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Long-term effects of Class II correction in Herbst and Bass therapy

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SUMMARY This study compared the initial and long-term skeletal and dental effects of Herbst and Bass appliance therapy for correction of Class II malocclusion. The sample comprised 18 pairs of boys matched for growth period at the time of therapy, with similar pre-treatment sagittal and vertical jaw base relationships. One boy in each pair was treated with the Herbst and the other with the Bass appliance. At follow-up, 15 boys of the Herbst group and 17 of the Bass group were available. Lateral cephalograms in centric occlusion taken before treatment, after 6 months of treatment and at the end of growth were analysed. After 6 months of treatment the Bass appliance seemed to have a greater effect on mandibular jaw base position. The correction of overjet and sagittal molar relationship was more complete in the Herbst patients due to dental changes. At follow-up varying effects both between and within pairs were observed. Overall, the skeletal and dental changes from start of treatment to end of growth were of the same magnitude. A restraining effect on the position of the maxilla was observed in both groups, somewhat more pronounced in the Bass sample. Both treatment methods are most useful in correction of severe Class II malocclusions. It was, however, difficult to find possible differences in treatment effects between the two methods due to great individual variations of growth.

Introduction

Pancherz *et al.* (1989) compared the effects of 6 months' treatment with Herbst or Bass appliances in 18 pairs of boys with Class II division 1 malocclusions. The Bass appliance seemed to have a greater influence on maxillary and mandibular jaw base positions. The Herbst appliance was more effective in correcting overjet and sagittal molar relationship.

The aim of the present study was to evaluate the long-term effects of Herbst and Bass therapy from start of treatment to end of growth and compare these effects with initial treatment changes, over a standard period of 6 months.

Subjects and methods

The patients consisted of 18 pairs of boys selected from two male samples treated with either Herbst (n = 72) or Bass appliances (n = 32). In selecting the pairs, the patients were first matched in relation to somatic maturation at time of treatment and secondly they were selected in relation to skeleto-facial morphology (Pancherz *et al.,* 1989). The duration of the initial observation period was comparable in the two appliance groups (Herbst: mean = 6 months, SD = ±0.6 months; Bass: mean = 6 months, SD = ±0.8 months). The age range at start of treatment was 10–13 years for the Herbst and 10–15 years for the Bass patients.

From the original sample, 15 boys treated with Herbst and 17 with Bass appliances were followed to the end of growth. Four patients, three in the Herbst and one in the Bass group were unavailable at follow-up.

Herbst treatment

The Herbst appliance is a fixed bite jumping

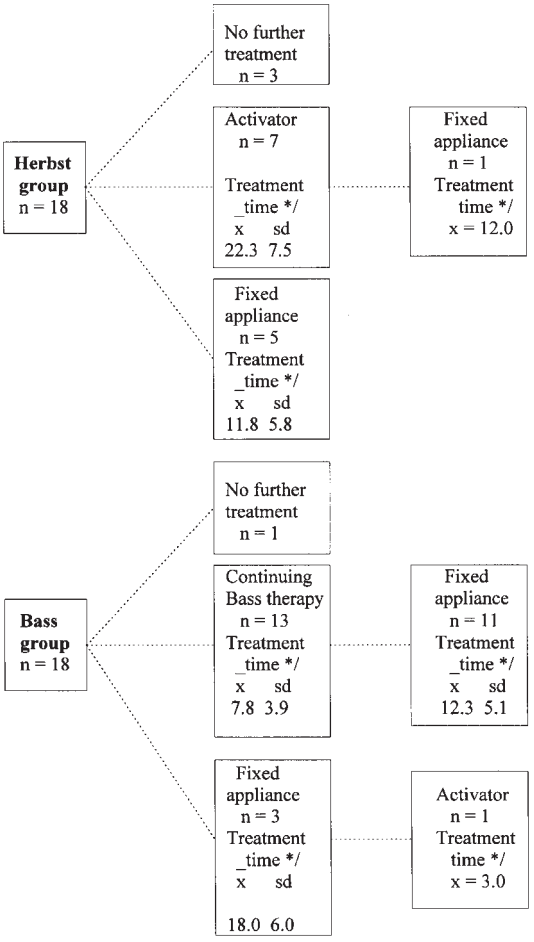

Figure 1 Follow-up treatment after initial 6 months of Herbst (n = 15) or Bass (n = 17) therapy. *Treatment time in months. One patient in the Herbst and three in the Bass group had four premolars extracted.

appliance (Herbst, 1934). A telescopic mechanism, on either side of the jaw, attached to orthodontic bands, maintains the mandible in protrusion 24 hours a day. The design of the Herbst appliance has been described in detail earlier (Pancherz, 1985). At start of treatment the mandible in each patient was advanced to an edge-to-edge position. In this way the posterior teeth were out of occlusion and the dental arches placed in a Class I relationship.

