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Pendulum appliance: skeletal and dentoalveolar effects. A systematic review.

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Abstract

Pendulum appliance in combination with fixed appliances can be considered an effective protocol for treatment of Class II malocclusion in the absence of mandibular crowding and severe skeletal discrepancies. In patients with second class malocclusion, the pandulum has a dentoalveolar effect distalizing the upper molars. However, the molar distalization movement is always accompanied by a distal tipping movement and an anchoring loss in the front teeth.

Introduction

The distalization of maxillary molars is the frequently used non-extraction treatment in Class II malocclusion to establish a Class I molar and canine relationships.

Traditional appliances for molar distalization such as extraoral traction has been successful in correcting class II malocclusion but these appliances rely partially or totally on patient cooperation to achieve molar distal movement. Recently, problems related to patient compliance have led many clinicians to prefer intraoral distalizing systems that minimize reliance on the patient and are under the orthodontistâ€™s control [1,2,3].

Several techniques have been developed to distalize maxillary molars, by means of extraoral[4,5] or intraoral forces[6]. Â These appliances have drawbacks of anchor loss, proclination of the maxillary incisors, tipping of the maxillary molars and difficulty in keeping the molars in position following distal movements.

The ideal treatment with an intraoral fixed appliance for molar distalization should fulfill the following requirements:

- Patient compliance;
- light and continuous forces;
- easy and measurable activation;
- simultaneous translation of the first and second molars;
- minimum anterior anchor loss;
- acceptable esthetics.

One factor that influences the movement rate is the type of movement and another factor is the timing of treatment. Usually faster movement occurs when the molars are tipped, whereas bodily movement takes a longer time. A favorable time to move molars distally appears to be in the mixed dentition before the eruption of the second molars[7]. The reason why it is more effective to move the maxillary first molars distally before the second molars have erupted is that there is one more tooth, and thus, a larger area of root surface to be moved when the second molars have erupted. Thus, the anchorage loss (forward movement of the maxillary incisors) will be lower if the molars are moved before eruption of the second molars[8]. Â However other authors concluded that second molars do not affect linear and angular changes in molar distalization[9,10,11].

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Pendulum

The pendulum device is one of the most commonly used intraoral conventional distalizing devices. This device was developed in 1992 by Hilgers, which consisted of:

- acrylic resin palatine button with anchor function
- cemented metal supports on the occlusal surface of the premolars
- two pendulums springs inserted into the palatal tube of the molars to be distalized.

Similar to other distalizing appliances, the Pendulum appliance seems to correct the Class II molar relationship mainly by dentoalveolar changes rather than by maxillary growth restriction.12

Several studies evaluated the efficacy of the pendulum appliance, relative to dentoalveolar and skeletal changes in the correction of Class II molar relationship [13â€“18].

The main limitations with this appliance are, anchorage loss, labial/mesial tipping and protrusion of the maxillary incisors and premolars, distal tipping of the maxillary molars, increase in lower anterior face height, clockwise mandibular rotation, and extrusion of the ?rst premolars. 19-21

Materials and Methods

Many articles have been published on international literature about this topic. The systematic review of

literature has been performed on the principal medical databases: PubMed (Medline), Embase and Scopus. The keywords used were: *pendulum appliance, molar distalization, maxillary tooth movement, distalization therapy.Â* The purpose of this review is to evaluate theÂ skeletral and dentoalveolar effect used Pendulum appliance. Following the search, 27 articles were selected.

Discussion

Skeletal changes

According to litterature, no statistically significant changes were observed in the sagittal positioning of the maxilla and the mandible with the pendulum appliance[22-24]. However, was observed a mandibular rotation secondary to distalization of the maxillary molars as a consequence of the distal tipping of the molar crowns. Clockwise mandibular rotation and counterclockwise inclination of the palatal plane were observed, confirming previous observations and the tendency toward bite opening.19 The bite opening might have been caused by extrusion of posterior teeth or the maxillary molars being distalized into the arc of closure, determining anÂ increase in lower anterior facial height.

Dental changes

Â The main objective of molar distalizing therapy is to induce a true bodily distal movement or at least to keep molar distal tipping to a minimum.

Many studies have establishedÂ that pendulm is an effective device in molar distalization by obtaining distalizations of variables from 4 to 6 mm, however, the distalization movement is always accompanied by a distal tippig of the crown of the first molar with a variable value from from 8.36Â° to 14.50Â°.

