Treatment and Posttreatment Effects of the Herbst Appliance on the Dental Arches and Arch Relationships

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The aim of this article was to give an overview of the dental effects of the Herbst appliance and to discuss their clinical consequences. The arch perimeter, arch widths, and interarch changes as well as mandibular incisor crowding and gingival recession during Herbst treatment are reviewed. The average changes in the short- and long-term perspective are shown, and the large individual variation is stressed. (Semin Orthod 2003;9:67-73.)

The forces from the Herbst appliance (Fig 1) are transferred to the maxillary and mandibular teeth as well as to the jaw bases. This will, thus, affect the tooth position and the sagittal, transverse, and vertical basal and dental arch relationships. The tooth movements contribute to a great extent to the correction of the existing Class II malocclusion but are basically a result of anchorage loss.[1,2]

The aim of this article was to give an overview of the dental effects of the Herbst appliance and to discuss their clinical consequences. The article is based on 5 articles [1-5] in which consecutively treated Herbst patients were analyzed on a short and long-term basis.

Arch Perimeter

Because of the distalizing forces of the telescope mechanism of the Herbst appliance on the upper first molars and the anteriorly directed forces on the lower front teeth, the maxillary and mandibular arch perimeters increase during treatment (T1-T2) (Fig 2).[3] The increase is larger in the maxilla than in the mandible. The arch perimeter changes are, however, of a temporary nature because of the settling of the teeth during the immediate posttreatment period (Fig 2). The arch perimeter continues to decrease after the settling period (T3-T4), and the net effect in the long-term perspective (T1-T4) is a decrease in arch perimeter in both the maxilla and in the mandible.[3] This is in accordance with the arch perimeter decrease over time, normally found in untreated subjects.[6] However, the increase in maxillary arch perimeter during treatment (distalization of the lateral maxillary segments) can be used in the treatment planning to gain space and eliminate maxillary dental crowding.

Arch Width

As the Herbst appliance is attached to the buccal surfaces of the teeth, this will create buccally directed forces. Thus, during treatment (T1-T2), the maxillary and mandibular dental arches expand laterally in both the canine and molar areas (Fig 3).[3] The expansion is more marked in the maxilla than in the mandible. In 53 Class II subjects treated with the Herbst appliance, the maxillary intermolar width increased by an average of 3 mm.[3] Although some arch constriction occurred after the treatment period (T2-T4), the net effect on a long-term basis (T1-T4) was an expansion of both maxillary intercanine and intermolar widths. In the mandible, however,

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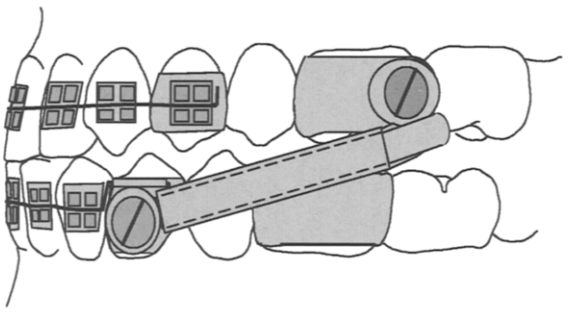

Figure 1. The Herbst appliance.

the expansion during treatment (T1-T2) rebounded during the immediate posttreatment period (T2-T3), and the net effect on a long-term basis (T1-T4) was an unchanged intermolar width and a slightly constricted intercanine width (Fig 3).[3] These long-term changes are in accordance with normal developmental changes.[6-8]

Interarch Changes

The changes in sagittal interarch relationship during Herbst treatment are a combination of skeletal and dental changes.[1,2,9]

Molar and Cuspid Relationship

In 53 Class II subjects treated with the Herbst appliance,[3] the molar relationship was normalized or overcorrected in 51 subjects and the cuspid relationship in 49 subjects (Figs 4 and 5). The correction was thus more effective in the molar than in the cuspid region (Figs 4 and 5). This could be explained by the anchorage system used in which the telescope mechanism was attached to the maxillary molars and mandibular premolars. Therefore, the maxillary molars were pushed directly distally by the telescope mechanism. The cuspids, on the other hand, were not directly engaged in the anchorage system, which thus could explain the smaller effect on these teeth.

