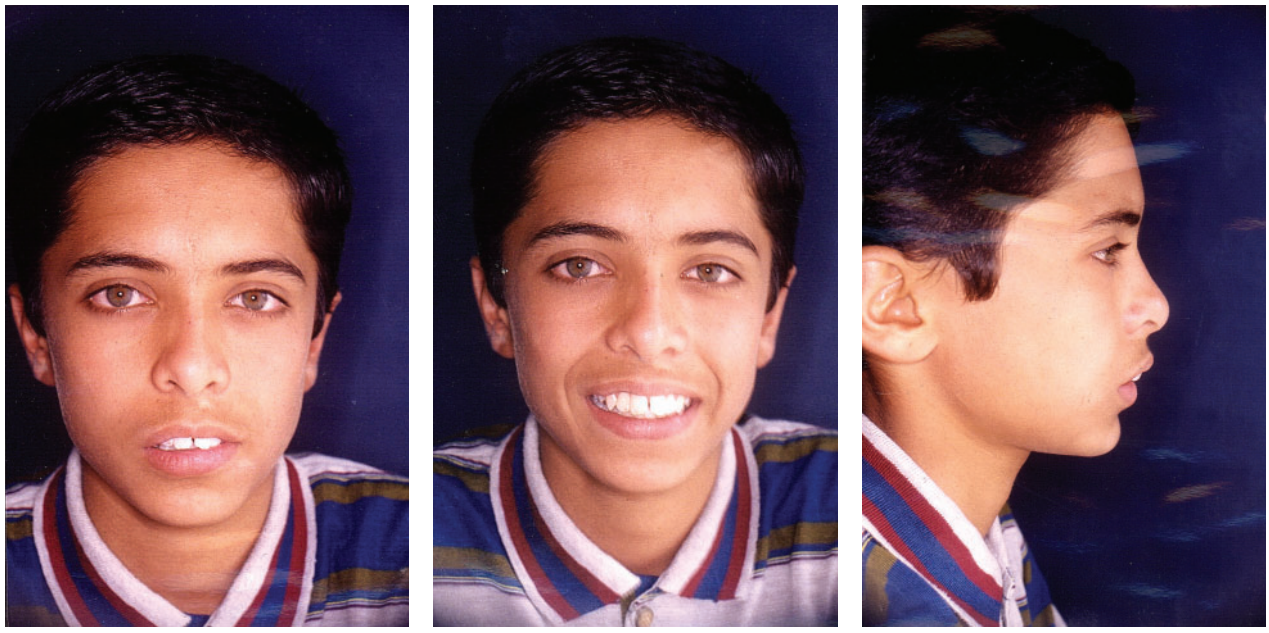
The extra-oral clinical examination showed a symmetric face with a convex profile due to severe dentoalveolar protrusion. The lips were incompetent, the upper lip being short and showing marked protrusion together with mentalis strain.

Intra-orally there was a Class II molar (full cusp on the right side and 'end-on' on the left side) and canine relation with an overjet of 11 mm and overbite of 5 mm (70–80% deep bite). Moderate to severe crowding was present in the lower arch together with an exaggerated curve of Spee (Figures 1 and 2). Cephalometric analysis revealed a skeletal Class II anterio-posterior discrepancy with an ANB angle of 7°. The patient had severely proclined maxillary incisors (U1–SN=122°), while the lower incisors were upright (IMPA=93°) (Figure 3, Table 1). A panoramic radiograph showed the complete dentition to be present, including the third molars (Figure 4).

The aetiology was partially skeletal and also due to a history of prolonged thumb sucking. Functional assessment revealed that mouth opening and excursions were within normal functional limits with no signs and symptoms of a temporomandibular disorder.

Address for correspondence: Madhur Upadhyay, Department of Orthodontics and Dentofacial Orthopaedics, KLES Institute of Dental Sciences, Nehru Nagar, Belgaum 590010, Karanataka, India.
Email: madhurup@yahoo.com

DOI 10.1179/146531207225022140



(a) (b) (c)

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

Treatment objectives

In the maxillary dentition, the treatment objectives were to reduce the severity of upper dentoalveolar protrusion, eliminate the lip strain on closure and achieve a more normal axial inclination of the incisors. Also, some intrusion of the incisors was required to reduce the increased 'incisor-stomion' distance. Because the maxillary incisors were excessively proclined, more anchorage was required to retract the incisors and prevent mesial movement of the maxillary molars.

