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"Three Dimensional Assessment of Maxillary Molars Following Distalization Using Two Different Approaches"

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Contents

Introduction

A common strategy to create space in the maxillary arch or to correct class II malocclusion with mild to moderate space deficiency by a non-extraction protocol, is to move the maxillary molars distally in the initial stage of treatment (1). Extra-oral traction has been used to correct skeletal discrepancy by restraining the forward growth of the maxilla and to correct the dental discrepancy by distalizing the maxillary molars (2). This method requires patient compliance and the exerted force is intermittent, thus prolonged treatment time is required (2).

Since early 1980s, various intraoral appliances for distal molar movement have been introduced to minimize the need for patient co-operation (3). These intraoral distal force appliances, were designed to apply continuous forces on the maxillary molars. This in turn causes mesial reactive forces on the anterior anchoring teeth represented as upper incisors protrusion and increased overjet (3).

In 2004, Papadopoulos et al. evaluated cephalometric changes following simultaneous distalization of first and second maxillary molars by a modification of the Jones Jig as a simple intraoral minimal-compliance fixed appliance. They found that the maxillary first molars were distalized to a mean of 1.4 mm. by a rate of 0.37 mm. per month, and tipped distally by a mean of 6.8°. The maxillary second molars were distalized to a mean of 1.2 mm. and tipped distally by a mean of 8.3°. The maxillary third molars did not move but tipped distally by a mean of 4.0°. They recommended third molars extraction to avoid their impaction, especially if the available space is not adequate. As a result of anchorage loss, the maxillary second premolars were mesialized by a mean of 2.6 mm. and tipped mesially by a mean of 8.1°. The overjet increased by a mean of 0.9 mm., and the overbite decreased by a mean of 1.00 mm. The distance from point A to PtV plane was increased significantly by a mean of 0.7 mm., while the SNA angle did not show any significant changes. The distance from point B to PtV plane and SNB angle were increased significantly (4).

In 2013, a systemic review evaluated the molar distalization efficiency associated with the second and third molar eruption stage. It had shown that in 1996, Ghosh and Nanda found that there were no significant differences in maxillary first molar movement and the anchorage loss between the group who had erupted maxillary second molars and the group who did not. This indicates that the eruption of the maxillary second molars had minimal effect on the maxillary first molar distalization (5).

However, in 2000, Bussick and McNamara found that distalization was most effective in patients with un-erupted maxillary second molars, for maximum distalization with minimal increase in the lower anterior facial height. While, in 2004, Kinzinger et al. found that the degree of the distal tipping of the maxillary first molars was greater in patients with un-erupted second molars. The degree of the distal tipping of the second molars was greater when the third molar bud was located in the direction of movement. They theorized that during distalizing a molar, a tooth bud acts on the mesial neighboring tooth as a fulcrum. They recommended germectomy of the third molar if a more bodily distalization is needed for first and second molars even when the second molars were not banded (5).

Finally, in 2006, Karlsson and Bondmark found that in patients with unerupted second molars, the amount of distalization was significantly greater within a shorter time [5].

Open coil springs have been used in orthodontic practice for distalizing maxillary molars. They have the characteristic of the ability to exert a long range of constant, light continuous force which is necessary for optimum tooth movement [6].

In 1984, Chaconas et al analyzed and compared open-coil-spring force production from continuous load- deflection curves generated for open coil springs of various wire diameter and lumen sizes, and four wire alloys from three manufacturers. They found that with a constant wire size, an increase in the lumen size produced a decrease in force at a given activation. With a constant lumen size and at a given activation, an increase in wire size produced increase in the force. The arch wire shape and size did not show a significant effect for the coil spring with the smaller lumen size. Larger lumen size springs used with rectangular arch wire showed a greater linear range than springs used with smaller round arch wire. Open coil spring with smaller pitch produced less force at a given activation than springs with larger pitch [7].

In 1998, Gianelly used a super elastic NiTi coils to move molar distally. He placed the coil between the first premolars and the first molars on 0.016×0.022 wires applying 100 gm. of force. Nance appliance was used for anchorage. It was fixed to the second primary molars in patients in mixed dentition stage or to the first premolars after they had erupted. Gianelly suggested to start non-extraction treatment by distalization in the mixed dentition stage before eruption of the maxillary second molars as the movement is the fastest and the anchorage loss is the least. Also, the E space in the lower arch is available in the late mixed dentition. If crowding is not present, the amount of distal movement of the maxillary molars can be reduced if the lower molars are moved mesially into the E space [8,9].

