Distalization of maxillary molars using a lever arm and mini-implant

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This article describes the orthodontic treatment of a young woman with a Class II malocclusion and maxillomandibular prognathism. One orthodontic mini-implant was placed in the posterior area of the palate to provide anchorage for a transpalatal arch. The force for molar distalization was applied using an elastic chain from the lever arm inserted on the transpalatal arch to the mini-implant. Two sliding jigs were applied buccally as a complement for Class II malocclusion correction. This system created an efficient mechanotherapy for maxillary molar distalization. The active treatment period was 19 months. Normal overjet and reduction of maxillomandibular prognathism were obtained, and labial balance was improved.

Key words: orthodontic mini-implant, Class II malocclusion correction, molar distalization appliance

The distalization of maxillary molars is commonly used for correcting molar relationships, especially in Class II malocclusions, providing intra-arch space to correct the dental occlusion. During many years, the main appliance indicated for molar distalization was facebow headgear (HG), which requires good patient cooperation. As a result of the unesthetic appearance of HG, the orthodontic literature has presented different maxillary molar distalizing orthodontic appliance alternatives that use other force systems to induce orthodontic movement.¹⁻⁸ The molar distalization appliances more commonly used to replace HG are pendulum, nickel titanium (NiTi) coils, transpalatal arches (TPAs), and distal jets.⁵⁻⁸ These appliances exert a distalization force on maxillary molars, causing distal tipping of the molars, anchorage loss expressed as mesial movement and tipping of the canines and the first or second premolars, and proclination of the incisors. The presence of these side effects creates an undesirable increase in treatment time.⁹⁻¹¹

Temporary anchorage devices (TADs) provide skeletal anchorage, which has shown superior stability when compared with other dental anchorage modalities. Among the types of TADs, mini-implants represent the simplest way to obtain anchorage for different types of tooth movement, including molar distalization.¹,²,⁴ Mini-implants require placement in a position that favors orthodontic mechanics while preserving anatomical and dental structures. For this purpose, the association or modification of orthodontic appliances is necessary in some situations to achieve desirable dental movement. This case report presents a maxillary molar distalization method that combines the use of a mini-implant placed in the palatal posterior area and the TPA joined through an elastomeric chain to produce a system of forces to distalize the molars, avoiding possible side effects.
CASE REPORT

Case summary
The patient, aged 17 years and 2 months, presented for orthodontic treatment. Her major reason for seeking treatment was lip incompetence. Facial analysis showed a convex profile, proportional facial thirds, obtuse nasolabial angle, protrusion of the lips, and a normal menton-cervical line. Frontal facial analysis demonstrated facial symmetry, a consonant smile, filled buccal corridors, coincident midlines, and lip incompetence (Fig 1).

Analysis of the dental casts showed half-cusp Class II molar and canine relationships. Overjet and overbite measured 5 and 4 mm, respectively. Mild irregularity of the maxillary and mandibular teeth was observed without tooth loss or significant rotations (Fig 2).

Fig 1  Pretreatment extraoral and intraoral photographs.
The Art and Practice of Dentofacial Enhancement

Case Report

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The panoramic radiograph demonstrated normal shape and size of skeletal and dental structures of the jaws. The third molars had not erupted, and the roots were still in formation. There was no sign of active periodontal disease (Fig 3a).

Cephalometrically, she had a skeletal Class II relationship (ANB = 4 degrees) with an accentuated protruded maxilla and a protruded mandible (SNA = 80 degrees; SNB = 84 degrees). The maxillary and mandibular incisors were proclined (UI-NA = 27 degrees; LI-NB = 36 degrees). The vertical cephalometric values were normal (Fig 3b and Table 1).

Treatment objectives

Based on the initial diagnosis, the following treatment objectives were developed: (1) correction of molar relationship; (2) correction of canine relationship; (3) dental alignment; (4) reduction of maxillomandibular prognathism; and (5) improvement in soft tissue, mainly eliminating the lip incompetence.
Treatment alternatives
To achieve the objectives proposed, three treatment options were suggested to the patient.

1. Distalization with HG. Treatment of a Class II malocclusion without significant crowding in the mandibular arch can be performed with distalization of the maxillary molars. The Kloehn HG (KHG) was proposed for use 24 hours per day in order to obtain molar distalization. However, this proposal was immediately rejected by the patient on the basis that the KHG has an unesthetic appearance that would cause embarrassment since the hours of use would have included periods of social activity.

2. Intraoral molar distalization appliance. The patient received the explanation that this type of appliance needs minimum patient compliance to obtain success. However, to retract the anterior teeth and correct the side effects produced by the distalizing appliance, extraoral devices are recommended. Therefore, actually, some patient compliance would be still necessary, and this dependence could hinder correction of the malocclusion, increasing the treatment time.