During the settling period (T2-T3) and the long-term follow-up period (T3-T4) to the end of growth (at least 5 years after treatment), the overcorrected sagittal molar and cuspid relationships normalized in the majority of the subjects but remained overcorrected in the molar region in a few cases (Figs 4 and 5). A rebound in the sagittal molar and cuspid relationships occurred in some cases. Thus, a distal molar relationship of more than half a cusp was found at the end of the growth period in 11 of the 53 cases (21%). For the cuspid relationship, a corresponding rebound was seen in 17 cases (32%).[3]

Overjet and Overbite

In the 53 Class II subjects analyzed,[3] overjet was reduced significantly during Herbst treatment (T1-T2) (Fig 6). The overjet reduction varied between 2.5 and 13 mm (Fig 7A). During the settling period after treatment (T2-T3), the overcorrected overjet recovered to normal values (Figs 6 and 7B) and remained, on average, almost unchanged thereafter (T3-T4) (Fig 6). On an individual basis, however (Fig 7C), there was an overjet relapse ranging from 1 to 2.5 mm in 16 of the 53 subjects. In 1 subject, the relapse was significant (6.5 mm). When considering the total observation period (T1-T4), there was a reduction of overjet in all subjects but one (Figs 6 and 7D).

The pattern of overbite changes was similar to that of overjet. The average overbite reduction during treatment (T1-T2) was 3.4 mm (Fig 6). In 51 of the 53 patients, the overbite was reduced

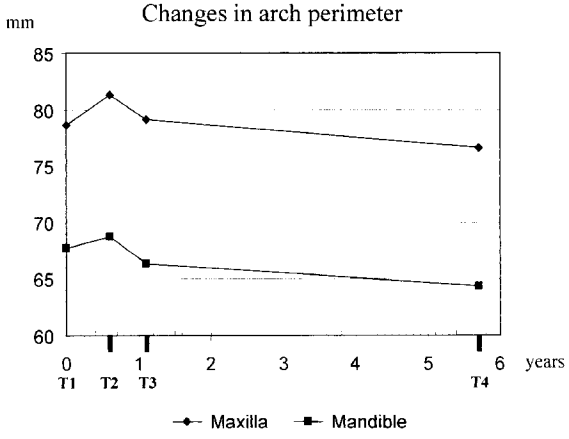

Figure 2. Maxillary and mandibular arch perimeter at 4 stages in 53 subjects treated with the Herbst appliance: T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4, at end of growth (at least 5 years after treatment).

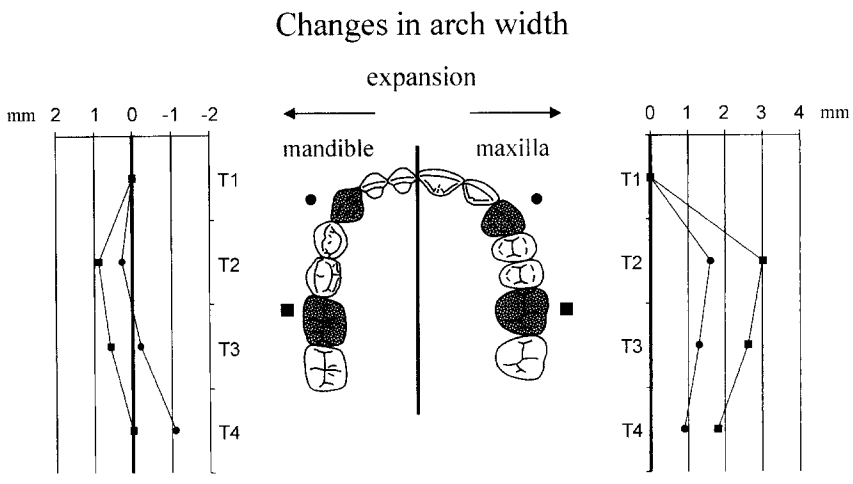

Figure 3. Maxillary and mandibular arch width at 4 stages in 53 subjects treated with the Herbst appliance: T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4, at end of growth (at least 5 years after treatment).

by 0.5 to 7.0 mm, whereas in 2 subjects the overbite remained unchanged (Fig 8A). The overcorrected overbite recovered to normal values during the settling period (T2-T3), and at the end of the follow-up period (T4), the overbite was on average 3.6 mm compared with 4.6 mm before treatment (Figs 6 and 8B-D).

