ORIGINAL ARTICLE

Closing anterior open bites by intruding molars with titanium miniplate anchorage

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The intent of this study was threefold: (1) to validate true intrusion of molars in adults, (2) to test the stability of miniplates as anchorage for intruding posterior teeth in the maxilla, and (3) to record the skeletal and dental changes of open-bite closure. Four adult patients who had anterior open-bite malocclusions were selected to undergo posterior intrusion with miniplate anchorage to close the open bite; all had true intrusion of the maxillary molars. Mean molar intrusion was 1.99 mm (range, 1.45-3.32 mm). No movement of miniplates occurred at any time during their use or before intentional clinical removal. Open-bite closure was achieved for all 4 patients. Mean closure of incisors was 3.62 mm (range, 3.0-4.5 mm) as the mandibular plane closed 2.62° (range, 1.5°-4.5°), and the occlusal plane decreased 2.25° (range, 1.0°-3.5°). Anterior facial heights decreased as the mandible closed and B-point rotated anteriorly and upward. (Am J Orthod Dentofacial Orthop 2002;122:593-600)

Many techniques, case reports, and limited studies have been reported for the orthodontic treatment of malocclusions characterized by anterior open bites. Extrusion or eruption of anterior teeth is a common method of bite closure. However, Harris and Butler[1] described a series of adolescent patients with anterior open bites as having significantly shorter roots and less facial bone support of the anterior teeth. Graber[2] pointed out that adults might be more prone to root resorption with orthodontic manipulation. Incisor extrusion to close the bite in adults could be destructive in this compromised area of the dentition. Reitan and Rygh[3] reported that extruded teeth are less stable than intruded teeth. Finally, the extrusion of maxillary anterior teeth might compromise esthetics. For all of these reasons, closing anterior open bites by dental extrusion is contraindicated in certain patients.

Other treatment methods for closing open bites apply intrusive forces to posterior teeth. Posterior bite blocks have been recommended to correct anterior open bites.[4,5] Bite blocks augmented with magnets[6-8] or springs[9] have also been used. Multi-loop edgewise archwire techniques have been applied after second or third molar extraction.[10,11] Reportedly, the occlusal plane is changed by extruding the anterior teeth while uprighting and intruding the posterior teeth to close the anterior open bite. High-pull headgear[5] and headgear with a posterior bite block[5,12] have been advocated for use in the mixed dentition to slow or prevent vertical development in the maxillary molar region of children as they continue to grow. This "relative intrusion" retards posterior vertical dentoalveolar development and decreases the potential for an anterior open bite to form.

Few 10-year posttreatment studies involving large numbers of patients with diagnostically comparable open bites have been published. Lopez-Gavito et al[13] reported the results of a study of 41 patients who had been treated for comparable open-bite malocclusions. Records gathered at least 9.6 years after orthodontic treatment were studied. On evaluating the sample, the authors noted a significant increase in the distance from the mandibular plane to the mandibular incisor during treatment, suggesting the use of incisor extrusion to assist in closing the open bite. Furthermore, at all time periods, the mandibular incisor's vertical position was depressed in the relapsed subgroup compared with the stable subgroup. More than 35% of the treated open-bite patients demonstrated a postretention open bite of 3 mm or more. No statistics were given for smaller open bites. This study and others[14] show that predictability of a stable outcome in the long term is low. Furthermore, these findings of compromise were in a group of patients whose pretreatment median age was 12.5 years. One might expect even more relapse and greater problems in treating open-bite malocclusions in adults.[12,15,16]

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Frost et al[17] studied a group of adults with anterior open bites, concluding that posterior maxillary dentoalveolar excess was present in or responsible for the development of the open bite. Thus, the treatment of choice for these patients was orthognathic surgical impaction of the posterior maxilla to allow the mandible to autorotate counterclockwise and close the bite. Frequently, orthodontic and facial vertical relationships are such that orthognathic surgery is the only (or at least the most plausible) treatment plan proposed.

