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Original article

Maxillary molar distalization: Pendulum and Fast-Back, comparison between two approaches for Class II malocclusion

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ABSTRACT

Objectives: To compare the dento-alveolar and skeletal effects produced by two different molar intraoral distalization appliances, Pendulum and Fast-Back, both followed by fixed appliances, in the treatment of Class II malocclusion.

Materials and methods: 41 patients for Pendulum (18 males and 23 females) and 35 for Fast-Back (14 males and 21 females) were selected, with a mean age at the start of treatment of 12.11 years in the Pendulum group and 13.3 for in the Fast-Back group. The durations of the distalization phase were 8 months in the Pendulum group and 9 months in the Fast-Back group, and the durations of the second phase of treatment with fixed appliances were 19 months in the Pendulum group and 20 months in the Fast-Back group. Lateral cephalograms were analyzed at 3 observation times: before treatment, after distalization and after comprehensive orthodontic treatment.

Results: During molar distalization the Pendulum subjects showed greater distal molar movement and less anchorage loss at both the premolars and maxillary incisors than the Fast-Back subjects. Pendulum and Fast-Back produced similar amounts of distal molar movement and overcorrection of molar relationship at the end of distalization though the Fast-Back induced a more bodily movement. Very little change occurred in the inclination of the mandibular plane at the end of the 2-phase treatment in both groups. At the end of treatment the maxillary first molars were on average 1 mm more distal in the Pendulum group compared to the Fast-Back group, while the total molar correction was 3.2 mm with 3.9° of distal inclination for the Pendulum and 2 mm with 1.1° of mesial inclination for the Fast-Back. Both appliance were equally effective in inducing a satisfactory Class I relationship in 97.2% of the cases.

Conclusion: The Pendulum and the Fast-Back induce similar dentoskeletal effects. The use of the two distalization devices, therefore, can be considered clinically equivalent.

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1. Introduction

The technologic progress in orthodontics, associated to the improved knowledge of the biomechanics principles, allowed to conceive and plan a new class of orthodontic devices that are characterized by no patient compliance and by a high control of tooth movement.[1–5] The scientific research is more and more directed to find therapeutic approaches that, although reducing duration of treatment, are able to produce physiologic tooth movement.

Correction of Class II malocclusion is one of the most common problem in orthodontics and it regards about one third of the treated patients.[6] Whereas in case of dentoalveolar protrusion or minor skeletal discrepancies the choice is directed to distalization devices,[7] the use of appliances that can stimulate mandibular growth is preferred in Class II cases presenting with mandibular retrusion.[8]

Conventional headgear can be effective in correcting Class II malocclusion, either by restraining forward growth of the maxilla or by distalizing maxillary molars. However, in patients with inadequate cooperation obtaining Class I occlusion by using headgear is difficult.[9,10] This is the reason why clinicians often prefer intraoral distalizing appliances that minimize the need for patient cooperation.Therefore, treatments that reduce the need for patient's cooperation, in relation to their correct use, would produce more controlled and predictable therapeutic results. On the other hand, there are drawbacks with these intraoral techniques, such as considerable anchorage loss, proclination of maxillary incisors, tipping of upper molars and difficulty in maintaining molars in position after distalization, which has been reported as relapse of the distal movement.[11–13]

Gosh e Nanda[11] found a distalization of the first molar of 3.37 mm and a distal tipping of 8.36°. The second molar was distalized 2.27 mm with 11.99° of tipping. First and second molar presented a distal and vestibular rotation with vestibular drifting of the second molar not banded. The effects of the second molar on the distalization of the first molar resulted of poor entity.

As for the effects on the vertical dimension, Bussick and Mc Namara[14] didn't find significant differences after distalization by using Pendulum, except for minor skeletal and aesthetic secondary effects. They analyzed dentoalveolar and skeletal effects of the Pendulum in patients in different phases of dentition and different skeletal characteristics. The average results after distalization showed a distal movement of the molar of 5.7 mm and a tipping of 10.6°.

On the contrary, according to other studies in the literature, the Pendulum influences significantly the vertical dimension. Kinzinger et al.[15] presented a study on the dentoskeletal effects produced by the Pendulum. Their results highlighted a decrease of 0.1°-0.4° of the SNA angle, confirming that point A remains almost stable. On the contrary, the authors found a clockwise and downward tipping of the palatal plane relatively to the anterior cranial base of 0.64°-1.61° and an increase of the lower facial height of 1.04°-1.93° associated to the opening of the mandibular plane angle.

D'Alessio et al.[16] conducted a study on the effects of the Fast-Back in 30 patients. In this study the authors found that the Fast-Back is able to produce a bodily distal movement of the maxillary molars, reduced tipping and good control of the dental movement, associated to a minimum anchorage loss. On the other hand it was emphasized that the mandibular response for the correction of Class II malocclusion (especially in those subjects treated during growth), already noticeable at the end of distalization, was associated to the temporary increase of the vertical dimension.