Mandibular Incisor Proclination and Crowding

The anteriorly directed forces of the telescope mechanism on the lower premolars triggers a forward movement of the entire mandibular dentoalveolar segment,[1,2] which results in a proclination of the lower incisors. In 24 Class II subjects treated with the Herbst appliance,[4] the proclination during treatment was 11° (Fig 9) with a large individual variation (Fig 10A). In the posttreatment period, however, the lower incisors moved posteriorly toward their pretreatment position, but, on average, they remained somewhat proclined (Figs 9 and 10B).[4] Again the individual variation was large (Fig 10B-D). The rebound in incisor inclination, which on average occurred almost entirely during the immediate posttreatment settling period (T2-T3),[1,2,4] could be assumed to cause crowding in the mandibular anterior segment. In the 24 Class II subjects treated with the Herbst appliance,[4] available space measurements were performed. Furthermore, lower anterior crowding was expressed by the irregularity index of Little.[10] The available space was reduced (Fig 11),

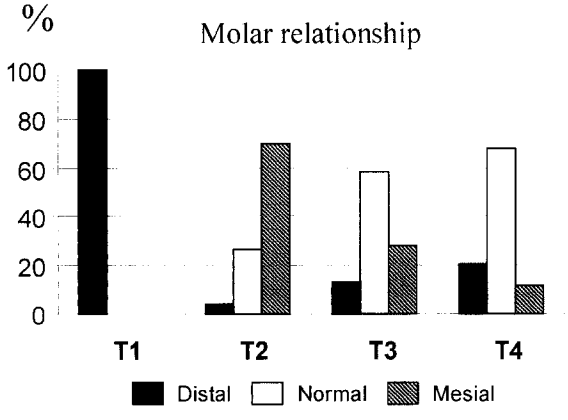

Figure 4. Molar relationship in 53 subjects treated with the Herbst appliance. T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4 at end of growth (at least 5 years after treatment).

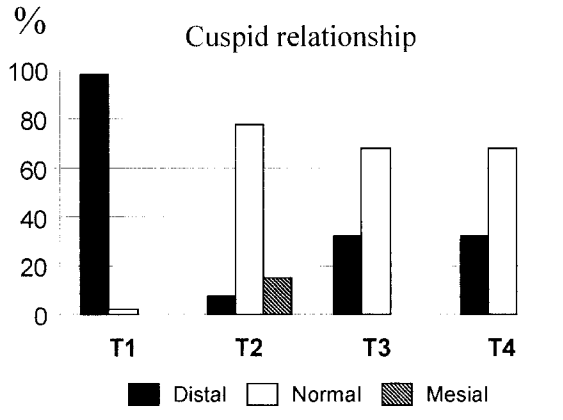

Figure 5. Cuspid relationship in 53 subjects treated with the Herbst appliance. T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4, at end of growth (at least 5 years after treatment).