However, there might be other, less-invasive treatment options not requiring orthognathic surgery. If it is possible to orthodontically intrude posterior teeth, the accompanying changes in occlusal plane, mandibular plane, lower anterior face height, and anterior dental overbite would close the patient's open bite. This can be accomplished by placing an implant or a miniplate and attachment to intrude the posterior teeth.

Several studies have reported on using dental implants for anchorage in orthodontics. Screw implants,[18,19] cylindrical implants,[20-23] and onplants[24] have been evaluated as skeletal anchorage to move teeth mesially or distally. Kanomi[25] reported the successful use of mini-implants to retract and intrude anterior teeth. One study reported on using titanium miniplates as skeletal anchorage in orthodontic treatment.[26] This study was unique in that the miniplates were used as skeletal anchorage to intrude mandibular posterior teeth in combination with the multiloop archwire technique to close open bites. The mandibular and occlusal planes rotated counterclockwise, thus closing the open bite. However, no maxillary posterior tooth intrusion was attempted in that study. Only general orthodontic and dentofacial effects of miniplate anchorage in the treatment of anterior open bite were given; there was little detail about specific tooth movements. Furthermore, interpretation of the results is compromised by potential contributing effects from the multiloop archwire appliance.

The present study was undertaken to test the use of titanium miniplates[27-29] as anchorage to intrude maxillary posterior teeth to close anterior open-bite malocclusions. Selection criteria were established for the size and shape of the miniplates, and their stability was assessed. Closure of the open bite, changes in dental overbite with changes of occlusal and mandibular plane angles, and anterior facial height were measured in patients undergoing treatment for a preorthodontic dental and skeletal vertical open-bite malocclusion. This study was designed to definitively measure the true intrusion of individual molars.

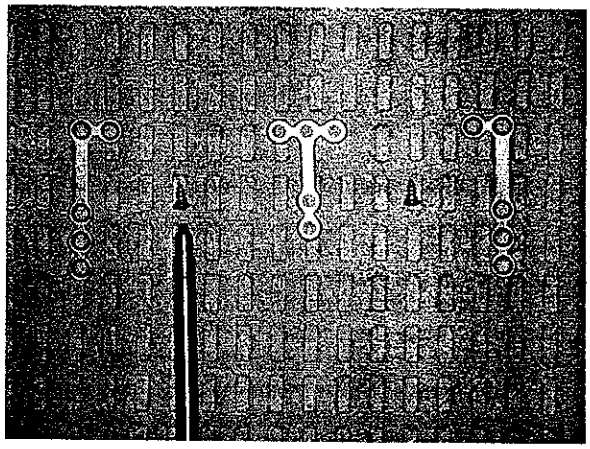

Fig 1. Leibinger miniplates, screws, and screwdriver.

Table I. Diagnostic positions of molars (Burstone analysis)

	Subject 1	*Subject 2*	*Subject 3*	*Subject 4*
U6-PP (mm) 23F-26M	30	27	28	30.5
L6-MP (mm) 32F-35M	40	38	35	36.5

U6, Maxillary first molar; *L6*, mandibular first molar; *PP*, palatal plane; *MP*, mandibular plane; *F*, female; *M*, male.

MATERIAL AND METHODS

The patients selected for this study were 4 adults (2 men and 2 women) who had long-standing open bites and no habit history. They had refused orthognathic surgery and elected this less-invasive, miniplate-assisted orthodontic treatment. A Burstone analysis[30] (Table I) of each patient's lateral cephalometric radiograph was completed to determine whether the maxilla or the mandible had posterior vertical dentoalveolar hyperplasia associated with the anterior open bite. All subjects demonstrated some degree of both maxillary and mandibular vertical excess in the posterior dentoalveolus. After obtaining appropriate informed consent, Leibinger titanium miniplates (Fig 1) were placed and used as anchorage to apply orthodontic intrusive forces to the molars.

Placing the titanium miniplates began with administering local anesthesia. A 2-cm incision was made in the vestibule buccal to the selected maxillary first molars. A full-thickness mucoperiosteal flap was reflected, and cortical bone was exposed over the zygomatic strut in the maxilla or the body of the mandible.