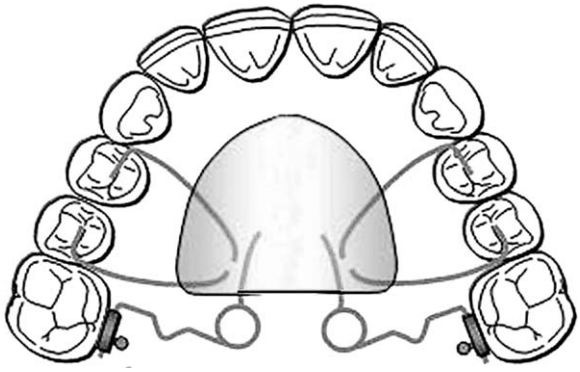

Figure 1 – The Pendulum appliance.

In year 2005 Chiu et al.[17] presented a study that compared the dentoskeletal effects of the Pendulum and the Distal Jet. They found that during molar distalization Pendulum subjects showed significantly more distal molar movement and significantly less anchorage loss at both the premolars and the maxillary incisors than Distal jet subjects. The Distal jet was used simultaneously with fixed appliances than the Pendulum. Both devices were equal in their ability to move the molars distally. Very little change occurred in the inclination of the mandibular plane at the end of the 2-phase treatment (less than 1°) in both groups. At the end of comprehensive treatment, the maxillary first molars were 0.6 mm mesial to their original positions in the Distal jet group and 0.5 mm distal in the Pendulum group. Nevertheless, total molar correction was identical in the 2 groups (3.0 mm), and both appliances were equally effective in achieving a Class I molar relationship. Simultaneous edgewise orthodontic treatment during molar distalization in the Distal jet group shortened the overall treatment time but produced significant flaring of both maxillary and mandibular incisors at the end of treatment.

The aim of this study was to compare the dentoalveolar and skeletal effects produced by two different intaoral molar distalization devices in the treatment of Class II malocclusion. Treatment effects were analyzed both at the end of distalization and at the end of comprehensive orthodontic treatment.

1.1. *Description of the appliances*

Pendulum (Fig. 1) and Fast-Back (Fig. 2) are two common intraoral appliances used for upper molar distalization without patient's cooperation.

The Pendulum appliance[1] is very well known and it is probably the most commonly used distalization appliance in the last years. It consists of an anterior anchorage unit consisting

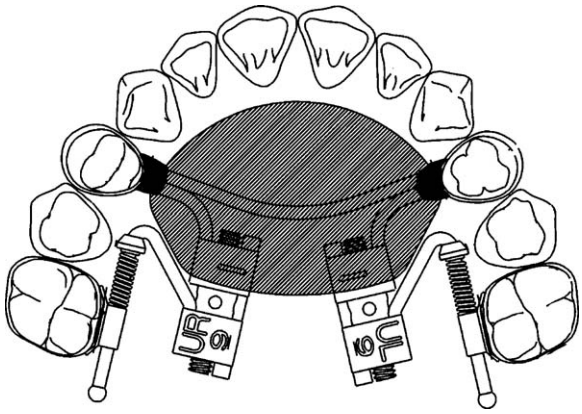

Figure 2 – The Fast-Back appliance.

of a modified Nance plate and metal arms, realized by heavy and elastic wire of 0.9 mm. The metal arms are embedded in the acrylic unit and they are modelled to be bonded onto the occlusal surface of the upper first and second premolars. The active unit consists of two 0.032 inch TMA wire springs (Ormco, Glendora, Ca, USA) that arise from the Nance plate and that are inserted into a palatal tube, soldered on molar bands. This device applies the force occlusal to the centre of resistance of the molars, so that it is impossible to obtain a molar distalization without distal crown tipping.[11]

In year 2001 a new distalization appliance, named Fast-Back (Leone Orthodontic Products, Florence, Italy) was proposed with specific and dedicated components (Fig. 2).[2,3] From a biomechanical point of view, the principle on which the Fast-Back is based is to apply on the molars continuous forces with constant intensity and determined directions. Forces are generated by Nickel-Titanium coil springs of 300 grams, that allow to maintain for a long time light and constant forces for dental movement, reducing the risk of root resorption and periodontal trauma, in association to a comfortable conditions for the patients.

The orthodontic control of tooth movement is obtained by means of an arm wire (0.040 inch) that is shaped according to the anatomic conformation of the upper arch. This arm is inserted into a round tube, diameter 0.045", laser soldered on the palatal surface of the molar band thus preventing dental tipping during distalization and allowing to obtain a bodily movement along a predetermined direction. The device presents an end stop for the dental movement that makes molar distalization perfectly programmable and self-blocking thus eliminating risks of overactivation. The activation is generated by turning an expansion screw in the direction indicated by an arrow printed on its surface, using a specific key till a complete compression of the spring is reached. Generally it takes about 30 days before the dental movement can be recorded clinically. The spring must be recharged to a complete compression every 4 weeks on average. The stability of the anterior area of the upper arch is guaranteed by a Nance plate that encloses the anterior components of the screws, the extensions of the first premolars bands and canine stops. The Fast-Back can be maintained in the mouth and used as an anchorage system till to the completion of the spaces closure.

