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Molar distalization by different intraoral device in orthodontics: A review

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Abstract
Molar distalization is one of the most popular treatment now a days for Class II malocclusion and borderline cases. Whenever there is space deficiency, the techniques for picking up space that strikes to our mind initially are extraction, expansion and stripping. Molar distalization can fulfill the requirement of space without doing extraction. Various intra oral appliances were introduced for molar distalization without patient compliance.

Keywords: Distalization, history, classification, appliance

1. Introduction
Molar Distalization' in orthodontics is characterized as the distalization of dental units to pick up space for the sagittal revision of malocclusion. Likewise with other dental movements along the curve, distalization can be a basic crown tipping molar or a real development of crown & root complex [1].
Non-extraction treatment regularly requires upper molar distalization into a final class I relationship. Distalization of upper molars in a person with class II and moderate space lack in the upper arch can be accomplished by extraoral traction or by a removable appliance [2].
Numerous specialists have built up various treatment modalities for class II rectification from consistence situated headgear treatment to noncompliance treatment utilizing intraoral devices to distal movement of upper molars into a class I occlusion. Headgear is dismissed by numerous patients on account of esthetic and social concerns. The trouble with wearing of headgear and reliance on patient cooperation energize a few examiners to develop new intraoral devices and systems for distal development of molar [3]. Intraoral methods have been observed to be successful for upper molar distalization.
The fundamental non-compliance appliances that utilized as an adaptable molar distalization force system which is palatally situated are the Pendulum Appliance and the Distal Jet Appliance. Patient consistence with extraoral forces and removable appliances has been broadly talked about and the introduction of these new – age appliances has decreased the intensity of patient's discomfort [1].

2. History
Norman William Kingsley [4] in 1892 planned the headgear appliance and was the principal individual to endeavor to move the upper teeth in reverse by utilizing headgear. The FCA (First Class Appliance) can be viewed as tooth-directing device proposed by Knapp [1] in 1899, which fused to screws for molar distalization. This device had been created by an engineer as a conceivable system of distalization with the screw situated on the palatal side. Renfroe (1956) [4] detailed that lip bumper essentially conceived to hold hypertonic lower lip caused a distal development of lower molars adequate to change class I to Class II.
Kloehn (1951) [1] depicted the impacts of cervical pull headgear. Gould (1957) [1] was first individual to portray about one-sided molar distalization with extraoral force. In 1960 Behrman portrayed the utilization of implanted magnets in the jaws to help denture maintenance and the utilization of magnets for tooth developments was first depicted by Crefcoeur and later on by Blechman and Smiley [1].

Graber TM (1969) [5] removed the upper second II molar and distalized the 1st molar to correct class II division 1. In 1978 Blechman and Smiley [2] utilized magnets for molar distalization and Gianelly *et al.* [2] in 1991 utilized super elastic NiTi coil springs for distalization of upper molar.
In 1995, Carano and Testa [1] presented a new "distalizer" to improve the control of molars amid distal movement. Since the presentation of the Distal Jet, a several modifications of the initial design have been recommended. In 1997, Erverdi and Koyutnrk [1] utilized magnets and NiTi coils springs for amendment of class II molar relationship. Goshgarian [4] introduced the Transpalatal arch for molar derotation in 2003. Cetlin and Ten Hoeve [4] demonstrated that the TPA is viable device for stabilization, rotation and distalization of the molars. Wilson distalizing arches, spring devices and inter maxillary elastics with sliding jigs, require significant patient consistence to be successful [4].

3. Indication and Contraindication

3.1 Indication

In Growing child

- To assuage mellow crowding
- Causes increment in arch length of about 2mm on each side.

