ORIGINAL ARTICLE

A long-term follow-up study of Class II malocclusion correction after treatment with Class II elastics or fixed functional appliances

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Introduction: The aim of this study was to compare dentofacial morphology and long-term follow-up changes in growing males with skeletal Class II malocclusions treated without extractions and with either Begg or Herbst appliances. **Methods:** Lateral cephalograms were obtained at the start of treatment, after active treatment, and after long-term follow-up. **Results:** Treatment effects differed between the groups, with usually more favorable effects in the Herbst group. However, during the follow-up period, many of the changes were reversed. During the total observation period, maxillary prognathism and lower anterior facial height increased more in the Begg group than in the Herbst group. **Conclusions:** Although there were initial marked differences in the treatment outcomes, most of these differences were not sustained over the longer term. (Am J Orthod Dentofacial Orthop 2007;132:499-503)

Class II malocclusions are commonly treated during the growth period by either 1-phase treatment with fixed appliance therapy or 2-phase treatment with the first phase (growth modification) usually followed by a second phase of fixed appliance therapy.[1] Several studies on growth modification were published recently.[1-4] These studies indicate that growth modifiers have a modest effect on jaw growth initially, but the final outcome for patients after the second phase of treatment with fixed appliance is no different than for patients treated with fixed appliances only.[1] Another study showed that functional appliance therapy affected mandibular growth during active treatment only, and there was reversion to the original growth pattern thereafter.[5]

Most studies considered immediate changes only, although a few short-term follow-up studies on still-growing samples were made.[1-5] Reports on long-term changes—with treated samples followed until growth ceased—have been infrequent and based on a relatively small number of common samples.[6,7]

The purpose of this study was to compare treatment and follow-up changes over the short and long terms in Class II subjects treated at a young age with 1 of 2 devices.

MATERIAL AND METHODS

In a previous study, 18 consecutive male patients with Class II Division 1 malocclusions, who were followed before treatment and later underwent nonextraction fixed appliance therapy with light wire (Begg) and Class II elastics, were matched with 18 subjects who had undergone Herbst appliance therapy in order to evaluate treatment changes after 12 months.[8] Our sample consisted of 15 of the original Begg patients followed to adulthood and their matched subjects from the Herbst group (Table I). The Herbst sample was followed until growth ceased (assessed from hand-wrist radiographs and longitudinal growth curves of height).[9] Growth data for the Class II subjects were obtained from the Begg group 6 months before active treatment. These data were adjusted to match the respective treatment periods and to assess treatment effects.

Dentofacial morphology and changes were assessed from lateral cephalograms taken in central occlusion obtained at the start of treatment (T0), after 18 months of treatment with the Begg technique (T1), and after 7 months of Herbst treatment followed by 6 months of no retention (2 patients), retention with an activator (12 patients), or retention with a bonded canine retainer (1 patient) and at young adulthood (T2) (Table I). The

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Table I. Age at start (T0) and end of treatment (T1) and follow-up (T2), and duration of treatment (T0-T1) and follow-up period (T1-T2) in the Begg (n = 15 males) and the Herbst groups (n = 15 males)

	Age (y)								
	T0			*T1*			*T2*		
	Begg	*Herbst*	*Difference*	*Begg*	*Herbst*	*Difference*	*Begg*	*Herbst*	*Difference*
Mean (y)	13.7	13.5	0.2	15.2	14.6	0.6	23.6	20.1	3.5*
SD	1.1	0.9		1.1	0.9		1.4	0.9	

*$P < .001$.