Table I – Sample selection and exclusionary criteria for Pendulum and Fast-Back with full fixed appliances.

Sample selection	Pendulum group	Fast-Back group
Patient sample	58	51
Primary esclusion criteria		
1. Poor film quality	3	2
2. Incomplete records	6	4
Secondary esclusion criteria		
1. T1 to T2 > 12 months	1	3
2. Non Class II malocclusions	2	3
3. Mandibular inclination S-N / Go-Gn > 37°	3	2
4. Use of other molar distalization methods between T1 and T2	2	1
Final sample	41	35

2. Materials and methods

This retrospective study was designed to evaluate cephalometrically the skeletal and dentoalveolar effects of molar distalization produced by the Pendulum and the Fast-Back appliances in subjects with Class II malocclusion. The sample selection started from 109 consecutively treated patients in one private orthodontic practice. To be included in the study each patients had to meet the criteria reported in Table I. The Pendulum group consisted of 41 subjects (18 male and 23 female). The mean age at the start of treatment was of 12.11 years. The Pendulum appliance used in this study was similar to the original described by Hilgers,[1] with bands on the first molars, occlusal rests on premolars, and initial activation of the TMA springs at about 90°. At the end of distalization the Pendulum was replaced with a Nance plate, leaving the second premolars free to drift spontaneously in a distal direction. Then a full fixed appliance was used to continue and complete the treatment.

The Fast-Back group consisted of 35 subjects (14 male and 21 female) and the mean age at the start of treatment was of 13.3 years. In the Fast-Back group the appliance was activated on average every 4 weeks and the frontal teeth remained free from brackets during the distalization phase. The Fast-back was maintained in the mouth as an anchorage device during the first phase of space closure (distalization of second premolars), than it was replaced with a Nance plate. The full fixed appliance was maintained till the end of treatment for finishing the occlusion.

In both groups the first phase of treatment was designed to achieve a Class I molar relationship with molar distalization. The activation of the two distalizing devices was stopped when a super Class I occlusion was achieved. The second phase consisted of fixed appliance therapy to align and detail the dentition (straight wire appliance, .022 inch brackets with Roth prescription). Three cephalograms for all patients in both groups were available at 3 observation times: before treatment (T1), after distalization (T2) and after orthodontic treatment (T3). The mean ages at T1, T2, and T3 and the mean treatment intervals are summarized for both groups in Table II.

Table II – demographics of observation periods and observation intervals.

Observation period/interval	Pendulum group (n = 41)				Fast-Back group (n = 35)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
T1	12y 11mo	1y 5mo	11y 2mo	14y 2mo	13y 3mo	1y 5mo	11y 5mo	14y 5mo
T2	13y 8mo	1y 4mo	12y 1mo	15y 1mo	14y 1mo	1y 3mo	11y 11mo	16y 4mo
T3	15y 4mo	1y 5mo	13y 5mo	16y 11mo	15y 9mo	1y 4mo	13y 2mo	17y 5mo
T1-T2	8mo	2mo	6mo	11mo	9mo	2mo	7mo	11mo
T2-T3	19mo	5mo	16mo	25mo	20mo	4mo	15mo	24mo
T1-T3	27mo	3mo	21mo	35mo	29mo	5mo	23mo	37mo

2.1. *Cephalometric analysis*

Lateral cephalograms for each patient at T1, T2 and T3 in both treatment groups were standardized as to magnification factor (6% enlargement). Cephalograms were hand traced by a single operator in the same manner and checked by a second investigator. For the cephalometric evaluation 68 landmarks and 4 fiducial markers (2 maxillary and 2 mandibular at T2) were used. The cephalometric analysis consisted of 12 angular and 14 linear variables for each tracing. Fiducial markers were placed in the maxilla and mandible on the T1 tracing and transferred to T2 and T3 tracing in each subject's cephalometric series, based on superimposition on maxillary or mandibular internal structures. The 68 landmarks and the 4 fiducial markers (anterior and posterior maxilla, anterior and posterior mandible) were done by hand and used for superimposition.[18] The cranial base superimposition was made on Ba-N line at Ptm and it was used to assess the movements of the maxilla and the mandible. These movements were shown by the direction and magnitude of displacement of the fiducial markers in the maxilla and mandible, relative to cranial base structures. The maxilla was superimposed along the palatal plane by registering on the bony internal details of the maxilla superior to the incisors and the superior and inferior surfaces of the hard palate. Fiducial markers were placed in the anterior and posterior part of the maxilla along the palatal plane. The movement of the maxillary dentition in the maxilla was determined from this maxillary superimposition. The mandibles were superimposed posterior on the outline of the mandibular canal. In the anterior region they were superimposed on the contour of the chin and the bony structures of the symphysis. Fiducial markers were placed in the centre of the symphysis and the body of the mandible near the gonial angle. This superimposition made easier measuring the movement of the mandibular dentition relative to the mandible.

