Comparison of sagittal anchorage conservation of mini-implants and modified Nance palatal buttons

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Objective: To compare the anchorage potential of mini-implants with modified Nance palatal buttons during simultaneous first and second maxillary molar distalization. Methods: Mini-implants (1.4 × 10 mm) placed to obtain indirect anchorage for maxillary molar distalization using a superelastic Ni-Ti open coil spring were compared with anchorage derived from a modified Nance palatal button incorporated in a distal jet appliance. Appliances were placed bilaterally in 19 adolescent patients. Lateral cephalograms with guide wires to differentiate the right from left sides were used for evaluation. All measurements (angular and linear) were obtained from these guide wires. Results: Anchorage loss at the first premolar was 13% with mini-implant–supported Ni-Ti coil spring appliances and 24.75% with the Nance palatal button (distal jet appliance) on the right side. On the left side, anchorage loss was 15.4% with mini-implant–supported Ni-Ti coil spring appliances and 23.9% with the Nance palatal button (distal jet appliance). Conclusion: Mini-implants do not provide absolute anchorage when used indirectly. However, anchorage conservation is more efficient than modified Nance palatal buttons. ORTHODONTICS (CHIC) 2012;13:e10–e19.

Key words: anchorage, distal jet, mini-implants

Maxillary molar distalization for gaining space in nonextraction treatment is a viable option for dentoalveolar Class II cases with minimal to moderate space requirement (up to 6 mm).

Intraoral distalization appliances are designed to deliver a continuous reciprocal force on the maxillary molars. Any action to move molars distally produces a mesial, undesirable reaction force on the anchoring teeth. As a consequence, if the premolars or incisors (or both) are the anchoring teeth, they move mesially, the incisors protrude, and overjet increases, which is referred to as anterior anchorage loss.

With the anchorage arrangement utilizing the palatal vault, and the premolar dental units (modified Nance palatal buttons) used in most the intraoral distalizers, it has been reported that significant anterior anchorage loss occurs.¹⁻⁵

In the literature, few articles exist comparing the potential of different anchorage systems to resist undesirable anterior tooth movement during the molar distalization phase of treatment.
Bondemark and Thornéus evaluated and compared the anchorage provided with the Nance appliance and the fixed frontal bite plane during intra-arch distal molar movement.

The outcome measures assessed were anchorage loss (anterior movement of maxillary central incisors), distal movement of maxillary molars, and bite opening effect. The mean amount of molar distalization within the maxilla was 1.7 mm in the Nance appliance group and 1.8 mm in the fixed frontal bite plane group. The data revealed that the maxillary central incisors moved anteriorly 1.4 mm in the Nance appliance group and 1.9 mm in the fixed frontal bite plane group. They stated neither the Nance appliance nor the frontal bite plane provided stable anchorage, and a second treatment phase was recommended to reverse anchorage loss after distal molar movement.

There are a few case reports describing indirect uses of mini-implants to conserve anchorage during distal molar movement. Choi and Park used indirect anchorage from a mini-implant for distal molar movement. The mini-implant was buccally placed between the maxillary second premolar and first molar. They reported no loss of anterior anchorage.

**METHODS**

This was a retrospective clinical study conducted on 19 patients (14 girls and 5 boys). All patients and/or their parents were apprised of the purpose of the study and procedure. All patients or their parents signed a consent form for the treatment.

Inclusion criteria were:

- Patients in between 12 and 15 years of age, regardless of sex
- Patients with a bilateral end-on or full-unit Class II molar relationship with minimal to moderate space requirement in the maxillary arch, with a normal, well-aligned mandibular arch
- Permanent dentition up to the permanent maxillary second molars erupted and in occlusion, with the maxillary third molar crowns present and developing
- Patients with normal vertical skeletal relation and ANB angle between 0 and 5 degrees

Exclusion criteria included:

- A history of orthodontic treatment
- Any syndrome or systemic diseases affecting teeth and bone
- Unerupted or missing premolars

**Records**

Pretreatment study casts, intra- and extraoral photographs, panoramic radiographs, and digital lateral cephalogram with teeth in occlusion were taken. The machine settings were kept at 65Kvp, 16 Amp for all cephalograms to obtain optimum visual contrast.