Late mixed dentition

- For alleviation of anterior crowding, lower space is used
- Maxillary molar distalization to get a class I molar relationship
- Class I – with labially placed and impacted canine
- Lacking of space for premolar eruption because of mesial migration of 1st molar
- Soft tissue profile is good
- Mild to moderate space inconsistency with missing second and third molars not yet erupted
- Axial tendency: mesially angulated upper molars
- Normal or hypodivergent development design
- Mild crowding in anterior in late mixed dentition

The signs of molar distalization can be condensed under the accompanying headings [4]:

1) Profile

- Straight profile

2) Functional

- Normal, solid tempromandibular Joint
- Correct mandible to maxillary relationship

3) Skeletal

- Class I skeletal
- Normal, short lower face height
- Maxilla/normal transverse width
- Brachycephalic development design
- Skeletal closed bite

4) Dental

- Molar relationship with class II
- Deep overbite

Permanent dentition

- Upper 1st molar mesially inclined
- Prior to emission of 2nd molar
- Upper arch cuspids labially dislodged
- Loss of arch length because of untimely loss of 2nd deciduous molar.

3.2 Contraindications

- A Class-II molar relationship due to mandibular retrognathism
- Retrognathic profile
- Skeletal and dental Open-bite
- Lower anterior facial height is excessive (Dolico-facial form)
- Constricted upper arch
- Patients with molar relationship of Class II and Class III

The contraindications of molar distalization can be summarized under the accompanying headings [4]:

Profile

- Retrognathic profile

Functional

- Numerous signs and side effects of Temporomandibular joint
- Posteriorly and superiorly displaced condyle

Skeletal

- Class II skeletal
- Skeletal open
- Excess lower face height
- Constricted maxillary arch
- Dolicocephalic growth pattern

Dental

- Class I or III molar relationship

Dental open bite

- Maxillary first molar distally inclined

4. Classifications (According to Chandra *et al.*) [2]

1. Extra-oral: Head gear.
2. Intra-oral:

4.1 Intra-oral

Table 1: Intra-oral appliance

ACCO (1969)	Pendulum Appliance (1992)
Transpalatal Arch (1972)	Jones Jig (1992)
Wilson Rapid Molar Distalization (1983)	K-Loop
Cetlin Appliance (1983)	Fixed Piston Appliance (1995)
Crozat Treatment (1985)	Distal Jet For Upper Molar Distalization (1996)
Lokar Appliance. (1996)	Molar Distalization by using Repelling Magnets (1988)
Molar Distalization using NiTi Coils. (1991)	Modified Nance Appliance For Molar Distalization (1997)
Super elastic NiTi wire (1992)	First Class Appliance For Molar Distalization (1999)
Distalization using Microimplants. (1999)	C-Space Regainer
BAPA (Bone Anchorage Pendulum Appliance) (2006)	

4.2 Transpalatal arch

It was presented by Massimiliano Maudrino [6] in 2001. This is an alteration of Cetlin's technique. It lessens treatment time and improves the effectiveness of unilateral upper molar distalization [6].032" TMA bar is used to make TPA. TMA is more elastic and resilient than SS and is used to make conventional Goshgarian arch. The heading of addition of Transpalatal arch into tubes is likewise unique. The arch is embedded from distal into the tube of maxillary. As an anchorage molar is utilized, and distalization of molar is to be done. This makes the TMA arch progressively viable due to the end inserted more posteriorly from the distal side than the end inserted from the mesial side. When it is activated, mesiobuccal rotation is applied to the arch to anchor molar and force is directed distally to the opposite molar. The Transpalatal arch can be developed by a research facility or in the workplace utilizing a weingart or comparative plier.

4.3 Pendulum appliance

Dr. Hilgers [7] in 1992, introduced the pendulum appliance for distal movement of molar It comprises of extensive nance acrylic button in palate for anchorage and 0.032''TMA springs that give continuous force to upper 1st molars for their distal movement without any effect on nance palatal button. Acrylic button covers midpoint of palate and connected to maxillary 1st and 2nd bicuspids through occlusal rests. The two posteriorly coordinating TMA springs are additionally appended to it [7].

