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REVIEW ARTICLE

MOLAR DISTALIZATION: A REVIEW

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ABSTRACT

Aim of distalization is to move molars distally so as to gain space. This procedure has gained popularity due to the fact that by distalization of maxillary molars, many Class II molar cases can be treated without extraction. Traditional upper molar distalization techniques require patient co-operation with the headgear or elastics. Recently, several different intraoral procedures have been introduced to minimize the need for patient co-operation. This article reviews and describes the various methods of molar distalization.

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INTRODUCTION

Molar distalization is one of the space gaining method in orthodontic treatment. This procedure has gained popularity due to the fact that by distalization of maxillary molars, many Class II molar cases can be treated without extraction. Management of borderline cases has always surmounted controversies. An estimated 25-30% of all orthodontic patients can be benefited from maxillary expansion, and 95% of class II cases can be improved by molar rotation, distalization & expansion (Corbet, 1997). The emergence of various modalities of molar distalization has given new meaning to the non-extraction treatment. These appliances have increased our treatment options and have evolved considerably over the past few years. The correction of Class II malocclusions has been hampered by the use of appliances which require the patient to co-operate with headgear, elastics, or the wearing of a removable appliance (Bolya *et al*., 2015)
The distal movement of the maxillary molars for the correction of a Class II malocclusion without extractions; to establish a class I molar relationship, requires maxillary molar distalization by means of intraoral or extra-oral forces (Bondemark and Karlson, 2005).

Indications for molar distalization

Profile

- Straight profile

Functional

- Normal, healthy temperomandibular Joint
- Correct mandible to maxillary relationship

Skeletal

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

Dental

- Class II molar relationship
- Deep overbite
- Permanent dentition
- Maxillary first molar mesially inclined.
- Preferably prior to eruption of second molar.
- Maxillary cuspids labially displaced.
- Loss of arch length due to premature loss of second deciduous molar.

Contraindications for molar distalization

- An end on or full Class-II molar relationship due to mandibular retrognathism.
- Retrognathic profile (Class-II skeletal with orthognathic maxilla and retrognathic mandible).
- Skeletal and dental openbite

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- Excessive lower anterior facial height (Dolicofacial form)
- Constricted maxilla
- Patients with Class-II or Class-III molar relation.

Appliance traditionally used to distalize molar can be divide into two categories

- Extra-oral
- Intra-oral

Extra-oral appliance

Typing extra-oral appliance include face-bows that attach to tubes on the upper first molar and headgears that attach directly to the arch wires or to auxiliaries connected to the arch wires. Headgears of various types are available.

To cause bilateral molar distalization

- High pull headgear,
- Straight pull headgear,
- Cervical or low pull headgear.

To cause unilateral molar distalization

- Power arm face-bow,
- Swivel- offset face bow,
- Soldered offset face bow,
- Spring attached face bow.

Intra-oral appliances

Vast number of intra-oral appliances also has been advocated for the purpose of molar distalization.

- Atkinson Buccal Bar
- Eureka
- Franzulum appliance
- Jasper Jumper
- Churro Jumper
- Pendulum appliance and its modification
- K loop molar Distalizer
- C space regainers
- Distal jet
- Fixed Piston.
- NiTi double loop system
- Jones jig
- Lip Bumper
- Molar Distalizing Magnets
- ACCO Appliance
- Transpalatal arch
- Herbst appliance
- Klapper super spring
- Molar Thruster appliance

Extraoral method

Headgears

Norman William Kingsley in 1892 described for the first time a headgear apparatus with which a Class I relationship of the molars could be achieved. Headgear receives anchorage from cervical, cranial or combination of both regions to move maxillary molars distally. Based on direction of pull with respect to occlusal plane headgear has three types (Figure 1).

- Cervical or low pull,
- Occipital or high pull
- Combination pull

Based on the means of attachment to teeth

- Facebow Headgear
- J hook headgear

Patient cooperation is mainly required for successful molar distalization with extraoral method.

Intraoral method

Various intraoral appliances have been introduced since 1980's and has nearly eliminated the need of patient cooperation except where Class II elastics are needed. Let us now evaluate in detail one by one the various intraoral distal molar movement techniques, which have recently assumed an important role in clinical orthodontics.

Atkinson Buccal Bar

In 1959, James J. Guerrero (Guerrero, 1959) said that the ideal appliance for moving molars posteriorly is the Atkinson buccal bar. It is used with the minimum amount of Class II elastic force of two ounces. This appliance will move the buccal segment posteriorly, whether second molars are present or not.

