European Journal of Orthodontics 19 (1997) 195–204

A comparative study of sagittal correction with the Herbst appliance in two different ethnic groups

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SUMMARY The dentofacial morphology of Chinese is different from Caucasians. The purpose of this investigation was to assess the skeletal and dental changes contributing to the sagittal correction in a group of consecutive Chinese children who were treated with the Herbst appliance. A comparison was made between 14 Chinese and 14 Swedish subjects who all had Herbst appliance treatment. All subjects were corrected from the Class II division 1 malocclusion to an overcorrected Class I or Class III dental relationship within a 6–8 month period. Lateral cephalograms taken before and immediately after the Herbst treatment were analysed. In general, the skeletal and dental changes during treatment were comparable between both ethnic groups. However, individual variations within the two groups were wide. It can be concluded that the Herbst appliance was equally successful in Southern Chinese children and similar treatment changes as those achieved in Swedish children could be found.

Introduction

The Herbst appliance (Herbst, 1934) was shown to be effective in correcting Class II division 1 malocclusion (Pancherz 1979, 1981, 1984; Pancherz and Hansen, 1986). On average the correction of the Class II division 1 malocclusion resulted equally from skeletal and dental changes (Pancherz, 1982). All previous studies (e.g. Pancherz, 1979, 1984; Wieslander, 1984; Valent and Sinclair, 1989) on treatment effects with the Herbst appliance were based on Caucasian subjects but the effects of the Herbst appliance on individuals of different ethnic groups are largely unknown. Dentofacial morphology of the Chinese has different characteristic features (Wei, 1965; Yen, 1973; Cooke, 1986; Cooke and Wei, 1989; Lundström and Cooke, 1991). The Chinese population, in general, have a bimaxillary profile with an increased procumbence of teeth and alveolar bone. The increased dental procumbence is attributed to the dentoalveolar compensation for teeth on a relatively small basal arch and the prominent marginal ridge of the maxillary incisors (Wei, 1965). The Herbst appliance produced significant dental changes, of which proclination of the mandibular incisors was marked (Pancherz and Hansen, 1986). The purpose of this investigation was to study the treatment effects in Chinese which might differ from those of Caucasians, to compare the patterns of skeletal and dental changes during Herbst appliance treatment in two ethnic groups, Chinese and Swedish children, and to assess the individual significant changes.

Subjects

The Chinese sample consisted of 14 (eight boys and six girls) consecutive patients treated with the Herbst appliance at the Department of Children's Dentistry and Orthodontics, Faculty of Dentistry, the University of Hong Kong in 1990–1991. Of these patients, 13 had no previous orthodontic treatment and one subject had been treated previously with a removable appliance to correct a posterior crossbite. The mean age of the subjects at the beginning of treatment was 13.4 years (SD = 1.9).

The Swedish sample consisted of 14 (eight boys and six girls) selected from a pool of approximately 200 consecutive patients treated with the Herbst appliance at the Department of Orthodontics, Faculty of Odontology, University of Lund, Sweden. The Swedish sample was matched in sex, age and duration of treatment with the Chinese sample. Mean age of the Swedish subjects before treatment was 13.3 years (SD = 2.1).

Both groups of children were either in the late mixed or early permanent dentition stage, and all had a full-unit Class II molar relationship before treatment. The design of the Herbst appliance used in treating all subjects was described by Pancherz (1985).

Methods

Lateral cephalograms in centric occlusion of each patient taken before and after treatment were assessed. The tracings were made on matt acetate tracing films with a sharp 3H pencil and the measurements were recorded with a calibrated caliper to the nearest 0.1 mm. When double projections gave rise to two points, the midpoint was used. The measurements were recorded twice independently in each subject and the mean value of two assessments was used for each parameter. The dentofacial morphology before and after treatment was analysed by the method described by Björk (1947) (Table 1). The changes which occurred during treatment were evaluated using the analysis devised by Pancherz (1982) (Fig. 1). The cephalometric measurements (Pancherz, 1982) comprised the following variables (1–8) (Fig. 1):

Skeletal measuring points

1. Position of maxillary base: ss–OLp
2. Position of mandibular base: Pg–OLp

Dental measuring points

3. Position of maxillary central incisor: Is–OLp
4. Position of mandibular central incisor: Ii–OLp
5. Position of maxillary first permanent molar: Ms–OLp
6. Position of mandibular first permanent molar: Mi–OLp

Table 1 Cephalometric measurements describing dentofacial morphology (Björk, 1947) of the Chinese and Swedish groups before and after treatment with the Herbst appliance.

