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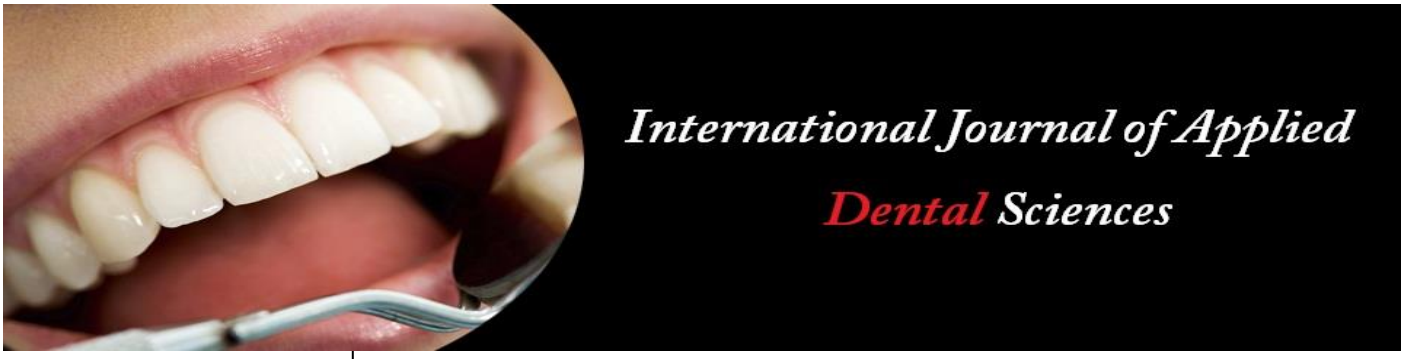

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Revisiting molar distalization

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Abstract
Over the past years orthodontists have pondered over gaining space in the arch. Various methods with advantages and disadvantages were hypothesized out of which extraction, reproximation of tooth surfaces and distalization were widely used and accepted. In this literature we are including the advent of distalization in orthodontics along with its advantages, disadvantages and devices used for the above.

Keywords: Molar distalization; orthodontics; arch discrepancies

Introduction
In the adult patients there is no clinically significant growth in the bone structure. Therefore, an alternative solution must be formed to obtain space in which the teeth can be moved to correct the malocclusion. In the past, orthodontists had two main options to create space in the arch; Expand the arch and extraction. However, today we are fortunate enough to have more techniques and appliances to gain space i.e. distalizing the molars.

History
Kingsley (1892) tried to move maxillary teeth backwards by means of headgear. Oppenheim (1944) advocated the use occipital anchorage for moving maxillary teeth distally into correct relationship without disturbing mandibular teeth [1]. Kloehn (1951) described effects of cervical pull headgear on distalizing the maxillary teeth. Roenfroe (1956) reported lip bumper primarily deviced to hold hypotonic lip caused a distal movement of lower molars sufficient to change Class I to Class II. Gould (1957) discussed about unilateral distalization with the use of extra-oral force. Graber (1969) extracted maxillary 2nd molar and distalized 1st molar to correct Class II Division 1 malocclusion. J. J. Hilgers (1999) modified Pendulum appliance was used to avoid unwanted tipping of the molars. In 2000, Graz-Implant supported Pendulum was introduced to distalize both the maxillary 1st and 2nd molars together in adults. In 2005, Kinzinger modified the standard pendulum by integrating a distal screw into its base and by special pre activation springs called K-Pendulum.

Indications
- Class II molar relation due to maxillary protrusion
- Class II molar relation due to impacted/high labially placed cuspids
- Class II subdivision requiring unilateral distalization
- Class II molar relation due to ectopic eruption of 1st/2nd bicuspids
- Midline discrepancy cases
- Regaining space loss due to mesial shift of 1st molars following premature loss of deciduous teeth
- Anchorage loss during active orthodontic treatment
- In a growing child → to relieve mild crowding (2mm)
- In Late mixed dentition → using of the Leeway Space of Nance for relieving mild crowding
- Axial inclination → mesially angulated upper molars
- Absence of third molars
- Cases having high mandibular plane angle as a wedging effect.

Contra-indications

- An End on/full class II molar relation due to mandibular retrognathism
- Retrognathic profile
- Skeletal openbite
- Excessive lower anterior facial height
- Constricted maxilla
- Presence of transverse crossbite

Diagnostic criteria (case selection)

First step in diagnosis is to confirm forward positioning of maxillary molar position during centric relation through cephalometric records. Kotm cautioned against using extraoral force in patients with undiagnosed meniscus disorders who are borderline clickers with an "end on click". Reason: - It may pushback maxillary molar; causing more posterior tooth contact backward (for true click); the mandible assumes its normal position but meniscus remains too far forward.

Second step is to check the sagittal relationship by Pterygoid Vertical Plane (PTV)/Maxillary molar relationship and also by convexity prognosis.

According to Ricketts, [2] normal maxillary molar (M1) position is given by the distal face of M1 to PTV. In a good skeletal and dental Class I relationship case, the facial axis crosses the mesial cusp of M1. If M1/PTV distance is shorter than normal, possibility of distalization is low and extraction will depend on growth potential and presence of 3rd molar.