Eureka Spring

Devincenzo (1997) described the Eureka spring (figure 2), which is a fixed intermaxillary force delivery system. The main component of the spring is an open wound coil spring encased in a telescoping plunger assembly. The spring rests in the buccal sulcus and attach posteriorly to headgear tubes on the upper first molars, and anteriorly to the lower arch wire distal to the cuspids.

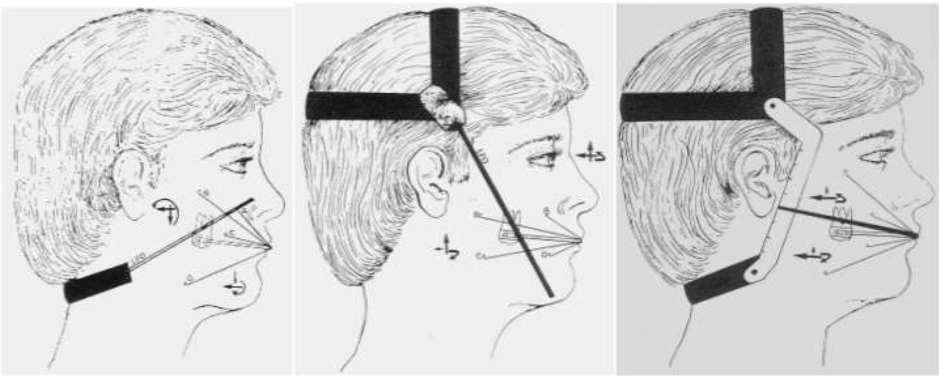
A triple telescoping action allows opening of the mouth to 60mm before disengaging. The mechanics of the appliance has the opposite effect to that of class II elastics in that it acts to intrude both the lower incisors and the upper molars. The effects of this appliance are entirely dento-alveolar and no orthopedic or bite-jumping effects are claimed by the clinicians who have developed the appliance. The dento-alveolar effects achievable with this appliance include maxillary molar distalization or advancement of lower anterior teeth in class II cases.

Franzulum appliance

Byloff, Darendeliler and Stoff (2000) introduced *Franzulum appliance* (figure3), that can distalize mandibular molars and increase arch length. It has an acrylic button as anterior anchorage unit, positioned lingually and inferiorly to the mandibular anterior teeth, and extending from mandibular canine to canine. The acrylic is atleast 5 mm wide to allow for larger dissipation of reactive forces produced by the distalizing unit. The posterior distalizing unit uses nickel titanium coil springs, about 18 mm in length, which apply an initial force of 100-120 gm per side.

Table 1. Classification of molar distalization

CLASSIFICATION OF MOLAR DISTALIZATION:			
1.	Location of appliance	Extra-oral	Headgear, facemask
		Intra-oral	Pendulum, Jasper Jumper, Churro Jumper
2.	Position of appliance in mouth	Buccal	Jasper Jumper, Churro Jumper
		Palatal	Pendulum, ACCOAppliance
3	Type of tooth movement	Bodily	M-Pendulum, Headgear, K-loop,Fixed Piston Appliance
		Tipping	Pendulum, Lip Bumper
4	Compliance needed from patient	Maximum	Headgear, ACCOAppliance
		Minimum or no Complaince	Pendulum, Jasper Jumper, Herbst appliance
5	Type of appliance	Removable	ACCOAppliance, Molar Distalizing bow
		Fixed	Pendulum, Jasper Jumper
6	Arches involved	Intra-arch	Pendulum, Franzulum appliance
		Inter-arch	Eureka Spring, Jasper Jumper
7	Appliances used:	Maxilla	Pendulum, Jones Jig
		Mandibulur	Franzulum appliance



(a) (b) (c)