The molar relationship should be overcorrected by approximately 2 mm. Overcorrection is considered a prepared anchorage to compensate for anchorage loss during retraction of premolars, canines and incisors. Forward movement of the molars to the class I position helps to upright the molars. The overjet increased as a result of anchorage loss. Gianelly recommended the placement of 100gm. class II elastics if the overjet increased by more than 2mm. If the second molars are present and the distalization rate is less than 1mm./month, and / or anchorage loss is excessive, he suggested sequential distalization or changing the treatment plan to extraction protocol. He recommended extraction of the third molars if they have erupted or close to erupt as they impede the distal movement of the first molars [8,9].

Recently, temporary anchorage devices have been used during upper molar distal movement. They eliminate the reactive forces from the distal force appliance, these prevent the side effects on the anterior anchoring teeth [3].

In 2004, Gelgör et al. investigated the skeletal, dental, and soft tissue changes after using intraosseous screw-supported distalization appliance. The maxillary first molars were distalized efficiently into an over corrected class I relationship. The force system passed occlusal to the center of resistance of the maxillary first molars, producing backward and upward movements and distal crown tipping. The distal movement of the maxillary molars did not tend to open the mandible due to the intrusive effect. The status of the maxillary second molar or patient age, has no role on the effectiveness of distalization. There was a slight anchorage loss represented by maxillary incisor proclination and increased overjet. This anchorage loss resulted from mesial tipping of the first premolar, which may be caused by instability of the screw, bone elasticity, flexibility of the TPA, or insufficient connection between the TPA and the screw. Gelgör et al., concluded that 88 % of the space created was from molar distalization and the remaining 12 % resulted from reciprocal anchorage loss [10].

In 2011, Fudalej et al. evaluated the effectiveness of the distalization of molars with temporary skeletal anchorage device (TSAD) and compared the effectiveness of the TSAD reinforced distalizers with tooth-born noncompliance distalizers. The authors findings indicate that the use of TSAD supported distalizers increased the amount of molar distalization, while the maxillary incisors remained stable. They suggested that in patients with TSAD, greater distal tipping of molars might be the result of excessive pressure exerted on the molars by the distalizers as the whole amount of force will act on the molars and no force will dissipate in the anterior direction. Skeletal anchorage system (SAS) showed the slowest distalization rate as the whole maxillary dentition was distalized simultaneously. They also found that, when implant or mini-plate supported distalization appliances are used; presence or absence of the second molars might play a smaller role. Because of the stability of the implant, no forces will dissipate within anterior direction causing mesial movement or tipping of the maxillary incisors [11].

In 2013, a meta-analysis compared the amounts of distalization and anchorage loss of conventional and skeletal anchorage methods in class II malocclusion correction with intraoral distalizers. The authors concluded that variation in distalization time (1.5 – 14.16 months) might be due to variations in the amount of force applied by each appliance and in the severities of class II malocclusion which required different amounts of distalization. Both conventional and bone-anchored systems were effective for molar distalization but they differed in anchorage loss. Intraoral distalizers with conventional anchorage showed anchorage loss because the Nance button and the anterior teeth can’t resist the reaction forces of distalization so they move in the opposite direction. Indirect skeletal anchor devices showed an amount of anchorage loss which is smaller than that with conventional distalizing device. This anchorage loss is the result of many factors such as reaction force, bone elasticity or absence of osseo-integration of the mini-implant allowing their movement, flexibility of the wire connecting the premolar-mini-implant. Direct skeletal anchor devices allowed spontaneous distal movement of the premolars without anchorage loss probably due to stretching of the inter-septal fibers [12].

In 2014, a retrospective study investigated the dentoalveolar and skeletal effects of two distalizing protocols with different anchorage systems, the MGBM system which is a skeletal anchorage system and the pendulum which is a conventional intraoral anchorage system. The skeletal anchorage of the MGBM system allowed a greater posterior displacement compared to the conventional system. Regarding the molar distal tipping, there was no significant difference between the two systems. When measuring the anchorage loss at the premolar level, there was no significant difference between the two systems. The MGBM system exhibited a significant less anchorage loss measured at the incisors with significantly less proclination. In the MGBM system, the buccal distalizing force resulted in a greater extrusive action on the first molars. These greater molar extrusion and greater amount of distalization leaded to a greater decrease in the SNB angle. This was a transitory effect as a greater amount of the vertical growth in the condylar area compensated the increase of the vertical dimension of the dentoalveolar region [(13)].