Variables (degrees or mm)	Chinese ($n = 14$)				Swedish ($n = 14$)				Ethnic differences	
	Before treatment		After treatment		Before treatment		After treatment		Before treatment	Before treatment
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Maxillary position (SNA)	83.6	2.5	83.4	2.9	80.7	2.8	80.3	2.5	2.9**	3.1**
Mandibular position (SNB)	76.9	2.4	78.7	2.8	75.5	2.2	76.4	2.0	1.4	2.3
Sagittal jaw relation (ANB)	6.6	1.4	4.8	1.5	5.2	1.8	3.9	1.7	1.4	0.9
Nasal plane angle (NL/NSL)	6.9	3.6	6.9	3.7	7.3	3.4	7.8	3.3	−0.4	−0.9
Mandibular plane angle (ML/NSL)	32.9	7.4	33.0	7.7	32.4	5.5	33.1	4.6	0.5	0.1
Vertical jaw relation (ML/NL)	26.0	7.5	26.1	6.9	25.1	5.2	25.3	4.2	0.9	0.8
Occlusal plane angle (OLs/NSL)	19.5	4.5	22.0	5.1	20.5	2.3	22.8	2.4	−1.0	−0.8
Maxillary incisor angle (Ils/NSL)	115.1	8.1	105.8	8.8	102.1	4.9	95.3	3.2	13.0**	10.5**
Interincisal angle (Ils/ILi)	108.8	8.4	106.9	8.3	128.4	8.8	125.3	8.5	−19.6**	−18.4**
Mandibular incisor angle (ILi/ML)	103.5	6.2	114.5	6.3	97.0	6.9	106.5	8.7	6.5	8.0**
Mandibular length (Pg–Ar) in mm	102.9	5.7	107.9	6.5	104.8	7.5	108.6	8.2	−1.9	−0.7

** $P < 0.01$.

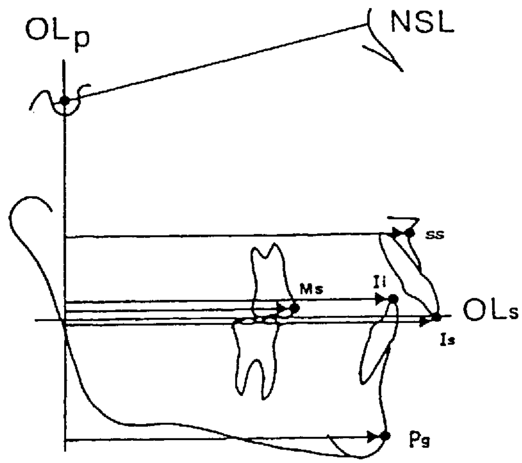

Figure 1 The registration line (NSL), reference grid (OLs and OLp) and measuring points used in the sagittal cephalometric analysis (courtesy of Pancherz, 1982).

7. Overjet: Is–OLp minus Ii–OLp
8. Molar relationship: Ms–OLp minus Mi–OLp

Evaluation of sagittal skeletal and dental changes

Changes in position of the measuring points were calculated by the difference (d) in landmark position before and after treatment. Changes in position of variables 1 and 2 represented the skeletal changes, while changes in position of variables 3 to 6 represented combined skeletal and dental changes (Pancherz, 1982).

The dental changes that occurred within the maxilla (variables 9 and 11) and mandible (variables 10 and 12) respectively were calculated as follows:

9. Change in position of the maxillary central incisor within the maxilla: Is–OLp(d) minus ss–OLp(d)
10. Change in position of the mandibular central incisor within the mandible: Ii–OLp(d) minus Pg–OLp(d)
11. Change in position of the maxillary first permanent molar within the maxilla: Ms–OLp(d) minus ss–OLp(d)
12. Change in position of the mandibular first permanent molar within the mandible: Mi–OLp(d) minus Pg–OLp(d)

The cephalometric magnification ratios of the images with reference to the midsagittal plane were 8 per cent and 7 per cent for the Chinese and Swedish groups respectively. As the difference in the magnification ratios of the two groups was small, no correction was made for the measurements.