Figure 1. Shows types of headgears used for molar distalization

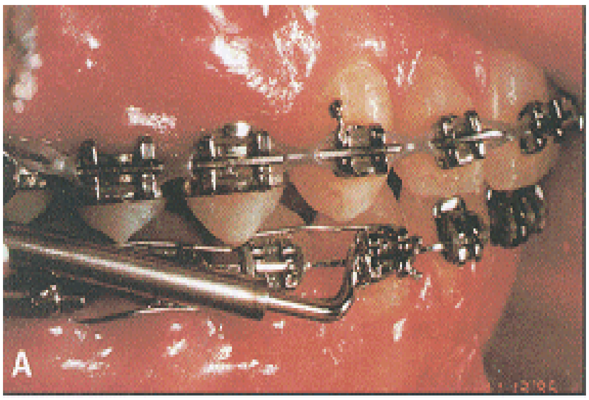


Figure 2. Eureka spring

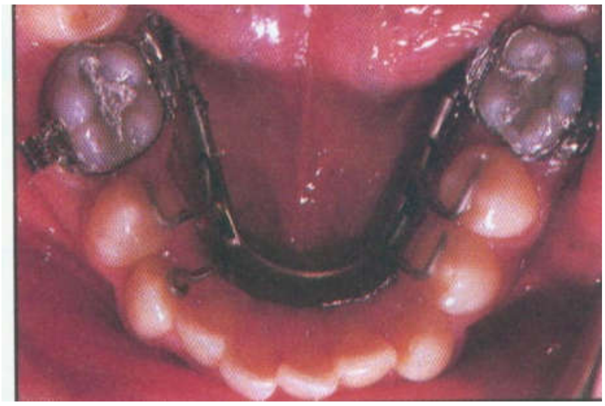


Figure 3. Franzulum appliance

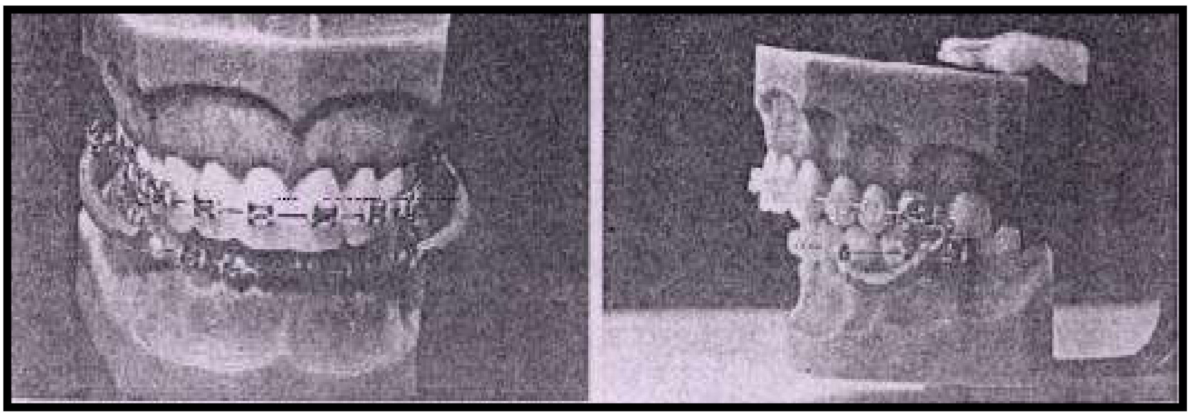


Figure 4. Jasper Jumper

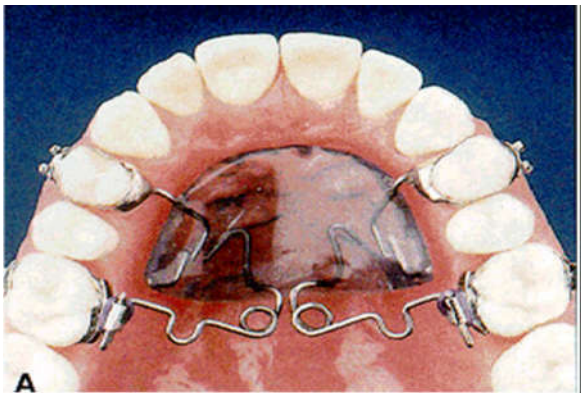


Figure 5. Pendulum appliance

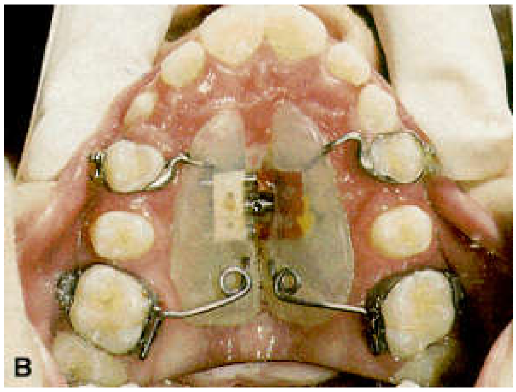


Figure 6. Pend-X Appliance

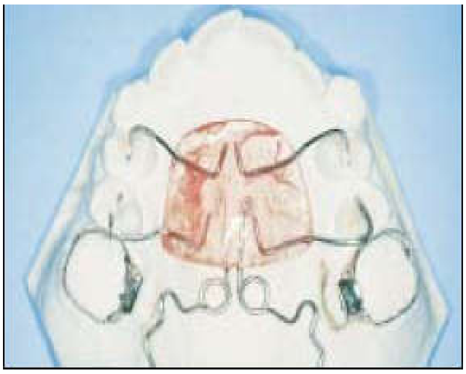


Figure 7. M- Pendulum

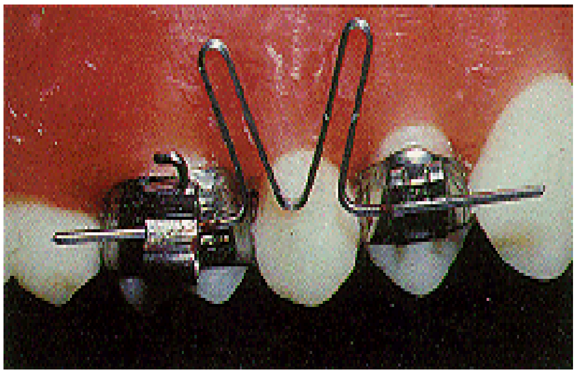


Figure 8. The K-loop molar distalizer

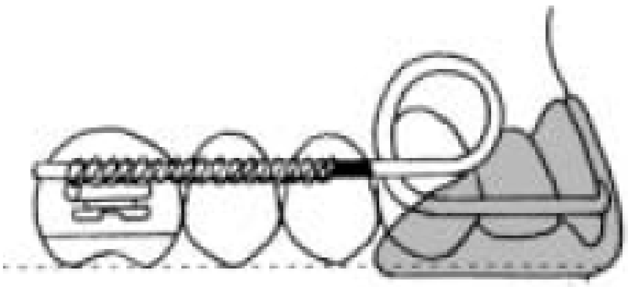


Figure 9. C-space regainer

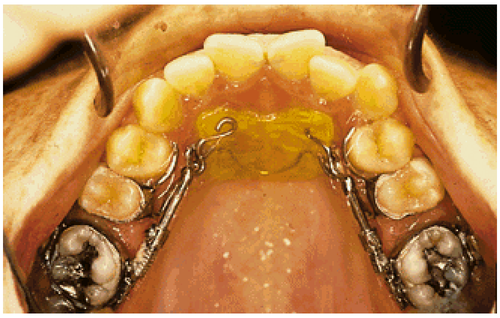


Figure 10. The Distal Jet appliance

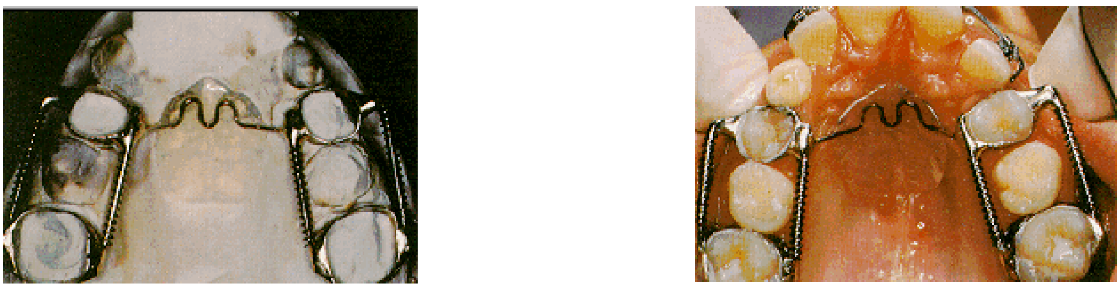


Figure 11. The Fixed Piston Appliance

Jasper Jumper (Jasper and McNamara, 1995): Jasper J.J. and McNamara James A. in 1995 described a modification of Herbst bite jumping mechanism known as *Jasper Jumper* (figure 4.) that can be attached to fixed appliances. This interarch flexible force module allows the patient greater freedom of mandibular movement than is possible with original bite jumping mechanism of Herbst.The system is composed of two parts, the force module and anchor units. The Force module is a stainless steel coil or spring surrounded by opaque polyurethane covering that is attached at both ends to stainless steel endcaps.

When the teeth come into occlusion, the spring of the force module gets curved axially, producing a range of forces from 1 to 16 ounces. This kinetic energy then is captured when the force module is curved, and the force is converted to potential energy to be used for a variety of clinical effects. In case of molar distalization, a transpalatal arch is not to be placed and the maxillary arch wire should not be tied or cinched back. The Jumper in such instances is made to produce 2 to 4 ounces of force. The module thus placed produces headgear effect and brings about distalization of upper posterior segments.

