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Original Research

Evaluation of dental and skeletal changes in patients with mandibular retrognathism following treatment with Herbst appliance using lateral cephalogram

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***ABSTRACT*:**
Background: Among the various types of malocclusion found in human population, class II division 1 is one of the most common. According to Dr. James McNamara, mandibular retrusion is the most common feature of class II division 1 malocclusion in growing children. It can be due to protrusive maxilla, retrusive mandible, or a combination of both. In patients who are at the end of prepubertal growth spurt or who are uncooperative, fixed functional appliances like Herbst, Forsus-FRD or Jasper Jumper can be used. Among all functional appliances for Class II malocclusion, the Herbst appliance is one of the most commonly used one. **Aim of the study:** To study dental and skeletal changes in patients with mandibular retrognathism following treatment with Herbst appliance using lat cephalogram. **Materials and methods:** The study was conducted in the Department of Orthodontics and Dentofacial Orthopedics of the Dental institution. For the study we selected 40 patients in the growing age from 8-14 years and bone age corresponding to the growth spurt, as revealed by a hand-wrist radiograph. Cephalometric radiographs of the patients were obtained at the beginning of the study (T1) and after 12 months of observation (T2). The change in the dento-skeletal parameters were studied by comparing T1 cephalogram and T2 cephalogram. **Results:** A total of 40 patients were selected in the study. The age of the patients ranged from 8-14 years. In case of skeletal changes, we observed significant increase in the spatial position of the mandible related to the anterior cranial base (SND) and significant reduction in the measurements related to maxillomandibular sagittal position (ANB, AO-BO). In case of dental parameters, we observed statistical changes on upper incisors position (1/NA degree) and on lower incisors tipping (1/NB degree), which resulted in significant reduction of interincisal angle. **Conclusion**: Within the limitations of the present study, it can be concluded that Herbst appliance used in class II malocclusion patients in growing age has significant improvement in the total mandibular length and anteroposterior relationship.
Keywords: Herbst appliance, functional appliances, malocclusion.

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INTRODUCTION:

Among the various types of malocclusion found in human population, class II division 1 is one of the most common. According to Dr. James McNamara, mandibular retrusion is the most common feature of class II division 1 malocclusion in growing children. Class II malocclusion is found in 15% of population in the world. Class II division 1 malocclusion is often

complicated by the presence of underlying skeletal discrepancy between maxilla and mandible. It can be due to protrusive maxilla, retrusive mandible, or a combination of both. The treatment of class II division 1 depends upon the age of the patient, growth potential, severity of malocclusion, and compliance of patient for treatment. [1, 2] In growing individuals, growth modification procedures can be carried out to correct the skeletal class II malocclusion, during mixed or early permanent dentition before the cessation of active growth. In patients who are at the end of prepubertal growth spurt or who are uncooperative, fixed functional appliances like Herbst, Forsus-FRD or Jasper Jumper can be used. [3] Among all functional appliances for Class II malocclusion, the Herbst appliance is one of the most commonly used one. It was developed by Emil Herbst in the early 1900s and reintroduced by Pancherz in the late 1970. [4] As a bilateral telescope anchored to the upper and lower arches, it keeps the mandible in a continuous anteriorly postured position during all the mandibular functional movements, [4] thereby resulting in sagittal and vertical dentoskeletal changes. In clinical settings, there are several variants of the Herbst appliance, including cast Herbst appliance and acrylic splint Herbst appliance. Herbst appliance does not require patients' cooperation due to its fixation on dental arches. [5, 6] Hence, the present study was conducted to study dental and skeletal changes in patients with mandibular retrognathism following treatment with Herbst appliance using lateral cephalogram.

MATERIALS AND METHODS:

The study was conducted in the Department of Orthodontics and Dentofacial Orthopedics of the Dental institution. The protocol of the study was approved from the ethical board of the institute before the study. For the study we selected 40 patients in the growing age from 8-14 years and bone age corresponding to the growth spurt, as revealed by a hand-wrist radiograph. The patients were selected according to the following inclusion criteria: individuals with mandibular retrognathism and Angle Class II, division 1 malocclusion greater than half-cusp (> 3 mm); individuals with overjet > 5 mm (permanent dentition); with model discrepancy under 4 mm; with clinical recommendation for mandibular advancement to be performed with functional orthopedic appliance. Individuals with absence of teeth, dental fractures and dental caries were excluded. Cephalometric radiographs of the patients were obtained at the beginning of the study (T1) and after 12 months of observation (T2). The change in the dento-skeletal parameters were studied by comparing T1 cephalogram and T2 cephalogram.