2.2. *Statistical analysis*

The power of the study was calculated on the basis of the sample size of the two groups and of an effect size equal to 1.[19] The power was equal to 99% at an alpha level of .05. Descriptive statistics were calculated for all cephalometric measures at T1 for the two groups and for the changes at T2-T1, T3-T2 and T3-T1 in each group. Significant between group differences were tested with the Hotelling T^2 as an initial exploratory test. When significance was detected an independent sample Student *t* test was used to identify significant between-group differences for each cephalometric variable. Statistical significance was tested at $P < .05$, $P < .01$ and $P < .001$.

2.3. *Error of the method*

Ten randomly selected cephalograms were traced on two separate occasions. No significant mean differences between the two series of records were found by using paired *t*-test. The method error ranged from 0.5° to 0.7° and from and 0.4 to 0.7 mm, corresponding to a coefficient of reliability of 0.95≈.

3. Results

Descriptive statistics for the cephalometric measures at T1 for the Pendulum and Fast-Back group are given in Table III. Multivariate analysis did not show a significant between-group difference in starting forms for the Pendulum and Fast-Back groups at T1. Descriptive and inferential statistics for changes during treatment intervals T1-T2, T2-T3 and T1-T3 are summarized in Tables IV–VI.

3.1. *Pre-treatment to post-distalization*

No significant differences in both sagittal and vertical skeletal changes could be detected between the two groups during the distalization phase, except for a slightly greater mandibular inclination in the Fast-Back group (S-N / Go-Gn, 1.1° vs 0.6°) (Table IV). In both groups overjet increased (2.5 mm for the Pendulum and 3.2 mm for the Fast-Back) and overbite decreased (-1.9 mm for the Pendulum and -2.9 mm for the Fast-Back) (Table IV). The Pendulum group showed a greater correction of molar relationship (4.5 mm vs 3.2 mm) and a larger amount of distalization (U6 horizontal, -5.2 mm vs -4.2 mm). However, the maxillary first molars in the Pendulum group showed significantly greater distal tipping (U6 to FH, -9.7° vs -2.2°). The maxillary first molars also extruded a little in both samples (U6-vertical, 0.5 mm for the Pendulum group and 0.9 mm for the Fast-Back group). At the end of the first phase of treatment no significant differences were found between the two groups in the amount of anchorage loss (U4-horizontal, 1.3 mm vs 1.6 mm) or in the amount of extrusion (U4-vertical, 0.4 mm vs 0.2 mm) measured at the first premolars (Table IV). The maxillary incisors in the Fast-Back group showed during molar distalization a greater flaring (5.2° vs 3.1°) and a significant intrusion (-1.3 mm vs -0.8 mm) with respect to the Pendulum group (Table IV).

Table III – Comparison of starting forms*.

Cephalometric measures	Pendulum (n = 41)		Fast-Back (n = 35)	
	Mean	SD	Mean	SD
Sagittal skeletal relations				
Maxillary position S-N-A	82.9°	4.3°	82.7°	4.8°
Mandibular position S-N-Pg	78.5°	3.5°	77.9°	3.3°
Sagittal jaw relation A-N-Pg	4.3°	2.1°	4.5°	2.6°
Vertical skeletal relations				
Maxillary inclination S-N / ANS-PNS	7.6°	1.4°	8.3°	1.9°
Mandibular inclination S-N / Go-Gn	30.5°	3.6°	32.5°	2.3°
Vertical jaw relation ANS-PNS / Go-Gn	24.3°	2.7°	24.4°	2.9°
Dento-basal relations				
Maxillary incisor inclination 1: ANS-PNS	116.8°	9.2°	119.9°	6.3°
Mandibular incisor inclination 1: Go-Gn	97.4°	6.7°	95.3°	5.6°
Mandibular incisor compensation 1 / A-Pg (mm)	3.4	1.5	3.7	2.1
Dental relations				
Overjet (mm)	5.3	3.6	5.6	3.1
Overbite (mm)	4.5	3.3	3.9	3.1
Interincisal angle (1/1)	124.6°	6.6°	119.7°	8.7°
Molar relationship (mm)	-2.4	1.3	-2.2	1.2

*Hotelling T2 initial exploratory test 0.745 (not significant).

Table IV – Comparison of changes during distalization period (T1 to T2)†.