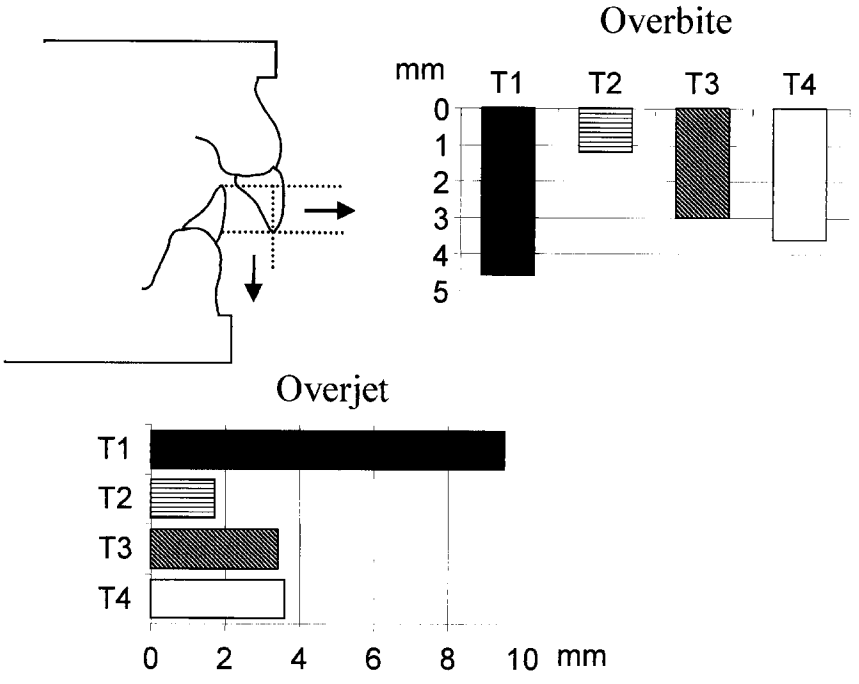

Figure 6. Overjet and overbite in 53 subjects treated with the Herbst appliance. T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4, at end of growth (at least 5 years after treatment).

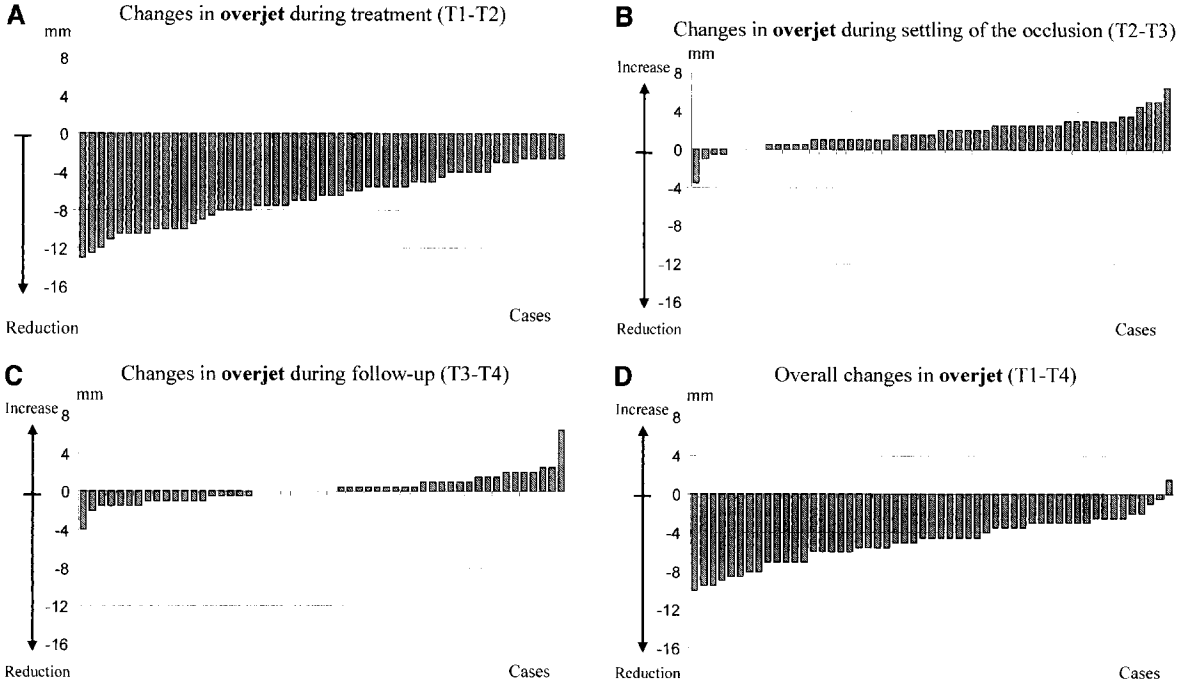

Figure 7. Changes in overjet in 53 subjects treated with the Herbst appliance. The cases are sorted according to the size of the changes. T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4, at end of growth (at least 5 years after treatment) (A-D).

