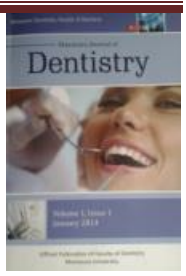
Mansoura Journal of Dentistry 2020;7(27):63-.65



Maxillary molars distalization: a review

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Abstract:

Class II malocclusion is ranked as the most prevalent type of glitches that require orthodontic treatment. It can be managed via several lines of treatment the choice between which must be dependent on each case requirements. Maxillary molars distalization is one of the most popular non extraction alternatives for class II treatment. There are many distalization appliances listed in the literature which can be categorized to either compliance or non-compliance types. Compliance distalization appliances include head gear, Cetlin appliance, Wilson Biometric Distalizing Arch and Carrière distalizer. Lack of patient cooperation comprises a major problem of these appliances and always leads to lengthy treatment in addition to less than ideal results.

Non-compliance distalization appliances for class II treatment include NiTi coil springs, Pendulum appliance, Distal jet, Keles slider and Fast Back appliance. Most of these appliances gain anchorage from dental structures or Nance palatal holding arch. This always leads to adverse effects as consequences of anchorage loss represented in mesial movement of premolars and anterior teeth, increased overjet and palatal tissue irritation by the non-hygienic Nance acrylic button.

Distalization appliances that involve a stable skeletally anchored modules have recently gained large popularity to avoid anchorage loss. It implies insertion of temporary anchorage devices (TADs) in different location of skeletal structures to receive and resist the reactive forces of distalization. Implant, miniplates and miniscrews are the main TADs used for orthodontic purposes. However, implants and miniplates are not widely used as they are expensive and require special surgical intervention. Miniscerws are the most common type of TADs due to their easy insertion, reasonable cost and many head designs that accommodate different orthodontic uses.

Introduction

E movable Several miniscrew supported palatal distalization appliances have been investigated for efficiency and seemed to produce satisfactory results but many of them are not rigid enough and involve expensive readymade components which may not be available in the market. Thus, this study was conducted to evaluate treatment outcomes of molars distalization by miniscrew supported Hyrax appliance which is commercially available and traditionally used for lateral expansion purposes.

Appliances for Maxillary Molar Distalization:

If molars distalization is planned, special attention should be paid to appliance design regarding method of activation, anchorage preparation, activation rate, vector and magnitude of force. Many types of distalization appliances and techniques have been invented and reviewed for their effectiveness and mechanics. These appliances were categorized on basis of many features including:

- Position: extraoral and intraoral appliances, which were further divided into two groups whether buccally, palatally positioned or involved both buccal and palatal components.
- Need for compliance: compliance and non-compliance appliances.
- Involved arches: intermaxillary and intramaxillary appliances.
- Rigidity of force system: rigid and flexible types.
- Mode of action: push and bull types.
- Source of anchorage: conventional and skeletal anchorage.

Extraoral appliances for maxillary molars distalization:

Head gear:

A traditional example of extraoral compliance appliances for treatment of class II malocclusion is the face bow head gear. It was first invented by Frank Nelson 1969. It didn`t have an exclusive dental effect but it produced skeletal changes as well, thus it was widely used for growth modification purposes. To produce more dental effect, amount of force was decreased and duration of wearing was increased more than those recommended for orthopedic purposes. About 4 N force per side was recommended for molar distalization purpose. Occipital pull, cervical pull and combination types of head gear were listed in the literature with different characteristics, indications and outcomes for each type. The main difference between them was projected to the effect on the molar in the vertical plane while occipital pull type produced intrusion and cervical pull one produced extrusion.

Graber noted that head gear assisted distalization of maxillary first molar with no erupted second molars had led to increased degree of distal tipping instead of bodily movement. To overcome this shortcoming, the line of force was recommended to be passing through the molar`s center of resistance (trifurcation area). Moreover, Cetlin recommended full-time intraoral force to be combined with part-time head gear protocol to end up with more bodily movement of molars.

One of the main head gear advantages was that it allowed for spontaneous drift of premolars and canines as it did not rely on them to gain anchorage. So, unlike many other distalization appliances, it caused no anchorage loss in the anterior segment. But the main shortcoming was that it involved more extraoral hardware impairing patients' esthetics and psychological status especially in adolescent school candidates. Also there were risks of injury to eyes, face and side effects on cervical spine from neck straps. A pilot study involving time recorder equipped head gears yielded that clinicians` instructions about hours of daily use were followed by only 56.7%.