At T1 (pretreatment), records were taken just before insertion of the molar distalization appliance. At T2 (postdistalization), for the cases that had a full-unit Class II relationship, T2 was determined upon achieving Class I molar relationship. In cases having an end-on (half-cusp) molar relation, T2 was recorded at a super Class I position. Super Class I was defined as overcorrection from Class I by 2 mm. There were seven patients with end-on relationships and 12 with full-unit Class II molar relationships.
Scientific Innovation

Anchorage conservation of mini-implants and modified Nance palatal buttons

Group 1 appliance construction
Group 1 was molar distalization using a buccally placed Ni-Ti coil spring appliance deriving indirect anchorage from mini-implants (Fig 1). The molar hook of the first molar tube was bent mesially on the right side, and the left side first molar tube hook was bent distally. In the banded first premolar brackets, a 0.019 × 0.025-inch stainless steel guide wire 7 mm in length with tip facing mesially on right side and distally on left side was secured in bracket slot. The lateral cephalogram was taken with guide wires in place (Fig 2). All linear and angular measurements were made from these guide wires.

Mini-implant insertion. A 1.4 × 10-mm mini-implant (Fig 3a) was self-tapped into place buccally in the interradicular space between the first molar and second premolar. A placement guide was used for mini-implant insertion. The armamentarium used for implant placement was as shown in Fig 3b.

Efforts were made to keep the implant position as low (occlusal) on the attached gingiva as anatomically possible. This was done to have a more horizontal ligation with the first premolar for better sagittal control of the anterior anchorage.

The sectional wire with a Ni-Ti coil spring was inserted in the first molar tube, compressed, and ligated to the second premolar. The compressed Ni-Ti coil spring was measured with the force dynamometer (Fig 3c) and delivered a continuous force of 240 g per side.
A 0.010-inch ligature wire (Fig 3d) was prestretched and threaded through the hole in the implant head and firmly ligated around the first premolar bracket. The plastic tube for patient comfort and ligature wire protection was obtained from a 18-gauge scalp vein set (intravenous line tubing) (see Fig 3c).

**Anchorage unit.** The mini-implant and the 0.010-inch ligature wire was firmly ligated from the implant to the first premolar and provided the main anchorage support.

**Group 2 appliance construction**
Group 2 was molar distalization with a distal jet appliance (American Orthodontics) (Fig 4) deriving anchorage from modified Nance palatal buttons.

**Appliance fabrication.** The modified Nance button was formed with clear cold cure acrylic with the connector wire and tag arms of the tubes embedded. Anteriorly, it was extended up to 2 mm behind the palatal marginal gingiva. Posteriorly, it was extended up to the middle of the first premolars. The Nance palatal buttons were anchored by supporting wires to the second premolars. Efforts were made to keep the size of acrylic palatal button the same in all patients. Lateral cephalograms were taken with guide wires in place (Fig 5).
Method of evaluation
Pretreatment and post distalization changes were evaluated from lateral cephalograms.

Cephalometric analysis. The reference line used was the Ptv (pterygoid vertical) plane for all linear measurements. The measurements were made parallel to the FH plane from the Ptv vertical to the most anterior point on the molar hook/guide wire. Angular measurements were made from the angle formed by a line drawn through the long axis of guide wire to the Sella nasion plane. The inside inferior angle was measured pretreatment and posttreatment (Fig 6).
Linear measurements in mm were made to 0.01 counts with a digital caliper. Angular measurements were made to the nearest 0.5 degree. No correction was made for the 10% linear enlargement inherent in lateral cephalograms. Intergroup comparison was done to evaluate the anchorage loss.

Anterior anchorage loss was measured as increase in overjet, increase in incisor proclination (degrees) and mesial movement (mm), and mesial movement and tipping of the first premolars.

RESULTS

A total of 912 readings from 38 cephalograms of 19 patients were recorded. Descriptive statistics including arithmetic means and standard deviations (SDs) were calculated for different variables for both groups. All intragroup treatment changes were evaluated with paired \( t \) tests to see significant differences among the parameters. Differences with probabilities of less than 5% \( (P < .05) \) were considered statistically significant.