Force magnitude and activation - Force of 200 to 250g is produced in a swinging arc segment like pendulum from midline, so it is named pendulum appliance. As per Hilger the pre-activation of appliance is finished by bending springs to 90 degree and around 30 degree is lost amid insertion of appliance results in 60° activation for molar distalization. Normally activation of appliance again isn't required and distal movement of molar by 5mm in 3 to 4 months. Loss of anchorage is least that is 1.5mm in bicuspids area and 1-2 degree proclination of upper anteriors. There is no requirement of intermaxillary elastics for anchorage, so no impact on lower arch [7].

Modifications of pendulum appliance

- PENDEX appliance
- Modified pendulum appliance/M pendulum
- Modified pendulum with removable arms
- Modified pendulum for anterior anchorage control
- T- REX appliance
- Franzulum appliance
- Hilger PhD appliance
- Mini distalizing appliance (MDA)
- Pendulum K appliance
- Bone anchored pendulum appliance (BAPA)
- Pendulum appliance with maxillary molar root uprighting bends

4.4 K loop

Varun Kalra [8] introduced the K-Loop molar distalizer in 1995. The appliance comprises of a K-loop to give the forces and moments. The K-loop is made of.017" X.025" TMA wire. It can be activated twice as much as SS before it undergoes to deformation. The loop of the 'K' should be 8 mm long and 1.5 mm wide. The legs of the 'K' are to be bent down 20° and inserted into the molar tube and the premolar bracket. The wires are marked at the mesial of the molar tube and the distal of the premolar bracket. Stops are bent into the wire 1 mm distal to the distal mark and 1 mm mesial to the mesial mark. The legs of the 'K' are to be bent down 20° ambedded into the molar tube & the premolar bracket. The wires are set apart at the mesial of the molar tube and the distal of the premolar bracket. Stops are bent into the wire 1 mm distal to the distal mark and 1mm mesial to the mesial mark. Each stop is well defined and is about 1.5mm long. These bends help to keep the appliances away from the mucobuccal fold, allowing a 2 mm activation of the loop [8].

The bends in the appliance produce moments that check the tipping moments made by the force, and these moments are strengthened by the moment of activation of the loop is squeezed into place. Thus, the molar experiences a translatory movement instead of tipping. Root movements are said to proceed even after the forces disseminate. For movement of molar, the reactivation is 2 mm after 6 to 8 weeks. The premolars move forward by 1 mm during 4 mm of distalized molar (the anchorage loss). To prevent anchorage loss a head gear (straight pull or high pull) with forces of 150 g to the premolars can be used [8].

Advantages

- They are simple yet efficient
- They control the moment to force ratio to produce bodily movement, create bodily movement, controlled or uncontrolled tipping as desired.
- They are easy to fabricate and place
- They are hygienic and comfortable for the patient
- They require minimal collaboration from the patient
- They are cheap.

4.5 Distal jet for upper molar

It was developed Carano and Testa [9] in 1996. This was created to defeat the side effects of other appliance.

4.6 Appliance design

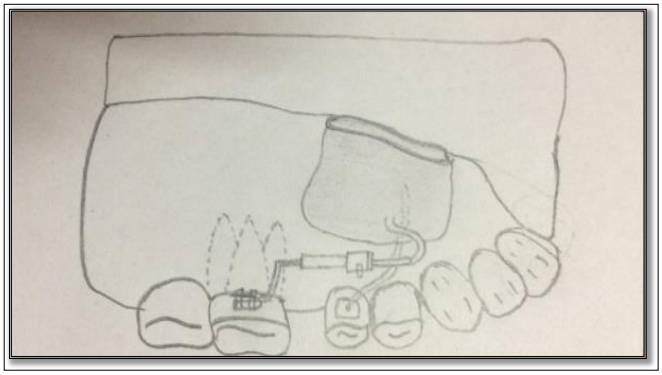

Fig 1: Distal jet appliance design, wire from nance button passes through tube & ends in bayonet bend in lingual molar sheath

Bilateral tubes of .036" internal diameter are appended to an acrylic nance button. A coil spring and a screw clamp are slide over each tube (Fig-1). (NiTi coil springs of 150g for children and 250g for adult, appliance can be made of SS spring) [9].

