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ORIGINAL ARTICLE

Hong Kong Dent J 2011;8:9-17

Condyle/glenoid fossa changes of Class II patients treated with the edgewise crowned Herbst appliance in the early mixed dentition period

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ABSTRACT

Objectives. To determine the condyle/glenoid fossa changes of Class II patients treated with the edgewise crowned Herbst appliance in the early mixed dentition period and the stability of treatment after phase II fixed appliance therapy. **Methods.** Twenty two patients, with a mean (standard deviation) age of 8.4 (1.0) years and Class II division 1 malocclusion treated consecutively with the edgewise crowned Herbst appliance in the early mixed dentition period, were included in the study. Lateral cephalograms were taken before Herbst treatment, immediately following Herbst treatment, and at the completion of phase II fixed appliance therapy. The results were compared with a control group of untreated Class II participants selected from the Bolton-Brush Study, who were matched for age, sex, and craniofacial morphology. Twenty two cephalometric variables were evaluated. Net changes due to treatment (treated minus control) were obtained by subtracting changes due to growth provided by the data from the matched control group. Data were analyzed using analysis of variance and *t* test. **Results.** Overcorrection with the Herbst appliance resulted in a mean net reduction in overjet of 7.0 mm and a change in molar relationship of 6.4 mm. Significant differences were found for the anterior movement of the condyle ($P = 0.02$) and anterior aspect of the glenoid fossa ($P = 0.01$) compared with the controls. At the completion of the fixed appliance therapy, the net change in overjet and molar relationship was reduced to 3.0 and 2.2 mm, respectively. Most of the remaining corrections were caused by restraint in the maxillary growth. No significant differences were found in the position of the condyle and remodeling of the glenoid fossa compared with the controls. Forward positioning of the condyle and fossa was maintained at the end of phase II fixed appliance therapy. **Conclusions.** Treatment of Class II malocclusion with the edgewise crowned Herbst appliance in early mixed dentition was accomplished by adaptive forward changes in the glenoid fossa during the entire treatment period.

Key words: Cephalometry; Mandibular condyle; Orthodontic appliances

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Introduction

Class II malocclusions are commonly treated by a one-phase fixed appliance or a functional appliance, followed by a fixed appliance [1,2]. The Herbst appliance can be used in conjunction with a fixed appliance to reduce patient compliance. Recent studies [3-5] have shown that fixed functional appliances can be effective in correcting Class II skeletal abnormalities by promoting growth of the mandible and remodeling of the glenoid fossa. However, the nature of condylar and fossa remodeling in response to functional appliance treatment is still not established. The purpose of this study was to investigate the condyle-fossa changes of Class II patients treated in the early mixed dentition period with the crowned Herbst appliance, and to examine the stability of these changes after phase II treatment with a fixed appliance. We hypothesized that there would be no significant condyle-fossa changes with edgewise crowned Herbst treatment, as well as after completion of phase II fixed appliance treatment when compared with the controls.

Methods

Participants

A total of 56 Class II patients, who were treated consecutively with the edgewise crowned Herbst appliance in the early mixed dentition period followed by phase II fixed appliance therapy, were recruited to the study. The criteria for selection included: (1) no history of previous orthodontic treatment; (2) Class II malocclusion in early mixed dentition with an ANB angle of greater than 4°; (3) completion of both phase I and phase II treatment (patients who did not require phase II or did not complete the phase II treatment were excluded from the study); and (4) no history of craniofacial anomalies. The number of patients who met the inclusion criteria was 22.

Serial cephalometric radiographs of 22 untreated patients with Class II malocclusion were obtained from the Case Western University Bolton-Brush Study [6] as the control group. The control participants were matched in sex, age, and craniofacial morphology with the patients.

Institutional Review Board approval was obtained from the West Virginia University prior to the study. Written consent was obtained from each patient. Approval was also obtained from the Bolton-Brush Center for the use of the orthodontic records and radiographs.

Appliance design

The Herbst appliance employed a bilateral telescope mechanism consisting of a tube, a plunger, two pivots, and two locking screws, which functioned to keep the mandible in a continuously anterior jumped position (Figure 1), as instructed by Dischinger [7]. The pivot for the tube was located on the maxillary primary second molar and the pivot for the plunger was attached to the mandibular primary second molar. The length of the tube determined the amount of anterior displacement of the mandible. The appliance was designed to incorporate edgewise brackets and mechanics into the correction of Class II malocclusions.