The statistical analysis of the data was done using SPSS version 11.0 for windows. Chi-square and Student's t-test were used for checking the significance of the data. A p-value of 0.05 and lesser was defined to be statistically significant.

RESULTS:

A total of 40 patients were selected in the study. The age of the patients ranged from 8-14 years. The number of male patients was 16 and female patients were 24. **Table 1** shows the mean change in dimensions of Skeletal and Dental parameters evaluated from T1 Cephalogram and T2 Cephalogram. In case of skeletal changes, we observed significant increase in the spatial position of the mandible related to the anterior cranial base (SND) and significant reduction in the measurements related to maxillomandibular sagittal position (ANB, AO-BO) ($p<0.05$) **[Fig 1]**. In case of dental parameters, we observed statistical changes on upper incisors position (1/NA degree) and on lower incisors tipping (1/NB degree), which resulted in significant reduction of interincisal angle ($p<0.05$) **[Fig 2]**.

Table 1: Mean change in dimensions of Skeletal and Dental parameters evaluated from T1 Cephalogram and T2 Cephalogram

Skeletal parameters	Mean change in dimensions (T2-T1)	p-value	Dental parameters	Mean change in dimensions (T2-T1)	p-value
SNA	1.21	0.41	**1/NA (mm)**	0.74	0.32
SNB	1.03	0.22	**1/NA (degrees)**	1.26	0.002*
SND	0.38	0.01*	**1/NB (mm)**	0.48	0.14
ANB	0.03	0.004*	**1/NB (degrees)**	0.71	0.01*
AO-BO	0.72	0.04*	**$1/G_0G_n$**	0.21	0.08
LAFH	0.81	0.41	**U_b/VL**	2.66	0.18
SN-SGn	-0.44	0.56	**L_b/VL**	2.47	0.12

Fig 1: Mean change in dimensions of Skeletal parameters

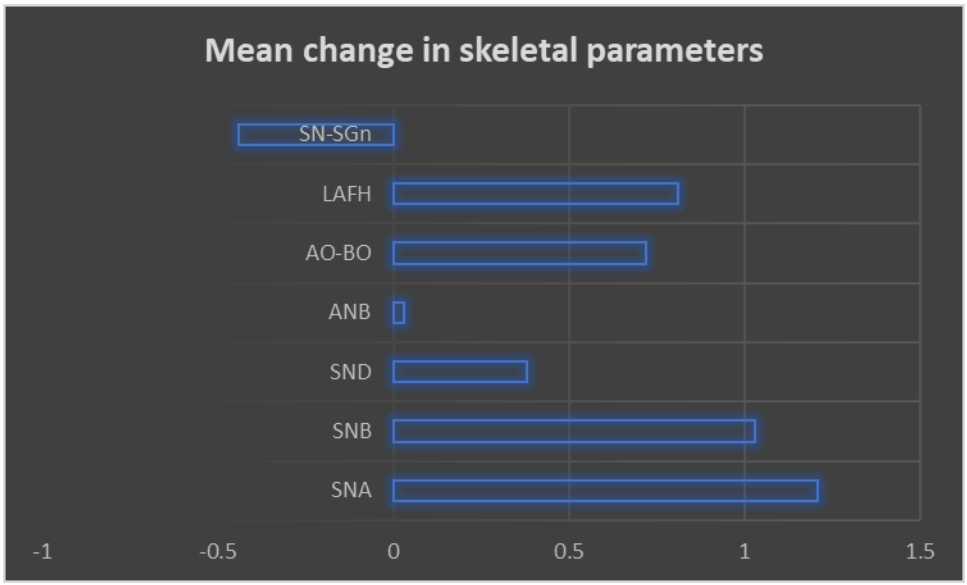
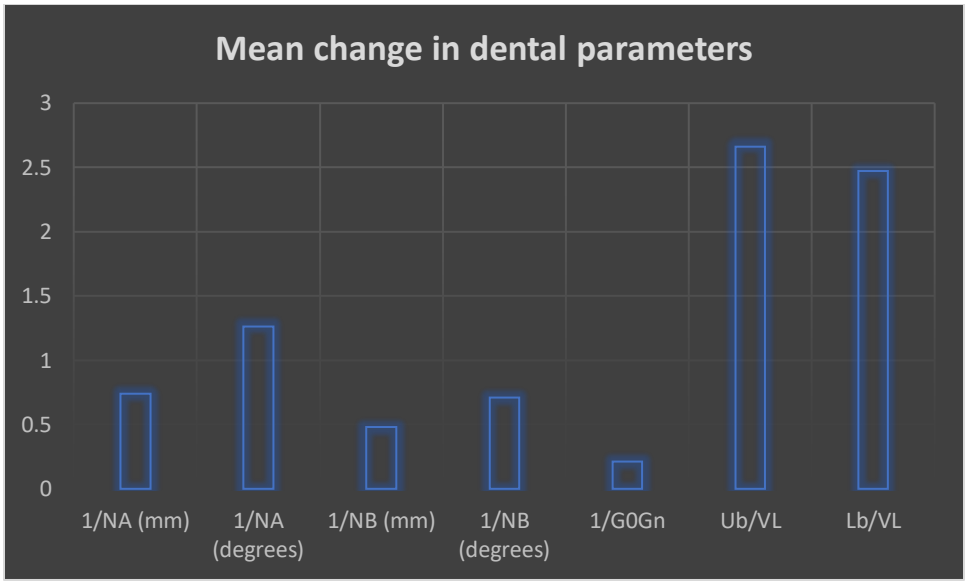