Table I. Continued

Duration (y)					
(T0-T1)			*(T1-T2)*		
Begg	*Herbst*	*Difference*	*Begg*	*Herbst*	*Difference*
1.5	1.1	0.4*	8.4	6.0	2.4*
0.1	0.1		0.7	1.0	

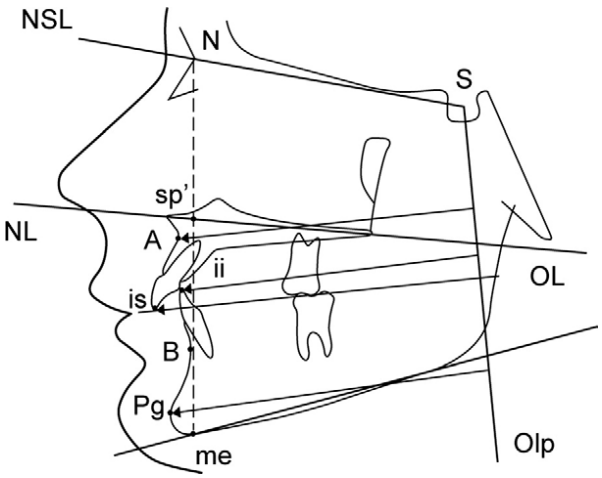

Fig. Reference lines and landmarks used. Data from Pancherz.[10]

cephalograms were analyzed by using measurement points and reference lines (Fig).[10] The dentofacial morphology at T0 was similar, except that the maxillary incisors were more proclined in the Begg group.

Statistical analysis

Independent *t* tests were used for differences in dentofacial morphology, treatment effects, and changes between the 2 groups. The paired *t* test was used for intragroup comparison. The combined method error did not exceed 0.8 units for any variable investigated.

RESULTS

There was no statistically significant age difference at T0 and T1 between the 2 groups, but, at T2, the mean age was significantly higher in the Begg group than in the Herbst group (Table I). The duration of treatment (T0-T1) and the follow-up period (T1-T2) were significant longer in the Begg group.

The treatment effects (T0-T1; Table II) on reduction of overjet and incisor movements were more pronounced in the Begg group. In both groups, maxillary forward growth was restrained; this resulted in improved jaw-base relationships in the Herbst group only, since in that group there was an effect on the mandible, whereas, in the Begg group, the forward positioning of the mandibular was less than that of normal growth. In the vertical plane, the increases in lower facial height and the maxillary plane angle were greater in the Begg group. There were differences in the sagittal treatment changes (T0-T1) between the 2 groups in terms of jaw-base relationship, mandibular prognathism, and retroclination of the maxillary incisors. The vertical treatment changes differed for lower facial height and mandibular plane angle.

During the follow-up period (T1-T2), there were more overjet relapse, greater proclination of the maxillary incisors, and increases in maxillary and mandibular prognathism in the Begg group (Table II). During the total observation period (T0-T2), there were also greater maxillary prognathism and increased lower facial height in the Begg group.

Table II. Treatment effects and changes (T0-T1), follow-up changes (T1-T2), and total observation changes (T0-T2) in the Begg (n = 15 males) and Herbst groups (n = 15 males)

