Influence of the banded Herbst appliance on dental changes in mixed dentition

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Abstract

Objective: This prospective clinical study was conducted with the purpose of evaluating the influence of the banded Herbst appliance on dental changes during the early treatment of Class II malocclusion. **Method:** The sample consisted of 15 prepubertal subjects (12 boys and 3 girls, initial age: 9 years and 6 months) who were treated with the Herbst appliance. Treatment effects were compared with those of a Class II Division 1 group of 15 subjects (8 boys and 7 girls, mean initial age 9 years and 1 month), not treated orthodontically. Statistical analysis was performed using Student t-test with 5% significance level. **Results:** The results showed that treatment with the banded Herbst appliance in the mixed dentition stage tended to upright maxillary incisors (mean: 4.14°). The maxillary molars were distalized and intruded significantly (mean 2.65 mm and 1.24 mm, respectively), the lower incisors slightly protruded anteriorly (mean 1.64 mm) and the molars showed no significant changes in the horizontal and vertical directions. Furthermore, significant improvements were noted in overbite (1.26 mm), overjet (4.8 mm) and molar relationship (12.08 mm). **Conclusions:** Changes in the upper dental arch were found to be greater than changes in the lower arch. Furthermore, mandibular anchorage loss was reduced due to the anchorage system used in the study.

Keywords: Herbst appliance. Anchorage system. Mixed dentition. Orthodontics. Cephalometry.

How to cite this article: Sampaio LP, Raveli DB, Santos-Pinto A, Landázuri DRG, Maia SA. Influence of the banded Herbst appliance on dental changes in mixed dentition. Dental Press J Orthod. 2012 Jan-Feb;17(1):44-6.

» The author reports no commercial, proprietary, or financial interest in the products or companies described in this article.

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Editor's abstract

The Herbst appliance is indicated for treatment of skeletal Class II malocclusion associated with mandibular retrusion, especially in non-compliant patients, in order to stimulate mandibular growth. Mandibular advancement is accomplished by a tube/piston system supported on bands, crowns or acrylic splints. As a result of tooth-borne or tooth-tissue-borne anchorage (in some cases), the Herbst eventually also promotes undesired dental changes.

The objective of this study consisted in assessing the changes with the banded Herbst appliance in mixed dentition patients. Fifteen patients took part in the treated group (12 boys and 3 girls) with initial mean age of 9.4 years, presenting Class II, Division 1 facial pattern associated with mandibular retrusion; dental Class II, Division 1 relationship; mixed dentition with erupted or currently erupting upper and lower incisors; absence of severe crowding in the lower dental arch, and crossbites. The Herbst tube/piston system was supported on maxillary and mandibular first molar bands (by means of a cantilever), combined with a transpalatal bar in the upper dental arch and a lingual arch in the lower dental arch. Mandibular advancement was performed in one single step until an edge-to-edge incisor relationship was reached. Patients were treated for 7 months.

The effects produced by the Herbst were compared with those of a control group whose subjects were recruited from the archives of the Burlington Growth Centre, University of Toronto/Canada, composed of 15 children (7 girls and 8 boys) with mean initial age of 9.08 years, with Class II, Division 1 malocclusion associated with mandibular retrusion. These individuals were followed up for approximately 1 year (final mean age of 10 years). Through the analysis of cervical vertebrae in lateral cephalograms it was found that children of both groups were in stages 1 and 2 of skeletal maturation, i.e., in the pre-pubertal growth spurt period. Lateral cephalograms obtained at the beginning and end of treatment/evaluation of both groups were traced and cephalometric points of interest were scanned using a flatbed scanner. Cephalometric variables related to vertical, sagittal and angular maxillary and mandibular incisors and first molars were measured by Dentofacial Planner Plus 1.2 software. To study the error, all tracings were once again scanned and the variables measured by the same operator within a two-week interval. The intraclass correlation test was used to determine method error.

