Comparison and measurement of the amount of anchorage loss of the molars with and without the use of implant anchorage during canine retraction

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Introduction: The purpose of this study was to compare and measure the amount of anchorage loss with titanium microimplants and conventional molar anchorage during canine retraction. Methods: Subjects for this study comprised 10 orthodontic patients (7 women, 3 men) with a mean age of 19.6 years (range, 18 to 25 years), who had therapeutic extraction of all first premolars. After leveling and aligning, titanium microimplants 1.3 mm in diameter and 9 mm in length were placed between the roots of the second premolars and the first molars. Implants were placed in the maxillary and mandibular arches on 1 side in 8 patients and in the maxilla only in 2 patients. A brass wire guide and an intraoral periapical radiograph were used to determine the implant positions. After 15 days, the implants and the molars were loaded with closed-coil springs for canine retraction. Lateral cephalograms were taken before and after retraction, and the tracings were superimposed to assess anchorage loss. The amount of molar anchorage loss was measured from pterygoid vertical in the maxilla and sella-nasion perpendicular in the mandible. Results: Mean anchorage losses were 1.60 mm in the maxilla and 1.70 mm in the mandible on the molar anchorage side; no anchorage loss occurred on the implant side. Conclusions: Titanium microimplants can function as simple and efficient anchors for canine retraction when maximum anchorage is desired. (Am J Orthod Dentofacial Orthop 2006;129:551-4)

Attempts to correct crowded, irregular, or protruding teeth go back to at least 1000 BC. In 1728, the French pioneer, Fauchard, introduced the first appliance and noted that, to exert mechanical pressure by means of an apparatus, sufficient resistance to the force must be exerted. Today, anchorage control is a major concern in the design of orthodontic appliances. Various techniques to reinforce anchorage have been devised and used in orthodontic practice. However, even some of the best-known intraoral appliances—palatal or lingual bars, the Nance holding arch, and intermaxillary elastics—have undesirable side effects, including protrusion, extrusion, and tipping of some teeth.

The introduction of extradental intraoral anchorage was a welcome event. A new type of intraoral extradental anchorage, the titanium microimplant, has been developed. This implant can be used as an alternative to conventional molar anchorage. Designed specifically for orthodontic use, it has a small diameter and a button-like head with a small hole that accepts ligatures and elastomers. The microimplant can be placed in many areas in the maxilla and the mandible that were previously unavailable, including between the roots of adjacent teeth.

The purposes of this pilot study were to determine the anchorage potential of titanium microimplants for retraction of canines during space closure, and to compare and measure the amount of anchorage loss of the molars with and without implants during canine retraction.

MATERIAL AND METHODS

This study was performed with patients at the Department of Orthodontics, Annamalai University, Tamil Nadu, India. The study design was reviewed and approved.
by the Institutional Review Board. Ten patients (7 women, 3 men), with a mean age of 19.6 years (range, 16-21 years) were chosen based on the following criteria: (1) comprehensive medical and dental history ruling out any systemic illness; (2) therapeutic extraction of first premolars required; (3) aligning and leveling phases completed; and (4) maximum anchorage, with 75% to 100% of space closure used for retraction of anterior segments. All selected patients had arch-length basal bone discrepancies of more than 5 mm. Patients with Angle Class I malocclusions and ANB angles of 2° to 4° were selected for implant placement in both the maxilla and the mandible; patients with Class II malocclusions and ANB angles greater than 5° had implants placed only in the maxilla, as part of camouflage treatment. No anchorage preservation methods were undertaken for any patient.

After initial leveling and aligning, informed consent was obtained from the patients before placing the implants. Routine blood studies were done to rule out any blood dyscrasias. The implants were positioned at the maximum thickness of interdental bone, between the roots of the second premolar and the first molar, on the selected quadrants. Orthodontic forces were applied 15 days after implant placement. Nickel-titanium closed-coil springs with a force of 100 g were stretched between the implant and the canine on the implant anchored side, and between the molar and the canine on the molar anchored side. The period of study ranged from 4 to 6 months.

Two sets of records were taken. The first was taken before implant placement and the other when the canine retraction was considered complete in accordance with the treatment plan for that patient. These included study models, cephalometric radiographs, orthopantomograms, and photographs.

To differentiate between the right and left molars on the lateral cephalogram, a 0.017 × 0.025-in stainless steel wire was shaped in the form of an “L” with 0.5 cm of vertical length and 1 cm of horizontal length. The horizontal portion was inserted from the mesial side of the buccal tube and cinched behind the tube (so that it would not slip out of the tube) on the right side. On the left side, the wire was inserted from the distal surface of the buccal tube and cinched mesially to differentiate the right and left molars on the lateral cephalogram. Care was taken to make the vertical segment of the L-shaped wires abut the buccal tubes to minimize errors during superimposition.

Molar anchorage loss was determined by superimposing the lateral cephalometric tracings before and after retraction (Fig), and mesial movement of the molars was measured by taking a stable landmark in the cranium as the reference.

For the maxillary measurements, the lateral cephalometric tracings taken before and after canine retraction were superimposed along the palatal plane registered at anterior nasal spine. In addition to the superimposition, the horizontal distance from pterygoid vertical to the distal surface of the first molar on both sides was calculated to measure anchorage loss.

For the mandibular measurements, the tracings were superimposed by registering on the best fit of the anterosuperior border of the chin, the inner cortical structures of the inferior surface of symphysis, and the mandibular canal. The horizontal distance from sella vertical to the distal surface of the first molars on both sides was also calculated, at the beginning and end of canine retraction.