An L-, Y-, or T-shaped plate was selected and

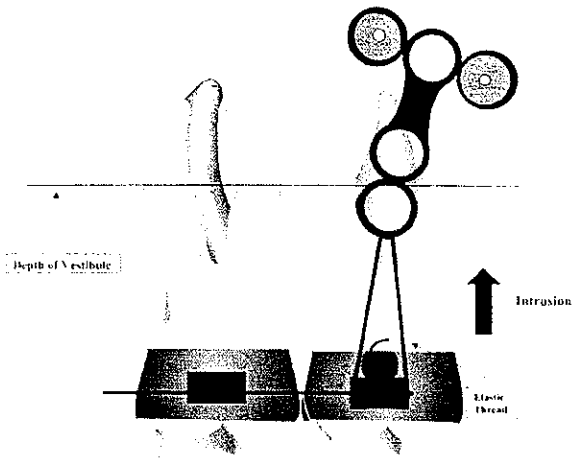

Fig 2. Diagram of miniplate inserted in maxilla with elastic traction connected to molar segment.

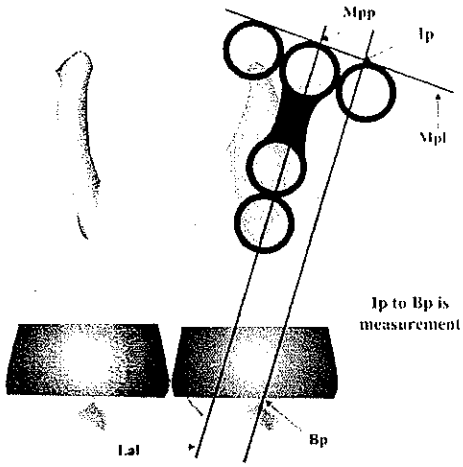

Fig 3. Diagram of panoramic analysis of intrusion.

contoured to the surface of the bone. Miniplate size and shape were based on the length of the roots of adjacent molars, and the contour and density of underlying bone. The plate was positioned so that only the last loop on the vertical (most occlusal) leg of the plate projected through the mucosal incision into the oral cavity. This loop was several millimeters apical to the brackets on the molars and adjacent to the teeth requiring the greatest amount of intrusion (Figs 2 and 4, *B*). Two self-tapping screws were placed to secure the plate to the bone. Incisions were closed primarily around the miniplate, insuring that the occlusal loop was cleanly exposed below the wound margin. Eight weeks was allowed for healing, integration, and adaptation before applying forces to the miniplates.

During healing and stabilization, orthodontic leveling was carried out in 3 independent sections of the dental arch. The 2 buccal segments and 1 anterior segment were independently leveled with light sectional wires, progressing to 0.016 × 0.022-in sectional stainless steel arch wires placed in the edgewise slots of the segments. This sectional treatment prevented the anterior eruption forces that would have occurred with a continuous arch.

Two months after miniplate placement (T2), standard orthodontic records were gathered—models, photographs, and lateral cephalometric and panoramic radiographs.

Intrusion was initiated. A coated elastic thread was passed through the exposed loop of the implanted miniplate and tied tightly to the bracket of the closest molar or molars to create a directly vertical intrusive force (Fig 2). To prevent buccal tipping of the molar segments from the vertical force of the elastic thread, a constricted secondary .020-in Australian archwire was used. It was inserted only into the auxilliary tubes of both maxillary first molars and was lightly ligated to the anterior sectional wire at the dental midline. It could rotate freely in the posterior vertical plane as the molars were intruded without affecting the anterior segment.

Intrusion forces were continued for 5.5 months (mean) and terminated when adequate anterior openbite correction was visually detected, or the incisors were in contact. Intruded molars were stabilized by tying a ligature wire from the molar tube and the bracket to the miniplate loop. Stabilization was maintained for at least 4 months and removed 2 months before debanding, debonding, and retaining. Standard orthodontic retention records were gathered (T3), and the miniplates were removed early in the retention phase.