To determine the convexity, differentiation must be between a forward maxilla and age of patient (4mm convexity at 8years of age could completely differ at maturity).

Treatment timing [3]

Ideal timing is the late mixed dentition stage as the maxillary tuberosity continues to grow till 14-15years in females and 16-17years in males.

Treatment planning and sequence

Objectives of 1st phase (space gaining phase): - Distalize the molars to occlude them in super class I (overcorrection) and achieve generalized spacing through denoalveolar widening and growth, also correct inclination and rotation.

Objectives of 2nd phase (consolidation phase): - Keeping in mind the Andrews 6 keys to normal occlusion, achieving ideal overjet, overbite and other malocclusion.

Appliance diversity

1. Acrylic-cervical-occipital (ACCO) [4]

The removable appliance is the **Margolis** ACCO defining a combination of a modified Hawley appliance reinforced with straight-pull headgear. The ACCO appliance aids within the correction of arch relationship and severe overjet, also in the removal of occlusal interferences which would be liable for mandibular deflection. It has the following components: -A. Retainer portion: - Palatal acrylic, Anterior bite plane, Labial bow, Finger springs and Clasps; B. Headgear portion: - Cervical-occipital headgear.

2. 3-D Bimetric dimensional arch (3D-BMDA) [5]

3D-BMDA was introduced for the correction of Class II malocclusions by **Wilson** in the year 1978. With this system, the maxillary molars were distalized using an open coil spring and Class II elastics.

3. Headgear [6]

Angle's headgear was developed to be utilized in conjunction with the traction bar, arch, and the chin retractor. This was a thought originally proposed by Dr. Norman W. Kingsley in 1866. The headgear consisted of a cap of silk netting covering the rear head. The netting is attached to a metal rim for the even distribution of force. Traction bar and the arch were designed for shortening the dental arch or moving distally multiple protruding incisors and cuspids. The arch was smooth and threadless designed to be used with clamp bands. Tubes on the molar bands allowed the arch to move distally.

4. Repelling magnets [7] (Anthony A. Gianelly)

Gianelly designed a Nance appliance that extends anteriorly to the incisor segment by means of a 0.045-inch wire soldered to the lingual aspect of the premolars. The acrylic component is placed against both the palatal vault and the incisors. Bilateral distal extensions with loops at the end are soldered to the labial aspect of the premolar bands in order to approximate the molar tubes and loops. Anchoring the modified Nance appliance to the first premolar encourages the distal drift of the second premolars that normally occurs as first molars are moved posteriorly. The modified appliance activates the magnets and also contains its reactionary force.

5. Pendulum appliance [8] (1992 by J J Hilgers)

The appliance consists of a palatal Nance component with rests that are bonded to the occlusal surface of the premolar teeth. The distalizing mechanism consists of bilateral helical springs made from titanium molybdenum alloy of 0.032" diameter delivering a continuous force against the maxillary first molars. The springs produce 200 to 250 g of force in a swinging arc movement, hence the name *Pendulum.* The springs can distalize the molar about 5mm in three to four months.

6. Jones Jig [9] (1992 by Jones and White)

The palatal button (0.5") was anchored to the maxillary second premolars with a 0.036" SS wire. After cementation of the modified Nance, one arm of the Jones jig was fit into the headgear tube and the other arm was fit into the slot of the first molar band. The appliance was then activated by an activation loop back with 0.010" ligature off of the anchor tooth bracket. The coils can be reactivated at 4 to 5 week intervals till the desired change in relation is achieved.

7. Superelastic NiTi wire [10] (1992 by Locatelli *et al*.)

Superelastic nickel titanium wires with the property of shape memory (Neo Sentalloy) allow moving maxillary molars distally. Stops are crimped distal to second premolar bracket and 5- 7mm away from anterior opening of molar tube. The main archwire inserted into molar tube and first premolar bracket, with excess deflection gingivally. Distal molar movement as wire tends to return to its original shape.

8. Lokar Appliance [11] (1994 by Scott)

This appliance was originally developed as a noncompliance treatment modality and have been found to be a vital part of both early-treatment and full-treatment regimens. It is inserted in to the molar attachment with an appropriately sized rectangular wire and a compressing spring that is activated by a sliding sleeve. Best used by Nance palatal button.

9. K Loop Molar Distalizing Appliance [12] (1995 by Varun Kalra)

The appliance consists of a K-Ioop to supply the forces and moments and a Nance button to resist anchorage. The loop is made of .017" x .025" TMA wire, which may be activated

twice the maximum amount as stainless steel before it undergoes permanent deformation, also produces less than one made with stainless steel. Each loop should be 8mm long and 1.5mm wide with a 20-degree bent at the legs of the K and inserted into the molar tube and the premolar bracket. The appliance is reactivated 2mm after 2 appointments move the teeth further.