Cephalometric measures	Pendulum (n = 41)		Fast-Back (n = 35)		
	Mean	SD	Mean	SD	Sig.
Sagittal skeletal relations					
Maxillary position S-N-A	0.2°	0.9°	0.4°	1.3°	NS
Mandibular position S-N-Pg	0.2°	1.1°	0.2°	1.0°	NS
Sagittal jaw relation A-N-Pg	0.0°	0.8°	0.2°	0.6°	NS
Vertical skeletal relations					
Maxillary inclination S-N / ANS-PNS	0.3°	0.9°	0.3°	0.1°	NS
Mandibular inclination S-N / Go-Gn	0.6°	0.6°	1.1°	0.8°	**
Vertical jaw relation ANS-PNS / Go-Gn	0.3°	0.7°	0.8°	0.7°	NS
Dento-basal relations					
Maxillary incisor inclination 1: ANS-PNS	3.8°	1.2°	5.2°	1.9°	NS
Mandibular incisor inclination 1: Go-Gn	1.3°	0.7°	1.2°	0.8°	NS
Mandibular incisor compensation 1 / A-Pg (mm)	3.4	1.5	4.3	1.3	NS
Dental relations					
Overjet (mm)	2.5	0.5	3.2	0.4	**
Overbite (mm)	- 1.9	0.9	- 2.9	0.3	***
Interincisal angle (1/1)	- 3.5°	1.2°	- 4.4°	1.6°	NS
Maxillary dentoalveolar					
Molar relationship (mm)	- 4.5	1.3	- 3.2	1.2	*
U1 horizontal (mm)	1.2	0.9	1.9	0.8	NS
U1 vertical (mm)	- 0.8	1.0	- 1.3	1.1	**
U4 horizontal (mm)	1.3	1.1	1.6	0.8	NS
U4 vertical (mm)	0.4	0.6	0.2	1.1	NS
U6 horizontal (mm)	- 5.2	1.1	- 4.2	0.8	*
U6 vertical (mm)	0.5	0.3	0.9	1.1	**
U1 to FH (°)	3.1°	1.1°	5.2°	1.1°	*
U4 to FH (°)	1.2°	1.3°	2.1°	0.8°	NS
U6 to FH (°)	- 9.7°	1.0°	- 2.2°	1.1°	***
Mandibular dentoalveolar					
L1 horizontal (mm)	0.5	0.7	0.7	0.8	NS
L1 vertical (mm)	0.5	0.5	0.5	0.7	NS
L4 horizontal (mm)	0.6	0.3	0.6	0.7	NS
L4 vertical (mm)	0.3	0.7	0.4	1.1	NS

†Student T test * P < .05 ** P < .01 *** P < .001.

Table V – Comparison of changes during postdistalization period (fixed appliance therapy) (T2 to T3)†.

Cephalometric measures	Pendulum (n = 41)		Fast-Back (n = 35)		
	Mean	SD	Mean	SD	Sig.
Sagittal skeletal relations					
Maxillary position S-N-A	- 0.1°	0.9°	0.3°	0.8°	NS
Mandibular position S-N-Pg	0.5°	1.7°	0.4°	1.2°	NS
Sagittal jaw relation A-N-Pg	-0.5°	0.5°	- 0.2°	1.1°	NS
Vertical skeletal relations					
Maxillary inclination S-N / ANS-PNS	0.4°	0.7°	0.2°	0.4°	NS
Mandibular inclination S-N / Go-Gn	0.4°	0.2°	0.5°	0.7°	NS
Vertical jaw relation ANS-PNS / Go-Gn	0.1°	0.7°	0.4°	0.5°	NS
Dento-basal relations					
Maxillary incisor inclination 1: ANS-PNS	- 2.4°	1.2°	-3.1°	1.9°	*
Mandibular incisor inclination 1: Go-Gn	- 1.5°	1.1°	-1.9°	1.2°	NS
Mandibular incisor compensation 1 / A-Pg (mm)	-2.3	1.2	-3.3	1.3	**
Dental relations					
Overjet (mm)	-4.8	0.5	-5.2	0.2	NS
Overbite (mm)	1.1	0.8	1.9	0.3	**
Interincisal angle (1/1)	4.7°	1.6°	5.6°	1.3°	*
Maxillary dentoalveolar					
Molar relationship (mm)	1.3	0.9	1.2	0.8	NS
U1 horizontal (mm)	-1.9	0.5	- 2.6	0.7	**
U1 vertical (mm)	1.1	0.9	1.9	1.6	*
U4 horizontal (mm)	0.4	0.3	0.6	0.3	NS
U4 vertical (mm)	0.7	0.9	1.2	1.1	NS
U6 horizontal (mm)	1.2	1.1	1.2	0.8	NS
U6 vertical (mm)	0.8	0.5	1.0	1.2	NS
U1 to FH (°)	- 3.9°	0.8°	- 4.9°	1.5°	*
U4 to FH (°)	- 1.1°	1.3°	- 1.3°	0.8°	NS
U6 to FH (°)	5.8°	1.3°	3.3°	1.5°	**
Mandibular dentoalveolar					
L1 horizontal (mm)	- 0.4	1.1	0.5	1.2	**
L1 vertical (mm)	0.9	0.4	0.5	0.8	NS
L4 horizontal (mm)	1.0	0.9	1.1	1.2	NS
L4 vertical (mm)	1.5	1.1	1.7	1.4	NS

†Student T test * P < .05 ** P < .01 *** P < .001.