Intraoral appliances for maxillary molars distalization:

Intraoral non-compliance distalization appliances consisted of two main components, namely active component and anchorage unit. Some involved buccally oriented active components such as repelling magnets, K-loop appliance, Jones Jig, Nickel-titanium coil springs and Ni-Ti wires. Others involved palatally oriented active components such as pendulum, Distal Jet, Keles Slider, Veltri's Distalizer and the Fast Back Appliance. Also there were appliances that had both buccal and palatal active components like the First class appliance. It was concluded that palatally acting distalization techniques produce less tipping of molars and even for teeth involved in the anchorage unit. This was referred to the fact that palatal appliances act near the teeth`s center of resistance thus the produced moments are decreased and bodily movement is more manifested.

Distalization appliances with conventional anchorage:

Repelling magnets:

Samarium-cobalt repelling magnets® ($SmCo_5$) were utilized by Gianelly et al for molars distalization. Two buccal magnets were used for each side, one anchored to the molar and the other to adjacent mesial tooth - either premolar or deciduous molar- which was attached to a Nance holding button resting on incisors` palatal surfaces. Bondemark and Kurol conducted a study on molar distalization by repelling magnets and ended up with 4.2 mm molar distal movement with 8° distal tipping. Upon comparing this technique with superelastic Ni-Ti coil assisted distalization, it was reported to be less efficient in terms of achieved distal movement magnitude and bodily manner. Magnets use had become obsolete due to high cost, large size and the decreased force with the gradual increase in distance between the two part as the distal movement proceeded.

Jones Jig:

Jones and White in 1992 developed the Jones Jig distalization appliance. It consisted of 0.030 inch wire with a nickel-titanium coil spring and sliding hook. The wire had 2 distal projection ends, one was inserted in head gear tube and the other in the main molar tube. Anchorage was provided through a Nance button held to premolars or primary molars by means of 0.036 inch wire. About 70 gm of force was prescribed for activation through tying back the hock to the anchor teeth brackets. Brickman et al investigated Jones Jig efficiency and reported 2.51 mm distal movement and 7.53° distal tipping of maxillary first molars. They measured anchorage loss and found that it was manifested in second premolars mesial movement of about 2 mm and mesial tipping of 4.76°. Equivalency was stated between its results and many other appliances such as Herbst appliance, Wilson mechanics, Repelling magnets, Pendulum, cervical headgear.

Ni-Ti open coil springs:

-Ti open coil springs have gained large popularity in distalization purposes for their good spring back action and light continuous force delivery. They produced about 100 gm of force when they are compressed by 10 mm between first premolars and first molars on a 0.016 * 0.022 inch stainless steel wire. This arch wire might be segmented or continuous and should have at least 5 mm length past the distal aspect of the first molars as a guide for movement. A study investigated their use in mixed dentition stage with anchorage derived from Nance holding arch concluded that single activation can produce molars distal movement at a rate of about 1 mm/month with 20% anchorage loss. Yildiz et al found 11° of molars distal tipping and 9.75° incisors proclination when Ni-Ti coils were used for molars distalization with conventional anchorage.

The Pendulum appliance:

It was first invented by Hilgers in 1992 and achieved distalization through active 0.032 inch beta-titanium alloy wire springs inserted in molars lingual sheathes. It utilized both palatal and dental structures to gain anchorage via Nance button and occlusal rests on first and second premolars. Active springs had a closed helix and horizontal adjustment loops and delivered about 230 gm light continuous force when inserted into molar sheathes. Researches evaluating its efficiency had concluded that it could distalize molars with little tendency to produce open bite or incisor proclination. On the contrary, Ghosh and Nanda stated that there were 43% anchorage loss with the use of pendulum distalizer manifested in about 1.3 mm increase in overjet.

Bussick and McNamara had investigated dentoskeletal changes after pendulum assisted molars distalization and found average distalization of 5.7 mm with 10.6° distal tipping and 0.7 mm intrusion of maxillary first molars. There were 1.8 mm mesial movement and 1.5° mesial tipping of the anchor teeth. They also noticed that mandibular first molars had extruded by 0.7 mm and attributed this to the pendulum occlusal rests which acted as mini-bite plane allowing lower molars extrusion. This effect, together with distal driving of upper molars into the wedge, have been blamed for the increase in lower facial height at the end of the treatment.

The standard pendulum has undergone many modifications to overcome its drawbacks and increase its efficiency. Pend-x appliance, M Pendulum, K-Pendulum, Franzulum Appliance, Modified Pendulum with removable arms and T-rex pendulum were some of its modifications.