3. TAD. As previously described in the literature, the distalization of the molars can be achieved by combining the use of a mini-implant in the palate and a TPA. This system for molar distalization usually generates a force vector that passes above to the center of resistance of maxillary molars, creating a moment that results in distal tipping of the roots. To distalize the molar crowns, Class II elastics are recommended. Therefore, some patient compliance is still necessary, but the compliance required is reduced because the roots are already distally tipped by the forces induced by the mini-implant system. Due to the simplicity of use and esthetic appearance, the patient chose this system for intraoral molar distalization. The use of the mini-implant and the TPA seemed to be the most appropriate alternative to reduce treatment time since, to date, no study has described side effects related to similar systems.

<table>
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<th>Measurements</th>
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<th>Posttreatment</th>
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<td>–3</td>
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<tr>
<td>LL–E-line (mm)</td>
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Case Report

Distalization of maxillary molars using a lever arm and mini-implant

Treatment progress

A 1.6 × 1 × 6–mm mini-implant (Dewimed) was placed in the middle of the median palatine suture. In order to increase the distance between the TPA and the mini-implant, a modification was done in the TPA design, including an anterior extension to work like a lever arm. To build the TPA, a 1.2-mm stainless steel (SS) wire was used, reaching from the maxillary first molar bands to the mesial surface of the first premolars. A 0.020-inch SS wire hook was welded onto the anterior portion of the TPA loop (Fig 4). Extraction of the two maxillary third molars was indicated.

A 0.022-inch-slot preadjusted edgewise appliance was placed to initiate leveling and alignment, starting with 0.014-inch NiTi wire, followed by 0.016 × 0.021–inch NiTi thermal activated wire, 0.019 × 0.025–inch NiTi wire, and 0.019 × 0.025–inch SS wire.

One month after the 0.019 × 0.025–inch SS wire was inserted, the distalization system was activated. Medium elastic chains were used, reaching from the mini-implant to the hook of the TPA, creating a monthly average force of 485 g, measured at each visit with a calibrated tension gauge.

Three months after the start of the distalization phase, a control panoramic radiograph was taken, which revealed significant distal inclination of the roots of the maxillary first molars (Fig 5). In order to obtain the distalization of the crowns, two sliding jigs were adapted at the accessory rectangular tubes of the maxillary first molars; both were made using 0.019 × 0.025–inch SS wire. The Class II intermaxillary elastic (3/16-inch) with medium force was used from the sliding jig to the mandibular first molar and replaced every 48 hours (Fig 6).
After 5 months of use, the sliding jigs were removed and replaced by Class II elastics with the same size/force to correct sagittal and occlusal positioning of the canines. Stripping of the mandibular incisors was performed to eliminate the tooth size discrepancy and to improve the inclination of the mandibular incisors.

The total treatment time was 19 months. The fixed appliances were removed at the same time as the mini-implant and TPA. For retention, maxillary and mandibular bonded canine-to-canine retainers (0.0195-inch coaxial wire) were used. The patient was instructed to continue with this retainer for at least a year, after which the quality of oral hygiene in the area of the retainer would be reevaluated, and a decision would be made regarding the maintenance or replacement of the retainer.
Case Report

Distalization of maxillary molars using a lever arm and mini-implant

**Results**

The posttreatment photographs demonstrate a good facial profile with competent lips (Fig 7). The final occlusion showed a Class I molar relationship on the right and left sides as well as normal overjet and overbite (Fig 8). The cephalometric superimposition demonstrated reduction of the maxillomandibular prognathism and improvement of the lip relationship (Fig 9). The panoramic radiograph showed satisfactory root parallelism (Fig 10).

![Fig 8](image1.png)  
*Fig 8*  Posttreatment dental casts.

![Fig 9](image2.png)  
*Fig 9*  Superimposition of pretreatment (*dotted line*) and posttreatment (*solid line*) cephalometric tracings.
DISCUSSION

TADs have allowed innovations in different orthodontic treatments. However, for the correct utilization of this new type of anchor it is necessary to understand that the biomechanics of orthodontic movement are changed when the TADs are applied. Also, it should be noted that TADs have been shown to be effective only for dental movement and are considered as a potential indication only for orthodontic corrections. In addition, one should consider that the numeric reference values of the obtained results still need to be replicated before being considered normal for patients who are treated orthodontically.15

The use of headgear applies various vectors of forces to obtain different kinds of dental movement. According to the range of force described in the literature, heavier forces create dental and skeletal effects; however, the smaller forces are used only for distal molar movement.12 A force of about 200 g on each molar is used for the distalization of maxillary molars.16 Recently, it has been observed that the movement of teeth through the anchorage with TADs is variable and depends mainly on the point of application. The forces should be smaller when applied directly to the molars, while the forces transferred to the molars should be higher in value.15