Panoramic radiographs provide the most easily discernable images for identification, location, and measurement because they show the entire treated dental segment, alveoli, and miniplates on each side. Furthermore, there is no overlap of images of the contralateral side as with a lateral cephalogram. Panoramic x-rays (T2 and T3) were corrected for magnification with Indiana University School of Dentistry's image version 1.5 software using the miniplate dimensions for standardization and calibrating for image distortion. Miniplates, nearest molars, and accompanying molar bands were traced, and a long axis line (Lal) was constructed through the long axis (middle) of the long vertical arm of the miniplate (Fig 3). The most superior point of the miniplate contacting this line was marked the miniplate point (Mpp). Another line, the miniplate line (Mpl), was drawn through this point

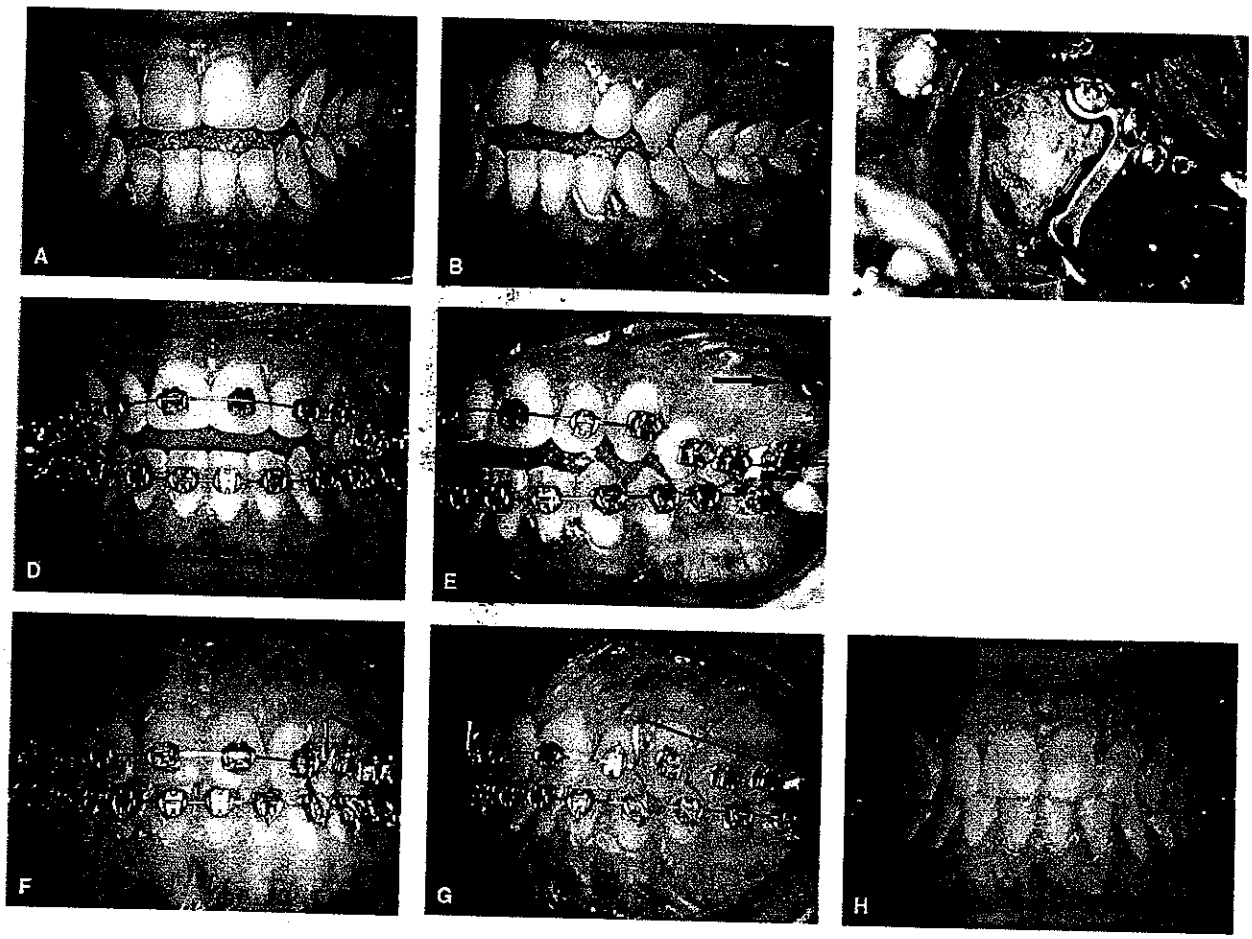

Fig 4. Clinical pictures: **A** and **B**, pretreatment frontal and lateral views; **C**, insertion of miniplate on maxillary strut (*arrow* points to loop on miniplate that will project through vestibule); **D**, preintrusion frontal view with segmental leveling; **E**, preintrusion lateral view (*arrow* points to miniplate loop); **F** and **G**, postintrusion frontal and lateral views with finishing archwires; **H**, 6 months after appliance removal.

perpendicular to the vertical line. On the more discernable occlusal or gingival margin of the molar band, a point, band point (Bp), was identified at the mesiodistal midpoint of the band image. Another vertical line was drawn through this point perpendicular to the horizontal line of the miniplate (Mpl) and parallel to the Lal. The point of intersection on the Mpl was indicated as the intersection point (Ip).

The distance between Bp and Ip was measured on tracings of preintrusion and postintrusion (T2 and T3) panoramic radiographs. Measurements were tabulated and differences calculated (Table II). The difference indicated the distance of intrusion.

Cephalometric radiographs (T2 and T3) were analyzed to assess changes in anterior facial height, and mandibular plane and occlusal plane angles. A decrease in these measurements indicated a counterclockwise rotation and closure of the mandible with a resultant open bite closure. Superimposition of lateral cephalometric tracings showed these changes in relationships as well as changes in incisor vertical positions and relationships (Table III).