Statistical analysis

The mean and SD of each cephalometric variable were recorded for each ethnic group. The null hypothesis was that treatment effects of the Chinese and Swedish subjects were similar. All variables describing the treatment changes were tested statistically using the analysis of variance. The variance ratios (F) were tested with the level of significance being $P<0.01$; $P>0.01$ was designated as being not significant (ns).

Results

The cephalometric measurements describing dentofacial morphology (Björk, 1947) of the 14 Chinese and 14 Swedish subjects before and after treatment with Herbst appliance are shown in Table 1. The maxillary prognathism was significantly greater in the Chinese sample both before and after treatment. After treatment the mandibular prognathism was significantly more increased in the Chinese sample. Before treatment the sagittal discrepancy was significantly more pronounced in the Chinese sample but not after treatment. The inclination of both maxillary and mandibular incisors was significantly more proclined in the Chinese sample before and after treatment.

The cephalometric changes (Pancherz, 1982) occurring during the 6–8 months of treatment in all children of both groups resulted in an overcorrected Class I or Class III dental relationship. The changes in the overjet and molar relationship were contributed to by both skeletal and dental changes (Figures 2 and 3, Table 2).

Overjet correction

Chinese group

On average, the maxilla moved forward by 0.2 mm and the maxillary incisors moved distally by 2 mm. The combined skeletal and

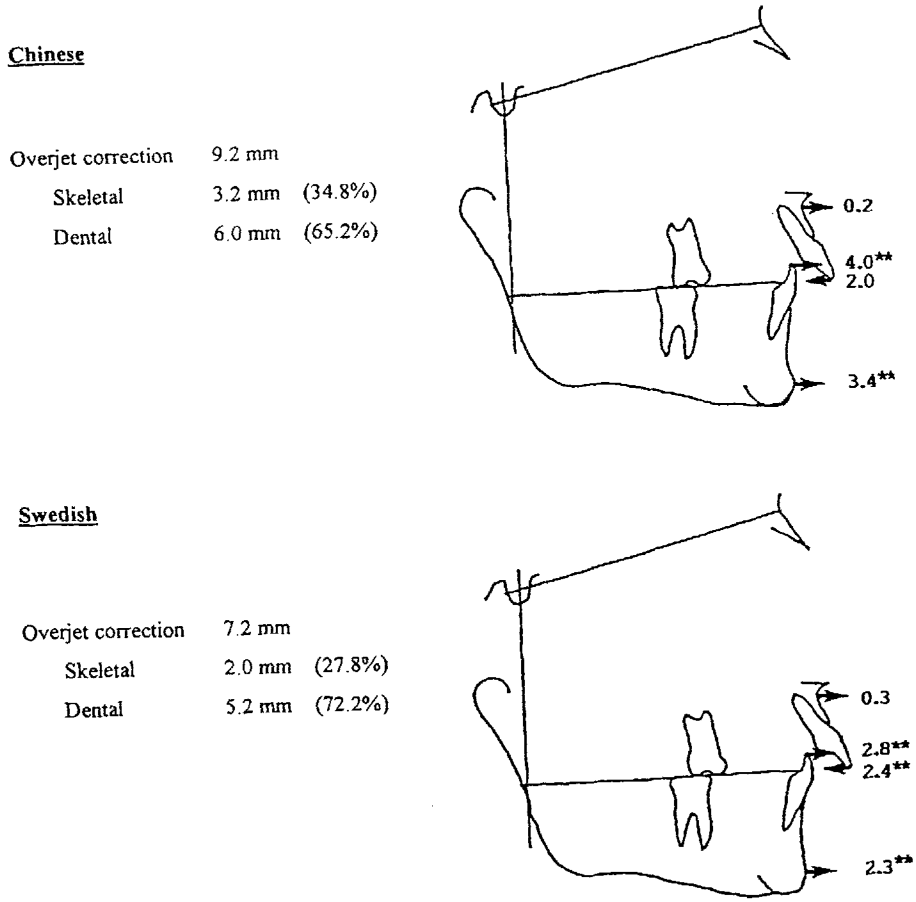

Figure 2 Diagrammatic representation of the overjet correction (mm) during the Herbst appliance treatment in the 14 Chinese and 14 Swedish subjects.

dental changes in the maxilla reduced the overjet by 1.8 mm (19.6 per cent of the overjet reduction).