4.7 Modification of distal jet

1. Double set screw distal jet - This modification grants easier, cleanser and more reliable transformation to a molar nance holding arch, by incorporating two set of screws. A tiny wrench is used to activate distal jet appliance which makes it difficult to handle and aspiration is a concern. An autoclavable Hex key handle, borrowed from hobby industry, makes the key easier to

use.

2. Modified mandibular distal jet- It was designed to upright mesially tipped 1st molars, when the original design is applied to mandibular 2nd molars. The distal bayonet bends often impinges on soft tissue in buccal vestibule, altering the appliance.

4.8 Bone anchored pendulum appliance (BAPA)

It is an intra-oral molar distalization technique for non-extraction treatment that was introduced by Kircelli and Pekta [10] in 2005 to bring about an effective and compliance- free molar distalization without anchorage loss [10].

BAPA indicated for Class II with moderate space inadequacy in maxillary dental arch and minimal or no crowding in dental arch. The appliance comprises of a pendulum appliance that connects acrylic plate to the titanium intraosseous screw (2.0 mm diameter × 8 mm length) which is acts as bone anchor. 0.032- inch TMA springs insert into lingual sheaths on the 1st molar bands [10].

Construction

A titanium intraosseous screw (2.0 mm diameter × 8 mm length is surgically embedded in the anterior paramedian region of the median palatal suture, 7–8 mm posterior to the incisive foramen and 3–4 mm lateral to the median line. After soft tissue healing, impressions and stone casts ware obtained with the IMF screws in place. On the stone model, the screw head is blocked out with wax, and the appliance is constructed according to Hilgers descriptions. The auxiliary wires that extend to the 1st and 2nd premolars are excluded. The adaptation of appliance is checked clinically & the springs are activated. The acrylic plate is connected to the screw head by using cold-cure acrylic resin. Finally activated 0.032-inch titanium molybdenum alloy (TMA) springs are embedded into the lingual sheaths on the 1st molar bands [10].

Advantages

- There is simultaneous distalization of bicuspids with molars. Besides the space gained in the posterior portion, a amount of space was also gained in anterior segment. Hence, spontaneous arrangement of anterior crowding is accomplised amid of molar distalization. So, there is no need for retraction the anterior teeth
- The total treatment time is less.
- There is no anchorage loss.
- The technique is minimally invasive and no patient cooperation is required.

Disadvantages

- Tipping occurs along with distalization of molars.
- Soreness of palatal mucosa may occur.
- Plaque accumulates below the acrylic plate.
- There is difficulty in separating in removal of the appliance [10].

4.9 Franzulum appliance

In the mandible gaining space is difficult than in the upper arch. Extraoral appliances are attached to the mandibular molars because they place the pressure on condyle. The Franzulum appliance was presented by Friedrich Byloff [11] in 2000.

The posterior unit uses NiTi coil springs, about 18mm in length, which apply an initial force of 100-120g/side. A ‘J’ shaped wire going through each coil is embedded into the tube of the anchorage unit. The recurved posterior part of the wire is engaged in the lingual sheath of lower 1st molar band. The anchorage unit is bonded to the cuspid and 1st premolar. The J shaped distalizing unit is then ligated to the lingual sheaths of the molar bands, pressing the coil springs. In this way the active part runs lingually at a level close to CR of the molar, to give a bodily movement [11].

4.10 Distalization using microimplants

The concept was first presented by Mannchen [12] in 1999. Traditional method of controlling anchorage during molar distalization tends to cause unwanted tooth movement of other teeth and require patient cooperation. These disadvantages can be overcome with skeletal anchorage. The midpalatal consists of cortical bone that is sufficient to support a miniscrew. Most of the soft tissue is thinner than 1 mm ensuring accurate placement of miniscrew and can be easily removed [12].

