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**Review Article**

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## Pendulum appliance and its modifications - A review

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### Abstract

Molar distalization is procedure used to move permanent molars distally in the arch. Distalization in maxillary arch is more common and easy than mandibular arch because maxillary bone has more trabecular bone where as mandible has more cortical bone. Both intra oral and extra oral appliances are used for distalization. Pendulum appliance is most popular appliance used for maxillary molar distalization.

**Keywords:** Distalization, anchorage, pendulum appliance.

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### Introduction

Edward angle set a non extraction approach for treating patients. According to him when teeth could be aligned by other methods, so extraction of teeth seemed inappropriate and unacceptable.<sup>1</sup> The question of extracting teeth or not always remain at the time of orthodontic treatment planning. In non- growing patients there is no

bone growth, so alternative approaches are needed to create space to move teeth for correction of malocclusion. Recent advancements in orthodontic mechanotherapy and changing concepts of treatment have decreased the need for extraction.<sup>2</sup> In approximately 25-30 % patients maxillary expansion is helpful and 95% of class II

patients can get better by using molar distalization, rotation and expansion.<sup>3</sup> Molar distalization with headgear and elastics needs patient co-operation. But nowadays various intraoral appliances are available for molar distalization minimizing patient compliance.<sup>4</sup>

### Indications of molar distalization

Molar distalization is not an option for all malocclusions. So appropriate case selection is needed. Molar distalization is recommended in following:

- Class II malocclusion or end on molar relationship.
- Well aligned arches with mild to moderate crowding.
- Long distal bases.
- Mesially positioned maxillary first molars due caries and early loss of deciduous second molars.

### Contraindications

- Skeletal or dental open bites.
- Increased mandibular plane angle.
- Increased lower facial height.
- Increased overjet with proclination of maxillary incisors.

### Pendulum appliance

Pendulum appliance for molar distalization was introduced by Dr. Hilgers<sup>5,6</sup> in 1992. It consists of large Nance acrylic button in palate for anchorage and 0.032'' titanium molybdenum alloy (TMA) springs that provide light and continuous force to maxillary first molars for their distalization without having any affect on Nance palatal button. Acrylic button covers midpoint of palate and connected to upper first and second premolars through occlusal rests. The two posteriorly directing TMA springs are also attached to it. (fig.1)



**Fig.1: Pendulum appliance**

Pendulum appliance produces force of 200 to 250 grams in a swinging arc like pendulum from midline, so it is named pendulum appliance. According to Hilger the preactivation of appliance is done by bending springs to 90 degree and approximately 30 degree is lost during insertion of appliance resulting in 60 degree activation for distalization of molars. Usually activation of appliance again is not needed and molars are moved distally by 5mm in 3 to 4 months. Anchorage loss is minimum that is 1.5 mm in premolar area and 1-2 degree proclination of maxillary anterios.<sup>7</sup>This appliance meets most of ideal requirements of an intraoral appliance such

as minimum anterior anchorage loss, need of minimum patient co-operation, bodily movement of molars in distal direction and less chair side time required for placement and reactivation. There is no need of intermaxillary elastics for anchorage, so no effect on mandibular arch.<sup>8,9</sup>

Although pendulum appliance has these benefits but still using pendulum appliance, there is distal tipping of molars and anterior anchorage loss occur. Joseph and Butchart observed 5.1 mm distal movement of molars with 15.7 degree distal tipping of first molar and 4.9 degree proclination of maxillary incisors.<sup>10</sup>

Bussick and McNamara reported that pendulum appliance is effective for molar distalization with minimum increase in lower facial height. It is most effective when used in patients having deciduous maxillary second molars for anchorage and unerupted permanent second molars.<sup>11</sup> Acar et al in their study compared combination of pendulum appliance and buccally placed K-loop with cervical headgear. They concluded that this combination prevents anterior anchorage loss and produces significantly less distal tipping of maxillary molars.<sup>12</sup> Thomali et al also reported that pendulum appliance with K-loop and implant supported pendulum, both significantly decrease anterior anchorage loss and distal tipping of maxillary molars.<sup>13</sup> Patil et al successfully treated class II malocclusion case in mixed dentition period with pendulum appliance. They obtained 4mm of space from molar distalization in 4

months.<sup>14</sup> Paranna et al also used pendulum appliance in a 10 year old patient to gain space for eruption of maxillary second premolar. Within 4 months they get sufficient space for second premolar, and suggested that pendulum appliance is an effective and reliable appliance for moving maxillary molars distally.<sup>15</sup>

