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Pendulum Compendium

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Abstract: *Most frequently usednon-extraction treatment modality in Class II malocclusion is molar distalization to establish a Class I molar and canine relationships. There are various intraoral and extraoral techniques for distalization of molars. As extra oral technique require patient compliance, intraoral techniques are favoured. Pendulum is most commonly used intraoral appliance used for distalization of molar.Original pendulum has few limitations but different modifications of pendulum eliminate allshortcomings. Thus it can be best used to advantage for a particular clinical situation to achieve desirable results.*

Keywords: *Molar distalization, Pendulum appliance*

The wrangling issue faced practically every time the orthodontists do a treatment plan for the patient, “Do we need to extract teeth or can the necessary space be created without extractions?.”

Edward Angle[1], the "father of modern orthodontics," advised non extraction treatment plan to correct malocclusion whenever other treatment modalities are possible. Moyer advised distalization of molar to correct class 2 malocclusion which is due to aggrevation of dental symptoms. There are various intraoral and extraoral techniques for distalization of molars. As extra oral technique require patient compliance, intraoral techniques are favoured. Pendulum is most commonly used intraoral appliance used for distalization of molar[2-5].

PENDULUM APPLIANCE

Hilger developed pendulum appliance in 1992. It consist of wire component and acrylic component. Wire component consist of pendulum spring which is present at distal end of acrylic button and a retention wire which is present at anterior end. Pendulum spring is formed by 0.032-inch titanium, molybdenum alloy (TMA) and consist of small horizontal adjustment loop, a closed helix, a loop for retention in the acrylic button and recurved wire for insertion into molar tube. Retention wire present at anterior end of acrylic button extends occlusally to rests on either the deciduous molars or the first and second bicuspids. Or it can be soldered to band on 1st premolar or deciduous 1st molar to provide stable retention. The lingual sheaths on the upper molars should be .036" so that the .032" wire fits loosely[5,6,7].

PREACTIVATION AND PLACEMENT

Pendulum spring can be activated intraorally or can be preactivated and then placed in oral cavity. During preactivation of spring , the springs should be bent parallel to the midline of the palate (or perpendicular to the body of the appliance. Hilger advised to bend the spring to 90 degree as 30 degree is lost during insertion of appliance resulting in 60 degree activation for distalization of molars.

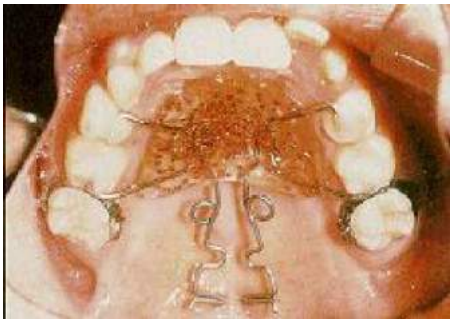


FIG. *Pendulum Appliance with preactivated spring*

First molar bands are cemented without the springs engaged, and the anterior portion of the appliance is then cemented in place. After cementation, each Pendulum spring is brought forward with finger pressure and the spring is seated in the lingual sheath. Molar moves on an arc toward the midline of the appliance. This tendency can be counteracted by opening the adjustment loop slightly to increase the expansion and molar rotation[6,8]. The force produced by spring is 200 to 250 g. Force is applied in a swinging arc movement, hence called as *pendulum.*[9]

REACTIVATION AND STABILIZATION

Reactivation is usually not needed. Patient should be seen after 3 weeks to check the force in the spring. During reactivation if needed the spring should be removed from the lingual sheath. The center of the helix is then held with a bird-beak plier and spring is

pushed distally toward the midline. Then the recurved portion is inserted into lingual sheath.

After movement of molars distally, they must be stabilized in their new positions to prevent their drifting back mesially[6, 10, 11]. .

BIOMECHANICS

Whenever orthodontic force is applied it leads to initial periodontal displacement of the tooth, alveolar deformation and compression of the periodontal ligament (PDL), followed by reactive remodelling of the PDL and bone by resorption and apposition(Luder, 1990)[12].

Regarding the force magnitude, optimal force should be applied which is equal to capillary blood pressure that is 0.2 to 0.3 N/cm^2 of root surface. Root surface area of maxillary molar of 1.20 cm^2. To provide translatory sagittal movement 1.5 – 2 N/cm^2 is required , as recommended by Ricketts *et al.* Once the Pendulum springs have been activated, their ends are inserted into palatal sheaths on the molar bands, then molars will move on Pendulum-like arc radii in the transverse and sagittal planes[13,14,15].

EFFECTS OF PENDULUM

The dentoalveolar treatment effects consist of increase in overjet and decrease in overbite due to slight mesial movement and flaring of the upper incisors as well as to a slight downward and backward relocation of the lower incisors and downward and backward rotation of mandible. And correction of the molar relationship toward a Class I relationship[20].