RESULTS

The radiographic analysis of the results is summarized in Table IV. Open-bite closure was clinically achieved for all 4 patients as typified by the patient shown in Figures 4 through 6. (Superimposed tracings of this patient are shown in Fig 7, *A* and *B*.) Mean closure at the incisors was 3.62 mm (range, 3.0-4.5 mm).

Cephalometric analysis showed a closing rotation of the mandible. There were reductions in the mandibular, occlusal, and Y-axis plane angles: the mean

Table II. Molar intrusion, corrected panographic measurements and vertical distances between miniplate and molar band

	Subject 1	*Subject 2*	*Subject 3*	*Subject 4*
R Bp-Ip, pre	12	24.22	24.25	15.52
R Bp-Ip, post	9.76	21.85	22.8	14.06
R Bp-Ip, diff (intrusion)	2.24	2.37	1.45	1.46
L Bp-Ip, pre	13.5	24.7	25.7	18.43
L Bp-Ip, post	11.44	21.38	24.25	16.49
L Bp-Ip, diff (intrusion)	1.71	3.32	1.45	1.94
Mean intrusion	1.98	2.84	1.45	1.7

Bp, Band point; *Ip*, intersection point; *pre-*, pretreatment; *post*, posttreatment; *diff*, difference; *R*, right; *L*, left.

Table III. Cephalometric changes

	Subject 1	*Subject 2*	*Subject 3*	*Subject 4*
N-Me (mm)				
N-Me, pre	145.5	129.5	135.5	138.5
N-Me, post	142.5	126.5	132.5	137
N-Me, diff	3	3	3	1.5
SN-MP (°)				
SN-MP, pre	34	29	47	43
SN-MP, post	29.5	27	44.5	41.5
SN-MP, diff	4.5	2	2.5	1.5
SN-OP (°)				
SN-OP, pre	11	14	23	21
SN-OP, post	8	12.5	19.5	20
SN-OP, diff	3	1.5	3.5	1
N-S-Gn (°)				
N-S-Gn, pre	68	63.5	74.5	74
N-S-Gn, post	63.5	61	73	72
N-S-Gn, diff	4.5	2.5	1.5	2
SNB (°)				
SNB, pre	81	85	72.5	76.5
SNB, post	84.5	86	75	77
SNB, diff	3.5	1	2.5	0.5
U1-L1 (mm)				
U1-L1, pre	−3	−2.5	−2.5	−2.5
U1-L1, post	0	2	1.5	0.5
U1-L1, diff	3	4.5	4	3

U1, Maxillary central incisor; *L1*, mandibular central incisor; *pre*, pretreatment; *post*, posttreatment; *diff*, difference.

decrease of the mandibular plane angle was 2.62° (range, 1.5°-4.5°), the mean decrease of the occlusal plane angle was 2.25° (range, 1.0°-3.5°), and the mean decrease of N-S-Gn was 2.62°. Anterior facial heights decreased in all patients with accompanying increases in SNB angular measurements.