On average, the mandible moved forward by 3.4 mm and the mandibular incisors were proclined by 4 mm. The combined skeletal and dental changes reduced the overjet by 7.4 mm (80.4 per cent of the overjet reduction).

Swedish group

On average, the maxilla moved forward by 0.3 mm and the maxillary incisors moved distally by 2.4 mm. The combined skeletal and dental changes in the maxilla reduced the overjet by 2.1 mm (29.2 per cent of the overjet reduction).

On average, the mandible moved forward by 2.3 mm and the mandibular incisor were proclined by 2.8 mm. The combined skeletal and dental changes reduced the overjet by 5.1 mm (70.8 per cent of the overjet reduction).

Molar correction

Chinese group

On average, the maxilla came forward by 0.2 mm and the maxillary first permanent molars moved distally by 1.9 mm. The combined skeletal and dental changes in the maxilla contributed 1.7 mm to the molar correction (23.6 per cent of the molar correction).

On average, the mandible came forward by 3.4 mm and the mandibular first permanent molars moved mesially by 2.1 mm. The com-

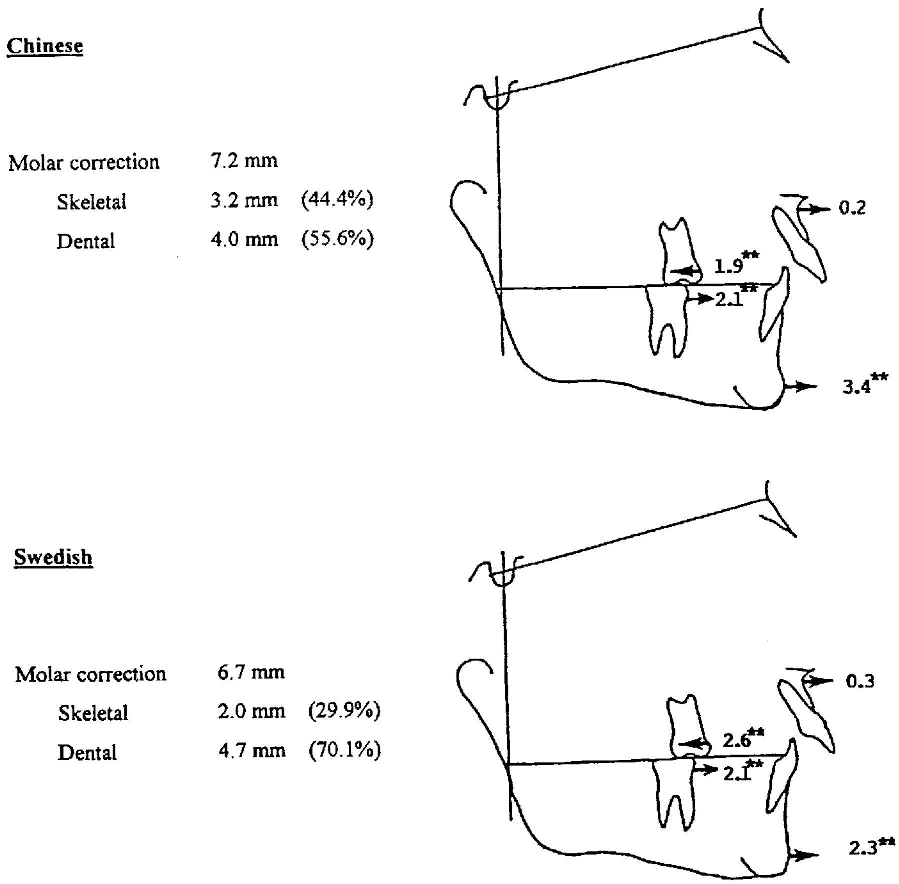

Figure 3 Diagrammatic representation of the molar correction (mm) during the Herbst appliance treatment in the 14 Chinese and 14 Swedish subjects.

bined skeletal and dental changes of the mandible contributed 5.5 mm to the molar correction (76.4 per cent of the molar correction).