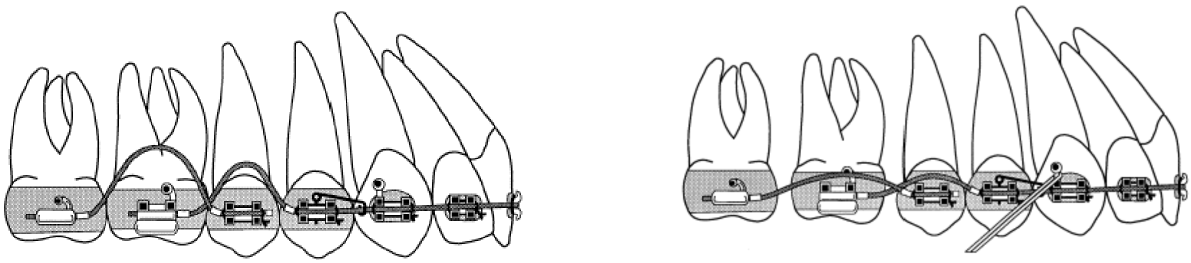


Figure 12. Nickel titanium Double Loop System

Figure 12. Jones Jig

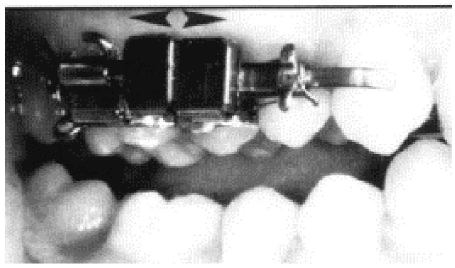


Figure 12. Molar distalizing magnets

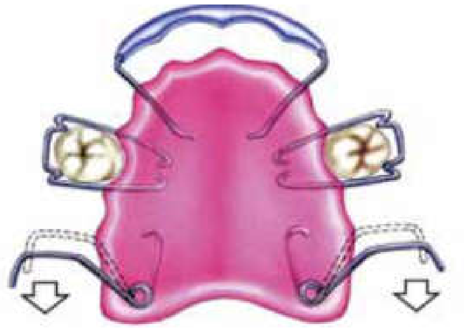


Figure 13. Acrylic Cervical Occipital (ACCO) appliance

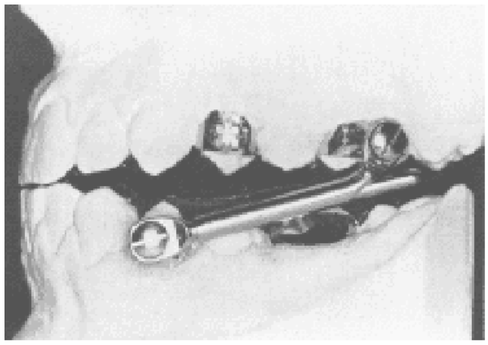


Figure 14. Herbst Appliance

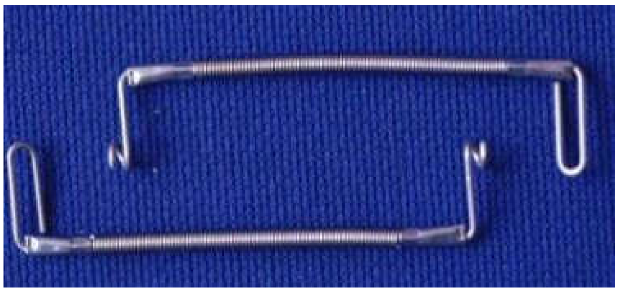


Figure 15. Klapper Superspring

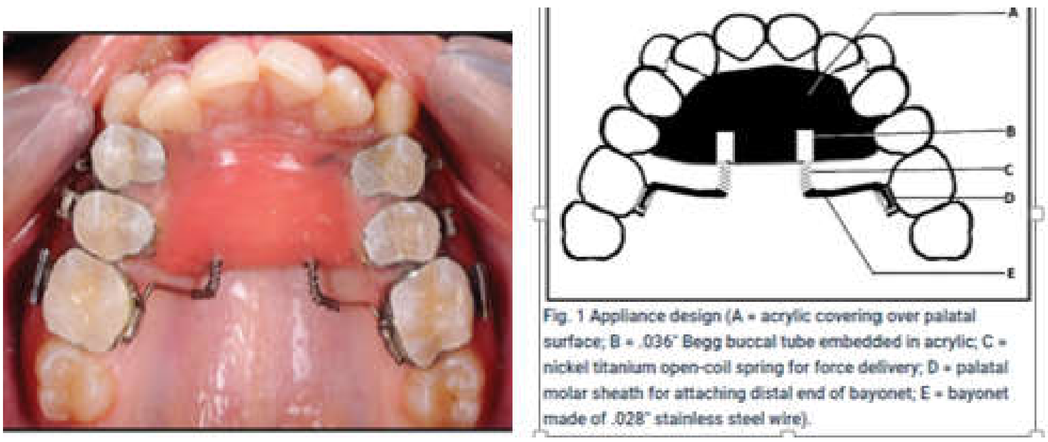


Figure 16. Molar Thruster appliance

The force applied by *Jasper Jumper* is more easily controlled by the clinician, greater flexibility increases patient comfort, allows more lateral movement possible than with Herbst appliance.

Churro Jumper (Castañon *et al*., 1998)

The Churro Jumper developed by Dr. Castanon, Valdes and White (1998) furnishes orthodontists with an effective and inexpensive alternative force system for the antero-posterior correction of Class II and Class III malocclusions. The appliance functions more like Jasper Jumper.

Pendulum appliance (Hilgers, 1992)

The *Pendulum appliance* (figure 5) was first described by *Hilgers* in 1992. This intraoral appliance seems to satisfy most of the requirements of an ideal molar distalization appliance. The appliance derives its name from its broad, swinging arc motion (like Pendulum motion) of the force from the midline of the palate to the upper molars. It is a hybrid appliance that uses a large Nance acrylic button in the palate for anchorage, along with 0.032" TMA spring that deliver a light, continuous force to the upper 1st molars without affecting palatal button. In cases requiring simultaneous expansion of the upper arch, a midpalatal jack screw can be incorporated into the centre of Nance button. This version of the appliance is called as ***"Pend-X"*** (figure 6).

M-Pendulum (Scuzzo, 1999)