3.2. *Post-distalization to end of orthodontic treatment*

Between T2 and T3 both appliances showed a reduction in the inclination of maxillary incisors (1:ANS-PNS, -2.4° for the Pendulum group and -3.1° for the Fast-Back group) (Table V). No statistically significant differences in the changes in vertical and horizontal skeletal relationship were found between the two groups. During the second phase of treatment with full fixed appliances, the maxillary first molars showed the same amount of mesial movement in the two groups (U6-horizontal, 1.2 mm). The Pendulum group, however, exhibited a significantly greater mesial tipping than the Fast-Back group (U6 to FH, 5.8° vs 3.3°). There were no significant differences in the horizontal and vertical movements of the first premolars between the two groups during the second phase of treatment. The first premolar tipped distally on average 1° and 0.5 mm in both groups. In the Pendulum group the mandibular incisors retroclined on average -0.4 mm (L1-horizontal) and extruded 0.9 mm (L1-vertical) while in the Fast-Back group they proclined on average 0. 5 mm (L1-horizontal) and extruded 0.5 mm (L1-vertical).

3.3. *Overall treatment effects*

During the overall treatment period the sagittal jaw relation decreased a little in both groups (A-N-Pog, Pendulum -0.7° vs Fast-Back -0.4°), while the vertical jaw relation increased in both groups with the Fast-Back group showing a significantly greater increment (ANS-PNS/Go-Gn, Pendulum 0.4° vs Fast-Back 1.2°) (Table VI).

At the end of treatment the Pendulum group showed a significantly greater molar distalization (U6-horizontal, -4.0 mm vs -3.0 mm). The Pendulum induced an amount of 3.2 mm of correction in molar relationship while the Fast-Back 2 mm. During overall treatment the maxillary first molars tended to tip mesially 1.1° in the Fast-Back group while in the Pendulum group the maxillary first molars tipped distally on average 3.9° (U6 to FH). There were no significant differences in horizontal and vertical movements of the first premolars between the two groups at the end of treatment (Table VI).

After comprehensive treatment, the maxillary incisors in the Pendulum group were slightly more lingual than in the Fast-Back group (U1-horizontal, -0.7 mm vs 1.3 mm; U1 to FH -0.8° vs 0.3°). The mandibular incisors proclined significantly

Table VI – Comparison of changes during overall observation period (T1 to T3)[†].

Cephalometric measures	Pendulum (n = 41)		Fast-Back (n = 35)		
	Mean	SD	Mean	SD	Sig.
Sagittal skeletal relations					
Maxillary position S-N-A	0.1°	1.1°	- 0.1°	0.9°	NS
Mandibular position S-N-Pg	0.7°	1.5°	0.2°	1.1°	NS
Sagittal jaw relation A-N-Pg	- 0.7°	0.3°	- 0.4°	1.3°	NS
Vertical skeletal relations					
Maxillary inclination S-N / ANS-PNS	0.7°	0.3°	0.5°	0.3°	NS
Mandibular inclination S-N / Go-Gn	1.0°	0.5°	1.6°	0.9°	NS
Vertical jaw relation ANS-PNS / Go-Gn	0.4°	0.9°	1.2°	0.6°	*
Dento-basal relations					
Maxillary incisor inclination 1: ANS-PNS	1.4°	1.6°	1.0°	2.1°	NS
Mandibular incisor inclination 1: Go-Gn	- 0.2°	1.0°	- 0.7°	1.2°	NS
Mandibular incisor compensation 1 / A-Pg (mm)	1.1	1.1	1.0	1.3	NS
Dental relations					
Overjet (mm)	-2.3	1.1	- 2.0	1.3	NS
Overbite (mm)	0.8	1.3	-1.0	0.9	NS
Interincisal angle (1/1)	1.2°	1.9°	1.2°	1.8°	NS
Maxillary dentoalveolar					
Molar relationship (mm)	3.2	1.5	2.0	1.3	*
U1 horizontal (mm)	-0.7	0.9	1.3	0.7	NS
U1 vertical (mm)	0.3	1.1	0.6	0.8	NS
U4 horizontal (mm)	1.7	1.2	2.2	0.6	NS
U4 vertical (mm)	1.1	0.7	1.4	0.9	NS
U6 horizontal (mm)	- 4.0	0.9	- 3.0	1.1	**
U6 vertical (mm)	1.3	0.5	1.9	1.3	NS
U1 to FH (°)	- 0.8°	0.6°	0.3°	0.6°	NS
U4 to FH (°)	0.1°	0.7°	0.8°	0.5°	NS
U6 to FH (°)	- 3.9°	1.2°	1.1°	0.8°	**
Mandibular dentoalveolar					
L1 horizontal (mm)	0.1	0.5	1.2	0.6	***
L1 vertical (mm)	1.4	0.9	1.0	1.2	NS
L4 horizontal (mm)	1.6	0.8	1.7	0.7	NS
L4 vertical (mm)	1.8	1.1	2.1	0.8	NS

[†]Student T test * P < .05 ** P < .01 *** P < .001.

in the Fast-Back group with respect to the Pendulum group (L1-horizontal, 1.2 mm vs 0.1 mm). There were no statistically significant differences in overbite and overjet between the two groups (Table VI).

4. Discussion

The aim of this study was to make a comparison between two intraoral distalizing appliances, testing their ability in the correction of Class II malocclusion in growing patients.