Intergroup comparisons were done with unpaired/independent sample \( t \) tests to calculate the significant difference between the posttreatment mean values of the two appliance groups (Tables 1 and 2 and Figs 7 and 8).
Mean distalization time with the implant-supported Ni-Ti coil spring appliances was 5 months and 20 days—with the distal jet, it was 6 months and 14 days. Of the 24 mini-implants placed in 12 patients, two failed in two different patients. These patients were not excluded from the study, but new mini-implants were replaced at a site just superior to the original location.

DISCUSSION

The distal jet appliance used in this study had modified Nance palatal buttons as anchorage support, anchored to the second premolars. Although the modified Nance palatal button is widely used with intraoral distalizing appliances, reduced hygiene under the acrylic resin button causing inflammation of the soft tissue and shallow palatal vaults are some of the reported problems with its use.

In the other appliance group, buccally placed Ni-Ti coil springs were used with mini-implants as the anchorage support instead of the Nance palatal button. The first premolars were firmly ligated to the buccally placed mini-implants to set up a sort of stationary anchorage. The crowns of premolars were held by indirect anchorage from mini-implants while the molars were free to tip distally.

To more accurately evaluate the anchorage loss and distal tipping measurement with the two appliances, distalizing forces of 240 g were applied in both appliances. Also, efforts were made to keep the amount of distal molar movement at which T2 records were taken equal. Statistically nonsignificant differences in distal molar movement was observed between the two groups.

Anchorage loss with mini-implant–supported Ni-Ti coil spring appliance

There was a 0.76 mm increase in overjet ($P < .05$), whereas the maxillary incisor inclination increased by 0.4 degrees, which is not statistically significant. Mesial movement of incisors of 0.41 mm was also not significant. Gelgör and Büyükkılmaz, using indirect anchorage from intraosseous screw implants, observed maxillary incisor proclination of 1 degree and increased overjet of 0.5 mm at the end of distal molar movement. They attributed this in their study to a small amount of mesial premolar movement.
The 1.05 degrees and 1.16 degrees of mesial tipping observed in right and left first premolars in this study were not significant \( (P > .05) \). This finding indicates the crowns of the first premolars were held firm with the ligature wire–implant assembly. The observation of minimal mesial tipping in this study is supported by Choi and Park\(^6\) who reported 0.9 degrees of mesial tipping of the anchor premolars.

The minimal amount of mesial tipping observed was also supported by the finding of Gelgör and Büyükyılmaz,\(^{11}\) who used Ni-Ti open coil springs with an intraosseous screw in the palatal region to obtain indirect anchorage. They reported a mean 2.8 degrees of mesial tipping of the first premolars. They stated this small amount of mesial tipping may be due to flexibility of the transpalatal arch connecting the first premolars to the implant screws or an insufficient connection between the transpalatal arch and the implant screw.

However, in this study, the right first premolar moved forward by 0.58 mm \( (P < .05) \) and the left first premolar moved 0.61 mm \( (P < .05) \). According to Liou and Pai,\(^12\) mini-implants are not always stationary, although the mean amount of tipping (about 0.4 mm) is not clinically remarkable. This finding is in support of observations of this study. Wehrbein and Glatzmaier\(^13\) also reported mesial movement of the anchoring premolars by 0.5 mm due to flexibility of the palatal bar using Strauman implants and the Orthosystem. The observation of minimal mesial movement of premolars in this study is also supported by Choi and Park,\(^6\) who also utilized indirect anchorage from a mini-implant. In their case report, the maxillary first premolar moved mesially 0.5 mm.

According to Chen and Kang,\(^14\) the immediate loading of mini-implants leads to some displacement and tipping of mini-implants with the result anchorage unit not being absolutely stationary. They recorded a mean mini-implant displacement of 0.98 mm in the maxilla with immediate loading. The mini-implants in our study also were loaded immediately with a force of 240 g.