Treatment with the Herbst appliance was finished after 6 months. No further treatment was performed in three patients, activators were used in seven patients and fixed appliances in five

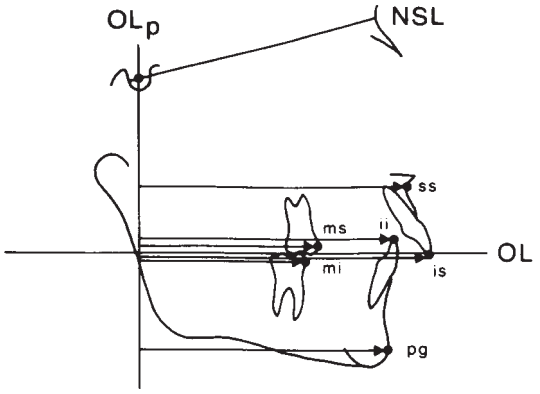

Figure 2 Measuring points used in the cephalometric analysis.

patients. One patient used an activator followed by a fixed appliance. The total average treatment time was 21 months with a maximum of 42 months (Figure 1).

Bass treatment

The Bass appliance (Bass, 1982) is a removable bite jumping appliance in combination with a high-pull headgear. The design of the appliance has been presented earlier (Malmgren and Ömblus, 1985). The construction bite was taken with the mandible half a cusp forward of the intercuspal position. The mandibular teeth were in contact with the maxillary splint. The mandibular mechanism was activated approximately 2 mm every 6 weeks. The Bass appliance was used full time (20–22 hours per day).

Treatment was finished in one patient after the initial 6 months and continued for 4–12 months in 13 patients. The Bass appliance was followed by a fixed appliance for 12 months in 11 patients. In three patients, treatment was completed directly with fixed appliances, followed in one patient with an activator. The total average treatment time was 23 months with a maximum of 42 months (Figure 1).

Evaluation

For each patient, profile radiographs were taken in centric occlusion at the start of treatment, after 6 months and at the end of growth. The patients were regarded to have reached end of growth when the annual increment of height did

Table 1 Long-term effects of Herbst and Bass therapy: (A) cephalometric records at start of treatment and (B) changes after 6 months of treatment (n = 18 in both groups); (C) changes during follow-up and (D) total changes from start of treatment to end of growth (Herbst group, n = 15; Bass group, n = 17).

Measurements in degrees	Herbst (H) Bass (B) therapy	A		B		C		D	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Maxillary position SNA	H	83.0	3.7	–0.6	1.3	–0.8	3.2	–1.3	3.4
	B	81.1	3.7	–0.4	1.0	–1.6	1.6	–2.1	1.7
	diff			–0.2		0.8**		0.8**	
Mandibular position SNB	H	75.2	3.4	1.2	0.9	0.3	2.3	1.6	2.3
	B	73.4	3.6	1.6	1.1	0	1.4	1.5	1.4
	diff			–0.4		0.3		0.1	
Sagittal jaw relation ANB	H	7.8	1.4	–1.8	1.0	–1.1	1.7	–2.8	1.6
	B	7.7	1.3	–2.0	1.1	–1.6	1.3	–3.6	1.4
	diff			0.2		0.5		0.8	
Mandibular SN/ML plane angle	H	31.9	4.9	0.5	1.5	–5.8	2.9	–5.5	2.8
	B	34.0	6.0	–1.2	1.0	–1.6	2.5	–2.7	2.4
	diff			1.7***		–4.2		–2.8	
Nasal plane SN/NL angle	H	7.4	3.0	0.6	0.7	1.0	1.7	1.7	1.9
	B	6.9	3.1	0.3	1.1	1.1	1.7	1.0	1.8
	diff			0.3		–0.1		0.7	
Occlusal plane SN/OL angle	H	17.8	3.6	5.0	2.6	–5.6	2.9	–1.4	3.6
	B	17.2	4.1	1.3	2.7	–1.3	3.3	0.1	2.7
	diff			3.7**		–4.3		–1.5	
Maxillary 11;21/SN incisor inclination	H	104.9	8.4	–6.2	9.0	–1.0	10.0	–6.0	9.0
	B	110.5	5.8	–1.8	6.0	–4.9	6.1	–6.9	6.3
	diff			–4.4*		3.9		0.9	
Mandibular 41;31/ML incisor inclination	H	100.5	6.9	8.8	4.9	–1.9	5.2	6.4	3.9
	B	96.8	7.0	2.2	3.8	2.3	4.7	5.1	4.5
	diff			6.6**		–4.2		1.3	

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

not exceed 5 mm (Taranger and Hägg, 1980). The follow-up period, from after initial treatment of 6 months to the end of growth, was on average 7.0 years (±2.0 years SD).