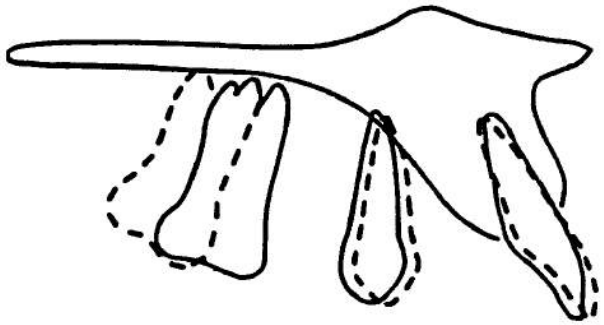


FIG. Treatment effects of the pendulum appliance

Effects on molar distalization, tipping and vertical Movement

Molar distalization varies from 2 to 6.4 mm[16,17], with the highest distalization noticed by Marure et al[18]. Along with distalization distal tipping of crown of molar is also seen from 8.36° to 14.50°. The amount of distal tipping per millimeter of distal molar movement in the pendulum appliance was 1.9°/mm. It is seen because appliance act on the dental crowns at a certain distance from the center of resistance of the molars[20].

This shows that purely distalization force application to the maxillary molars is not possible with Hilgers pendulum appliances[19].

Vertical movement of maxillary molar was minimal with intrusion varied from 0.10 to 1.68 mm[21].

Effects on the premolars and incisor/anchorage unit

Reciprocal force reacting to the distalization force will lead to anchorage loss in anterior and premolar region. Anchorage loss is more in anteriors compared to premolars[22]. Labial tipping of incisors occurred. The maxillary incisors had 3.4° of labial tipping and 1.11 mm of protrusion. There was also an increase of 1.56 mm in overjet as a direct effect of labial tipping of the maxillary incisors[9, 23,25]. Anchorage loss is more in subjects with erupted second molars[24]. The percentages of anchorage loss for the pendulum appliance have been reported to be 24% to 43%[23].

Skeletal effects.

The mandibular plane angle, lower anterior facial height increased leading to opening of occlusal plane. Mandible is rotated downward and backward.

MODIFICATIONS OF PENDULUM

1.PENDEX

Pendex appliance was given by Hilgers. He added palatal expansion screw in the midline of original pendulum appliances. It is used in patients with class 2 malocclusion with constricted maxilla[6].

2. MODIFIED PENDULUM

FIG. *Pendulum and modified pendulum*

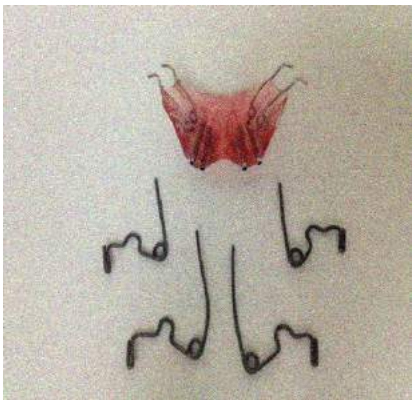
It was given by Dr. Scuzzo in 1999. He inverted the omega loop to produce buccal and distal uprighting of molar roots, for bodily movement. Loop can be activated by opening it, The Pendulum springs are activated to about 40-45° with a Weingart plier Before intraoral placement of the appliance, to produce 125g of force on each side.[26]

3. PENDULUM WITH UPRIGHTING BENDS

FIG schematic illustration of uprighting bend

An uprighting bend is incorporated into the distalizing spring during the second phase of treatment. It helps to avoid excessive distal tipping of the maxillary molars which was observed with conventional pendulum appliance. Side effect are more anchorage loss of the maxillary incisor edge and increased treatment time[27].

4.MODIFIED PENDULUM WITH REMOVABLE ARM



Precise activation of pendulum intraorally is difficult to perform. Scuzzo modified the pendulum in which springs of appliance can be removed for extra oral activation. Rest part of appliance remains fixed. The active components of pendulum appliance are inserted into acrylic sheaths of Nance palatal button and these can be easily removed from sheaths for activation. This modified pendulum produces controlled molar distalization[28]

5. FRANZULUM

Fig. Franzulum Appliance. B. Nickel titanium coil spring over J-shaped wire. C.insertion of Posterior distalizing unit into tube of anterior anchorage unit. D. Recurved portion of J-shaped wire tied into molar band sheath.

It is used to distalize the molars in mandibular arch. Anchorage unit consist of an acrylic button, which extends from the mandibular left canine to the mandibular right canine and positioned lingually and inferiorly to the mandibular anterior teeth. The active components are received by tubes between second premolars and first molars . Active component consist of nickel titanium coil springs of 18mm in length, which apply 100-120g of force per side. The recurved portion of the wire is engaged in the lingual sheath of the mandibular first molar band.[29]

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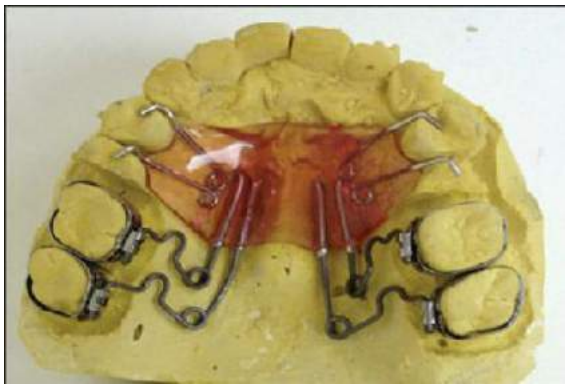
6. HILGERS Phd

Acrylic anchorage unit is replaced by an all-metal design. The advantage of this design is comfort and improved hygiene for the patient. Anchorage is formed by banded first premolars with stabilizing wires from the premolars to the molar bands. The pendulum springs soldered to the palatal side of the expansion screw housing. This configuration allows the clinician to remove the springs, either before palatal expansion is started or for adjustments/reactivation of the springs during the molar distalizing phase[10].