	Treatment effects (T0-T1)					*Treatment changes (T0-T1)*				
	Begg (1.5 y)		*Herbst (1.1 y)*			*Begg (2.5 y)*		*Herbst (1.1 y)*		
Variable	*Mean*	*SD*	*Mean*	*SD*	*Difference*	*Mean*	*SD*	*Mean*	*SD*	*Difference*
Sagittal (mm)										
Overjet	−5.0‡	1.2	−3.7‡	1.8	−1.3*	−5.8‡	1.4	−4.3‡	2.6	−1.5
A-OLP	−1.2†	1.3	−0.9*	1.0	−0.3	0.6	2.0	0.4	1.3	0.2
Pg-OLP	−1.3*	2.0	0.8*	1.5	−2.1†	1.7*	2.6	3.0‡	1.7	−1.3
A-Pg	0.2	1.4	−1.7‡	1.4	1.9†	−1.0*	1.5	−2.6‡	1.5	1.6†
Is-A	−3.5‡	−3.5	−1.5†	1.9	−2.0†	−3.9‡	2.1	−1.8*	2.8	−2.1+
Ii-Pg (°)	1.8‡	1.8	0.6	1.4	1.2*	0.8	1.8	−0.1	1.8	0.9
SNA angle	−1.7‡	1.0	−0.8*	1.2	−0.9	−1.6†	1.4	−0.7	1.8	−0.9
SNB angle	−1.1†	1.2	0.5	1.1	−1.6†	−0.6	1.4	0.9*	1.2	−1.5†
ILs/NL	−10.7‡	3.8	−5.6‡	4.4	−5.1‡	−9.9‡	6.8	−5.0†	8.0	−5.0
ILI/ML (mm)	3.0‡	2.7	0.4	2.2	2.6‡	3.8†	5.0	1.0*	3.9	2.8
Overbite	−2.6‡	1.7	−2.1‡	1.4	−0.5	−2.9‡	2.3	−2.3‡	1.8	−0.6
N-sp'	0.7*	1.2	0.9*	1.2	−0.2	1.8‡	1.7	1.7‡	1.7	0.1
sp'-me (°)	2.6‡	1.3	1.1†	1.3	1.5†	5.1‡	1.5	2.9‡	1.6	2.2‡
NSL/ML	0.8*	1.2	−0.5	1.3	1.3*	1.2†	1.5	−0.2	1.6	1.4†

A-OLP, maxillary base position; *Pg-OLP,* mandibular base position; *A-Pg,* jaw base relationship; *Is-A,* maxillary incisor position; *II-Pg,* mandibular incisor angulation; *ILs/NL,* maxillary incisor angulation; *ILI/ML,* mandibular incisor angulation; *N-sp',* upper face height; *sp'-me,* lower face height; *NSL/ML,* mandibular plane angle.
*$P < .05$; †$P < .01$; ‡$P < .001$.

Table II. Continued

	Follow-up changes (T1-T2)					*Observation changes (T0-T2)*				
Begg (8.4 y)		*Herbst (6.0 y)*			*Begg (9.9 y)*		*Herbst (7.1 y)*		
Mean	*SD*	*Mean*	*SD*	*Difference*	*Mean*	*SD*	*Mean*	*SD*	*Difference*
1.5†	1.1	0.5	1.0	1.0*	−4.3‡	1.2	−3.8†	2.2	−0.5
4.8‡	2.0	2.6‡	2.7	2.2*	5.5‡	2.8	3.0†	3.2	2.5*
8.6‡	3.4	5.2‡	5.0	3.4*	10.2‡	3.9	8.3‡	4.6	1.9
−3.8‡	2.8	−2.7†	3.3	−1.1	−4.8‡	2.9	−5.3‡	2.8	0.5
2.6‡	1.7	0.8	1.9	1.8†	−1.3*	2.3	−1.0	2.7	−0.3
−2.6‡	2.4	−2.4†	2.3	−0.2	−1.8*	2.5	−2.5†	2.9	0.7
1.2*	1.5	0.0	2.2	1.2	−0.4	2.6	−0.7	2.2	0.3
2.3‡	1.1	0.8	1.5	1.5†	1.7†	2.0	1.7‡	1.3	0.0
5.2‡	4.6	0.0	5.0	5.2*	−4.7†	6.3	−5.0†	6.9	0.2
−0.7	4.9	−0.3	2.9	−0.4	3.1*	5.9	0.7	3.1	2.4
1.2†	1.3	0.5	1.3	0.7	−1.6*	2.3	−1.8‡	1.5	0.2
0.2	1.9	1.6†	2.0	−1.5	2.0†	2.5	3.3‡	2.3	−1.3
4.5‡	2.3	2.8‡	2.5	1.7	9.6‡	3.3	5.7‡	2.8	3.9‡
−3.4‡	3.4	−3.4‡	1.9	0.0	−2.2*	4.0	−3.6‡	2.1	1.4