The mandibular incisor brackets incorporated a -10º inclination to minimize the proclination of incisors during Herbst treatment. Stainless steel crowns on the maxillary and mandibular permanent first molars anchored the Herbst appliance to the dentition. Double buccal tubes were placed on the molar crowns to permit the use of an auxiliary archwire to intrude the maxillary or mandibular incisors as necessary. The maxillary arch was tied back to the hooks on the molar tubes to prevent space from opening in the maxillary arch and the maxillary molars from distalizing. In addition, consolidation of the maxillary arch distributed the load applied to all the teeth. In the mandibular arch, a

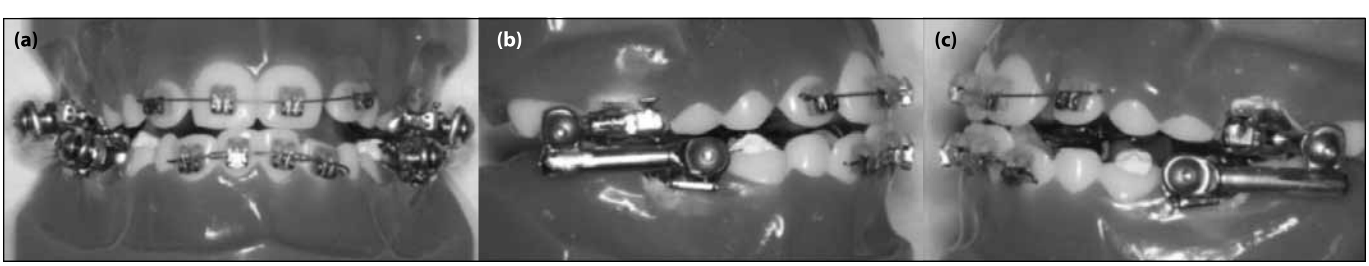

Figure 1 (a) Anterior view; (b) right lateral view; and (c) left lateral view of the edgewise crowned Herbst appliance used in the early mixed dentition

2-mm half-round cantilever was placed between the second primary molar and interproximal area between the first primary molar and cuspid. The axle was placed at the mesial end of the cantilever, and a 0.022″ x 0.028″ archwire tube was placed above and below the axle.

A transpalatal arch was not included in the appliance to allow the first molars to rotate as the Class II relationship was corrected. A lower lingual holding arch was not incorporated in the appliance to allow easier placement of the appliance and prevent possible tipping of the lower anterior incisors. Both arches were free to accommodate expansion during treatment, if necessary. An occlusal stop, which was added either off the cantilever arm or directly soldered to the stainless steel crowns extended into and rested on the distal central fossa of the first primary molar, was used to prevent tipping of the cantilever arm, impingement into the buccal mucosa and minimize tipping of the mandibular first molar.

Treatment protocol

The Herbst appliance was activated to an edge-to-edge incisor relationship with the skeletal midlines in alignment. Brackets were bonded to the maxillary and mandibular incisors, and heat-treated copper nickel titanium (CuNiTi) archwires (Ormco Co., Orange [CA], USA) were used to control incisor inclination and mandibular molar movement. Archwire sequence began with a 0.014″ CuNiTi. A 0.016″ x 0.025″ CuNiTi was then used with the maxillary wire tied back to the hook on the maxillary molar, and the lower wire was annealed and cinched to prevent anterior movement of the wire. Next, a mandibular 0.019″ x 0.025″ reverse curve NiTi archwire was placed when more leveling was necessary. Finally, a 0.019″ x 0.025″ titanium molybdenum alloy wire (TMA; Ormco Co., Orange [CA], USA) was inserted if more leveling or torque was desired.

To achieve maximum orthopedic effect, the maxillary archwire was tied back to prevent distalization of the maxillary molars. The appliance was activated in a step-by-step fashion by 4 mm every 12 weeks until the maxillary cuspid achieved an end-to-end or full tooth overcorrection relationship with the mandibular first premolar or primary first molar. The overcorrected position was held for 12 weeks. A corrected tomogram was taken prior to placement of the Herbst appliance and before removal of the appliance to confirm the condylar position. If the condyles were reasonably centered in the glenoid fossa, then a lateral cephalogram was taken and the patient was scheduled for Herbst appliance removal as soon as possible.