Due to a mismatch in the assessment times of the experimental and control groups, the data were annualized and subjected to the independent t test for comparing the groups in the initial phase and comparing the changes that took place during the study period ($p<0.05$). The results indicated that the minimum intraclass correlation index achieved was 0.983, and the method was therefore considered accurate. Thus, the means reached between the first and second measurements were used for each variable. When the experimental and control groups were compared in the initial phase it was found that there was similarity in more than 50% of the variables.

The Herbst promoted several dental effects such as relative intrusion (inhibition of vertical development) and distalization of first molars caused by a force vector delivered by the telescopic system in the upward and posterior direction. Furthermore, the lower incisors protruded and the molar relationship was adjusted relative to the control group. The Herbst also decreased the overbite and overjet of treated patients. The authors concluded that changes in the anchorage system are recommended with a view to minimizing the dental effects produced by the Herbst appliance in the mixed dentition.

Questions for the authors

1) The Herbst assessed in the study was anchored in the lower arch, with a lingual arch positioned at a distance of 3 mm from the anterior teeth. Considering that the patients were in the mixed dentition stage and that the lower first molar moved mesially in relation to the pogonion during treatment (although with no statistically significant differences compared to the control group), was there any clinically significant impact on leeway space?

No. The Herbst appliance moved the molar mesially by 1.11 mm. This movement occurred in the same direction as the lower molar in the control group (0.24 mm), but in a slightly more pronounced manner. In addition, when patients entered van der Linden's second transitional phase, the lower molar would be expected to move mesially (late migration of the molars). However, molar movement occurred earlier during treatment with the Herbst appliance. The purpose of using a lingual arch at a distance of 3 mm would be to minimize lower incisor flaring, since there was no direct contact between the anchorage system and these teeth, which reduced the force produced by the telescope system in this region. Moreover, it would also reduce the risk of trauma to the lingual mucosa of the lower incisors caused by inserting the lingual arch in the region.

2) Considering the results, which modifications in the banded Herbst appliance system are recommended by the authors?

Since it has been well established that different types of anchorage can provide different dentofacial responses, we recommend that clinicians be aware of these dentofacial changes induced by different designs of the Herbst appliance in order to develop a better treatment strategy for each patient. In our study, the Herbst appliance simulated, in the upper jaw, the effect of a high pull headgear, i.e., there was intrusion and distalization of the molars. With the purpose of minimizing this dental effect, we suggest incorporating more teeth into the anchorage structure because the lower the number of teeth included in the anchorage system, the greater the dental changes observed. And the more teeth are included in the anchorage structure, the greater the anchorage control, since more skeletal changes will tend to occur in relation to the dental changes. Therefore, a wire segment could be welded to the upper bands in the buccal and palatal sides, extending to the region of deciduous canines. This wire extension should therefore be secured with composite resin in deciduous molars and canines.

3) What are the advantages and disadvantages of using the Herbst appliance combined with first molar bands?

One of the factors that led us to use the banded Herbst appliance was the fact that patients were in the mixed dentition phase. Therefore, using this anchorage structure would not interfere with the tooth eruption process when permanent teeth eventually replaced primary teeth. Another reason is that cleaning is easier with this type of anchorage and consequently the risk of decalcification, caries and enamel fractures is reduced when compared to the Herbst appliance with acrylic splints, for example. Furthermore, removal of the banded structure and bonding material on the proximal surfaces after treatment is easier to perform when compared to structures with acrylic splints or metal crowns. The banded Herbst appliance barely interferes with chewing and is less traumatic to the periodontium compared to the Herbst appliance with metal crowns. In terms of cost, the banded anchorage structure is more affordable when compared to other anchorage structures. However, the major disadvantage of the banded structure used in this study is that it provides less anchorage control. Additionally, there is increased risk of band weld failure, especially in the upper molars, and trauma to the lingual mucosa of lower incisors.

Submitted: November 3, 2008
Revised and accepted: April 21, 2009

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