Fig 2: Mean change in dimensions of Dental parameters



DISCUSSION:

In the present study, we observed that a total of 40 patients were selected in the study. The age of the patients ranged from 8-14 years. In case of skeletal changes, we observed significant increase in the spatial position of the mandible related to the anterior cranial base (SND) and significant reduction in the measurements related to maxillomandibular sagittal position. In case of dental parameters, we observed statistical changes on upper incisors position (1/NA degree) and on lower incisors tipping (1/NB degree), which resulted in significant reduction of interincisal angle. The results were consistent with other similar studies from the literature. de Abreu Vigorito F et al assessed the dentoskeletal changes observed in treatment of Class II, division 1 malocclusion patients with mandibular retrognathism. Treatment was performed with the Herbst orthopedic appliance during 13 months (phase I) and pre-adjusted orthodontic fixed appliance (phase II). Lateral cephalograms of 17 adolescents were taken in phase I onset (T1) and completion (T2); in the first thirteen months of phase II

(T3) and in phase II completion (T4). Differences among the cephalometric variables were statistically analyzed (Bonferroni variance and multiple comparisons). From T1 to T4, 42% of overall maxillary growth was observed between T1 and T2 ($P < 0.01$), 40.3% between T2 and T3 ($P < 0.05$) and 17.7% between T3 and T4 (n.s.). As for overall mandibular movement, 48.2% was observed between T1 and T2 ($P < 0.001$) and 51.8% between T2 and T4 ($P < 0.01$) of which 15.1% was observed between T2 and T3 (n.s.) and 36.7% between T3 and T4 ($P < 0.01$). Class II molar relationship and overjet were properly corrected. The occlusal plane which rotated clockwise between T1 and T2, returned to its initial position between T2 and T3 remaining stable until T4. The mandibular plane inclination did not change at any time during treatment. They concluded that mandibular growth was significantly greater in comparison to maxillary, allowing sagittal maxillomandibular adjustment. The dentoalveolar changes (upper molar) that overcorrected the malocclusion in phase I, partially recurred in phase II, but did not hinder correction of the malocclusion. Facial type was preserved. Baysal A et al evaluated dentoskeletal effects of Herbst and Twin Block (TB) appliance therapies in Skeletal Class II malocclusion. Herbst group consisted of 11 girls and 9 boys (mean age = 12.74 ± 1.43 years), TB group comprised of 10 girls and 10 boys (mean age = 13.0 ± 1.32 years), and control group included 9 girls and 11 boys (mean age = 12.17 ± 1.47 years). Mean treatment/observation times were 15.81 ± 5.96 months for Herbst, 16.20 ± 7.54 months for TB, and 15.58 ± 3.13 months for control group. Pre-treatment (T0) and post-treatment (T1) lateral cephalograms were traced using a modified Pancherz's cephalometric analysis. Inter-group differences were evaluated with one-way analysis of variance, and intra-group differences were assessed with paired samples t-test at the $P < 0.05$ level. In control group, all sagittal and vertical skeletal measurements increased as a result of continuing growth. However, skeletal discrepancy and overjet remained unchanged. After functional appliance therapy, greater increases were recorded in TB group for all mandibular skeletal measurements compared with those in control group. Upper dental arch distalization and lower incisor protrusion were significant in Herbst group, compared with control. All face height measurements increased after functional appliance therapy. They concluded that in TB group, the treatment effects were mainly due to mandibular skeletal changes. Both skeletal and dental changes contribute to Class II correction with Herbst appliance therapy. Herbst appliance may be especially useful in Skeletal Class II patients with maxillary dentoalveolar protrusion and mandibular dentoalveolar retrusion, whereas TB appliance may be preferred for skeletal mandibular retrognathy patients.[7, 8]