Fast Back Appliance:

Lanteri et al has introduced Fast Back distalization appliance that utilized Memoria springs and two sagittal screws for ease of activation. It gained anchorage from Nance holding arch attached to the first premolar bands and the anterior ends of the two sagittal screws. The appliance was calibrated in terms of force delivered through each activation of the screw which in turn compressed the Memoria spring to move molars distally sliding on a 1.1 mm wire inserted in their palatal tubes. It was prescribed that activation should be done every 30-45 days to deliver 200-300 gm of force.

Alkasaby et al performed a prospective study on 10 female class II patients and used Fast Back appliance for molar distalization. In a mean duration of 3.8 months, molars were distalized by 3.4 mm and distally tipped significantly by

3.55°. Intermolar width was increased by 3.55 mm while vertical and rotational changes of molars were insignificant. First premolars drifted mesially by 3.21 mm and tipped by 3°. Maxillary incisors proclined by about 1.63 mm and ovejet increased by 2.02 mm. Incisors and premolars changes were attributed to anchorage loss.

Caprioglio et al compared Fast Back and Pendulum appliances and concluded that Pendulum appliance produced more distal molar movement and less anchorage loss during the distalization phase though it produced more molar distal tipping. However, both appliances did not show significant difference in maxillary dentoalveolar changes at the end of the treatment at all.

Simplified Molar Distalizer (Frog appliance):

Walde 2003 first presented a new distalization technique and called it the Frog appliance or Simplified Molar Distalizer. It consisted of a midline sagitally opening screw, two preformed 0.032-inch wire springs inserted in palatal tubes of molars bands and a Nance holding button attached to first premolars by means of occlusal rests for anchorage. The screw vertical position was set parallel to occlusal plane and 10-12 mm apical to molars occlusal table to be in level with their center of resistance and produce bodily movement. According to manufacture instructions, one complete turn of the screw opens it by 0.4 mm. So three rotations were recommended at four to five weeks intervals.

A Three dimensional evaluation of the Frog appliance was carried out using Cone Beam Computed Topography (CBCT) on 40 class II patients. The maxillary first molars were effectively distalized by 4.25 mm and 3.53 mm for the dental crown and root apex respectively. An insignificant degree of molar tipping (about 2.25°) was produced and molars were rotated disto-buccally. Anchorage loss was manifested in 2.76° proclination of maxillary incisors.

A study was performed by Burhan to compare effects of using the Frog appliance alone and its combination with night-time head gear appliance. He concluded that the combination between the two appliances resulted in more distal movement and less distal tipping of molars in addition to less anchorage loss at premolars and anteriors.

The New Distalizer:

Baccetti and Franchi in 2001 have modified the Veltri distalizer by addition of Nance button attached to the anterior section of the screw and called it the New Distalizer. This modification aimed at increasing anchorage control to be derived from both the palate and maxillary premolars. Rate of activation was also two quarter turns per week to achieve 1.5 mm movement per month. After distalization phase, the screw was locked, arms connecting the screw to the premolars bands were cut and the nance button was left in place as an anchor component during remaining teeth retraction.

The New Distalizer, pre and post distalization views, quoted from Baccetti and Franchi

The New distalizer was used for maxillary first molar distalization in a 12 years old case with flat facial profile and skeletal bimaxillary retrusion, the reason which excluded extraction from the treatment options. Superimposition of pre and post distalization cephalometric radiographs showed that molars almost moved bodily for 4.3 mm distance with minimal tipping. Anchorage loss measured by mesial movement of premolars and anteriors was negligible.

Arash et at 2014 investigated the Hyrax screw in molars distalization for 24 patients with half unit class II molar. Results showed that, in 12 weeks period, first molars was distalized by 1.76 mm with 2.95° distal tipping which seemed to be less than tipping produced by most of the other distalization appliances. First premolars and upper incisors were moved mesially by 2.45 mm and 2.98 mm respectively. There were 3.45° and 4.2° of mesial tipping of first premolars and incisors respectively. There were insignificant differences in molars vertical position and lower anterior facial height after distalization period.

Distalization appliance	Mean distal molar movement
Repelling magnets	4.2 mm
Jones Jig	2.51 mm
NiTi open coil springs	3.5 mm
Pendulum	5.7 mm
Fast Back	3.4 mm
Frog appliance	4.25 mm
The New distalizer	1.76 mm