Intrusion of supra-erupted molars using miniscrews: Clinical success and root resorption

Farzin Heravi, Shahin Bayani, Azam Sadat Madani, Mehrdad Radvar, and Najmeh Anbiaee

Mashad, Iran

Introduction: Conventional orthodontic techniques do not intrude posterior teeth effectively, and almost all methods result in anterior extrusion rather than posterior intrusion. New absolute anchorages (miniscrews and miniplates) are said to make posterior tooth intrusion possible. The aim of this study was to evaluate the clinical success of a new method for molar intrusion with miniscrews and its probable accompanying side effects.

Material and methods: Ten women with overerupted upper first molars participated in this study. Upper molar bands with brackets were cemented. Two miniscrews were placed, 1 in the mesiopalatal and another in the mesiobuccal aspect of the upper first molars; a spring made of 0.017 × 0.25-in titanium-molybdenum alloy (TMA) wire was used to apply 100 g of force through the attachments (50 g each side). Molar intrusion and external apical root resorption were evaluated by comparing parallel periapical radiographs with bite blocks at 3 intervals: beginning of treatment (T0), at the end of active treatment (T1), and 6 months after treatment completion (T2).

Results: The mean value of intrusion was 2.1 mm after completion of active treatment. On average, 0.4 ± 0.2 mm relapse had occurred during 6 months of retention, and the mean residual intrusion was 1.7 mm, which was statistically significant. Mean root resorption of 0.3 ± 0.2 mm for palatal root and 0.4 mm for mesiobuccal and distobuccal root was measured. Conclusions: Statistically significant intrusion (2.1 ± 0.9 mm) was obtained during active treatment. The mean value of relapse was 0.4 ± 0.2 mm, and the mean value for residual intrusion was 1.7 ± 0.6 mm. Minor apical root resorption occurred during treatment. (Am J Orthod Dentofacial Orthop 2011;139:S170-5)

Overextrusion of maxillary molars usually results from early loss of antagonistic teeth. The elongated dentoalveolar process may induce problems such as functional disturbances and occlusal interference and cause great difficulty during prosthetic reconstruction. Conventional options for removing such interference include coronal reduction of molar crown—which often requires root canal therapy—and crown restorations or posterior subapical osteotomy, with the risk of general anesthesia and high cost.

Orthodontic intrusion of molars seemed to be unsuccessful until the development of a skeletal anchorage system. Conventional techniques for intrusion require anchorage reinforcement by incorporating multiple teeth and using extraoral devices that depend heavily on patient cooperation and usually result in extrusion of other teeth rather than posterior intrusion.

Skeletal anchorage, including dental implants, surgical miniplates, and miniscrews, is now growing in popularity because of its ability to provide absolute anchorage. The literature contains several reports of molar intrusion accomplished by miniplates in patients with anterior open bite or overextruded molars. However, compared with miniplates, miniscrews have several disadvantages, including higher cost, limited area for insertion, and the need for 2 separate insertion and removal surgeries.

To date, the available literature for molar intrusion with skeletal anchorage devices, especially miniscrews, consists mainly of case reports and a few animal studies. The literature clearly shows that teeth can be successfully intruded in variable rates ranging from 1.2 mm in Carillo et al’s study to 5 mm in Unemori et al’s study. Intrusion forces also ranged from 50 g in Carillo et al’s study to 500 g in Unemori et al’s study. In some of these studies, elastomeric materials were used for delivering intrusion forces, which
may have several shortcomings like rapid force degradation, hygiene problems, and need for patient cooperation. Also, besides elastomeric materials, NiTi coil springs used in some other studies\textsuperscript{10,11,23,24} lack the ability to change force vector, which is sometimes needed for controlling molar crown torque during intrusion, and operators were obliged to use lingual or transpalatal arches or brackets on multiple teeth for correcting crown torque\textsuperscript{9,10,16,19,25}.

On the other hand, measuring the amount of intrusion and root resorption in nearly all the human studies was based on lateral cephalograms\textsuperscript{9,10,12,13,15,17,19,25} or panoramic images\textsuperscript{11} which are not accurate enough for this application.