7. HILGER MDA

It is an all metal pendulum appliance and rapid palatal expander (RPE). It is used for both expansion and distalization. It consist of pre activated 0.032'' removable TMA springs and expansion screw. Advantages are more patient comfort, easy access for oral hygiene [30].

8. MODIFIED PENDULUM FOR ANTERIOR ANCHORAGE CONTROL



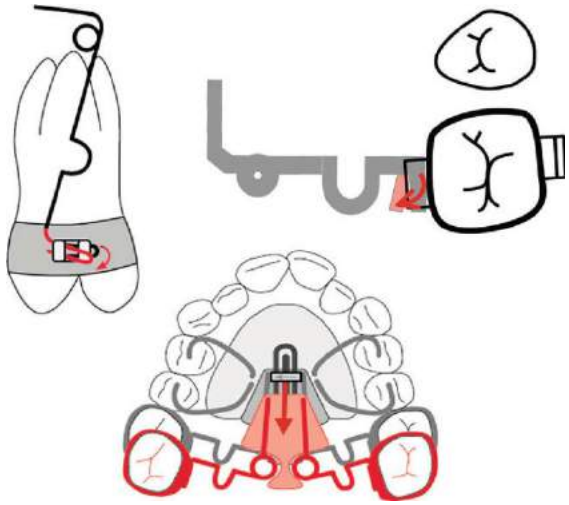
In cases of extreme overjet or where anchorage is critical, such as with reduced periodontal support or excessive lower facial height, modified pendulum is used. In this design four removable arms are present for both first and second molars and four stainless steel tubes are embedded in acrylic button for insertion of four removable arms[31].

9. BAPA

As anchorage loss is seen with conventional pendulum design, to prevent this a new system is used which take anchorage from bone[8].

Beyza et al[32] has designed BAPA which uses intraosseous miniscrew (2.0 mm diameter , 8 mm length) as anchorage unit. The screw was inserted 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. Predrilling with 1.3-mm-diameter drill was used for the primary stability of screw.

10. PENDULUM K



Schematic representation of the Pendulum K with distal screw, integrated uprighting activation, toe-in bend, and distal activation in the Pendulum spring region for bilateral molar distalization.

In this modification orthodontic screw is used which divides acrylic button into anterior and posterior part. Anterior component consist of retainer wire which are fixed to four anchorage teeth with composite. The posterior part consists of preactivated active pendulum springs. The appliance can be reactivated by turning the screw without removing the springs from

molar sheaths. This appliance produce translatory distalization of molars, prevents distal tipping and palatal movement. Uprighting activation in appliance produces uprighting moment on molar roots[33].

11. PENDULUM FOR UNILATERAL DISTALIZATION

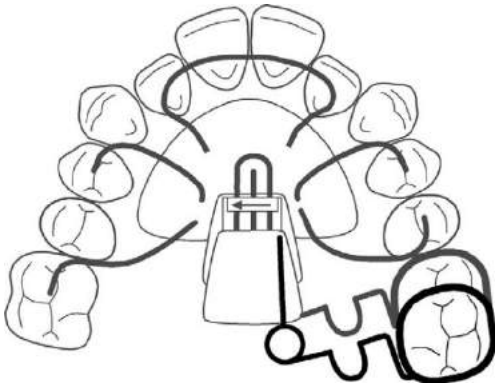


Fig *Modified pendulum appliance.*

Pendulum appliance is modified to produce unilateral distalization of molar. As anchorage loss is major drawback with conventional pendulum With unilateral distalization, anchorage loss can be reduced to 6.50%. This design consist of an acrylic Nance button with a distalization screw in the midline at the distal part of the acrylic portion. The pendulum spring consisted of a 0.032-in beta-titanium-alloy wire which is placed with a preactivated starting force of about 180 Cn[34].

12. T Rex

This modification produces both maxillary expansion and molar distalization. It consists of two wires extending from palatal acrylic and soldered to lingual surface of maxillary first molar bands. These wires give additional stability during expansion phase of treatment. After completion of expansion, these wires are removed and molar distalization is started[10].

CONCLUSION

Although many appliances are used for molar distalization. But pendulum is very efficient appliance. Original pendulum has few limitations but different modifications of pendulum eliminate all shortcomings. Thus it can be best used to advantage for a particular clinical situation to achieve desirable results.

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