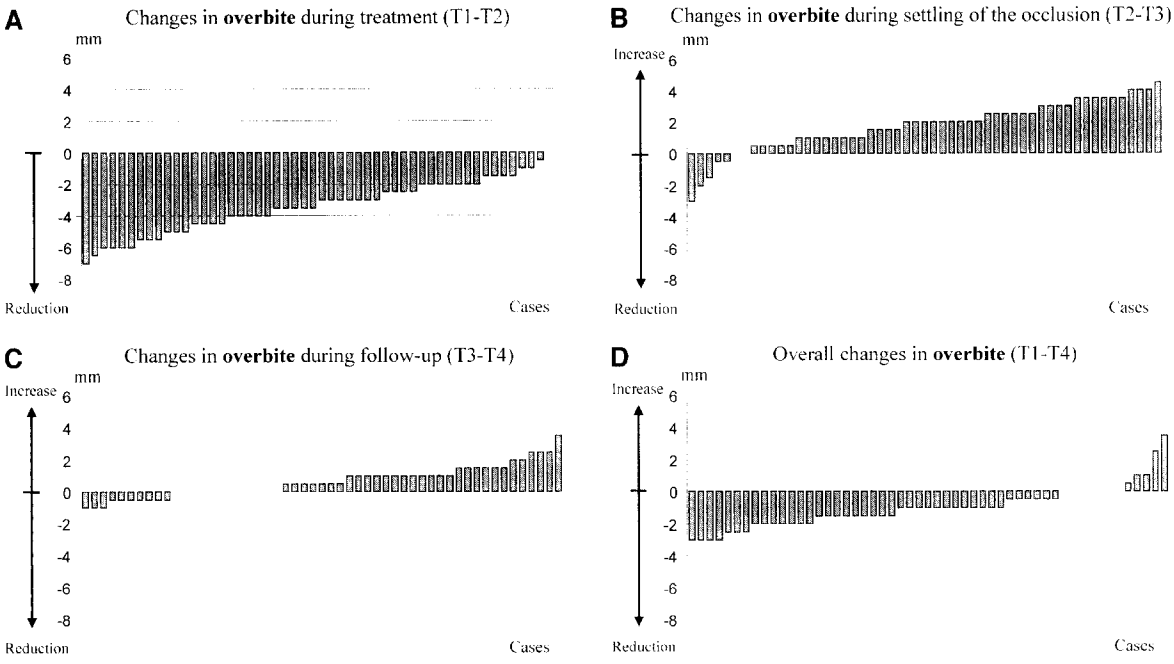

Figure 8. Changes in overbite in 53 subjects treated with the Herbst appliance. The cases are sorted according to the size of the changes. T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4, at end of growth (at least 5 years after treatment) (A-D).

and the lower irregularity index was increased, but this occurred mainly during the later part of the observation period (T3-T4) (Fig 12). The average value for the lower irregularity index at the time of follow-up (T4) was 4.4 mm. According to Little,[10] this value could be considered to represent moderate crowding. The conclusion of the investigation was that the proclination of the lower incisors during Herbst treatment did not result in lower anterior crowding after treatment. In the long-term perspective, the development of incisor crowding was instead thought to be caused by normal craniofacial and dentoalveolar growth changes.[11]

Mandibular incisor proclination

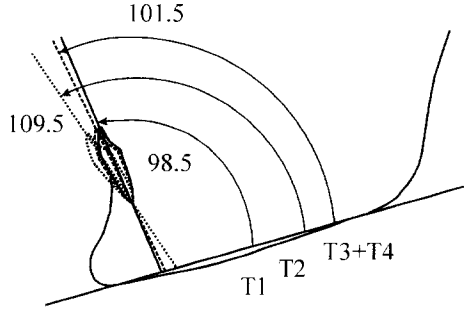

Figure 9. Mandibular incisor proclination in 24 subjects treated with the Herbst appliance. Average values of the incisor inclination. T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4, at end of growth (at least 5 years after treatment).