M- Pendulum (figure 7) is the modification of the *Pendulum appliance,* the horizontal loops are inverted to allow bodily distalization of molars. The preactivation given prior to intraoral placement is also 40 to 45 degree rather than 60 degree as in conventional or *Hilger's Pendulum appliance.* By using the *Pendulum appliance,* the maxillary first molars move distally at a monthly rate of 1.02mm (± 0.68 mm) using an initial force of 200 to 250 grams in a mean period of 4 months with a mean anterior movement of incisors of only 0.74 mm. (Echarri, 2003). The *Pendulum appliance* causes insignificant skeletal effects with only significant effect being increase in lower facial height by 2.79mm (Ghosh and Nanda, 1996; Asensi, 2001).

K-loop molar distalizer

The appliance was designed by Dr. Varun Kalra (1995) to achieve bodily movement or controlled or uncontrolled tipping of molars as required by the case. An efficient, yet simple appliance causes first molar distalization without much loss of anchorage even after the eruption of second molars. The appliance consists of an active part, the *K-loop* (figure 8)to provide force and moments and an anchorage unit, a Nance button.The *K-loop* is made of 0.017 X 0.025 inch CNA (TMA) wire. Each loop of 'K'should be 8mm long and 1.5mm wide.The legs of *'K'* are bent down 20 degrees and inserted into the molar tube and premolar bracket.

C-space Regainer (Chung *et al*., 2000)

To overcome the drawback of incisor flaring caused by equal and opposite mesial force exerted by various intraoral methods of molar distalization, a removable appliance *"C-space regainer"* (Figure 9). Was introduced by Chung, Park and Ko (2000) of Korea. It consists of labial framework and an acrylic splint. The labial framework is formed from 0.036 inch stainless steel wire which extends from buccal molar tubes of one side to another. It incorporates a closed helix in each canine region and a 0.010 inch x 0.040 inch open coil spring soldered immediately distal to the helix. The length of the coil spring should be about 130% of the length between the soldered point and mesial edge of headgear tube on the first molars.