In the mixed dentition treatment after Herbst appliance removal, the first permanent molars were banded and brackets were placed in the maxillary incisors until the anterior occlusion was corrected, the overbite was corrected, and proper torque on the incisors was achieved. The upper and lower first permanent molar width was also coordinated. If more arch length was necessary, molar bands with 0.022″ x 0.028″ extension tubes soldered in the archwire slots were placed, and open-coil springs were used to create more arch length. Appliance removal occurred in two appointments. At the first appointment, upper and lower alginate impressions were taken, and sectional archwires were placed. At the second appointment, incisor brackets were removed and maxillary and mandibular lingual holding arches were placed. Patients were instructed that the holding arches would remain in place until all the permanent teeth had erupted. At that time, the patients were re-evaluated for comprehensive orthodontic treatment to finalize the occlusion.

Cephalometric analysis

Lateral cephalograms taken before Herbst treatment (T1), immediately after Herbst treatment (T2), and at the completion of phase II fixed appliance therapy (T3) were scanned into digital format with an Epson Expression 1680 scanner (Epson America, Long Beach [CA], USA) and printed out on a Lexmark C510 Printer (Lexmark International, Lexington [KY], USA). Each printout was superimposed on the original radiograph to ensure a 1:1 conversion with no distortion. Digital radiographs obtained from the Bolton-Brush Study [6] were scanned at 12-bit grayscale resolution with a spatial resolution of 0.1 mm per pixel and stored in uncompressed TIFF format. The images were then converted to JPEG format with the IrfanView version 4.0 (Irfan Skiljan, Bosnia/Herzegovina), and loaded into Adobe Photoshop 6.0 (Adobe Systems, San Jose [CA], USA) for size analysis. All original radiographs from the Bolton-Brush Study [6] were indexed with four corner fiduciary points using a template according to the method described by Baumrind and Miller [8]. Within Adobe Photoshop, the resolutions of the images were verified (600 dpi), and the images were resized to the original dimensions of the unscanned radiographs. Printouts were then made and the fiduciary points were measured with an electronic digital caliper to ensure a 1:1 conversion with no distortion from the original radiographs.

Tracings were performed by one operator using a #2 HB mechanical lead pencil (Pentel 0.5 mm lead; Art Supply Warehouse, Westminster [CA], USA), an orthodontic protractor, and 0.003" matte cephalometric acetate tracing film (3M Unitek, Monrovia [CA], USA). A custom cephalometric analysis was performed using landmarks described by published cephalometric systems [9-11]. The reference lines used for this analysis were formed by the occlusal plane OLp and a plane perpendicular to the occlusal plane OLs (Figures 2 and 3). All sagittal and vertical measurements were made with this reference grid from the T1 radiograph and transferred to the T2 and T3 radiographs through superimposition on the anterior cranial base. The data were normalized to account for magnification differences between the cephalometric machine used for the Bolton-Brush Study [6] (5.6%) and the cephalometric machine used for the treated patients (10%). The measurement for each condyle/glenoid fossa measurement was performed with an electronic digital caliper and evaluated to the nearest 0.1 mm.

Error analysis

The reliability of the cephalometric measurements was tested by examining the error in locating, superimposing, and measuring the changes of all landmarks. Pretreatment and post-treatment lateral cephalograms of 10 randomly selected patients were retraced at least 2 weeks after the initial tracing and analyzed to evaluate error. For all cephalometric variables, differences between the measurements recorded at the first tracing and the second tracing were compared for each individual at T1, T2, and T3. A matched-pair *t* test was performed to compare the two registrations. A correlation coefficient was established for each variable at each time point to determine the degree of reliability. Overall, the method of cephalometric analysis used in this study, including landmark identification, superimposition of radiographs, and measurements were determined to be reliable with most of the correlation coefficients of above 0.9.