VanLaecken R et al investigated skeletal and dental changes in patients with Class II malocclusions treated with the edgewise Herbst appliance. Fifty-two consecutive patients were treated with the edgewise Herbst appliance; 32 (18 girls, 14 boys) met the criterion of 16 months out of Herbst treatment and were included in the study. Mean treatment time with this appliance was 8.0 +/- 1.8 months. Patients in the mixed dentition received additional treatment with 2 x 4 appliances until proper overbite, overjet, and torque on the incisors and permanent first molars were achieved. Patients in the permanent dentition were treated with full appliances to finalize the occlusion. Cephalometric measurements were taken at pretreatment, posttreatment, and 16 months after removal of the Herbst appliance, and the results were compared with 32 untreated Class II subjects from the Bolton Brush Study, matched for sex, age, and cephalometric dentofacial morphology. Data were analyzed with ANOVA, Tukey-Kramer multiple comparison tests, and 2-tailed t tests. After 8 months of Herbst treatment, incisal relationship was overcorrected to an end-to-end incisal relationship and improved 8.4 mm, compared with the control group. The maxilla moved backward 1.4 mm at Point A, and the mandible moved forward 1.7 mm. The maxillary incisors moved lingually 1.7 mm, and the mandibular incisors were proclined 3.6 mm. The molars were corrected to a Class III relationship with a change of 7.2 mm compared with the control group. The mandible moved downward and forward. However, the condyle showed only 0.2 mm forward movement in the fossa. Sixteen months after appliance removal, the molars had relapsed into a Class I relationship, for a net change of 2.4 mm compared with the control group. Net overjet gain was 2.7 mm. Net restraint of maxillary growth was 1.3 mm, and net forward movement of the mandible was 1.0 mm. The maxillary incisors had no net movement, and the mandibular incisors had a net forward movement of 0.3 mm. Overall, skeletal change contributed 85% of the net overjet correction. They concluded that class II treatment with the edgewise Herbst appliance is accompanied by both skeletal and dental changes. The changes are stable, with significant skeletal differences remaining 16 months after appliance removal. The forward and downward movement of the mandible with minimal changes in the position of the condyles in the fossae suggests a combination of condylar growth and remodeling of the glenoid fossa with treatment. Yang X et al systematically investigated review in literature the effects of the Herbst appliance for patients with Class II malocclusion patients. They performed a comprehensive literature survey on PubMed, Web of Science, Embase, CENTRAL, SIGLE, and ClinicalTrial.gov up to December 2014. The selection criteria: randomized controlled trials or clinical

controlled trials; using any kind of Herbst appliances to correct Class II division 1 malocclusions; skeletal and/or dental changes evaluated through lateral cephalograms. And the exclusion criteria: syndromic patients; individual case reports and series of cases; surgical interventions. Article screening, data extraction, assessment of risk of bias, and evaluation of evidence quality through GRADE were conducted independently by two well-trained orthodontic doctors. Consensus was made via group discussion of all authors when there is inconsistent information from the two. After that, sensitivity analysis and subgroup analysis were performed to evaluate the robustness of the meta-analysis. Twelve clinical controlled trials meet the above-mentioned criteria, and were included in this analysis. All included studies have eleven measures taken during both active treatment effect and long term effect periods, including four angular ones (i.e., SNA, SNB, ANB, mandibular plane angle) and seven linear ones (i.e. Co-Go, Co-Gn, overjet, overbite, molar relationship, A point-OLp, Pg-OLp) during active treatment effect period were statistically pooled. Meta-analysis and sensitivity analysis demonstrated that all these measures showed consistent results except for SNA, ANB, and overbite. Subgroup analysis showed significant changes in SNA, overbite, and Pg-OLp. Publication bias was detected in SNB, mandibular plane angle, and A point-OLp. They concluded that the Herbst appliance is effective for patients with Class II malocclusion in active treatment period. Especially, there are obvious changes on dental discrepancy and skeletal changes on Co-Gn. As to its long-term effects, more evidence is needed to draw conclusions. [9, 10]

CONCLUSION:

Within the limitations of the present study, it can be concluded that Herbst appliance used in class II malocclusion patients in growing age has significant improvement in the total mandibular length and anteroposterior relationship.

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