The starting forms showed that the Pendulum and Fast-Back patients were in general not significantly different at the start of treatment and confirmed that this study has a low susceptibility bias (Table III).

In any scientific study, it is important that the power is high and the characteristics of any withdrawal subjects are known. The clinical cases examined showed a real gain of space at the end of distalization associated to the overcorrection of dental relationship for both the appliance.

One of the most important finding of this study was that the amount of correction of molar relationship was greater in the Pendulum group, but the first molars had a significant distal molar tipping than the Fast-Back group, where the movement was more bodily. Either the first molars or the first premolars tended to extrude during distalization in both groups, while the upper incisors tended to flare in the Fast-Back group. A satisfactory clinical Class I correction was obtained in 97.2% of the cases.

The two appliances did not have any considerable corrective effect on Class II skeletal relationship but at the end of treatment pogonion increased vertically and sagittally more in the Fast-Back group, although the first molars resulted at least in their original position after superimposition in both groups.

Chiu et al,[17] in their study on the Pendulum and Distal Jet, outlined that, at the end of treatment with full fixed appliances, the forward movement of the maxillary molars must be expected as a part of a normal process of dento-alveolar compensation. As the mandible continues to outgrow the maxilla and through intercuspation of the buccal segments and dento-alveolar compensation, the maxillary molars need to move mesially to maintain the Class I molar relationship.[10]

The orthodontic literature is, in any case, rather poor about the dentoskeletal effects of various therapeutic approaches, either for orthodontic appliances or intraoral and extraoral

distalizing appliances, especially after comprehensive treatments with full fixed appliances. Burkhard et al[8] comparing the effects of the Herbst and Pendulum appliances after fixed orthodontic treatment, which are two treatment options theoretically and diametrically opposed, found no differences in mandibular growth between groups, although they noted slightly greater increases in lower anterior facial height in the Pendulum group. Treatment success with both appliances occurred primarily from dentoalveolar changes.

5. Conclusions

The results of the present study indicated that the Pendulum and the Fast-Back induced similar dentoskeletal effects. The few dentoskeletal changes that showed a statistically significant difference were not significant from a clinical point of view (differences smaller than 1.5 mm or 1.5°) with the exception of the amount of distal tipping of the upper molars that was both statistically and clinically greater in the Pendulum group (about 4°). The use of the two distalization devices can be considered clinically equivalent.

Conflict of interest

The authors have reported no conflict of interest.

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Riassunto

Obiettivi: *Confrontare gli effetti dentoalveolari e scheletrici risultanti dall'utlizzo di due differenti dispositivi intraorali per la distalizzazione dei molari superiori, il Pendulum ed il Fast-Back, nel trattamento della malocclusione di classe II, entrambi seguiti dall'utilizzo di apparecchiatura fissa multiattacchi.*
Materiali e metodi: *Sono stati selezionati 41 pazienti per il gruppo Pendulum (18 maschi e 23 femmine), con un'età media all'inizio del trattamento di 12,11 anni, e 35 pazienti per il gruppo Fast-Back (14 maschi e 21 femmine), con un'età media all'inizio del trattamento di 13,3 anni. La durata della fase di distalizzazione è stata in media di 8 mesi per il Pendulum e 9 mesi per il Fast-Back, mentre la durata della seconda fase del trattamento con apparecchiature fisse è stata di 19 mesi per il gruppo Pendulum e 20 mesi per il gruppo Fast-Back. Sono state analizzate le teleradiografie latero-laterali in tre periodi di osservazione: prima del trattamento, dopo la distalizzazione e al termine del trattamento ortodontico.*
Risultati: *Durante la distalizzazione molare il Pendulum ha mostrato una maggior distalizzazione e una minor perdita di ancoraggio, sia a livello dei premolari sia a livello degli incisivi rispetto al Fast-Back. Sia il Pendulum sia il Fast-Back sono stati entrambi capaci di ottenere la distalizzazione dei molari superiori e l'ipercorrezione della relazione molare alla fine della distalizzazione ma il secondo in maniera più corporea. L'inclinazione del piano mandibolare è aumentata poco al termine del trattamento in 2 fasi in entrambi i gruppi. Al termine del trattamento i primi molari superiori si presentavano in media 1 mm più distali nel gruppo Pendulum rispetto al gruppo Fast-Back, mentre la correzione della relazione molare è risultata di 3.2 mm con 3.9° di tip distale per il Pendulum e rispettivamente di 2 mm con 1.1° di tip mesiale per il Fast-Back. Entrambe le apparecchiature si sono mostrate efficienti nell'ottenere una soddisfacente I Classe molare nel 97.2% dei casi.*
Conclusioni: *I risultati, in relazione agli effetti dento-alveolari e scheletrici riscontrati per le due apparecchiature, indicano che le differenze tra Pendulum e Fast-Back, sebbene in alcuni casi statisticamente significative, come per le relazioni scheletriche sagittali e verticali, non sono clinicamente significative. Le due apparecchiature possono quindi essere considerate clinicamente sovrapponibili.*