Lower Incisor Proclination and Gingival Recession

The large amount of lower incisor proclination during Herbst treatment could be thought to cause breakdown of the labial gingival attachment and create gingival recessions.[12-16] This was analyzed in 98 Class II subjects treated with the Herbst appliance.[5] Dental casts from before and 6 months after treatment (when the gingival irritations caused by treatment had healed) were used to measure the individual crown heights of the lower incisors. Intraoral photographs from before and 6 months after treatment were analyzed to detect possible gingival recessions. A total of 392 lower incisors were evaluated. Lateral head films were analyzed to assess the degree of incisor proclination. During treatment, a varying amount of lower incisor proclination oc-

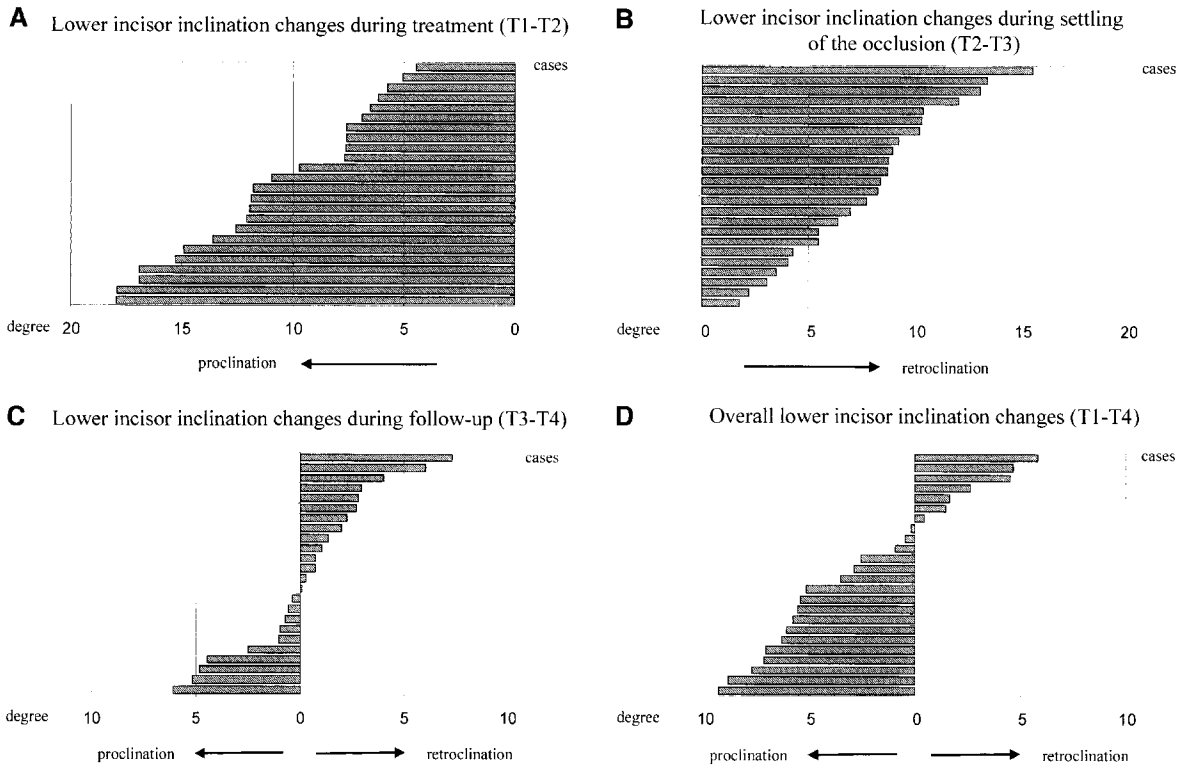

Figure 10. Mandibular incisor inclination changes in 24 subjects treated with the Herbst appliance (individual values). The cases are sorted according to the size of the changes. T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4, at end of growth (at least 5 years after treatment) (A-D).

curred (mean, 8.9°; maximum, 19.5°; minimum, 0.5°). In 380 (97%) of the surveyed teeth, either no recessions developed or preexisting recessions remained unchanged. In only 12 teeth (3%), recessions either developed or preexisting recessions deteriorated during treatment. For these teeth, the mean increase in crown height was 0.4 mm. No correlation was found between the amount of incisor proclination and the development of gingival recessions. The conclusion of this study was that in children and adolescents a temporary orthodontic proclination of lower incisors seems not to result in gingival recessions.