10. Distal Jet [13] (1996 by Caranna and Testa)

The Distal Jet comprises of a two piston and one tube arrangement, with the tube embedded in a Nance button in the palate, supported by attachments on the one of the two premolars. A bayonet wire is inserted into the lingual sheath of each first molar band and the free end is inserted into the tubes, much like a piston. A NiTi open-coil spring and an activation collar are placed around each tube. Compressing the coil spring generates a distally directed force. The activation collar is retracted and the mesial setscrew in each collar is locked onto the tube to maintain the force.

11. Lip bumper [14] (Fig 1)

The lip bumper is capable of neutralizing the centripetal force produced by lips and cheeks, releasing expansive action produced by the tongue. The wire component is made of 0.045" stainless steel wire and coated with acrylic or plastic. The lip bumper is positioned in front and away from the lower anteriors and gets inserted into the molar tubes. Lip bumper appliance is used for gaining space or for distalization of molar in mixed dentition cases. The similar one used in the maxillary arch is called Denholtz appliance.

Fig 1: Lip Bumper

12. First Class Appliance [15] (1999 by Fortini)

The most important feature of this appliance is that it produces rapid molar distalization with very low tipping even with second molars present. The double track system prevents any rotation in dentition and constriction of arches.

13. Franzulum appliance [16] (2000 by Byloff)

An acrylic button of 5mm width is used as anchorage. This appliance rests on the cuspids and bicuspids through 0.032" wire. Niti coil springs are inserted into the tube which exerts 100-200gm of distalizing force on each side.

14. C space Regainer [17] (2000 by Chung)

A removable appliance used to achieve bodily movement of molar without significant flaring of incisor. Also used to intrude teeth along with moves them distally. Indicated in cases with mild arch length discrepancy treated by extraction of second or third molars, and also in open bite cases.

15. Keles Slider [18] (2001 by Keles)

The sliding jig consists of a distalizing rod, a0.040″ SS ball tip, a lock, a 10 mm long NiTi heavy coil spring and a 0.045″ tube with wire extension which attaches to the cleat of the first molar bands. A light-cure triad acrylic gel material is applied chairside.

16. Transpalatal Arch (TPA) [19]

Massimiliano Mandurino and Laura Balducci in 2001 introduced TPAs constructed with TMA wire for asymmetric distalization of molars. This TPA distally engages into the tube of the maxillary molar as anchorage and mesially into tube of the maxillary molar that has to be distalized. On activation the TPA produces mesiobuccal rotation to anchor molar and distally directed force to the opposite molar.

17. Frog Appliance [20] (2003 by Kelvin Walde)

A frog appliance kit comprises of a screw, a preformed spring and a screw driver. Wires (0.028" SS) bonded to the premolars lying in the embrasures distal to the anchor teeth aids in the anchorage of the appliance. The distalization force was produced by the activation of the screw by simply turning the screw counterclockwise. Bodily molar movement occurs in just 4 months. Unilateral molar distalization can also be achieved.

18. Carriere Motion 3D Appliance [21] (2004 by Luis Carriere)

Appliance consists of two rigid bars bonded bilaterally to the maxillary cuspids and first molars. The canine pad has an attachment used for elastics. Posteriorly, the molded pad with a ball-and-socket joint is bonded to the first molar at its clinical center to facilitate molar derotation and distalization.

19. K pendulum [22] (2005 by Kinzinger *et al.*)

One of the modifications of the conventional Pendulum appliance. A distal screw is put into the Nance button and an uprighting and toe-in bend in the region of the pendulum springs is incorporated to prevent the potential side effects like palatal movements of the molars and tipping of the dental crowns.

20. Implant supported [23] (2006 by Beyza, Papadopoulus)

They provide absolute maximum anchorage minimizing the side effects like tipping, anchorage loss and rotation of traditional orthodontic appliances. They are fixed directly into the bone and removed once the distalization is completed. However, this no anchorage loss has several problems related along with: the screw can fracture, and risks of infection around the screw are significant. Intra-radicular micro-implant supported- Buccal and Palatal; Palatal Micro-implants and Conventional appliances like Distal Jet and Pendulum appliances supported with micro-implants are various different methods of using implants.

21. Top Jet Appliance [24] (2013 by Winsauer)

This molar distalizer is a compact, prefabricated appliance with welded twin tubes: a distalizing "power module" and an "adjustment module". The design allows simple chairside adjustments in a single appointment. It can be used unilaterally or bilaterally according to the requirement. The anterior palate is stabilized by a single miniscrew lateral to the midpalatal suture. The power module comprises of a NiTi coil spring and a C-clip anteriorly for connection to the miniscrew. The adjustment module has a piston that extends distally for

attachment to a transpalatal arch (TPA) using a T-shaped connector. This forms a hinge along the axis of the TPA and provides resistance from molar tipping vertically.

Influence on surrounding structures on distalization

Graber noted that extraoral traction on 1st molars, when 2nd molars have not totally erupted, led to the distal tipping only and not bodily. Bondemark starred the presence of 2nd molars did influence tipping and distal movement of 1st molars (treatment time increases).

Kinzinger used modified pendulum appliance for bilateral maxillary molar distalization in 36 adults in various stages of dentition. Analysis showed a tooth bud acts on the mesial tipping neighboring tooth like a fulcrum. So, degree of tipping in cases where 2nd molars eruption was incomplete was more.

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