Treatment objectives in the mandibular arch included resolving the crowding, levelling the curve of Spee, followed by protraction of the molars to achieve a Class I relation, while maintaining the normal axial inclination of the incisors. Anchorage needed to be burnt on the right side, where more than 6 mm of molar protraction was required to achieve a Class I relation. It was therefore decided to use mini-implants in both the upper and lower arches, in order to meet the anchorage demands of this case.

Additional objectives were to achieve a normal Class I mutually protected occlusion with normal overjet and overbite, together with improved function and aesthetics; especially a pleasing upper lip profile.

Table 1 Cephalometric data.

Measurement	Normal	Pre-treatment	Post-reatment
SNA (°)	82±2	84	82
SNB (°)	80±2	77	77
ANB (°)	2	7	5
NPg–FH (°)	89±3.9	86	85
Ar–Go–Me (°)	126±6	132	129
FMA (°)	25	27	27
SN–GoGn (°)	32	31	31
UI–NA (mm)	4	11	3
UI–NA (°)	22	39	18
U1–SN (°)	102±2	122	99
LI–NB (mm)	4	7	7
LI–NB (°)	25	23	25
IMPA (°)	90	93	95
E line: U (mm)	−4	1	−4
E line: L (mm)	−2	−2	−2
G–Sn–Pg' (°)	12±3	17	12

Treatment alternatives

Initially, the treatment plan involved growth modification with headgear and overbite correction followed by fixed appliances and elastics. In the lower arch it was planned to carry out interproximal tooth reduction to alleviate the crowding. However, due to aesthetic and social concerns the patient refused to wear a headgear. His parents were also not sure whether he would cooperate. Therefore, the alternative treatment plan of extracting the upper first premolars was recommended. In the lower arch it was decided to extract the first