Procedure

A contra angled hand piece is required and it must be longer than the depth palate to maintain the strategic distance from contact with the upper front teeth. Because the cortical bone can be damaged easily by frictional heat. From the screw to the transpalatal arch hook, a power chain is attached, for distalization [12].

4.11 First class appliance (FCA)

This appliance was introduced by Dr. Fortini, Lupoli, & Parri [13] in 1999. Since the distal jet appliance produced anchorage loss when molars were distalized, first class appliance was introduced to overcome this problem. It tends to be utilized for distalization with minimal anchorage [13].

Appliance design

Bands are placed on the upper 1st molar and on either upper 2nd premolar or 2nd deciduous molars. Impression is taken with these bands in place and a working cast is poured. The laboratory procedure is carried out as follows.

Vestibular components

Formative screws are soldered on the buccal sides of the 1st molar bands occlusal to 022” x 028” single tube so they will not interfere with subsequent insertion of the arch wire. Split rings welded to the second premolar or second deciduous molars bands, control the vestibular screws. Stop screws are used to maintain the distal positions of the molars after active movement has been completed [13].

Palatal components

In the palatal aspect, the appliance is much like a modified Nance button, but is wider and has a butterfly shape for added stability and support during retention. The butterfly part is welded to the 2nd premolar or deciduous molar bands. The embedded .045" wires should be in single sections, without welded joints, to prevent breakage. Sections of .045" tube are welded to the palatal sides of the 1st molar bands for insertion of the butterfly component of the appliance. These tubes permits the distalization of molar without undesirable tipping. NiTi .010" ×.045" coil springs, approx 10mm each long, are completely compressed between the premolars solder joints and the tubes on the deciduous molar or 2nd bicuspid bands. These springs are made to balance the action of the vestibular screws, preventing rotations of molar and development of posterior crossbites. Bodily distalization of 1st molars on both sides occurs at end of activation [13].

4.12 Jones jig

Jones and White [14] introduced the jones jig in 1992. The appliance design comprises of open coil NiTi spring. The NiTi coil spring slides over a.036 main frame, which has embellishments for the connection to the headgear tube and the arch wire slot in the triple tube of the maxillary molar [14].

The Jones Jig assembly consists of a mainframe of two prescriptions (0.018 & 0.22 inches respectively), which can be molded in the anterior 1/3rd. It also consists a hook which is attached to the hook of the molar tube. The force is produced by a NiTi coil spring, which acts along the centralized wire, when activated using a ligature. A 0.014 inch wire is commonly used to fasten the eyelet tube to the premolar bracket, which compresses the NiTi coil springs. The outrageous mesial end of the completed assembly should rest no further than the distal 1/3rd of the bicuspid. It takes very less chair time to reactivate [14].

Treatment time

In Pseudo class II, where it is the rotated class I which needs to be adjusted, the treatment time is 90-120 days. In true class II molar relationships, the corrected class I can be achieved in 120-180 days. However the duration is slightly increased in brachyfacial patterns.

Drawback

Since, force application is coronal to the CR of root, distal tipping of molars and mesial tipping of premolars always occur. The utilization of the nance appliance causes tissue impingement. Laboratory expense. More appointment needed to fit the appliance. Coils demand extra diligence in cleaning [14].

5. Conclusions

Distalizing teeth has always been a challenge to orthodontist of which molar distalization is the most difficult. Class II molar relationship can be corrected by several methods. One possibility apart from extraction is by distalizing to create space in the lateral segments for retraction of cuspid and anterior teeth. This type of mechanotherapy is typically used in patient with maxillary skeletal and dentoalveolar protrusion.

Many appliances have been proposed for distalizing such as removable and fixed appliances. Although there are many advantages and disadvantages for both methods, the main drawback of extraoral approach is the patient compliance. To fight a borderline case distalization procedure is an important weapon in the orthodontist armamentarium. Right appliance should be selected for the right patient and one should not select the patient for the appliance, rather the appliance should be selected for the patient.

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