DISCUSSION

At the follow-up in young adulthood more than 8 years after the start of treatment, 75% of the original subjects remained in the study. At the start of treatment, there was practically no difference in dentofacial morphology between the groups. The matched group of Herbst patients was followed from about the same age as the Begg patients, but the follow-up period ended at the average age of 20 years, 3.5 years younger than that of Begg patients (Table I). Condylar growth normally ceases at about 19 years in males,[9] and all Herbst subjects were followed until indications were observed

that growth had ceased.[11] The amount of facial growth after the complete fusion of the radius was reported to be less than 1 mm in 80% of subjects,[12] and the fusion of the radius occurs in males at 18.0 ± 0.9 years,[11] ie, 2 to 5 years earlier than the mean ages of our samples at T2. Consequently, any remaining facial growth at T2 in both samples should be considered negligible.

The total reduction of overjet (T0-T2) in both the Begg and the Herbst groups was about 4 mm; this agreed with previous follow-up studies on Class II treatment.[2,7] The average amount of overjet reduction observed in an untreated Class II sample followed from age 12 years to adulthood was about 1 mm.[13] There was a lasting reduction of overjet in the Class II subjects treated at a young age, regardless of the treatment method.

The maxillary incisors retroclined significantly, and the final net change in maxillary incisor angulation was the same in both groups at T2 (Table II). In untreated Class II subjects, the angulation of the maxillary incisors increases by about 2°.[14] Subsequently, the net retroclination in maxillary incisor angulation seems to have been about 7° with both treatment methods.

The mandibular incisors were significantly proclined in the Begg group only at T2. In untreated Class II subjects, mandibular incisors procline on average 1.5°.[14] This might indicate that the proclination during treatment in the Begg group was maintained in the long term due to underlying growth changes, whereas, in the Herbst group, there was actually a net retroclination of the mandibular incisors.

Over the total observation period (T0-T2), there was no significant difference in the improvement of jaw-base relationship between the 2 groups (Table II). The total amount of improvement of the jaw-base relationship in this study also generally agreed with findings from a long-term study on early treatment with the Herbst appliance and prolonged retention.[7] It was about twice that observed in untreated subjects,[14] indicating that the change in jaw-base relationship due to treatment at an early age had lasted over the years, regardless of the method of treatment.

The results of this study indicate that maxillary prognathism increased less during the total observation period (T0-T2) in the group treated with Herbst appliances followed by retention with an activator; this agreed with a previous study with a similar concept,[7] indicating a lasting effect on maxillary prognathism.

There was no difference in the change of mandibular prognathism over the whole observation period (T0-T2); SNB angle increased 1.7° in both groups. This change is consistent with a previous long-term study on Herbst treatment and with the reference data of normal growth changes interpolated from the Bolton standards.[6]

In this study, there was a similar statistically significant reduction of overbite in both groups during the total observation period (T0-T2) that was significantly larger than the change of overbite due to growth only.[13]

Lower facial height increased significantly more during the total observation period in the Begg group than in the Herbst group. In North American untreated Class II subjects, the increase of lower facial height from 9 to 18 years of age was reported to be 9 mm,[14] which might indicate that Herbst treatment did not influence lower facial height, whereas Begg treatment might actually lengthen lower facial height, not only during active treatment, but also in the long term.

The increase in the mandibular plane angle during treatment with the Begg appliance seems not to have persisted in the long term. The follow-up changes of the mandibular plane angle observed for both groups are consistent with those reported for untreated Class II subjects.[14] It appears, therefore, that the mandibular plane angle might be temporarily affected during treatment but not over the long term, regardless of the treatment method.

CONCLUSIONS

The study showed, in the treatment of young patients with Class II malocclusion, that the immediate treatment outcomes differed markedly with the 2 orthodontic devices, but the differences did not last in the long term. This might indicate that the final outcome of treatment of a Class II malocclusion might be similar independent of the orthodontic device used.

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