Antoszewska and Papadopoulos\(^15\) placed 350 self-tapped mini-implants to investigate factors contributing to the success rates of mini-implants. They stated that reliable stability of mini-implants is not always tantamount to absolute immobility of mini-implants. Slight movement of the mini-implant under loading would result in some mesial premolar movement as observed in our study.

**Anchorage loss with the distal jet (Nance palatal button) appliance**

There was a statistically significant increase in incisor proclination by 2.78 degrees. The maxillary first premolars tipped mesially by 4.92 degrees and 5.21 degrees \( (P < .001) \).

Bolla and Muratore\(^16\) reported an increase in maxillary incisor inclination of 0.6 degrees. Ngantung and Nanda\(^17\) reported a highly significant increase. Chiu and McNamara\(^18\) reported an increase of 13.7 degrees in the incisal inclinations. These findings could be because of the preadjusted full bracketed appliance used along with the distal jet.

In this study, the linear mesial movement of first premolars was 1.00 mm on the right side and 1.11 mm on the left side, which was statistically significant \( (P < .001) \).

The mesial movement of premolars in this study is supported by Nishii and Hidenori,\(^19\) who observed 1.5 mm of mesial movement in their study.

This finding is also supported by Bolla and Muratore,\(^16\) who reported anchorage loss of 1.3 mm per side, measured at the first premolars. However, in contrast, Chiu and McNamara\(^18\) reported more mesial movement of premolars—2 mm per side. Ngantung and Nanda\(^17\) observed 2.6 ± 2.0 mm of mesial movement (anchorage loss) of the second premolar.

The amount of anchorage lost by mesial movement of premolars may be
attributed to inclusion of the first or second premolars in the anchorage setup. With second premolars in the anchorage unit, less anchorage loss is expected, since there are two more teeth (the first premolars) for anchorage conservation. This study had second premolars in the anchorage setup, whereas Bolla and Muratore\textsuperscript{16} and Chiu and McNamara\textsuperscript{18} had first premolars.

A mesial tipping of first premolars by 4.92 and 5.21 degrees was observed in this study. Chiu and Muratore\textsuperscript{18} reported mesial tipping of premolars by 2.4 degrees when the distal jet was used alone and 0.3 degrees when the distal jet was used with full bracketed appliances.

Ngantung and Nanda\textsuperscript{17} reported a distal tipping of 4.3 degrees of the anchor second premolars. Bolla and Muratore\textsuperscript{16} observed distal tipping of the premolars by 2.8 degrees. They stated that when second premolars were used as anchorage support for distal jet, a range of tipping from 4.3 degrees distally to 6.3 degrees mesially was reported.

These results represent anchorage loss ranging from 26.6% to 111.8% relative to molar movement (premolar or incisor mesial movement/molar distal movement \times 100).

The anchorage loss in this study utilizing a Nance palatal button was observed to be 24.75% on the right side and 23.9% on the left side (mesial premolar movement/distal molar movement \times 100).

The variation in this large difference with different researchers may be because of the following reasons:

- No specific standardization of the extent of acrylic palatal coverage. Complete coverage of palate has also been advocated.
- The number of dental units incorporated in the Nance appliance setup. Anterior contact with palatal aspect of incisors and interarch elastics to augment dental anchorage may have been used.
- Irregularly spaced interdental contacts will lead to a greater loss of anchorage.
- Individual morphology of palatal vault.

CONCLUSION

The following can be concluded from this study:

- The indirect use of mini-implants to support anchorage during molar distalization provides superior results than modified Nance palatal buttons of distal jet appliances.
- The anchorage loss at the first premolar was 13% with implant-supported Ni-Ti coil spring appliances and 24.75% with the distal jet appliance on the right side. On the left side, anchorage loss was 15.4% with implant-supported Ni-Ti coil spring appliance and 23.9% on the left side. Mini-implants do not provide absolute anchorage when used indirectly.
- Less time was required to set up the implant-supported Ni-Ti coil appliance, whereas the distal jet required considerable laboratory procedures to assemble and fabricate.
- Patient acceptance and tolerance of both the appliances was good.
- In this study, a larger sample size would have better qualified the statistical results obtained.
REFERENCES