The purpose of this study was to introduce a new approach for molar intrusion with miniscrews, with better force consistency and force vector control during treatment, and to evaluate its clinical success and concomitant root resorption by a more accurate method.

**MATERIAL AND METHODS**

**Participants**

Ten female subjects admitted to the orthodontic department were selected for this study. Their mean age was 43.6 years (25 to 57 years) and each had at least overerupted maxillary first molar, which contributed to prosthodontic replacement of the opposite tooth. None of them had previous orthodontic treatment or active periodontal disease in the beginning of treatment.

**Materials**

For molar intrusion, we used an Absoanchor Miniscrew Minikit (Dentos Inc, Daegu, Korea), which consists of long and short hand drivers for miniscrew insertion, a round bur (1.9-mm diameter, 21-mm length) for making an indentation in the cortex, and bracket type miniscrews (1.3-mm diameter, 7-mm length).

Stainless steel bands with .018 × .030 welded brackets (Dentauro, Inspringen, Germany) was banded over extruded teeth. In order to force delivery, a .017 × 0.25-in titanium-molybdenum alloy (TMA) spring was constructed, which was attached to the miniscrew’s head in 1 end and ligated to the bracket in the other end to reach the predetermined force (Fig 1).

**Application of intrusive force**

Two miniscrews with bracket-type head were inserted: 1 in the mesiobuccal aspect and another in the mesiopalatal aspect of the selected tooth. After a 2-week interval for soft tissue healing, bands with brackets were cemented on the teeth and the .017 × 0.25-in TMA springs were fitted into the slot on the miniscrew’s head and ligated. The other end of the spring was ligated to the bracket that was welded on the band. In order to have just 1 contact point, the spring was not engaged in the bracket slot on the tooth (Fig 1). By pulling the occlusal arm of the spring with a force gauge hook, it could be adjusted in order to deliver 50 g of force on each side of the tooth. Patients were visited every 4 weeks for spring adjustments and observation of treatment progress.

**Radiographic evaluation**

We used parallel periapical radiographs with bite blocks to measure the amount of intrusion and root resorption in 3 intervals: at the beginning of treatment (T0), treatment completion (T1), and 6 months after retention (T2). Film–film holder–tube position should have remained the same in these 3 intervals in order to make radiographs comparable. Thus patients’ bite record and film holder position were registered with polyvinylsiloxane material, and at the same time, the horizontal and vertical angles of the tube were recorded for each patient. Radiographs were scanned with a high-resolution scanner (700 dpi) by magnification of 1:1 and were saved in separate files.

In order to have a precise assessment of tooth movement and root resorption, we used a computer software named PLANMECA Dimaxis Classic (PLANMECA USA, Roselle, Ill), which could measure the variables by pixel units and then convert them to millimeters.

Two obvious and distinguishable landmarks in adjacent teeth (like restoration edge or cusp tip) were determined, and a line connecting them was used as the reference axis for further measurements. In order to measure the amount of intrusion in each root, a perpendicular line was drawn from this axis to each root apex. The program automatically calculated the distances in pixel units (Fig 2). The highest intrusion amount between roots was considered the intrusion amount of tooth.

To measure root resorption, a line passing the furcation point of the tooth was drawn parallel to the reference axis, and the perpendicular distance of each root apex to this line was computed in pixel units (Fig 2). A single calibrated examiner was used throughout the study period. In a pilot study on 20 variables, the mean and standard deviation of differences between duplicate measurements of the examiner were 0.02 ± 0.1 mm and considered to be a reflection of intraexaminer reliability.

Finally, by finishing the active treatment (T0–T1), patients were referred for prosthetic replacement of the opposite edentulous area, and during this period they were supposed to use a maxillary acrylic splint as retainer.

Patients were asked for pain and irritation symptoms at each visit during treatment.
Statistical analysis

A 1-sample Kolmogorov-Smirnov test was used for determining normality of the data. Changes in tooth position and root resorption were evaluated by a 1-sample t test, and finally a Spearman correlation test was used to assess the correlations between variables.