Swedish group

On average, the maxilla came forward by 0.3 mm and the maxillary first permanent molars moved distally by 2.6 mm. The combined skeletal and dental changes of the maxilla contributed 2.3 mm to the molar correction (34.3 per cent of the molar correction).

On average, the mandible came forward by 2.3 mm and the mandibular first permanent molars moved mesially by 2.1 mm. The combined skeletal and dental changes of the mandible contributed 4.4 mm to the molar correction (65.7 per cent of the molar correction).

Ethnic differences

When the changes occurred during treatment between the two groups were compared (Table 2), the mean changes at the mandibular base and the mandibular incisors were larger in the Chinese group (1.1 and 1.2 mm respectively), whereas the mean changes in the maxillary base and in the maxillary incisors were similar. However, the differences of the skeletal and dental changes between the two ethnic groups were not statistically significant ($P > 0.01$).

Individual sagittal skeletal and dental changes

Individual assessment of the sagittal skeletal and dental changes of the Chinese and Swedish

Table 2 Sagittal treatment changes in the Chinese and Swedish groups.

	Chinese ($n=14$)		Swedish ($n=14$)		Ethnic differences (Chinese–Swedish)
	Mean	SD	Mean	SD	Mean
1. Overjet (Is–OLp minus Ii–OLp)	−9.2**	4.9	−7.2**	2.8	−1.9
2. Molar relation (Ms–OLp minus Mi–OLp)	−7.2**	2.9	−6.7**	1.6	−0.5
Skeletal changes					
3. Maxillary base (ss–OLp)	0.2	1.1	0.3	1.0	−0.1
4. Mandibular base (Pg–OLp)	3.4**	1.8	2.3**	1.5	1.1
Dental changes					
5. Maxillary incisor (Is–OLp)	−2.0	2.8	−2.4**	2.1	0.4
6. Mandibular incisor (ii-OLp)	4.0**	2.1	2.8**	1.2	1.2
7. Maxillary molar (Ms–OLp)	−1.9**	1.5	−2.6**	1.6	0.7
8. Mandibular molar (Mi–OLp)	2.1**	1.5	2.1**	1.2	0.0

** $P<0.01$.

subjects are shown in Table 3. The pattern of variation in individual skeletal and dental changes were similar between the two groups.

On average, the change of the maxillary base was small (mean change for Chinese = 0.2 mm; mean change for Swedish = 0.3 mm) but there was a wide individual variation in both the Chinese (−1.3 to 1.6 mm), and the Swedish (−1.6 to 2.1 mm) groups. The mandibular base came forward in all subjects and the individual variation was wide, in Chinese (0.8–6.7 mm), and in Swedish (0.2–5.7 mm).

The maxillary incisors moved distally in most subjects except in three Chinese (cases 2, 3 and 4) and one Swede (case 26) where they were proclined. Proclination of mandibular incisors was found in all subjects. The individual variation was 1.3–8.3 mm in the Chinese group and 1.0–5.4 mm in the Swedish group.

The maxillary first permanent molars were moved distally in all subjects except one Chinese subject (case 3). Individual variation was wide being −4.2 to 0.9 mm in the Chinese group and −6.3 to −0.3 mm in Swedish group. The mandibular first permanent molars were moved mesially in all subjects except one Swedish subject (case 23). Individual variation was wide being 0.1 to 5.3 mm in the Chinese group and −0.9 to 3.6 mm in the Swedish group.