In addition to measuring the force intensity, the direction of the force should also be observed, confirming the basic concepts of biomechanics. A change in the anchorage device merits a better understanding of the generated forces since these components should provide the same force moments. In this case report, the movement was generated by the application of force between a midpalatal mini-implant to a hook that was located mesial to the maxillary first molars. This force vector created a moment that resulted in distalization of the roots of the maxillary molars. In terms of the force generated, two segments of elastic chain modules made a force of 850 g. However, in a period of 1 week, this force was reduced to an average of 485 g, resulting in an average force of 240 g for each molar. This reduction in the amount of force is due to degradation of the elastomer chain, estimated to be approximately 43% within 1 week for the brand of elastic chain used.17 Since the distance between the force vector and the center of resistance of the molar was measured in the computed tomograph as 4.25 mm, the moment of force for distalizing two molars on each side can be measured around 2,000 g/mm. Although NiTi springs generate a constant force, we decided not to use them to avoid any tongue discomfort. The monthly replacement of elastic chains proved to be sufficient to maintain the distalization of the roots. This pattern resembled that obtained by the use of headgear, since the force vector follows the same biomechanical principles.

Fig 10  Posttreatment panoramic (a) and cephalometric (b) radiographs.
Compared with other methods of intraoral distalization, the technique used in this case report showed no side effects regarding tooth positioning, such as anterior displacement of premolars and anterior teeth.

Following the initial distalization of maxillary molars, we found a case report with a similar design to the one presented in the present article, using a larger number of mini-implants and also a TPA with a lever arm to avoid the side effect of molar rotation. Currently, the clinical application of mini-implants appears to vary greatly, and there are several differing examples of how to best procure orthodontic movement in the patient. Regarding molar distalization, the most frequent proposals suggest using acrylic supports screwed into the anterior region of the palate and telescopic systems with springs to distalize the molars.

The alternative method to molar distalization described here, combining a mini-implant, a modified TPA, and intermaxillary elastics used with sliding jig is simple, hygienic, and easy to perform. In addition, this distalization design is versatile because it can be applied in children or adults because it allows the application of different force magnitudes to move one or two teeth on each side. For young patients at ages in which the median palatine suture has not yet fused, it is possible to install two analogous paramedian mini-implants. In this case report, the Class II intermaxillary elastics associated with the intraoral SS sliding jig were used in order to increase the crown distalization of the maxillary first molars. The force vector created by the elastics that pass below the center of resistance enabled the distalization of the molar crowns. The combination of the mini-implant, modified TPA, and intermaxillary elastics resulted in the translation movement of the molars. These results make all of the aforementioned factors indispensable when obtaining correction of the Class II dental occlusion presented by the patient. As with any orthodontic appliance, treatment plans must be individualized, and a monthly evaluation of the applied forces should be performed to allow them to remain effective during the intervals between visits and to reduce treatment time. One aspect to be observed is the palatal vault depth because the deeper the palatal vault, the more root tipping may occur. Nevertheless, mesial tipping of the molar crown will increase the archwire deflection, increasing the distalization of the maxillary teeth, but the occlusal molar relation will be unstable. Clear communication with the patient is important to improve compliance with the intermaxillary elastics. One important point to discuss with the patient is that the time of treatment is reduced when the intermaxillary elastics are used for Class II malocclusion correction.

Furthermore, we reinforce the importance of the extraction of the third molars in order to facilitate the movement of the first and second molars. The presence of the third molars in an advanced stage of development leads to an alveolar position that is closer to or located in the oral cavity. The force levels that we proposed were effective for the distalization of two molars on each side, but may be considered ineffective for the movement of another tooth. Increasing the average level of force in order to promote movement of the third molars could substantially increase the force load on the mini-implant, compromising its stability.

It is important to note that the level of force initially applied on the mini-implant is well above the recommended amount. However, because the force was generated by an elastomeric chain, it must be emphasized that the amount of applied force is significantly reduced within the first hours after installation, resulting in a force level that is compatible with those indicated for mini-implants.

The results observed in this case report reveal that adherence to biomechanical principles appear to be a key factor in the proper usage of TADs as treatment tools. In cases in which it is not possible to favorably position the TAD in regard to its proper biomechanics, TAD use is not indicated. In
addition, the design of the orthodontic appliance to be used in conjunction with the TAD should be simple, comfortable, and effective in order to result in an efficient orthodontic correction. Regarding the biomechanics details, it becomes clear that the initial distal inclination of the first molar roots yielded favorable traction and locking of the rectangular steel arch. As a result, retraction of the maxillary teeth and reduction of overjet were obtained.\textsuperscript{18}

This alternative use of mini-implants is indicated to replace HG in the correction of dental problems, and its use can also be suggested in Class II relationships that need a great amount of distalization.

CONCLUSIONS

In this case report, an alternative method to molar distalization, combining a mini-implant, a modified TPA, and intermaxillary elastics used with sliding jigs, was presented for dental correction of Class II malocclusions. The association of these appliances allowed avoidance of the use of HG and other distalizers that could promote undesirable dental movements of anchorage teeth. The use of this device was demonstrated to be effective because it corrected the malocclusion and was easily fabricated, comfortable to use, esthetic to the patient, and easy to clean. The design of the arch can be customized to suit biomechanical needs, generating moments for different amounts of distalization of the molars in order to reduce overjet.

REFERENCES