True intrusion of maxillary or mandibular first molars occurred in all patients. Vertical, apically directed intrusion was achieved with every involved molar. The mean molar intrusion was 1.99 mm (range, 1.45 to 3.32 mm).

There was no discernable movement of any miniplate, either clinically or radiographically. No postoperative infection was attributable to the placement, presence, or maintenance of the miniplates. The patients' tolerance of the plates was excellent. For 1 patient, a plate required an adjustment by bending the exposed loop buccally on the plate to prevent the elastic thread from impinging on the attached gingiva. Clinical bending of this loop did not affect the stability of the plate.

DISCUSSION

The results of this study show that open bites can be closed without orthognathic surgery by using miniplates as skeletal anchorage to intrude posterior teeth. Umemori et al[26] had previously reported on closing open bites with miniplates in the mandible. Our study proves that maxillary posterior teeth can be intruded with miniplate skeletal anchorage as well. The bite closed, facial height and mandibular plane angle decreased, and the anterior teeth did not need to be extruded. Therefore, tooth, gingiva, and lip esthetic relationships were not compromised. Furthermore, the anterior periodontal structures were not endangered, and the stability of the anterior dentition was not jeopardized. Based on the report of Reitan and Rygh[3] that intruded teeth are more stable than extruded teeth, this process of intruding the posterior teeth with orthodontic forces applied from the miniplates and no anterior tooth extrusion is expected to result in good stability. The forces of occlusion might help in preventing a reopening of the bite through resistance to potential molar eruption. Follow-up of these patients and those of future studies will contribute valuable information regarding stability. In addition, special methods for retaining treated open bites that have undergone intrusion of posterior teeth, might be developed from future studies. If the force of occlusion assists in maintaining the correction as suggested by the equilibrium theory,[31] no special retention might be needed. As future patients refuse orthognathic surgery and choose miniplate intrusion of posterior teeth for their open-bite malocclusions, more information can be obtained from well-planned and well-organized studies. Including various levels of severity of open bites for study will allow development of criteria and guidelines for acceptance of and recommendations to patients. Rates of intrusion can be established as well as different

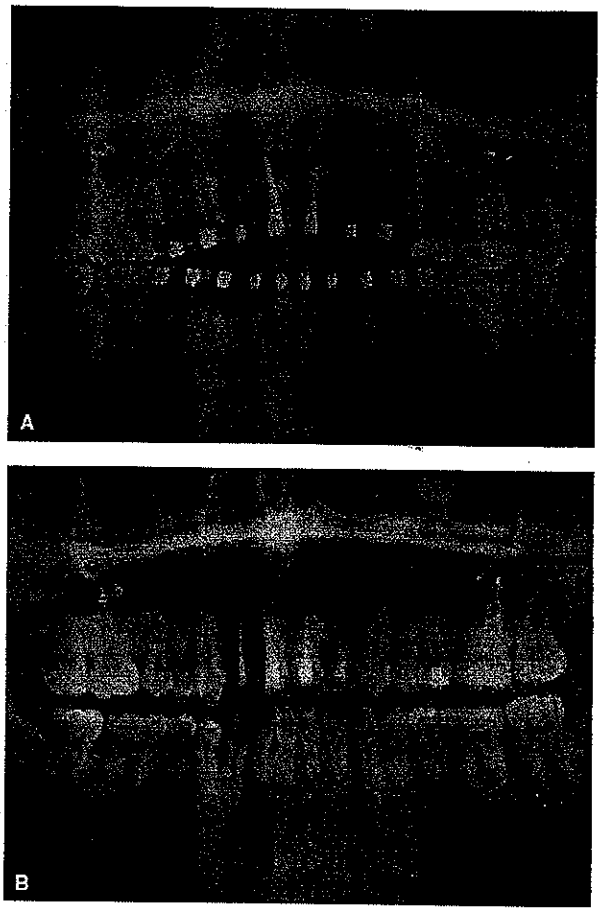

Fig 5. Panoramic radiographs: **A**, preintrusion; **B**, postintrusion.