Discussion

These Chinese subjects were the first group of consecutive patients with Class II division 1 malocclusion who were treated with the Herbst appliance. The Swedish group was obtained from a pool of over 200 patients who had been treated with Herbst appliance at the Department of Orthodontics, Faculty of Odontology in Malmö, Sweden. The selection of the Swedish subjects was made to match with respect to sex, age and duration of treatment with the Chinese subjects. These factors were important as they could affect the treatment results (Tulloch *et al.*, 1990). It would be ideal to have a larger sample size, and in addition, to group the subjects accordingly to their maturity status and sex (Pancherz and Hägg, 1985; Hägg *et al.*, 1987; Malmgren *et al.*, 1987). Nevertheless, this study gave reliable information of the treatment effects of the Herbst appliance in Southern Chinese subjects. The treatment effects were found to be similar to the group of matched Swedish subjects, for whom, longitudinal data

Table 3 Individual sagittal changes (mm) for overjet (Is/OLp minus Ii/OLp), molar relation (Ms/OLp minus Mi/OLp), maxillary base (ss/OLP), mandibular base (Pg/OLp), maxillary incisor (Is/OLp), mandibular incisor (Ii/OLp), maxillary molar (Ms/OLp) and mandibular molar (Mi/OLP).

Case number	Overjet	Molar relation	Maxillary base	Mandibular base	Maxillary incisor	Mandibular incisor	Maxillary molar	Mandibular molar
Chinese group								
1	−5.9	3.1	−0.6	0.8	−2.9	1.7	−0.9	0.9
2	−6.0	7.0	−1.0	0.9	0.6	4.7	−2.3	2.8
3	−6.1	4.7	−1.3	2.1	1.7	4.4	0.9	2.2
4	−3.0	4.7	0.9	2.1	1.6	3.4	−1.8	1.7
5	−5.8	6.4	−0.9	2.5	−1.1	1.3	−1.5	1.5
6	−4.3	5.9	1.1	2.7	−0.5	2.3	−4.2	0.1
7	−11.7	7.4	0.2	2.9	−5.8	3.1	−2.5	2.2
8	−10.7	10.9	−0.4	3.4	−8.2	7.1	−1.8	5.3
9	−19.1	7.9	0.8	3.6	−4.0	4.0	−3.3	1.9
10	−11.6	6.5	−0.6	3.8	−0.7	6.5	−0.7	1.4
11	−5.5	5.3	0.4	3.8	−0.8	1.4	−0.2	1.7
12	−10.2	6.1	1.6	5.4	−3.5	3.0	−0.7	1.7
13	−18.2	14.3	1.4	6.3	−5.1	8.3	−4.2	5.3
14	−10.3	10.0	0.8	6.7	−0.1	4.4	−3.6	0.5
Swedish group								
15	−4.9	4.2	1.0	0.2	−3.0	2.7	−3.1	1.9
16	−5.5	7.4	−1.2	0.3	0.1	2.1	−3.6	2.3
17	−4.6	7.9	−1.2	0.3	−1.0	3.8	−3.8	3.5
18	−12.7	6.2	0.7	0.8	−2.2	2.4	−3.2	3.0
19	−3.5	6.8	−0.3	1.9	−5.1	5.4	−1.0	3.6
20	−6.6	4.2	1.2	2.0	−4.1	1.8	−2.4	2.4
21	−8.1	8.8	2.1	2.4	−5.3	2.8	−6.3	2.1
22	−8.5	5.3	1.5	2.4	−6.2	1.0	−3.3	1.1
23	−6.5	3.8	−1.1	2.7	−3.0	1.9	−0.9	−0.9
24	−6.7	6.1	1.2	2.9	−1.3	3.6	−1.2	3.3
25	−8.4	7.0	−0.1	2.9	−1.1	2.6	−2.4	1.7
26	−6.1	8.9	−0.1	3.1	0.5	3.5	−3.5	2.3
27	−6.3	6.7	0.5	4.2	−1.2	1.4	−1.6	1.5
28	−13.1	8.9	−1.6	5.7	−1.3	4.5	−0.3	1.4

on the effects of the Herbst appliance have been established (Pancherz, 1979, 1982, 1991; Pancherz and Hägg, 1985; Pancherz and Hansen, 1986, 1988; Hägg and Pancherz, 1988; Pancherz and Fackel, 1990; Hansen *et al.*, 1990, 1991).