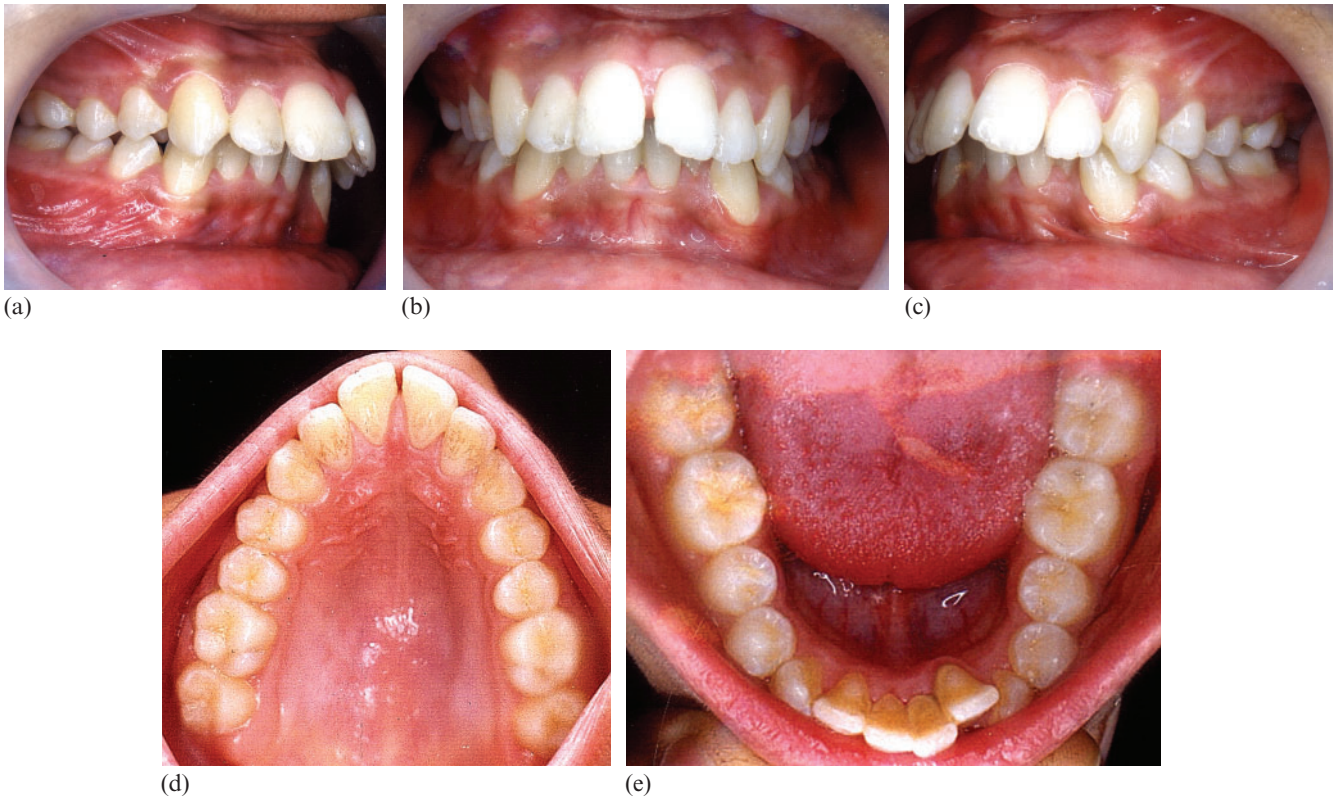


Figure 2 (a–e) Pre-treatment intra-oral photographs

Figure 3 Pre-treatment lateral cephalogram

premolar on the left side and second premolar on the right side. The primary consideration in selecting this treatment plan was the severity of maxillary dentoalveolar protrusion and mandibular anterior crowding as well as achieving a stable Class I molar and canine relation.

Treatment progress

The maxillary molars were banded and the remaining teeth bonded with pre-adjusted edgewise appliance (0.022-inch Roth slot, GAC International). Initial alignment was achieved with 0.016-inch and 0.016 × 0.022-inch nickel titanium archwires. The archwires

Figure 4 Pre-treatment panoramic radiograph

(a) (b)

Figure 5 (a,b) 'En masse' retraction of maxillary anterior teeth with mini-implants

were cinched to avoid proclining the incisors. Shortly afterward the premolars were extracted in the upper and lower arches as discussed in the treatment plan. Self-drilling mini-implants (1.3 mm in diameter, 8 mm in length) were inserted into the buccal alveolar bone between the maxillary first molar and second premolar on either side of the arch. The implants were inserted under local anaesthesia using a low speed (400–500 rpm) contra-angle implant drill. Periapical X-rays were taken for each implant to confirm that no contact was made with the roots of the adjacent teeth. A 0.017×0.025-inch stainless steel archwire with 'anterior hooks' (crimpable hooks) placed distal to lateral incisors, was inserted into the upper arch. One hundred and fifty grams of force were applied on each side with a nickel titanium coil spring (closed) extending from the implant head to the hook for the retraction of maxillary anterior teeth 'en masse' (Figure 5).[9] After five months of retraction, the archwire was cut distal to the canines to increase the intrusive component on the anterior segment (Figure 6). Complete space closure was achieved two months later. The incisors were intruded by 3 mm.

In the lower arch a segmented T-loop[10] was placed and activated to simultaneously retract the lower left canine and protract the first molar into a Class I molar relation (Figure 5a). After completing canine retraction the previously blocked out lateral incisor was bonded. Levelling and aligning was done with continuous nickel titanium archwires. Later, a mini-implant was inserted into the buccal alveolar bone between the mandibular canine and premolar on the right side. A closed nickel titanium coil spring exerting a force of 200 g was stretched between the first molar hook and the implant head. After about 5 mm of space closure, uprighting of the first molar was done by disengaging the coil springs for two months. A 20° 'gable bend' was placed in the archwire distal to the first premolar. Subsequently, protraction was resumed until complete space closure was achieved. It took eight months to protract the molar by more than 6 mm (Figure 6).

0.019×0.025-inch TMA archwires and cusp-seating elastics were used in the final stages of treatment. A removable Hawley retainer was placed on the maxillary teeth, and a bonded lingual retainer on the mandibular teeth. The implants were removed under topical anaesthesia by unscrewing in the anticlockwise direction (Figure 7).

Treatment results

Total treatment time was 30 months. Favourable facial changes were observed with harmonious relationship of the facial soft tissue. The patient showed a broad symmetric smile with ideal amount of tooth structure displayed and the incisal line running along the border of the lower lip. Upper lip protrusion was reduced by 5 mm and the mentalis strain eliminated, resulting in a straightened profile (facial convexity reduced by 5°) and increased chin prominence (Table 1, Figure 8).