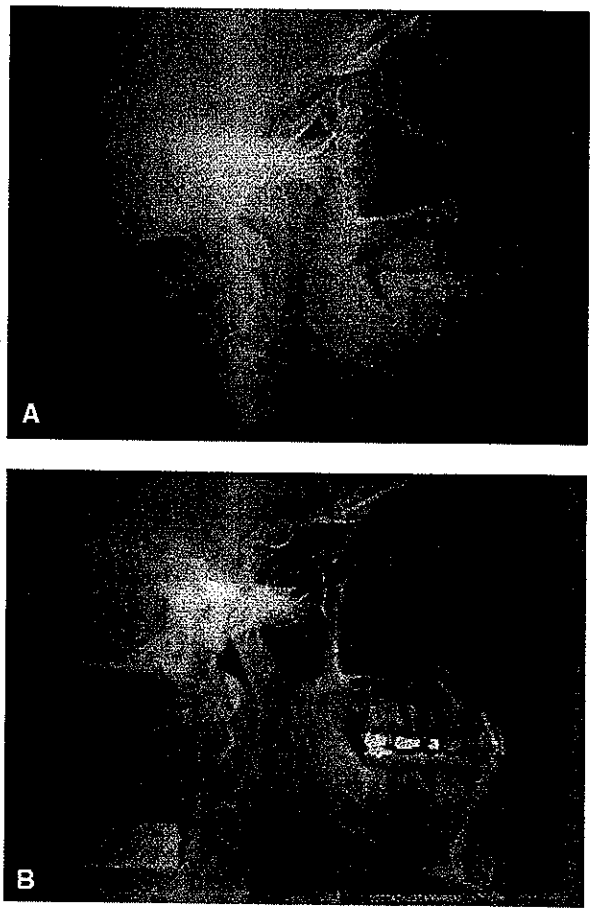

Fig 6. Cephalometric radiographs: **A**, preintrusion; **B**, postintrusion.

techniques and procedures to attain the most effective rate and distance for intrusion.

This study was designed to enable identification of pure molar intrusion and measure its progress. Identification and measurement methods were established. All patients had measurable molar intrusions. Other posterior teeth were intruded as they were attached via sectional archwires to molars undergoing pure intrusion. In a clinical setting, where research design does not require such refined control to determine the effects on individual teeth, one might choose an orthodontic appliance plan similar to that used by Umemori et al[26] in their treatment. Intrusion of molars by applying an apically directed force to a tube or a bracket on the buccal tooth surface will tip molars buccally and impair intrusion. A lingual component of force must be applied to avoid this; we accomplished this with a buccal secondary constricted archwire attached to the first molars. A transpalatal or lingual arch maintained well away from the tissue is recommended. These appliances were avoided in our study to eliminate the added variable of intrusive forces from the tongue being applied to a transpalatal or lingual appliance.

Table IV. Summary of radiographic changes for 4 patients

	Mean	*Range*
Molar intrusion Bp-Ip (mm)	1.99	1.45-3.32
Incisor closure U1-L1 (mm)	3.62	3-4.5
N-Me decrease (mm)	2.62	1.5-3
SN-MP decrease (°)	2.62	1.5°-4.5
SN-OP decrease (°)	2.25	1°-3.5
N-S-Gn decrease (°)	2.62	1.5°-4.5
SNB increase (°)	1.88	0.5°-3.5

Bp, Band point; *Ip*, intersection point; *U1*, maxillary central incisor; *L1*, mandibular central incisor.