Résumé

Objectif: *Comparer les effets dento-alvéolaires et squelettiques se dégageant de deux différents dispositifs intra-oraux pour distaliser les molaires supérieures, à savoir Pendulum et Fast-Back, afin de traiter les malocclusions de Classe II; dans les deux cas, on a utilisé par la suite des appareils fixes multi-attaches.*
Matériels et méthodes: *On a sélectionné 41 patients pour le groupe Pendulum (18 garçons et 23 filles), âge moyen 12,11 ans au début du traitement et 35 patients pour le groupe Fast-Back (14 garçons et 21 filles), âge moyen 13,3 ans au début du traitement. La durée de la phase de distalisation a été de 8 mois en moyenne pour l'appareil Pendulum et de 9 mois pour l'appareil Fast-Back, alors que la durée de la deuxième phase du traitement par les appareils fixes a été de 19 mois pour le groupe Pendulum et de 20 mois pour le groupe Fast-Back. On a analysé les téléradiographies latérolatérales à trois moments: avant le traitement, après la distalisation et à la fin du traitement d'orthodontie.*
Résultats: *Pendant la distalisation molaire l'appareil Pendulum à montré plus de capacité de distalisation et une perte d'ancrage moindre, aussi bien au plan des prémolaires qu'au plan des incisives par rapport au Fast-Back. Le Pendulum et le Fast-Back ont été capables d'obtenir la distalisation des molaires supérieures et l'hypercorrection de la relation molaire à la fin de la distalisation, mais le deuxième appareil l'a fait de manière plus corporelle. L'inclinaison du plan mandibulaire n'a pas tellement augmenté à la fin du traitement en deux paliers dans les deux groupes. À la fin du traitement, les premières molaires supérieures se présentaient en moyenne 1 mm plus distales chez le groupe Pendulum par rapport au groupe Fast-Back, alors que la correction de la relation molaire était de 3,2 mm avec 3,9° de tip distal pour l'appareil Pendulum et 2 mm avec 1,1° de tip mésial pour l'appareil Fast-Back. Les deux appareils ont été efficaces pour ce qui est de l'obtention d'une Classe I molaire dans 97,2% des cas.*
Conclusions: *Les résultats, pour ce qui est des effets dento-alvéolaires et squelettiques enregistrés pour les deux appareils, font état que les différences entre Pendulum et Fast-Back, bien qu'importantes dans des cas donnés (relations squelettiques, sagittales et verticales), ne sont pas cliniquement significatives. Les deux appareils peuvent donc être considérés comme cliniquement équivalents.*

Resumen

Objetivo: *Comparar los efectos dentoalveolares y esqueléticos que proceden del uso de dos diferentes aparatos intraorales para*

distalizar los molares superiores, Pendulum y Fast-Back, en el tratamiento de la maloclusión de Clase II, ambos seguidos de aparatos fijos.

Materiales y métodos: *Se seleccionaron 41 pacientes para el grupo Pendulum (18 chicos y 23 chicas) con una edad media de 12,11 años al empezar el tratamiento y 35 para Fast-Back (14 chicos y 21 chicas) con una edad media de 13,3 años al principio del tratamiento. La duración de la fase de distalización fue de 8 meses de promedio en el grupo Pendulum y de 9 meses en el grupo Fast-Back; las duraciones de la segunda fase del tratamiento con aparatos fijos fue de 19 meses en el grupo Pendulum y de 20 meses en el grupo Fast-Back. Se analizaron las telerradiografías latero-laterales en tres momentos diferentes: antes del tratamiento, después de la distalización y al final del tratamiento ortodóncico.*

Resultados: *Durante la distalización molar el aparato Pendulum consiguió mayor distalización y una pérdida inferior de anclaje, tanto a nivel de los premolares como a nivel de los incisivos con respecto al aparato Fast-Back. Tanto Pendulum como Fast-Back lograron obtener la distalización de los molares superiores y la hipercorrección de la relación molar al final de la distalización, pero el segundo lo hizo de manera más corporal. La inclinación del plano mandibular poco aumentó al final del tratamiento en 2 fases, en ambos grupos. Al final del tratamiento los primeros molares superiores se presentaban en media 1 mm más distales en el grupo Pendulum con respecto al grupo Fast-Back, mientras que la corrección de la relación molar fue de 3,2 mm con 3,9° de tip distal para el aparato Pendulum y de 2 mm con 1,1° de tip mesial respectivamente para el aparato Fast-Back. Ambos aparatos resultaron ser eficaces en la consecución de una satisfactoria Clase I Molar en el 97,2 de los casos.*

Conclusiones: *Los resultados en relación con los efectos esqueléticos y dentoalveolares encontrados con los dos aparatos hacen hincapié en que las diferencias entre los aparatos Pendulum y Fast-Back, si bien en algunos casos estadísticamente relevantes (por ej., relaciones esqueléticas, sagitales y verticales) no son clínicamente significativas. Resulta de lo anterior que los dos aparatos pueden ser considerados equivalentes.*

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