Intra-orally, a well-interdigitated buccal occlusion with a Class I canine and molar relation was obtained. Ideal overjet and overbite were established. In the lower arch, normal alignment was achieved without altering the arch form or the axial inclination of the incisors. However, the major achievement was the bodily protraction of the lower right first molar by more than 6 mm from a full cusp Class II relation to a Class I relationship (Figure 9). Cephalometric radiographs and superimpositions showed 11 mm of maxillary incisor retraction and 3 mm of intrusion with titanium screw anchorage. The SNA angle was reduced by 2° (Figures 10 and 11).

Post-treatment panoramic radiograph showed, good root paralleling, except for the upper lateral incisors. Supporting tissues appeared healthy, and only minimal

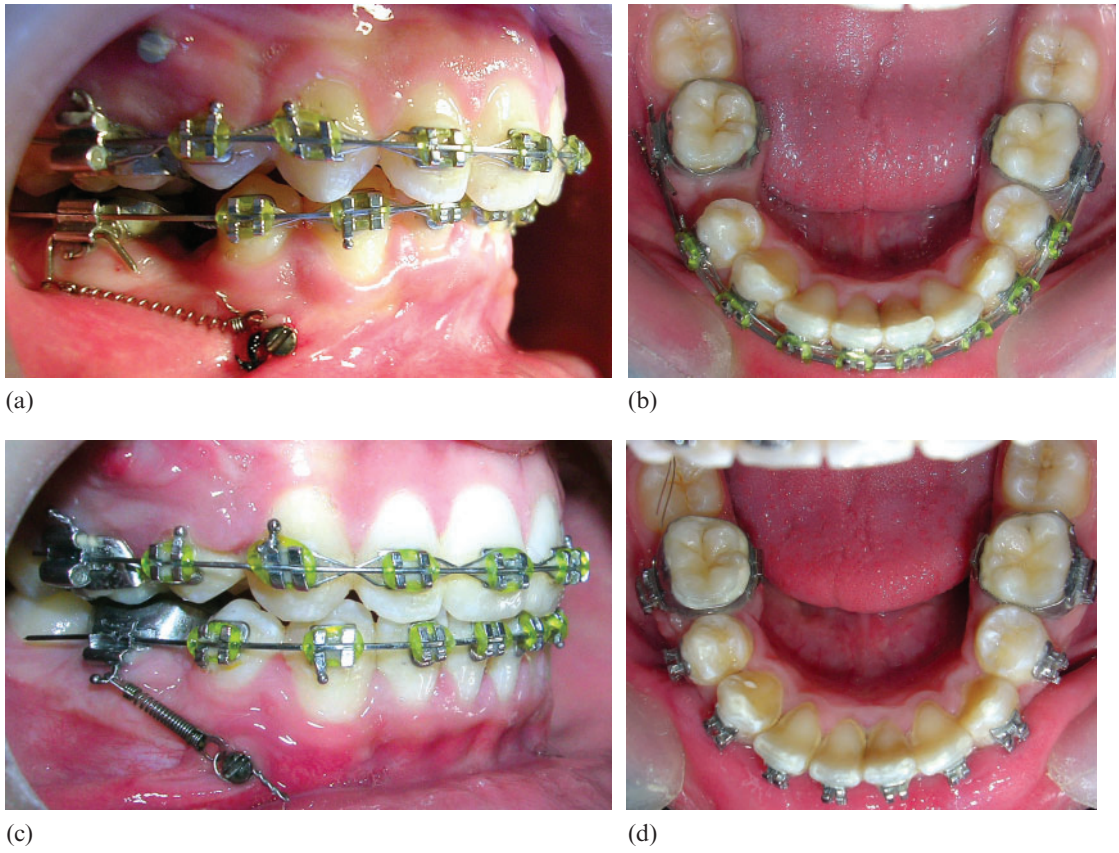


Figure 6 Mesial movement of the lower right mandibular first molar with mini-implant. (a,b) Protraction in progress. (c,d) Protraction complete

apical blunting of the upper central incisor roots was observed (Figures 12 and 13).The patient has been in retention for more than 15 months and the results have been maintained (Figure 14).

Figure 7 Removal of mini-implant

Discussion

Effectiveness, efficiency and potential patient cooperation are important considerations in determining the appropriate appliances to use in Class II correction. Cervical headgear is an uncomplicated and highly effective appliance to correct a Class II malocclusion. The mandible tends to grow forward more than the maxilla during pubertal growth spurt. Therefore, maxillary growth can be inhibited with a headgear while achieving the correction with mandibular differential growth.