Figure 9: C-space regainer

Distal Jet

The *Distal Jet* is a fixed lingual appliance that can produce unilateral or bilateral molar distalization typically in 4 to 9 months without relying on patient compliance. The *Distal Jet*[16]was introduced by Carano Aldo and Testa Mauro (1996) of Italy. The appliance permits simultaneous use of full bonded appliances, thus avoiding the need for two phases of treatment. The *Distal Jet* appliance (Figure 10) consists of a wire emerging from acrylic Nance button and passes through tube of 0.036 inch internal diameter. In addition, a coil spring (NiTi or stainless steel) and a screw clamp are slid over each tube. The wire extending from the acrylic through the tube ends distally in a bayonet bend that is placed in the lingual sheath of the first molar band. Another wire extends from acrylic button and is soldered onto the palatal aspect of second premolar band. The *Distal Jet* can be reactivated on monthly basis by sliding the screw clamp closer to the first molar. After the desired amount of distalization, the anchor wire soldered to premolar band is simply cut or light cured or cold cure acrylic added over the spring assembly. Only Class II elastics use is recommended during the second phase of treatment to avoid mesial relapse of the molars.

Fixed Piston Appliance (Greenfield, 1995)

The *Fixed Piston Appliance* introduced by Greenfield (1995) claims to produce bodily distal movement of maxillary first molars without need of extraoral appliance and with no loss of anterior anchorage.The *Fixed Piston Appliance* (figure 11)consists of bands adapted on maxillary first molars and maxillary first pre-molars. A 0.036 inch tube is soldered on occlusal third of first premolar band both buccally and lingually and extends to a length just mesial of maxillary first molars. A soldered 0.030-inch stainless steel wire extends from buccal and lingual surfaces of the first molars and is encassed in the tubing. Over the tubing a 0.055 inch nickel titanium open coil springs are placed over the entire length. After cementation, 2mm split rings are added on the mesial of tubes and slipped distally regularly to provide a total of about 50gms of force. The anchorage is formed by a Nance palatal button which is attached to first premolar bands by a 0.040 inch stainless steel wire extending from the acrylic button and soldered to gingival third on palatal surface of premolar bands.

Nickel titanium Double Loop System (Giancotti, 1998)

In an effort to overcome the difficulty in first molar distalization using nickel titanium wires after complete eruption of permanent second molar, *Giancotti and Cozza* in 1998 introduced *Double Loop System* (figure 12) which utilizes super elastic nickel titanium wire with shape memory for simultaneous distalization of first and second molars.

Jones Jig / Open Coil Jig / Sectional Jig

Jones Jig (figure 12) was introduced in 1992 by *Jones and White* (Hilgers, 1992). The appliance is capable of producing maxillary molar distalization with second molars erupted or unerupted, in the mixed or permanent dentition, and in growing or non-growing individuals. It consists of a heavy round wire and a light wire projecting through the molar tube. Both the wires are soldered to a fixed attachment sheath and hook posteriorly. Anteriorly, a sliding sheath is placed. Between the two sheaths an open coil nickel titanium spring is placed to deliver 70-75 gms of force, over a compression range of 1-5 mm, to the molars.The appliance requires a modified Nance button which is half an inch in diameter and is attached to anchor teeth by 0.036 inch stainless steel wire soldered to the bands. Gulati, Kharbanda and Prakash (1998) in their study reported a mean distal movement of 2.78 mm in a treatment period of 12 weeks using 150 gms of force. Jones Jig assembly therefore seems more appropriate for distalization in those cases in which no orthopedic effect is desired on the maxilla as in skeletal Class I or border line Class II case with a normal mandibular plane angle.

Lip Bumper

The *Lip Bumpers* have been used for gaining space in both maxillary and mandibular arches. The *Lip Bumpers* change the oral environment by holding the lips and cheeks away from the dental arches, thus altering the equilibrium between the forces from the circumoral muscles acting on the teeth. The *Lip Bumper* is a myofunctional appliance, constructed from 0.045 inch spring temper stainless steel wire. U-shaped loops are incorporated which serve as adjustment areas and stops mesial to the molar tubes. Anteriorly the shield made from acrylic in the labial fold opposite, the anterior teeth should lie 2-3 mm away from the labial surfaces of these teeth. The use of *Lip Bumper* mainly produces increase in arch perimeter by widening of the dental arch in the canines and premolars and slight proclamation of incisors. Hassler and Ingervall (2000) evaluated the effect of use of a *Lip Bumper* appliance on maxilla. They reported widening of the dental arch across the premolars, a moderate increase in arch length due to proclamation of incisors, and moderate distal tipping of the first molars. They also found that the state of development and eruption of second molars did not influence the effect of *Lip Bumper* appliance on the first molars.