Data analysis

A matched-pair *t* test was used to compare the starting forms between the treated patients and the controls at T1 (Table 1). The differences between the treatment and control participants for each variable across the three time periods

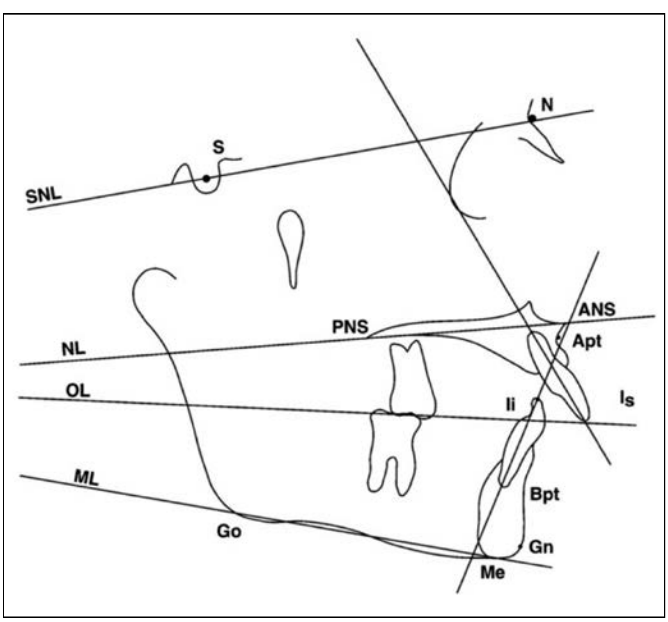

Figure 2 Cephalometric landmarks for angular measurements

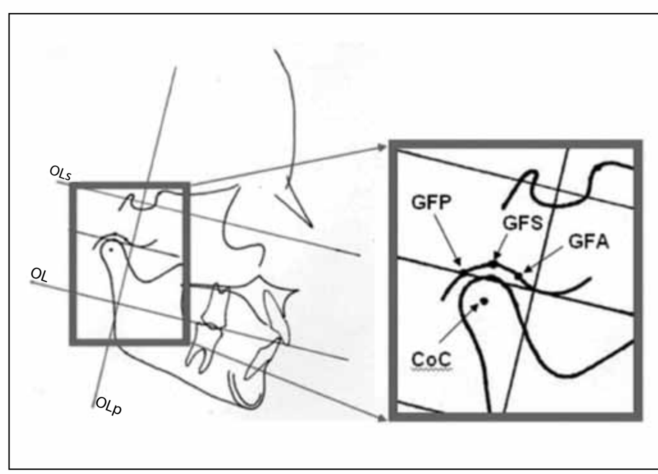

Figure 3 Landmarks and reference lines for sagittal and vertical measurements of the condyle/glenoid fossa
OL denotes occlusal plane; OLp occlusal plane perpendicular; OLs occlusal plane passing through sella; CoC center of condyle; GFA anterior aspect of glenoid fossa; GFS superior aspect of glenoid fossa; and GFP posterior aspect of glenoid fossa

(T1 through T3) were analyzed for male, female and pooled participants. A repeated measures analysis of variance was performed to determine whether the differences between the treated patients and the controls were the same across the three time periods. A matched-pair *t* test was also performed for each variable to identify treatment effects of the Herbst appliance (treated subjects [T2-T1] vs. controls [t2-t1]), and the combined Herbst and phase II treatment (treated subjects [T3-T1] vs. controls [t3-t1]). The level of significance was set at $P<0.05$.

Results

Sample size and age distribution

The final sample size consisted of 22 patients (7 male and 15 female) for the study group and 22 participants from the Bolton-Brush Study [6] who were matched for age and sex to the study group. The respective mean (standard deviation) age of the treatment and control groups was 8.4 (1.0) and 8.4 (1.1) years at T1; 9.3 (0.9) and 9.4 (0.8) years at T2; and 14.6 (1.4) and 14.7 (1.5) years at T3. No significant differences in age were found between these two groups for any of the time periods.

Gender differences

Gender differences were analyzed for pretreatment craniofacial morphology as well as treatment changes. Due to the small quantity of data, only pooled data were reported.