In general, the method of cephalometric analysis (Pancherz, 1982) used in the present study was reliable. The error of most variables was small for the purpose of analysing the treatment changes (Table 4) (Wong, 1992). However, interpretation of treatment changes at the first permanent molars should be undertaken with great caution as the method error was considerable, and the measured individual change could be due to the measurement error.

The dentofacial morphology of the Chinese and the Swedish subjects in the present study was compared by analysing the cephalograms (Björk, 1947) taken before treatment. On average, the Chinese subjects had significantly larger mean SNA and ANB angles; and the maxillary and mandibular incisors were more proclined when compared with the Swedish subjects (Table 1). These findings were consistent with previous studies which reported racial dentofacial morphological differences between young Chinese and Caucasian adults with normal occlusion (Wei, 1965) and in randomly-selected children (Cooke and Wei, 1989).

The same pattern of differences in dentofacial morphology between the two ethnic groups were maintained at the end of Herbst treatment (Table 1). The Chinese subjects had maintained a larger mean SNA; the maxillary and mandibular incisors were more proclined. These findings indicated that the dentofacial changes that occurred during the treatment were comparable. The maxillary incisors were retracted as indicated by the decrease of the maxillary incisor

Table 4 Error of the cephalometric values on repeated measurements of both the before and after treatment lateral cephalograms.

Variables (degrees or mm)	Chinese ($n=14$)				Swedish ($n = 14$)			
	Before treatment		After treatment		Before treatment		After treatment	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Maxillary position (SNA)	0.0	0.72	−0.6	1.04	0.1	0.51	0.0	0.78
Mandibular position (SNB)	0.0	0.43	−0.2	1.29	−0.2	0.49	0.1	0.40
Sagittal jaw relation (ANB)	0.0	0.50	−0.2	0.45	0.1	0.38	−0.1	0.48
Nasal plane angle (NL/NSL)	0.3	1.44	0.7	1.51	0.4	1.18	−0.3	0.96
Mandibular plane angle (ML/NSL)	0.0	0.62	0.8	1.22	0.3	0.67	0.1	1.04
Vertical jaw relation (ML/NL)	−0.3	1.20	0.5	0.95	0.0	0.88	0.2	1.03
Occlusal plane angle (OLs/NSL)	−0.1	0.77	0.2	1.16	0.3	0.98	−0.1	1.07
Maxillary incisor angle (Ils/NSL)	−0.6	1.38	−0.5	1.67	−0.3	1.51	−0.1	1.62
Interincisal angle (Ils/ILi)	−0.1	1.98	0.3	1.91	0.5	1.88	0.5	2.35
Mandibular incisor angle (ILi/ML)	0.7	1.82	−0.8	1.56	−0.8	1.62	−0.1	1.56
Mandibular length (Pg-Ar) in mm	0.1	0.49	−0.1	0.43	0.0	0.43	0.0	0.25
Maxillary base (ss–Olp)	0.2	0.51	0.1	0.69	0.4	0.59	0.1	0.60
Mandibular base (Pg–PLp)	−0.1	0.70	0.1	0.81	0.0	0.86	0.1	0.92
Maxillary incisor (Is–Olp)	−0.1	0.53	0.0	0.61	0.1	0.76	0.3	1.00
Mandibular incisor (Ii–OLp)	−0.2	0.60	−0.1	0.75	0.2	0.62	−0.3	0.57
Maxillary molar (Ms–Olp)	−0.1	0.56	−0.3	0.63	0.2	0.51	0.0	0.69
Mandibular molar (Mi–Olp)	−0.6	0.75	0.0	0.67	0.0	0.68	−0.3	0.63

** $P<0.01$.

angle (ILs/NSL) · (Table 1). The mandibular incisors were proclined as indicated by the increase of the mandibular incisor angle (ILi/ML) (Table 1).

The telescopic mechanisms of an activated Herbst appliance exerted a posterior directing force on the maxillary teeth and an anterior directing force on the mandibular teeth. In both groups of subjects (Chinese and Swedish), there was no significant forward maxillary growth but the mandibular growth was significant. These findings are in agreement with a previous study which reported that forward growth of the maxilla was restrained and mandibular growth was stimulated by the Herbst appliance when compared with an untreated control group (Pancherz, 1982).