Molar distalizing magnets

Molar Distalization System employed two repelling magnets for each maxillary quadrant to move molars distally. (Gianelly *et al*., 1998; Itoh, 1991) Bondemark and Kurol (1992) (figure 13). Used similar appliance design while using samarium-cobalt-repelling magnets for simultaneous distalization of first and second molars. All the studies presented a distinct advantage of magnet appliance that no patient cooperation was necessary to obtain molar movement. Though the system requires frequent reactivation as magnetic force drops sharply as they move apart, but is well tolerated by all patients and consistently 80% of the space created was due to molar distalization and only 20% of space was attributed to anchor loss (Gianelly, 1989).

ACCO Appliance (Bernstein, 1969)

The acrylic cervical occipital appliance is a removable appliance used along with a headgear to effect enmass distalization of buccal segments. The appliance originally proposed by Dr. Hebert Margolis, can be used on maxillary as well as mandibular buccal segments. It was a modification of the Hawley retainer, with the addition of Class I finger springs mesial to the maxillary molars (Figure 13). This removable appliance exerts a continuous distalizing force on the molars, with the springs' reactiveforces dissipated through the acrylic button into thepalate and the maxillary teeth mesial to the molars.

The appliance has three parts

- A labial bow over the incisors, embedded in anacrylic wraparound plate with Adams clasps on thefirst premolars.
- Round (.028") or rectangular (.019" × .025") finger springs that are activated posteriorly to exert alight, constant force of no more than 100-125g.
- An anterior biteplane placed from canine tocanine to disocclude the buccal segments.

Herbst appliance (Pancherz, 1979)

The Herbst appliance (figure 14) is completely tooth-borne and uses both the maxillary and mandibular dentition to transfer the force exerted from the telescopic arms of the Herbst bite jumping mechanism to the bases of the maxilla and the mandible. The telescopic system produces a posterosuperiorly directed force on the maxillary posterior teeth and an anteriorly directed force on the mandibular dentition. As a result, Class II molar correction generally is a combination of skeletal and dentoalveolar changes irrespective of facial morphology. The distalizing effects are reported to range from an average of 1.8 mm to 2.8 mm. The intrusive effects are 1mm approximately. The amount of distal and vertical movement of maxillary molars is found to be independent of the presence of erupted 2nd molar.

Klapper superspring (Klapper, 1999): In 1997 Lewis Klapper introduced the *Klapper Superspring* for the correction of Class II malocclusions. It resembles a Jasper Jumper with the substitution of a cable for the coil spring. (figure 15) The Klapper Superspring creates a moment on the molar, which is expressed clinically as distal root tip, but extended wear of the appliance results in excessive distal root tipping. Because the Klapper Superspring inserts gingivally on the molar and cannot roll to the buccal as readily as a Jasper Jumper, there may be a greater vertical component to the force vector. If this were of clinical significance, a patient with a pronounced curve of Spee would level more quickly with the Klapper Superspring. However, extended wear should produce excessive intrusions and may require removal before sagittal corrections have been completed.

Molar Thruster appliance (Gandhi *et al*., 2017)

This appliance (figure 16) was developed by Gandhi *et al* in 2017 for molar distalization as part of a two-phase treatment sequence in Class II patients. The first premolars and first molars are banded; banding of the second premolars is recommended for better anchorage. Palatal sheaths are welded to the upper first-molar bands. The first and second premolars are attached with .040" wire to an acrylic covering that is in close contact with the palatal surface. If the overbite permits, this acrylic covering can be converted to an anterior biteplane to disclude the posterior teeth, thus enhancing molar distalization and deep-bite correction. Before polymerization, two .036" Begg buccal tubes are embedded in the acrylic near the distal margin, 5mm from the midline. Two bayonets are constructed from .028" stainless steel wire. One end of each bayonet is attached to the palatal molar sheath; the other is inserted into the Begg buccal tube along with a nickel titanium open-coil spring. When the bayonet is placed, the spring is compressed to push the molar distally. The appliance generates 150-200g of force, optimal for distalization of both the first and second molars. Reactivation can be accomplished by placing a new bayonet wire with a longer anterior arm and a longer nickel titanium spring.

Conclusion

The molar position and the relationship between opposing molars have been a key topic of the orthodontic literature. Of the various suggested modalities of Molar distalization, extraoral require patient compliance. So, various intraoral noncompliance appliances for maxillary molar distalization have been introduced and evaluated. But with those appliances two negative effects like in intermaxillary appliances have protrusive effects on mandibular teeth have been reported. It is important that molars are held back with some appliance on completion of distilization. The use of a Nance palatal arch or TPA has proven not to resist the anchorage loss during subsequent retraction od anterior segment, so to solve these problems of noncompliance appliances, intraoral distalizing mechanics combined with palatal implants have attracted attention.

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