Pretreatment craniofacial morphology

Table 1 shows the pretreatment craniofacial morphology of the treatment and control groups. No significant differences were found between the two groups for the tested variables at T1, except the ANB difference (P = 0.002). The

Table 1 Comparison of the pretreatment craniofacial morphology in pooled participants *

Variable	Controls	Treated patients	Difference (treated minus control)	P value
Sagittal (mm)				
Wits	1.1 (1.6)	1.1 (1.9)	0.0	0.98
Overjet	4.7 (2.1)	5.6 (2.6)	0.9	0.17
Molar relationship	0.3 (0.9)	0.8 (2.0)	0.5	0.32
Vertical (mm)				
ANS-Me	57.0 (4.6)	56.9 (3.2)	-0.1	0.93
Overbite	1.6 (3.0)	1.4 (3.4)	-0.2	0.80
Angular (°)				
SNA	79.9 (3.2)	81.4 (3.9)	1.5	0.16
SNB	75.3 (3.0)	75.0 (3.6)	-0.3	0.81
ANB	4.6 (1.3)	6.4 (2.1)	1.8	0.002
SNL-NL	7.5 (3.2)	8.3 (3.6)	0.8	0.46
SNL-ML	34.1 (4.6)	34.4 (7.9)	0.3	0.88
SNL-OL	20.3 (3.5)	22.3 (4.2)	2.0	0.11
Is/NL	111.0 (5.9)	109.6 (6.0)	-1.4	0.42
Ii/ML	94.6 (5.7)	96.0 (9.3)	1.4	0.54
Interincisal angle	127.6 (7.9)	126.7 (10.3)	-0.9	0.74
Condyle/glenoid fossa (mm)				
OLp-CoC	-5.9 (2.0)	-5.1 (2.8)	0.8	0.28
OLp-GFS	-6.1 (2.4)	-5.9 (2.9)	0.2	0.79
OLp-GFA	-1.8 (2.1)	-1.4 (2.5)	0.4	0.57
OLp-GFP	-11.7 (2.2)	-11.8 (3.4)	-0.1	0.91
OLs-CoC	21.7 (2.3)	20.9 (2.6)	-0.8	0.29
OLs-GFS	15.8 (2.4)	14.8 (2.8)	-1.0	0.20
OLs-GFA	17.3 (2.3)	16.6 (2.6)	-0.7	0.35
OLs-GFP	19.2 (2.2)	19.0 (2.5)	-0.2	0.85

* Data are shown as mean (standard deviation), unless otherwise specified

maxillomandibular difference was greater in the treated group than the controls.

Treatment effects after the Herbst therapy

Table 2 compares the skeletal and dental changes in response to the Herbst treatment, as well as the condyle/glenoid fossa changes between the treatment and control groups for the pooled participants. Overcorrection with the Herbst appliance resulted in a mean net reduction in overjet of 7.0 mm and a change in molar relationship of 6.4 mm. The change in overjet was contributed by forward maxillary growth, forward movement of the mandible, backward movement of maxillary incisors, and forward movement of mandibular incisors. The change in molar relationship was caused by the skeletal changes together with backward movement of the maxillary molars and forward movement of the mandibular molars. A net decrease in ANB of 2.0° was found in the treatment relative to the control group. The position of the maxilla relative to the mandible along the functional occlusal plane (Wits) showed a difference of -3.7 mm compared with the controls. Vertically, overbite was decreased by 2.4 mm. A net increase of 1.7° in the palatal plane angle (SNL-NL) and that of 2.8° in the functional occlusal plane angle (SNL-OL) were found. The inclination of the maxillary incisor (Is/NL) decreased by 7.0° compared with the controls. However, the mandibular incisor angle (Ii/ML) had a net increase of 7.6° compared with the control group.

Significant differences in condylar position (OLp-CoC) [P=0.02] and the anterior aspect of the glenoid fossa (OLp-GFA) [P=0.01] were found between the treatment and control groups. In addition, all sagittal condyle/glenoid fossa variables in the treatment group showed a forward movement compared with the controls. A net anterior

Table 2 **Comparison of treated versus control participants after Herbst treatment** *