### Modifications of pendulum

#### PENDEX appliance

It was also introduced by Dr. Hilgers. Its design is same as original pendulum appliance except for presence of a palatal expansion screw in the midline. (fig.2) It is used in class II malocclusion cases where transverse expansion is needed to correct constricted maxillary arch.<sup>6</sup>



**Fig.2: PENDEX appliance**

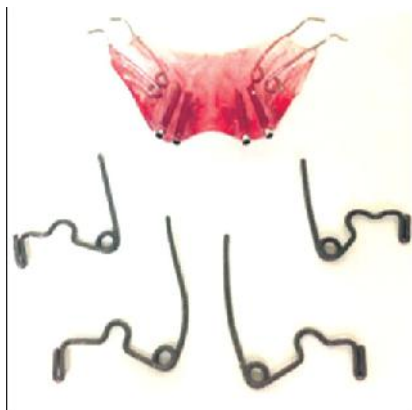
#### Modified pendulum appliance/ M pendulum

It was given by Dr. Scuzzo et al in 1999. In this pendulum appliance omega loops are inverted for bodily movement of maxillary molars. Loop can be activated by opening it and it results buccal and/ or distal uprighting of molar roots, thus producing bodily movement of maxillary molars.<sup>9</sup>

#### Modified pendulum with removable arms

Pendulum appliance is fixed compromising maintenance of oral hygiene. Precise activation of appliance cannot be done intraorally. Scuzzo gave

solution to these problems by introducing modified version of pendulum in which springs of appliance can be removed for extra oral activation. (fig.3) 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 molar distalization at a rate of 1.5mm per month and distalization of maxillary molars can be controlled more accurately as compared to opening of loops intraorally.<sup>16</sup>



**Fig.3: Removable springs of pendulum appliance**

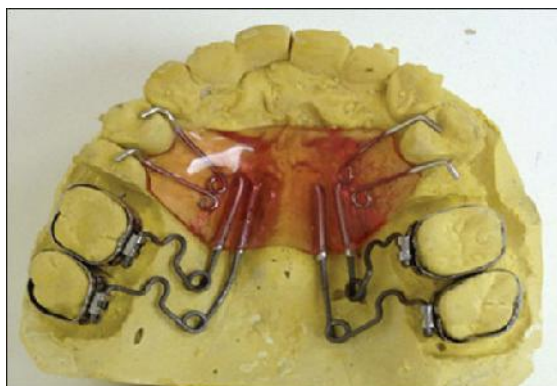
**Hegde et al** gave another modified design which makes insertion and removal of pendulum appliance easy for extra oral activation and cleaning of tissue surface under Nance palatal button. In this modified version round 0.036'' tubes are soldered lingually on first premolar bands for inserting retaining wires. The springs are inserted into lingual sheaths of first molar bands. Thus the appliance can be easily removed and placed again.

Advantages: It permits precise activation of springs extra orally. Maintenance of oral hygiene and cleaning of appliance becomes easy. Palatal

area under Nance palatal button can be cleaned after removing appliance where food is accumulated.<sup>17</sup>

#### **Modified pendulum for anterior anchorage control**

In cases where anterior anchorage is very critical, modified pendulum appliance 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.<sup>18</sup>(fig.4)



**Fig.4: Modified pendulum for anterior anchorage**

Alberto introduced another design of pendulum appliance in which Nance palatal button is retained in position by soldering to first premolar bands. A lingual 0.036''stainless steel wire soldered to first premolar bands and contoured to

the lingual surface of maxillary incisors. This modification minimizes debonding of appliance. It also reinforces anterior anchorage during distal movement of molars.<sup>19</sup>

### T- REX appliance

This appliance is used for both maxillary expansion and molar distalization. This appliance consists of two wires extending from palatal acrylic and soldered to lingual surface of

maxillary first molar bands (fig.5). These wires give additional stability during expansion phase of treatment. After completion of expansion, these wires are removed and molar distalization is started.<sup>7</sup>



Fig.5: T-REX appliance

### Franzulum appliance

It was introduced by Byloff et al and used for distalization of molars in mandibular arch. It is based on pendulum appliance. It comprised of acrylic button positioned lingually and inferiorly to mandibular anterior teeth, extending from canine to canine and provides anchorage. Acrylic button kept 5mm wide to dissipate the reactive forces of active parts and to prevent trauma to mucosal tissue. For molar distalization nickel titanium coil springs of 18mm length are used,

which applies force of 100-120 grams per side. A wire in J shape passes through each coil spring and inserted into corresponding tube in anchorage unit. The posterior curved part of wire is inserted into lingual sheath of mandibular first molar band. Rests made from 0.032'' stainless steel wire, placed on canine and first premolars. Active components are present in tubes between second premolars and first molars. (fig.6) This appliance produces bodily movement of molars as active component of appliance present close to center of resistance of molars.<sup>20</sup>