Experimental studies of mandibular forward displacement have documented a stimulating effect on condylar growth (Stockli and Willert, 1971; McNamara, 1973), thereby increasing the mandibular length. The forward change in position of the mandible could also be explained to a certain extent by anterior remodelling of the glenoid fossa (Stockli and Willert, 1971; Woodside *et al.*, 1987).

Clinical studies have shown that the amount of sagittal mandibular skeletal change is related to the skeletal maturity of the patients. Greater skeletal change occurring when treatment is carried out in the peak growth period (Pancherz and Hägg, 1985; Hägg *et al.*, 1987). It has also been reported that the stimulation of mandibular growth was directly related to the amount of mandibular forward displacement (Pancherz, 1982).

In general, the mandibular skeletal change in the Chinese group seemed somewhat, (though not significantly), larger than that in the Swedish group. That the mandible of the Chinese subjects in the present study was generally positioned more anteriorly by the activated Herbst appliance than the Swedish subjects, is due to a larger pretreatment overjet in the Chinese group, which would explain the difference in mandibular growth between the two ethnic groups (Pancherz, 1982).

As the design of Herbst appliance used in the present study was completely tooth-borne, the dental changes which occurred during treatment were the result of anchorage loss. In the maxillary arch, the buccal teeth were moved distally and the incisors were retroclined. In the mandibular arch, the buccal teeth were moved mesially and the incisors were proclined.

In the maxillary arch, the spaces created by distalization of the maxillary buccal teeth were generally sufficient to align the crowded and/or to retract the proclined incisors. However, in two Chinese subjects (cases 3 and 4, Table 3), the maxillary incisors were proclined during the Herbst appliance treatment which indicated that the spaces required for aligning the crowded anterior teeth might have come partially from labial tipping of the maxillary incisors. In one Chinese subject (case 8) (Table 3), the presence of dental spacing before treatment allowed considerable retraction of the maxillary incisors despite the amount of distal movement of the maxillary buccal teeth being small.

Dental changes in the mandibular arch could not be avoided (Pancherz and Hansen, 1988). It was expected to be especially undesirable for Chinese who already had proclined mandibular incisors. Even by changing the appliance's anchorage design in the mandibular arch (Pancherz, 1985), it was not possible to reduce the amount of mandibular incisal proclination (Pancherz and Hansen, 1988). In this study, the mandibular incisor changes in the Chinese group seemed somewhat, though not significantly, larger than those of the Swedish group but the mandibular molar changes were similar. These findings might suggest that for the same amount of mesial movement of the mandibular buccal teeth in two ethnic groups, the amount of mandibular incisor proclination would be greater in the Chinese subjects.

The proclination of mandibular incisors during treatment should not be a major concern as it has been found that the mandibular teeth (especially the incisors) tend to upright, returning to their original position after treatment without causing significant crowding (Pancherz and Hansen, 1988; Pancherz, 1991). Nevertheless, the post-treatment changes of the mandibular teeth require further investigation.

Clinical significance

The Herbst appliance is highly effective in correcting Class II division 1 malocclusion in growing Southern Chinese subjects. In general, the correction was accomplished within a period of 6–8 months and improvement in facial appearance was dramatic.

This study found that the effects of the Herbst appliance in Southern Chinese and Swedish children were similar, and the transformation from a Class II malocclusion to overcorrected Class I or Class III occlusion was achieved by a combination of skeletal and dental changes. On average, 35 per cent of overjet correction was contributed by skeletal changes while the other 65 per cent was contributed by dental changes.

The results of this study support the use of the Herbst appliance in Southern Chinese subjects and similar treatment changes as those achieved in Swedish subjects can be expected. In summary, the treatment changes in the Chinese and the Swedish groups were comparable but individual variation within the two groups large.

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Acknowledgements

The authors would like to thank Professor Hans Pancherz and the Department of Orthodontics, Faculty of Odontology, University of Lund, Sweden, for their material; Edward Lo for setting up statistical analysis; the Dental Illustration Unit for the illustrations; and Miss Christine Chung for preparing this manuscript. This research was supported by the University of Hong Kong with grant number: 335/251/0773.

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