Variable	Controls (t2-t1)	Treated subjects (T2-T1)	Difference (treated minus control)	P value
Sagittal (mm)				
Wits	-0.7 (1.6)	-4.4 (3.0)	-3.7	0.001
Overjet	0.6 (1.6)	-6.4 (3.9)	-7.0	<0.001
Molar relationship	-0.2 (0.9)	-6.6 (2.8)	-6.4	<0.001
Vertical (mm)				
ANS-Me	1.7 (1.4)	1.3 (1.7)	-0.4	0.50
Overbite	1.3 (2.9)	-1.1 (3.6)	-2.4	0.08
Angular (°)				
SNA	0.6 (1.4)	-0.3 (2.4)	-0.9	0.23
SNB	0.6 (1.6)	1.6 (2.1)	1.0	0.17
ANB	0.0 (1.2)	-2.0 (2.4)	-2.0	0.01
SNL-NL	-0.7 (2.0)	1.0 (1.8)	1.7	0.03
SNL-ML	-0.1 (1.8)	0.1 (1.6)	0.2	0.73
SNL-OL	0.6 (2.1)	3.4 (3.8)	2.8	0.03
Is/NL	-0.3 (3.4)	-7.3 (7.3)	-7.0	0.004
Ii/ML	-0.5 (2.8)	7.1 (6.9)	7.6	0.001
Interincisal angle	-0.8 (6.0)	1.4 (9.4)	2.2	0.49
Condyle/glenoid fossa (mm)				
OLp-CoC	-0.5 (1.6)	1.2 (1.7)	1.7	0.02
OLp-GFS	-0.1 (1.7)	0.9 (1.8)	1.0	0.16
OLp-GFA	-0.5 (1.7)	1.6 (1.8)	2.1	0.01
OLp-GFP	-0.3 (2.0)	1.3 (2.5)	1.6	0.08
OLs-CoC	1.1 (1.3)	0.5 (1.6)	-0.6	0.28
OLs-GFS	0.5 (1.2)	0.5 (1.5)	0.0	0.93
OLs-GFA	0.5 (1.0)	0.2 (1.3)	-0.3	0.60
OLs-GFP	0.2 (1.2)	0.0 (1.7)	-0.2	0.81

* Data are shown as mean (standard deviation), unless otherwise specified. T1/t1 denotes measurements before Herbst treatment, and T2/t2 measurements immediately after Herbst treatment

movement of 1.7 mm was found for the condylar position (OLp-CoC). Net anterior movements were also found for the superior (OLp-GFS; 1.0 mm), anterior (OLp-GFA; 2.1 mm), and posterior (OLp-GFP; 1.6 mm) aspects of the glenoid fossa. No significant differences were found in the vertical condyle/glenoid fossa variables between the treatment and control groups.

Combined treatment effects of the Herbst and fixed appliances

Table 3 compares the skeletal and dental changes, as well as the condyle/glenoid fossa changes after phase II fixed appliance therapy. At the end of fixed appliance therapy, the mean net change in overjet was reduced to 3.0 mm. Most of the remaining overjet corrections were caused by restraint in maxillary growth. The mandible moved posteriorly as compared with T2 and the mandibular incisors moved forward. A net decrease in ANB of 2.1° was found in the treated group compared with the controls. The position of the maxilla relative to the mandible along the functional occlusal plane (Wits) showed a difference of 1.6 mm compared with the control group. Vertically, the overbite difference was reduced to 1.4 mm. No significant differences in overbite changes, as well as condyle/glenoid fossa changes were found between the treatment and control subjects. However, all sagittal glenoid fossa variables (OLp-GFS, OLp-GFA, and OLp-GFP) showed a forward movement in the treatment group compared with a backward movement in the control group. The condyle variable OLp-CoC showed a forward movement of 0.8 mm in treated group when compared with the controls. Net anterior movements of 0.9 mm, 0.6 mm, and 1.7 mm were found in the superior, anterior, and posterior aspects of the glenoid fossa, respectively.

Table 3 Comparison of treated versus control participants after second phase of fixed appliance therapy *