In 2015, a study compared two distalizing systems, the MGBM system as an example of indirect skeletal anchorage system and the Distal Screw as an example of direct skeletal anchorage system. MGBM showed a greater amount of molar distalization, less distalization time and a significant distal crown tipping. Although distalization with crown tipping has less resistance to the movement resulting in less treatment time, this increases the anchorage requirement during the subsequent phase of fixed appliance therapy. Premolars showed a mesial movement and incisors showed a slight proclination. This is because of the low rigidity of the metallic ligature connecting the modified trans-palatal arch and the mini-screws. Distal Screw showed a smaller amount of distalization within a greater time and a more bodily distalization, probably due to the rigidity of the appliance. The premolars were distally pulled with a consistent distal probably due to the trans-septal fibers acting mainly on the dental crowns. This might facilitate the reaction of the premolars and canines during fixed appliance therapy [(14)].

Therefore, the idea of this study is to evaluate the effect of using coil spring and mini screw anchorage system during maxillary molars distalization.

Objective

The aim of this study is to evaluate the effect of using coil spring and mini screw anchorage system during maxillary molars distalization.

Study methodology

Study population:

This Randomized Clinical study will be conducted on 20 patients with age ranging from 18 to 25 years, selected from the outpatient clinic of the Orthodontic Department, Faculty of dentistry, Ain Shams University.

<u>The subjects will be selected to fulfill the following inclusion criteria:</u>

1. Skeletal class I, or mild to moderate skeletal class II malocclusion.
2. Full cusp or end to end class II molar relationship.
3. Mild to moderate crowding in the upper dental arch and/or increased overjet.
4. Any other indication requiring maxillary molar distalization unilaterally or bilaterally.
5. Full permanent dentition with exclusion of third molars.
6. Both first and second maxillary molars are in occlusion.
7. Normal or horizontal growth pattern.
8. Non-extraction treatment plan.
9. All subjects are free from any dental anomalies as well as periodontal and systemic diseases that may influence orthodontic treatment.

<u>Exclusion criteria:</u>

1. Previous orthodontic treatment.
2. Severe profile convexity requiring orthognathic surgery.
3. High mandibular angle.
4. Severe molar rotation.
5. Poor oral hygiene.
6. Severe carious lesions.

Study procedure:

An informed consent will be signed by the patients before their enrollment in the current study in which the aim of the study, the methodology and possible complications will be clearly described. This research will be reviewed by research ethics committee, Faculty of dentistry, Ain Shams University.

- Full orthodontic records will be taken for patients who meet the inclusion criteria. These records are:
  1- Extra-oral and intra-oral photographs.
  2- Orthodontic study casts.
  3- Panoramic radiograph: will be used to detect any dental or bone anomalies, general periodontal condition & bone level, stage of eruption & position of third molars.
  4- Lateral cephalometric radiograph: will be used to determine skeletal pattern & mandibular plane angle to verify fitting the inclusion criteria.

- Extra orthodontic records: Cone Beam Computed Tomography.
- The randomization will be through computer generated selection software.

Procedure:

- The maxillary first and second molars will be banded. Brackets will be bonded to the maxillary first and second premolars.
- Leveling of these segments will be carried out using orthodontic wires sequentially, till 0.019"x 0.025"stainless steel archwire is reached.
- Segmented stiff 0.019"x 0.025"stainless steel archwire will be used to minimize the distal tipping and rotation of the molars. It will be extended from the maxillary second molar to the maxillary first premolar.
- In the first approach, a nickel titanium open coil spring will be inserted mesial to the maxillary first molar to provide distalizing force. In the second approach, two pieces of nickel titanium open coil springs will be inserted mesial to the maxillary first molar and mesial to the maxillary second molar.
- Mini screw anchorage system will be used as a mean of indirect anchorage.
- The patients will be seen every four weeks for reactivation until Class I molar relationship is obtained, as assessed clinically.

Methods of assessment:

- The rate of tooth movement will be analyzed using computer software on digital models obtained every four weeks. When a Class I molar relationship is obtained distalization will be considered achieved, which will be assessed clinically.
- Cone beam computed tomography (CBCT) will be taken for every patient pre-treatment and post-distalization.

Adverse event reporting

Anticipated adverse effects regarding the use of mini screw and its remedy

1. **Pain and discomfort:** If present, it may last 1–2 days and could be reduced by instructing the patient to use warm mouth rinse containing local anesthetic agent.
2. **Irritation to the buccal mucosa:** Bonding resin or a periodontal wound dressing could be applied to the head of the mini screw to smooth its surface and to minimize soft-tissue irritation.
3. **Inflammation around mini screw:** The screws need to be thoroughly cleaned. Mild infections can be controlled by using antiseptic mouthwash and by regular brushing.
4. **Mini screw mobility or failure:** The patient will be instructed to avoid manipulating the screw with fingers, tongue, or with foreign objects like pens. The mini screw could be tightened and left for 1–2 months with no loading, or light loading if necessary. If stability cannot be regained, the mini screw will be removed and replaced.

Statistical analysis

All gathered data will be tabulated and statistically analyzed.

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