Titanium miniplates, as used in this study, are acceptable to patients and recommended for establishing skeletal anchorage to intrude teeth. Placement and

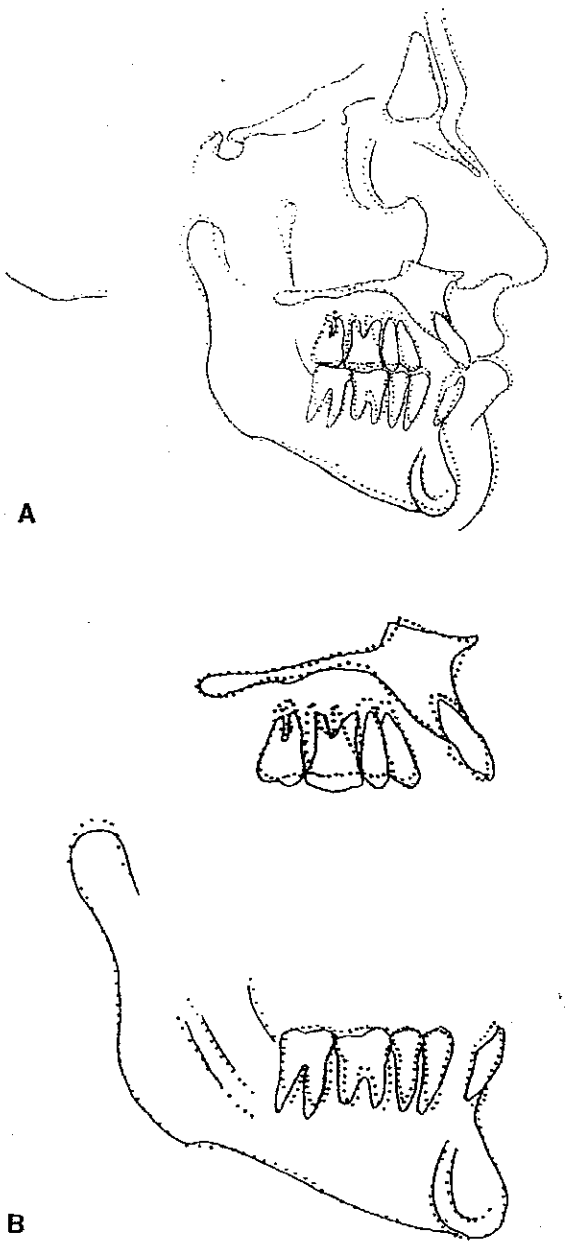

Fig 7. Superimposed tracings (*solid line*, preintrusion; *dotted line*, posttreatment): **A**, overall; **B**, maxilla and mandible.

removal are minimally invasive, with mild postoperative discomfort and few risks. We recommend placing the screws apical to the root tips to prevent root damage or interference with intrusion. The L-shaped miniplate was found to be useful for the mandible because the lower leg projects anteriorly, making access easier for screw placement. In the maxilla, a Y or T plate can be contoured around the maxillary strut where there is dense cortical bone, avoiding the thin plate of bone overlying the sinus cavity anteriorly. The miniplates remained stable throughout their use. Stability was maintained even when challenged in a patient when the clinician adjusted the loop with orthodontic pliers. The titanium miniplates are made of biocompatible materials and have been used safely and effectively for years by oral surgeons for various purposes. This study demonstrates another use for miniplates. This type of skeletal anchorage is used at Nova Southeastern University to intrude unopposed overerupted teeth during orthodontic preparation of dentitions for prosthetic dentistry. A report of this is being prepared for future publication. Use of miniplates as studied here offers the orthodontist another option for skeletal anchorage, an alternative to orthognathic surgery, and other methods of tooth movement.

CONCLUSIONS

Titanium miniplates, as used in this study, offer stable skeletal anchorage for intruding molars. True intrusion of molars can be accomplished in adults. The occlusal plane angle of open-bite patients changes accordingly. Anterior open bites can be closed orthodontically by intruding posterior teeth, resulting in reduced anterior vertical face height, decreased mandibular plane angle, and counterclockwise rotation of the mandible.

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