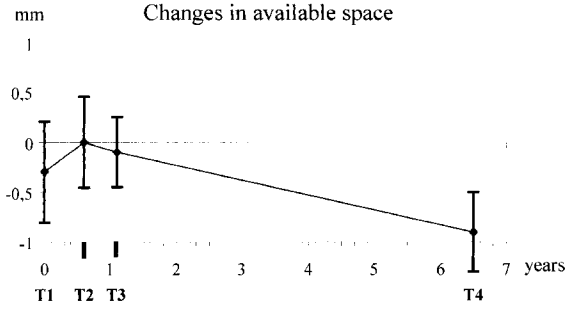

Figure 11. Available space in the mandibular anterior region (33-43) in 24 subjects treated with the Herbst appliance. T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4, at end of growth (at least 5 years after treatment).

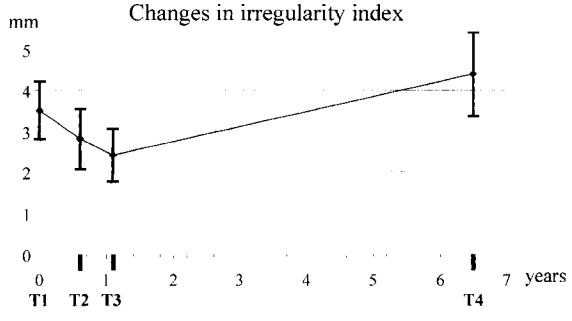

Figure 12. Mandibular incisor irregularity index according to Little[10] (1975) in 24 subjects treated with the Herbst appliance. T1, start of treatment; T2, after treatment; T3, 6 months posttreatment; and T4, at end of growth (at least 5 years after treatment).

References

1. Pancherz H, Hansen K. Occlusal changes during and after Herbst treatment: a cephalometric study. Eur J Orthod 1986;8:215-228
2. Pancherz H, Hansen K. Mandibular anchorage in Herbst treatment. Eur J Orthod 1988;10:149-164.
3. Hansen K, Iemamnuecisuk P, Pancherz H. Long-term effects of the Herbst appliance on the dental arches and arch relationship: a biometric study. Br J Orthod 1994; 22:123-134.
4. Hansen K, Koutsonas T G, Pancherz H. Long-term effects of Herbst treatment on the mandibular incisor segment: a cephalometric and biometric investigation. Am J Orthod Dentofac Orthop 1997;112;92-103.
5. Ruf S, Hansen K, Pancherz H. Orthodontic proclination of lower incisors and gingival recessions. Am J Orthod Dentofac Orthop 1998;114:100-106.
6. Moyers RE, Van der Linden FPGM, Riolo ML, et al. Standards of Human Occlusal Development. Monograph No 5, Craniofacial Growth Series, Center for Human Growth and Development. Ann Abor, MI: University of Michigan, 1976.
7. Moorrees CFA. The dentition of the growing child. Cambridge, MA: Harvard University Press, 1959.
8. Van der Linden FPGM. Development of the dentition. Chicago, IL: Quintessence Books Co, 1983;172-176.
9. Pancherz H. The mechanism of Class II correction in Herbst appliance treatment: A cephalometric investigation. Am J Orthod 1982;82:104-113.
10. Little RM. The Irregularity Index: A quantitative score of mandibular anterior alignment. Am J Orthod 1975;68: 554-563.
11. Little RM. Stability and relapse of Mandibular anterior alignment: University of Washington studies. Semin Orthod 1999;5:191-204.
12. Artun J, Krogstad O. Periodontal status of mandibular incisors following excessive proclination. A study in adults with surgically treated mandibular prognathism. Am J Orthod Dentofac Orthop 1987;91:225-232.
13. De Loor P, De Smit AA, Adriaens PA. Periodontal changes induced by orthodontically changed incisor inclination. Eur J Orthod 1995;17:57 (abstr).
14. Coatoam GW, Behrents RG, Bissada NF. The width of keratinized gingiva during orthodontic treatment: Its significance and impact on periodontal status. J Periodontol 1981;52:307-313.
15. Dorfman HS. Mucogingival changes resulting from mandibular incisor tooth movement. Am J Orthod 1978;74: 286-297.
16. Hollender L, Rönnerman A, Thilander B. Root resorption, marginal bone support and clinical crown length in orthodontically treated patients. Eur J Orthod 1980;2: 197-205.