Bussick and McNamara[19] have calculated that the amount of distal tipping per millimeter of distal molar movement in the pendulum appliance was 1,9Â°/mm. Â The reason is that intraoral distalizing appliances act on the dental crowns at a certain distance from the center of resistance of the molars, therefore distal tipping of the crowns is expected on distal movement.

This shows that purely distalization force application to the maxillary molars is not possible with Hilgers pendulum appliances, also part of the molar distalization will be lost during the second phase of treatment with a fixed device. The forward movement of the maxillary molars after applying a device for distalization must be expected as part of a normal process of dentoalveolar compensation. As the mandible continues to outgrow the maxilla, and through intercuspation of the buccal segment and dentoalveolar compensation, the maxillary molars need to move mesially to maintain the Class I molar relationship[25].

Ancorage loss

The forces and the movements exercised by the activators of the distalization appliance cause movement of anchored teeth with anchorage loss and mesial movement, with intrusion or extrusion of incisors. In the investigated studies, anchorage loss occurred more markedly in the areas of the incisors compared with that of the premolars, leading to proclination of the maxillary incisors. This might be related to the fact that the reciprocal force reacting to the distalization force is directed to the anterior teeth from premolars as all the premolars will be used as anchor units. This proves that the the acrylic button in palatal depth is insufficient to resist the reciprocal mesial force of the appliance, unless reinforcement with skeletal anchorage is used[4,10,21].

A meta-analysis[4] evaluated the efficacy of conventional versus bone-anchored anchorage, showing that both systems were effective for molar distalization but that there were differences in anchorage loss. Conventional and indirect skeletal anchorage showed a certain amount of anchorage loss at the premolars and incisors, whereas these side effects were not seen with direct skeletal anchorage. Anchorage loss is also demonstrated by increased labial tipping and protrusion of the maxillary incisors[16,18].

The maxillary incisors had 3.4Â° 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. Similar values were found in other studies[18,21,26,27], but anchorage loss was greater in subjects with erupted second molars[4,8]. Bussick and McNamara[19], who studied the largest sample of subjects treated with the pendulum appliance to date, suggested to start moving the first molars distally before the eruption of the second molars.

It was calculated that during molar distalization, the anchoring loss caused a mesial movement of the first premolar of 1.4 mm. For every millimeter the maxillary first molar moved distally, the premolars moved forwardÂ 0.2 mm in the pendulum patients. The percentages of anchorage loss for the pendulum appliance have been reported to be 24% to 43% [4, 18].

Vertical changes

Most studies reported that distal molar movement is accompanied by an increase in vertical facial dimension and lower facial height[19,20,21], however, bite

opening tended to decrease during the postretention period.

According to litterature the vertical changes produce a reduction in overbite[4,19,21,27]. The decrease in overbite was consequent to the effect of the occlusal rests and the second premolar bonding, which could have acted as a selective bite plate, allowing vertical development of the molars, associated with the clockwise mandibular rotation[19].

Finally, the molar distalization is also associated with premolars exstruction. The extrusion of the premolars is explained by the fact that the Nance button is supported by the premolars, and activation of the appliance produces a vertical force component that leads to extrusion of the premolars and intrusion of the molars.

Conclusion

- The Pendulum appliance yields a predominantly dentoalveolar effect, and mandibular growth can be crucial for correction of the Class II malocclusion in growing subjects.
- Distalization movement is always accompanied by a distal tippig of the crown of the first molar.
- The loss of anterior anchorage results in a mesial movement of the premolars and a vestibularization of the upper incisors.
- Pendulum appliance in combination with fixed appliances can be considered an effective protocol for treatment of Class II malocclusion in the absence of mandibular crowding and severe skeletal discrepancies
- Â The increase in vertical facial dimension can be partially or completely compensated by residual growth of the mandibular ramus after the completion of orthodontic treatment.

References

1. Graber TM. Extraoral forceâ€”facts and fallacies. Am J Orthod 1955;41:490-505.

2. Kloehn SJ. Evaluation of cervical traction of the maxilla and upper first permanent molar. Angle Orthod 1961;31:91-104.

3. Poulton DR. The influence of extraoral traction. Am J Orthod 1967;53:8-18.

4. Hilgers JJ. The pendulum appliance for class II noncompliance therapy. J Clin Orthod 1992 Nov;26(11):706-714.

5. Carano A, Testa M. The distal jet for upper molar distalization. J Clin Orthod 1996 Jul;30(7):374-380.

6. Kalra V. The K-loop molar distalizing appliance. J Clin Orthod 1995 May;29(5):298-301.

7. Chaques-Asensi J, Kalra V. Effects of the pendulum appliance on the dentofacial complex. J Clin Orthod. 2001;35:254â€“257.