However, in the case presented, the patient strongly rejected this option and demanded a treatment alternative which would involve no extra-oral appliance. Therefore an extraction treatment plan was adopted primarily due to upper incisor proclination, increased overbite and lower arch crowding. It is important to consider maxillary incisor position relative to lip position to determine whether to maintain, intrude or extrude the maxillary incisors relative to the upper lip.[11] The final position of the incisors should be such that the lips exhibit harmonious relationship with the nose and chin.[12]

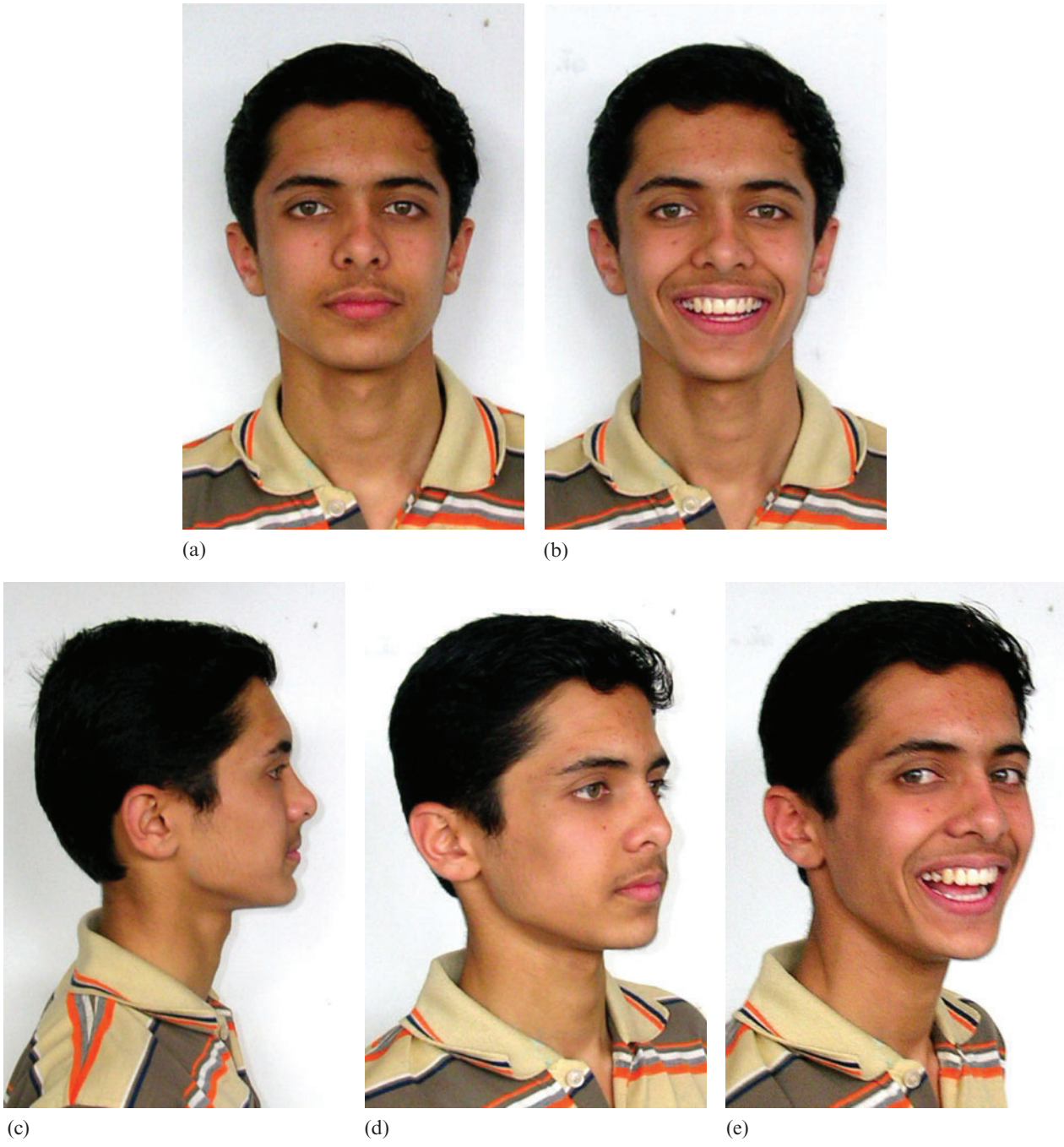


Figure 8 (a–e) Post-treatment facial photographs

Careful attention to anchorage was critical to ensure ideal Class I occlusal relationships without over retraction of the incisors and creating a retruded lip profile. Anchorage requirement was variable in each arch depending on when and where it was needed. For instance, after initial alignment, increased maxillary anchorage was required to attain Class I canine and anterior relationships. This was accomplished by using skeletal anchorage. 'En masse' retraction and intrusion was efficiently carried out with no mesial movement of the molars. In the process 'point A' was relocated posteriorly thereby reducing the SNA angle by 2°. Good control of the vertical plane was achieved with minimal changes in the mandibular plane angle (Table 1).