Fig.6: Franzulum appliance

### Hilger Phd appliance

It is Acrylic free modification of pendulum and totally made from metal. Anchorage obtained from banded or bonded first premolars with stabilizing wire extending from premolars to molar bands. The springs of appliance are inserted

into sheaths soldered to palatal side of expansion screw, and can be removed during expansion phase or for reactivation. (fig.7) The stabilizing wires are cut after expansion when molar distalization is initiated. This appliance is more comfortable and oral hygiene is also improved.<sup>7</sup>



**Fig.7: Hilger Phd appliance**

### Mini distalizing appliance (MDA)

This appliance combines features of pendulum appliance and rapid palatal expander (RPE). It is also an all metal appliance, used for both

expansion as well as molar distalization using RPE and pre activated 0.032'' removable TMA springs. (fig.8) It gives more patient comfort, easy access for oral hygiene and there is no tissue impingement.<sup>21</sup>



**Fig.8: Mini-distalizing appliance**

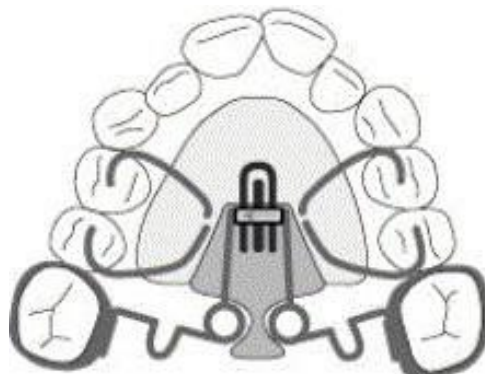
### Pendulum K appliance

This appliance consists of an orthodontic screw which divides acrylic button into two parts. Anterior component joins four anchorage teeth via wire retainers and these wires are fixed to

teeth with composite. The posterior part consists of active pendulum springs. These springs are pre activated by applying certain bends prior to insertion. The appliance is reactivated by turning the screw without removing the springs from molar sheaths. (fig.9)

This appliance allows translatory distalization of molars and also corrects or prevents distal tipping and palatal movement. Uprighting activation in

appliance produces uprighting moment on molar roots and toe-in bend is used for de-rotation of molars which have rotated mesially inwardly.<sup>22</sup>



**Fig.9: Pendulum K-appliance**

### **Bone anchored pendulum appliance (BAPA)**

Conventional pendulum produces unfavorable side effects such as mesial movement of canines, bicuspid and incisors. These can be minimized by using a modified bone anchored pendulum appliance. Beyza et al used titanium screws of 2 mm diameter and 38 mm length. These were placed 7 to 8 mm posterior to incisive foramen and 3 to 4 mm away from paramedian suture. They achieved both molar and premolar distalization without any anterior anchorage loss.<sup>23</sup> Cambiano et al used screw of 2.4 mm diameter and 14mm length, placed 6 to 9mm posterior to incisive foramen and 3 to 6 mm

lateral to paramedian suture. 8mm of screw heads were visible in oral cavity and covered by Nance acrylic button. Two TMA springs inserted into telescopic tubes.(fig.10) These springs were preactivated to generate force of 250 grams and 15 degree antibending inclination incorporated to decrease palatal movement of molar. A vertical loop was also added and can be activated to avoid posterior crossbite. They also reported distal movement of maxillary first molars and premolars and no change in position of incisors.<sup>24</sup> Distal movement of premolars occurred without any force application due to transseptal periodontal fibre action.<sup>25</sup> Thus use of pendulum with skeletal anchorage can control collateral effect.<sup>23,25</sup>



**Fig.10: Bone anchored pendulum appliance<sup>24</sup>**

## Conclusion

Although many appliances are used for molar distalization. But pendulum is very efficient appliance. Original pendulum has few limitations such maintenance of oral hygiene and some anterior anchorage loss but different modifications of pendulum eliminate all shortcomings. Modified pendulum can also be used to correct constricted arches along with molar distalization. Thus pendulum and its modifications are best appliances for molar distalization due to following features:

- Comfortable to patient.
- Achieve molar distalization without anterior anchorage loss.
- Esthetically acceptable.
- Easy maintenance of oral hygiene.
- Less chair side time for placement and reactivation.

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**Conflicts of Interests:** There are no conflicts of interests

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