8. Kinzinger GS, Fritz UB, Sander FG, Diedrich PR. EfficiencyÂ of a pendulum appliance for molar distalization related to second and third molar eruption stage. Am J Orthod Dentofacial Orthop 2004 Jan;125(1):8-23.

9.Fuziy A, Rodrigues de Almeida R, Janson G, et al. Sagittal, vertical, and transverse changes consequent to maxillary molar distalization with the pendulum appliance. Am J Orthod Dentofacial Orthop. 2006;130:502â€“510.

[10] Angelieri F, Almeida RR, Almeida MR, et al. Dentoalveolar and skeletal changes associated with the pendulum appliance followed by fixed orthodontic treatment. Am J Orthod Dentofacial Orthop. 2006;129:520â€“527.

[11] Taner TU, Yukay F, Pehlivanoglu M, et al. A Comparative analysis of maxillary tooth movement produced by cervical headgear and pend-X appliance. Angle Orthod. 2003;73:686â€“691.

12. Burkhardt DR, McNamara JA, Baccetti T. Maxillary molar distalization or mandibular enhancement: a cephalometric comparison of comprehensive orthodontic treatment including the Pendulum and the Herbst appliances. Am J Orthod Dentofacial Orthop. 2003;123:108â€“116.

13.Mariani L, Maino G, Caprioglio A. Skeletal versus conventional intraoral anchorage for the treatment of class II malocclusion: dentoalveolar and skeletal effects. Prog Orthod. 2014;15:43.

14. Taner TU, Yukay F, Pehlivanoglu M, et al. A Comparative analysis of maxillary tooth movement produced by cervical headgear and pend-X appliance. Angle Orthod. 2003;73:686â€“691

15. Caprioglio A, Cafagna A, Fontana M, et al. Comparative evaluation of molar distalization therapy using pendulum and distal screw appliances. Korean J Orthod. 2015;45:171â€“179.

16. Caprioglio A, Fontana M, Longoni E, et al. Long-term evaluation of the molar movements following Pendulum and fixed appliances. Angle Orthod. 2013;83:447â€“454.

17.Chiu PP, McNamara JA, Jr, Franchi L. A comparison of two intraoral molar distalization appliances: distal jet versus pendulum. Am J Orthod Dentofacial Orthop. 2005;128:353â€“365.

18. Byloff FK, Darendeliler MA. Distal molar movement using the pendulum appliance. Part 1: clinical and radiological evaluation. Angle Orthod. 1997a;67:249â€“260.

19.Bussick TJ, McNamara JA Jr. Dentoalveolar and skeletal changes associated with the pendulum appliance. Am J Orthod Dentofacial Orthop. 2000;117:333â€“343.

20. Byloff FK, Darendeliler MA, Clar E, et al. Distal molar movement using the pendulum appliance. Part 2: the effects of maxillary molar root uprighting bends. Angle Orthod. 1997b;67:261â€“270.

21. Ghosh J, Nanda RS. Evaluation of an intraoral maxillary molar distalization technique. Am J Orthod Dentofacial Orthop. 1996;110:639â€“646.

22. Bondemark L, Kurol J. Distalization of maxillary first and second molars simultaneously with repelling magnets. Eur J Orthod 1992; 14:264-72.

Â 23. Bondemark L, Kurol J, Bernhold M. Repelling magnets versus superelastic nickel-titanium coils in simultaneous distal movement of maxillary first and second molars. Angle Orthod 1994; 64:189-98.

24. Haydar S, UÂ¨ ner O. Comparison of Jones jig molar distalization appliance with extraoral traction. Am J Orthod Dentofacial Orthop 2000;117:49-53.

25. Melsen B, Dalstra M. Distal molar movement with Kloehn headgear: is it stable? Am J Orthod Dentofacial Orthop 2003; 123:374-8.

26. Kinzinger G, Fuhrmann R, Gross U, Diedrich P. Modified pendulum appliance including distal screw and uprighting activation for non-compliance therapy of Class II malocclusion in children and adolescents. J Orofac Orthop 2000;61:175-90.

27. Joseph AA, Butchart CJ. An evaluation of the pendulum distalizing appliance. Semin Orthod 2000;6:129-35.

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