The data obtained were subjected to statistical analysis. The mean, standard error, and standard deviation were tabulated. The Student t test was used to determine the level of significance and the correlation of anchorage loss in the maxilla and the mandible, and between the sexes.

**RESULTS**

At the end of the study, the canines were retracted successfully on both implant and nonimplant sides in all subjects.
The superimpositions showed that anchorage loss occurred on the nonimplant side; this was evident with the mesial migration of that molar; anchorage loss did not occur on the implant side, and no mesial movement was noted there (Fig).

Anchorage loss was less than 20% on the molar-anchored side; this was acceptable for the subjects selected. Anchorage loss in this study ranged from 1 to 2 mm with means of 1.6 mm in the maxilla and 1.7 mm in the mandible (Table I). Statistical analyses showed a significant anchorage loss in both the maxilla and the mandible, but the amounts were independent and did not differ by sex (Table II).

All implants were stable throughout treatment. No damage was registered in any implant under the conditions of orthodontic loading. Implant deformation was not observed in any implants. One patient had peri-implant inflammation, perhaps due to improper oral hygiene. The inflammation subsided uneventfully with proper oral-hygiene measures.

**DISCUSSION**

 Advances in implant dentistry have made it possible to use implants for anchorage in adult orthodontic patients. Although the concept of metal components for orthodontic anchorage dates back to at least 1945, it was popularized when, in animal studies, Roberts et al.8,9 and Turley et al.10 showed good implant stability. Similar results were achieved later in humans by Roberts et al.11 and Odman et al.12 Kanomi13 and Costa et al.14 introduced microimplants and miniscrews for orthodontic anchorage. Specially designed orthodontic implants were placed in various locations.11,13-17 Studies with microimplants positioned between the roots of the second premolar and the first molar have shown successful retraction of the entire anterior segment with nickel-titanium coil springs.3,18

This study was aimed at evaluating the anchorage loss encountered during canine retraction, with and without implants. Storey and Smith19 showed that 5% to 50% of the total extraction space can be taken up by an anchor unit made up of the first molar and the second premolar when used to retract a canine. Aronsen et al.20 showed anchorage losses of 2.4 mm in 1 monkey and 1.4 mm in another. The results of these previously studies matched the results of our human study, in which anchor- age losses of 1.6 mm in the maxilla and 1.7 mm in the mandible were observed on the side where the molars were used as anchorage.

Relatively few studies have measured the amount of anchorage loss during canine retraction in humans, and there are no studies measuring anchorage loss with implant-assisted canine retraction. In this study, an attempt was made to evaluate the anchorage loss by using more than 1 variable: by superimposing and by measuring the amount of anchor loss (L-shaped wires as reference points) in the lateral cephalogram before and after retraction.

The most important result of this investigation is that all loaded implants retained stability throughout the period of continuously applied orthodontic mesiodistal force. The implants were nearly immobile; this is by

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### Table I. Anchorage loss in each subject

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age (y) and sex</th>
<th>Maxilla</th>
<th>Mandible</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Implant side</td>
<td>Nonimplant side</td>
</tr>
<tr>
<td>1</td>
<td>21/F</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>18/M</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>3</td>
<td>16/F</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>21/F</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>19/F</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>20/M</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>7</td>
<td>21/F</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>8</td>
<td>21/F</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>9</td>
<td>20/F</td>
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<td>1</td>
</tr>
<tr>
<td>10</td>
<td>19/M</td>
<td>0</td>
<td>1.5</td>
</tr>
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</table>

### Table II. Mean anchorage loss in men and women

<table>
<thead>
<tr>
<th>Sex</th>
<th>n</th>
<th>Mean (mm)</th>
<th>SD</th>
<th>SE of mean</th>
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<tbody>
<tr>
<td>Maxilla</td>
<td>Combined</td>
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<td>1.60</td>
<td>.3536</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>3</td>
<td>1.50</td>
<td>.0000</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>7</td>
<td>1.67</td>
<td>.4082</td>
</tr>
<tr>
<td>Mandible</td>
<td>Combined</td>
<td>8</td>
<td>1.70</td>
<td>.2739</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>3</td>
<td>1.50</td>
<td>.0000</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>5</td>
<td>1.88</td>
<td>.2500</td>
</tr>
</tbody>
</table>

M, Male; F, female.

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definition a rigid orthodontic anchoring system. The same conclusions were drawn by Roberts et al, 8,9 Turley et al,10 and Southard et al21 in trials in which force was applied for a maximum of 16 weeks. However, implant size, implant location, magnitude of applied force, biomechanical force system, and duration of orthodontic force application differed from our study. Miyawaki et al22 reported that implants with a diameter of less than 1 mm in the buccal alveolar bone for orthodontic anchorage are less stable. In our study, titanium microimplants were 1.3 mm in diameter.

En-masse retraction was observed on the implant side in a few patients. The reason for this could be the increase in vertical vector of the retractive force applied from the implant to the canine whereby some binding of the archwire to the bracket might have prevented the free sliding of the canine over the archwire, and the force thereby was transmitted to the archwire, causing the en-masse retraction.

At the end of the study, the asymmetric anchorage loss was managed by allowing mesial movement of the molars on the implant side.

CONCLUSIONS

This study showed mesial movement of molars in the nonimplant side and no movement on implant side. It can be concluded that, with proper patient and implant selection, implants as anchorage for retraction of canines can be incorporated into orthodontic practices with complete success.

REFERENCES