Variable	Controls (t3-t1)	Treated subjects (T3-T1)	Difference (treated minus control)	P value
Sagittal (mm)				
Wits	0.0 (1.7)	-1.6 (2.0)	-1.6	0.01
Overjet	0.7 (1.6)	-2.3 (2.8)	-3.0	<0.001
Molar relationship	-0.7 (1.1)	-2.9 (2.0)	-2.2	<0.001
Vertical (mm)				
ANS-Me	6.8 (2.4)	5.8 (3.0)	-1.0	0.22
Overbite	1.7 (3.2)	0.3 (3.2)	-1.4	0.17
Angular (°)				
SNA	1.8 (2.3)	-0.8 (2.9)	-2.6	0.002
SNB	1.9 (2.0)	1.4 (2.4)	-0.5	0.39
ANB	-0.1 (1.3)	-2.2 (1.6)	-2.1	<0.001
SNL-NL	-0.9 (2.7)	0.3 (3.3)	1.2	0.20
SNL-ML	-1.3 (2.3)	-1.1 (2.6)	0.2	0.78
SNL-OL	-2.4 (3.2)	-0.9 (3.2)	1.5	0.13
Is/NL	-1.0 (5.6)	0.5 (6.4)	1.5	0.44
Ii/ML	0.0 (4.9)	3.0 (7.7)	3.0	0.11
Interincisal angle	1.6 (7.4)	-0.3 (13.4)	-1.9	0.57
Condyle/glenoid fossa (mm)				
OLp-CoC	-1.1 (2.1)	-0.3 (2.3)	0.8	0.24
OLp-GFS	-0.9 (2.9)	0.0 (2.6)	0.9	0.29
OLp-GFA	-0.1 (2.5)	0.5 (2.5)	0.6	0.42
OLp-GFP	-1.2 (2.6)	0.5 (3.5)	1.7	0.07
OLs-CoC	3.7 (1.9)	2.4 (2.8)	-1.3	0.06
OLs-GFS	3.0 (1.9)	2.3 (1.9)	-0.7	0.19
OLs-GFA	3.0 (1.6)	2.3 (1.6)	-0.7	0.13
OLs-GFP	3.0 (1.5)	2.1 (1.7)	-0.9	0.02

* Data are shown as mean (standard deviation), unless otherwise specified. T3/t3 denotes measurements after completion of phase II fixed appliance therapy, and T2/t2 measurements immediately after Herbst treatment

Discussion

This is the first report on the quantitative changes in the condyle/glenoid fossa with Herbst treatment followed by phase II fixed appliance therapy. The use of lateral head films to measure condyle-fossa changes suffered from the fact that double registrations that may cause errors in the measurement are sometimes seen on the radiographs. Computed tomography and magnetic resonance imaging have been used to quantify changes in the temporomandibular joint with more accurate results [5,12-15].

Wieslander [16,17] reported the long-term effect of headgear-Herbst treatment in a group of children with severe Class II malocclusion. The patients were followed up after orthodontic retention at a mean age of 17 years 4 months and compared with an untreated control group. The mean forward movement of the mandible reduced from 3.9 mm to 1.5 mm. However, the 1.5 mm headgear effect on the maxilla continued to increase, partly due to the use of an activator as a retention device [16,17]. The skeletal changes reported by Wieslander [16,17] were similar to those found in our study, confirming the effect on the maxilla partly compensated the relapse tendency observed in the mandible after Herbst treatment.

In the current study, both the condyle and the glenoid fossa remodeled forward with Herbst treatment, compared with backward movements of the condyle/glenoid fossa in the control group. After fixed appliance therapy, no significant differences were found with the position of the condyle/glenoid fossa. However, both the condyle/glenoid fossa were found to be in a more anterior position in the treatment group compared with a continuous backward movement in the control group. These results suggest that the condyle/glenoid fossa undergo adaptive changes during and after Herbst appliance treatment. Previous studies [5,12,13] reported that the placement of the Herbst appliance caused forward and downward movements of the condyle, which induced adaptive growth, modeling, and remodeling of the condyle, the glenoid fossa, and the articular tubercle. It has been shown that adaptive growth in the condyle and remodeling of the glenoid fossa contribute to forward relocation of the mandible [5,14,15]. These changes have been reported to be stable after Herbst treatment [13]. In a primate study, Voudouris *et al*. [18] reported that the growth modification measured in the glenoid fossa was in an inferior and anterior direction. The authors [18] also noted that the restriction of the downward and backward growth of the fossa observed in the control participants may contribute to the Class II correction.

Conclusions

Overcorrection of patients with Class II division 1 malocclusions with the crowned Herbst appliance in the early mixed dentition period resulted in a reduction in overjet and improvement in molar relationship. This was caused by a restraint in the forward movement of the maxilla and anterior movement of the mandible. Concurrently, significant anterior movement of the condyle and anterior aspect of the glenoid fossa were found. During phase II fixed appliance therapy, the change in overjet and molar relationship were reduced. The maxilla continued to remodel forward but the forward movement of the mandible was reduced. This was accompanied by adaptive relocation of the glenoid fossa throughout the entire treatment.

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