Results

The maxillary first molars were successfully intruded in all the patients according to their clinical needs. Mean treatment duration was 7.7 months and ranged from 4.3 to 11.5 months. Changes in tooth position and root resorption during active treatment (T0-T1), retention...
period (T1-T2), and total treatment (T0-T2) are shown in Table I. The mean intrusion value was 2.1 ± 0.9 mm during active treatment (P < 0.001), 0.4 ± 0.2 mm relapse took place during the retention period (P < 0.001). The average amount of intrusion between T0 and T2 was 1.7 ± 0.6 mm (P < 0.001).

We found a mean palatal root resorption of 0.2 mm during active treatment (P = 0.08) and further 0.1 mm during retention period (P = 0.08). Total palatal root resorption was 0.3 mm (P = 0.045). On average 0.4 mm resorption had occurred in the mesiobuccal (P = 0.003) and distobuccal roots (P = 0.009) from T0 to T2. There was no evidence of resorption at the furcation of the first molar regardless of the amount of intrusion and patient age. The Spearman test showed significant correlation between treatment duration and mesiobuccal root resorption from T0 to T2 (r = 0.83, P = 0.000). No significant correlation was found between patient age and the amount of intrusion.

In addition to evaluation of clinical and radiographic variables (Table II), some questions were asked about the patients’ symptoms after miniscrew insertion. Nine of 10 patients reported a dull pain on the day after surgery, and the pain continued to the second day for 6 of them. Most patients required pain medication during this period. All the patients reported tongue irritation caused by the palatal miniscrew, which lasted for about a week. There was no need for local anesthesia during screw removal for 14 of 20 miniscrews.

### DISCUSSION

Intrusion by conventional methods usually is accompanied by extrusion of the anchorage unit, based on the law of action and reaction. Preventing this side effect is the key of successful intrusion. In existing methods, many brackets have to be bonded or an extra oral appliance designed in order to reinforce the anchorage unit. However, despite these efforts, efficient intrusion of molars is still difficult to accomplish.

In contrast to traditional methods, intrusion of molars has been facilitated by inserting miniscrews to minimize extrusion of adjacent teeth. We used a new, simple approach for molar intrusion with a .017 × 0.25-in TMA spring and bracket-type miniscrews, which had some advantages over other methods for posterior intrusion using miniscrews including:

- Lighter and more continuous force in contrast to elastic materials used for force delivery used in some studies.9,15,18,19
- Excellent control of force vector by altering the horizontal extension of the occlusal arm of the spring or ligating it to different wings of the bracket, which has the advantage of selective intrusion of the mesial or distal part of the tooth
- Perfect control of the labiolingual position of the tooth during intrusion by altering the force in buccal or palatal springs, in contrast to others that are obliged to use extra devices like TPA, lingual arches, or conventional fixed appliances to control tooth buccolingual position.9,10,16,19,25

Intrusion was finished when the tooth was leveled with the neighboring teeth. Therefore, the amount of intrusion ranged from 1.5 to 4.5 mm in this research, which was reasonable considering the different amount of overeruption of teeth in each patient.

To avoid root resorption, intrusive force levels should be kept optimal.26 Although an optimal force has not yet been suggested for intrusion with miniscrews, forces greater than what is generally accepted for intrusion in conventional treatments are reported to be applied with miniscrews and miniplates. Umemori et al.9 used 500 g, Paik et al.27 used 150 to 250 g, Jeon et al.12 used 400 g, Erverdi et al.13 used 200 g, Xun.25 used 150 g, Park et al.15 used 200 to 300 g, and Kanzaki et al.22 used 100 g. We preferred 100 g force (50 g per miniscrew) to intrude the teeth in this study, which was the lowest among the above-mentioned studies.

Intrusion amounts also varied in the literature according to clinical needs. Umemori et al.9 achieved 3.5 and 5 mm; Erverdi et al.,10,13 2.6 and 3.6 mm; Kuroda et al.,12 3 mm; Kanzaki et al.12 1.7 to 2.3 mm; Canillo et al.24 1.2 to 2.3 mm; and Xun et al.25 1.8 mm. In our study, the amount of intrusion was between 1.5 and 4.5 mm, which was in a similar range as other studies.