In the mandibular arch, anterior anchorage was critical because the axial inclination of the incisors had

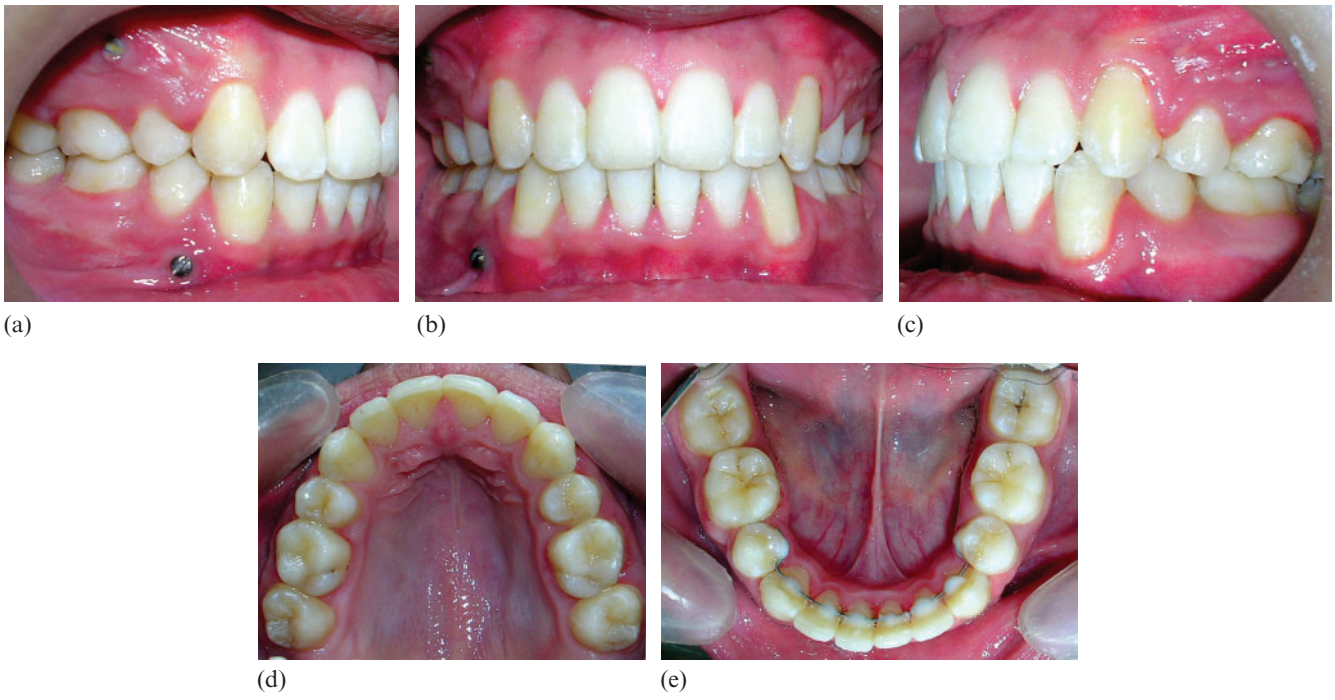


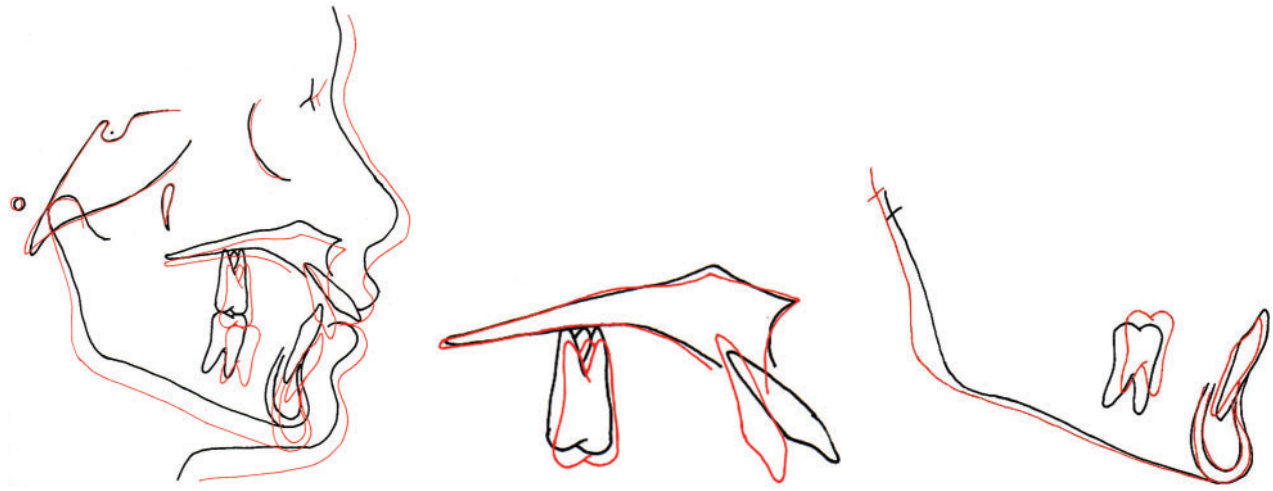
Figure 9 (a–e) Post-treatment intra-oral photographs

Figure 10 Post-treatment lateral cephalogram

to be maintained during protraction of the molars into the extraction spaces. A segmented T-loop was used to protract the lower left molar while a mini-implant was used for the lower right molar which showed more than 6 mm of molar protraction with no lingual tipping of incisors (Table 1). Previously, Roberts *et al.*[2,13] placed a dental implant in the retromolar area to close the space of a missing mandibular first molar, without causing any lingual tipping of incisors.

In the present case, mini-implants were implanted in the buccal alveolar bone of the maxilla and mandible where they remained invisible and sufficient bone thickness was available for stable anchorage.[14] The small size of the bone fixtures allow them to be inserted in most of the anatomic locations so that force can be applied in any direction. It also provides easier accessibility and better oral hygiene maintenance. The mini-implants used in this case 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 nickel titanium coil springs), the authors modified the shape of the head and made the neck slightly longer.

In the post-treatment radiographs, the maxillary central incisors and the lower right first molar show minor blunting of the root tips. However, comparisons



(a) (b) (c)

Figure 11 Pre-treatment (black) and post-treatment (red) cephalometric tracings, superimposed on: (a) sella-nasion plane at sella; (b) palatal plane at ANS; (c) mandibular plane at menton

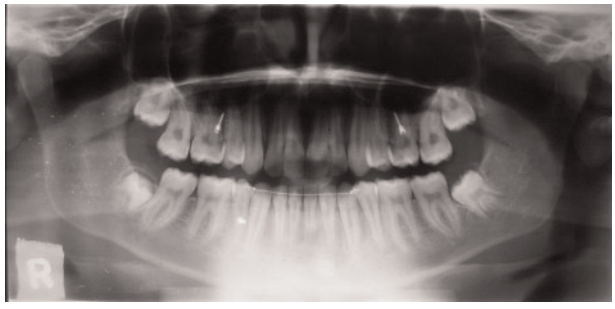
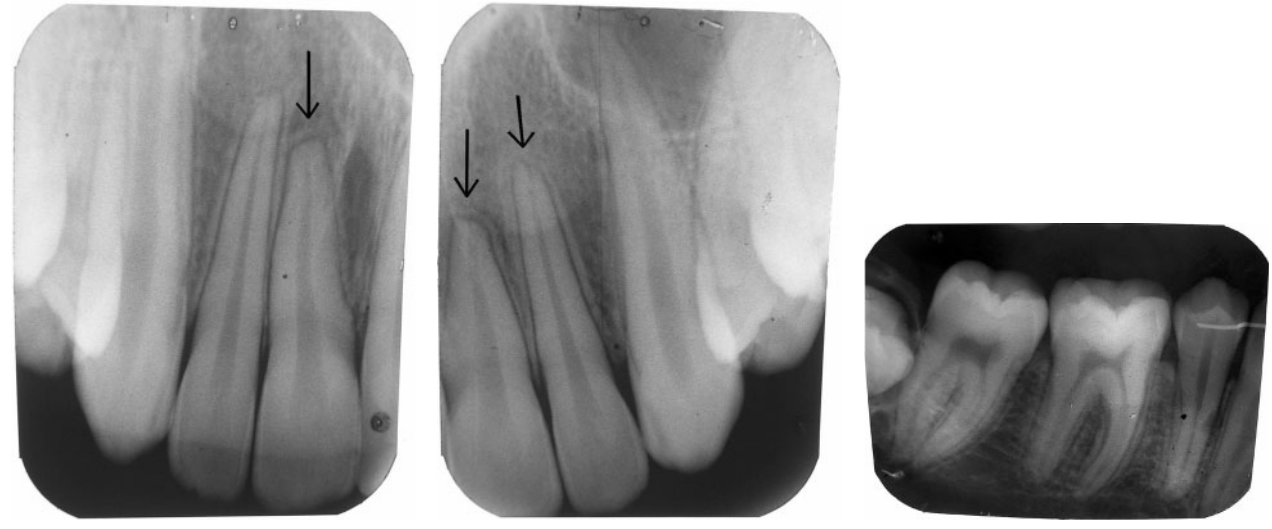