### Table I. Mean ± standard deviation (min, max) of intrusion amount and root resorption

<table>
<thead>
<tr>
<th>Variables</th>
<th>Changes during active treatment (T0-T1)</th>
<th>Changes during retention period (T1-T2)</th>
<th>Total change (T0-T2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrusion (mm)</td>
<td>2.1 ± 0.9 (1.5, 4.5)</td>
<td>−0.4 ± 0.2 (0.1, −0.7)</td>
<td>1.7 ± 0.6 (1.1, 2.9)</td>
</tr>
<tr>
<td>Palatal root resorption (mm)</td>
<td>0.2 ± 0.2 (0.0, 6)</td>
<td>0.1 ± 0.2 (0.0, 5.5)</td>
<td>0.3 ± 0.2 (0.0, 9)</td>
</tr>
<tr>
<td>Mesiobuccal root resorption (mm)</td>
<td>0.4 ± 0.3 (0.0, 9)</td>
<td>0 ± 0.3 (−0.3, 0.4)</td>
<td>0.4 ± 0.4 (0.0, 9)</td>
</tr>
<tr>
<td>Distobuccal root resorption (mm)</td>
<td>6.2 ± 0.3 (0.8)</td>
<td>0.2 ± 0.3 (−0.2, 0.6)</td>
<td>0.4 ± 0.3 (0.0, 8)</td>
</tr>
</tbody>
</table>

Statistically significant differences between groups are indicated by *.

Significance was determined at the P < 0.05 (1-sample t test). Positive changes denote tooth intrusion and root resorption, and negative changes indicate tooth extrusion (relapse) and root formation.
The root resorption in our study was 0.3 to 0.4 mm on average, which was statistically but not clinically significant. The amount of root resorption was approximately similar to other studies, 20,21,23,24 except for Ari-Demirkaya’s 11 study, which had reported higher root resorption than our study (0.8 mm) maybe because he used OPG images to assess root resorption which can overestimate resorption amount 28. According to small amount of root resorption in our study we can suggest this new technique for intrusion with the confidence of little side effects.

We also found a small amount of crest resorption in all our cases during active intrusion. As the crest resorption was not comparable to the amount of intrusion, final root coverage was improved at the end of treatment.

By reviewing the literature, it was noticed that in all human studies on molar intrusion with skeletal anchorage, an accurate method for calculating the amount of intrusion and root resorption was not used. Most of them used pretreatment and posttreatment lateral cephalograms 9,10,12,13,15,17,19,25 to assess these variables, and 1 of them used OPG 11 for this purpose. We used parallel periapical radiographs with Rinn X-C-P film holders and bite registering material for obtaining a reproducible film-tube-film holder position. Also, precise computer software was used in this study that could accurately estimate variables.

According to our study, some relapse (extrusion) occurred during the retention period, which was in line with Sugawara et al’s, 29 Erverdi et al’s, 13 and Park et al’s 16 results and was in contrast to Kurroda et al’s 12,19 studies, which reported good stability after posterior intrusion. Paying attention to controversies in this subject, more complete and perfect studies with greater sample size are needed to determine effective factors in relapse, time needed for stabilization of treatment outcomes, and best retention appliance after posterior intrusion.

**CONCLUSIONS**

1. The amount of intrusion during active treatment (T0-T1) was 2.1 ± 0.9 millimeter, relapse during retention period (T1-T2) was 0.4 ± 0.2 mm, and the remaining intrusion was 1.7 ± 0.6 mm throughout the entire treatment (T0-T2), which was statistically significant in all these periods.
2. Total amount of resorption was 0.3 mm for palatal root and 0.4 mm for mesiobuccal and distobuccal roots, which was statistically but not clinically significant.
3. There was a significant correlation between treatment duration and mesiobuccal root resorption. No significant correlation was found between patient age and the amount of root resorption and intrusion.
4. Almost all the patients reported a dull pain about 2 days after screw insertion, which needed pain medication. Tongue irritation also was seen, which disappeared after about a week.

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**REFERENCES**