Figure 12 Post-treatment panoramic radiograph

with the initial panoramic radiograph show no significant root resorption.

Conclusion

This case report demonstrates the versatility of mini-implants in carrying out different types of tooth movement, in a Class II division 1 patient showing severe dentoalveolar protrusion. One hundred per cent anchorage was maintained throughout treatment which helped the authors to maximize their treatment results.



(a) (b) (c)

Figure 13 Periapical radiograph of (a,b) maxillary central incisors (black arrows show minor blunting of the apical root tips) and (c) lower right first molar

Figure 14 (a,b) Facial and (c–g) intra-oral photographs following one year of retention

There was a significant improvement in the occlusion along with favourable profile and smile changes.

References

1. Deguchi T, Takano-Yamamoto T, Kanomi R, *et al.* The use of small titanium screws for orthodontic anchorage. *J Dent Res* 2003; **82:** 377–81.
2. Roberts WE, Nelson CL, Goodcare CJ. Rigid implant anchorage to close a mandibular first molar extraction site. *J Clin Orthod* 1994; **28:** 693–704.
3. Umemori M, Sugawara J, Mitani H, Nagasaka H, Kawamura H. Skeletal anchorage system for open-bite correction. *Am J Orthod Dentofacial Orthop* 1999; **115:** 166–74.
4. Kanomi R. Mini-implant for orthodontic anchorage. *J Clin Orthod* 1997; **31:** 763–67.

5. Creekmore TD, Eklund MK. The possibility of skeletal anchorage. *J Clin Orthod* 1983; **17:** 266–69.
6. Park HS, Bae SM, Kyung HM, Sung JH. Micro-implant anchorage for treatment of skeletal Class-I bialveolar protrusion. *J Clin Orthod* 2001; **35:** 417–22.
7. Park HS, Kwon TG, Kwon OW. Treatment of open bite with microscrew implant anchorage. *Am J Orthod Dentofacial Orthop* 2004; **126:** 627–36.
8. Prabhu J, Cousley RRJ. Current products and practice: bone anchorage devices in orthodontics. *J Orthod* 2006; **33:** 288–307.
9. Samuels RH, Rudge SJ, Mair LH. A clinical study of space closure with nickel-titanium closed coil springs and elastic module. *Am J Orthod Dentofacial Orthop* 1998; **114:** 73–79.
10. Kuhlberg AJ, Burstone CJ. T-loop position and anchorage control. *Am J Orthod Dentofacial Orthop* 1997; **112:** 12–18.
11. Sarver DM. The importance of incisor positioning in the esthetic smile: the smile arc. *Am J Orthod Dentofacial Orthop* 2001; **120:** 98–111.
12. Drobocky OB, Smith RJ. Changes in facial profile during orthodontic treatment with extraction of four first premolars. *Am J Orthod Dentofacial Orthop* 1989; **95:** 220–30.
13. Roberts WE, Marshall KJ, Mozsary PG. Rigid endosseous implant utilized as anchorage to protract molars and close an atrophic extraction site. *Angle Orthod* 1990; **60:** 135–52.
14. Miyawaki S, Koyama I, Inoue M, Mishima K, Sugahara T, Takano-Yamamoto T. Factors associated with stability of titanium screws placed in the posterior region for orthodontic anchorage. *Am J Orthod Dentofacial Orthop* 2003; **124:** 373–78.