The radiographs were analysed with a computer system (Bergin *et al.,* 1978). A total of 31 reference points defined earlier (Malmgren and Ömblus, 1985) were used for the schematic illustrations. The nasion–sella line, constituting the x-axis of the co-ordinate system, was transferred from the first tracing to the following by superimposing the radiographs on stable structures in the cranial base (Björk and Skieller, 1983).

The method for assessing skeletal and dental changes contributing to Class II correction in Herbst and Bass treatment has been presented earlier (Pancherz, 1982) (Figure 2). For linear measurements no correction was made for radiographic enlargement (approximately 7–10 per cent in the median plane).

Measuring procedure

For all linear measurements on the tracings from before treatment, after 6 months of treatment and at end of growth, the occlusal line and the occlusal line perpendicular (OLp) from the first head film were used as a reference grid for sagittal recordings. The grid was transferred from the first tracing to the following by superimposition of tracings on the nasion–sella line (NSL) with Sella (S) as reference point. The profile roentgenographic analysis comprised the variables presented in Table 2.

Table 2 Long-term effects of Herbst and Bass therapy: (A) cephalometric records at start of treatment and (B) changes after 6 months of treatment (n = 18 in both groups); (C) changes during follow-up and (D) total changes from start of treatment to end of growth (Herbst group, n = 15; Bass group, n = 17).

Measurements (in degrees)	Herbst (H) Bass (B) therapy	A		B		C		D	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Overjet is/Olp	H	9.9	2.9	–7.9	4.1	2.2	2.4	–4.9	4.0
minus ii/OLp	B	13.1	3.3	–4.8	2.5	–3.2	2.8	–8.0	2.9
	diff	–3.2		–3.1*		5.4		3.1	
Molar relation	H	3.3	1.4	–6.4	1.9	0.4	1.6	–5.7	2.0
ms/Olp minus	B	2.7	1.8	–3.8	1.7	–2.0	2.5	–5.4	2.1
mi/OLp	diff	0.6		–2.6***		2.4		–0.3	
Maxillary base	H	80.6	3.7	0.1	1.2	4.8	2.5	4.9	2.9
ss/OLp	B	82.8	5.2	–0.5	1.0	3.7	2.6	3.1	2.7
	diff	–2.2		0.6		1.1		1.8	
Mandibular base	H	80.3	4.6	1.9	1.7	7.6	2.9	9.6	2.7
pg/OLp	B	80.8	7.3	3.2	2.1	5.7	4.6	8.6	4.3
	diff	–0.5		–1.3		1.9		1.0	
Maxillary incisor	H	89.9	5.1	–3.0	3.3	1.0	2.6	–1.5	3.5
is/Olp minus	B	93.4	5.6	–1.1	1.1	–0.8	2.5	–2.2	2.2
ss/OLp	diff	–3.5		–1.9*		1.8		0.7	
Mandibular	H	80.0	3.6	3.1	1.3	–3.8	3.2	–1.4	2.4
incisor ii/Olp	B	80.3	6.5	0	1.0	0.5	3.1	0.3	3.5
minus pg/OLp	diff	–0.3		3.1***		–4.3		–1.7	
Maxillary molar	H	56.7	3.1	–2.7	1.6	3.0	1.5	0.6	2.0
ms/Olp minus	B	56.7	5.7	–0.7	0.8	1.9	2.7	1.7	2.2
ss/OLp	diff	0		–2.0***		1.1*		–1.1	
Mandibular molar	H	53.4	3.2	1.9	1.3	–0.5	1.7	1.4	1.7
mi/Olp minus	B	54.0	6.1	–0.6	0.7	1.2	2.5	1.6	2.6
pg/OLp	diff	–0.6		2.5***		–1.7		–0.2	

*P < 0.05; **P < 0.01; ***P < 0.001.

Statistical methods

The mean and SD were calculated for each cephalometric variable. The Herbst and Bass groups were compared by the t-test for independent samples.

The size of the combined error of the landmark location, superimposition and measurement of changes, has been ascertained in a previous study (Pancherz *et al.,* 1989). The error of method (δ) did not exceed ±0.6 (mm or degrees) for any of the variables investigated, except for the inclination of incisors 31/ 41-ML and 11/21-SN, for which it was 1.3 and 1.1 degrees, respectively.

Results

The changes recorded during the initial treatment period of 6 months, the follow-up period and the total observation period from before treatment to end of growth are presented in Tables 1 and 2.

Skeletal effects

During initial treatment the position of the maxilla was retarded in both groups and this restraining effect persisted at follow-up and was more pronounced in patients treated with the Bass appliance; the difference, although small, was significant (Table 1).

The forward growth of the mandible during initial treatment was greater in patients treated with the Bass appliance, but at the end of growth there was no significant difference. A forward rotation of the mandible during initial treatment was found in patients treated with the Bass

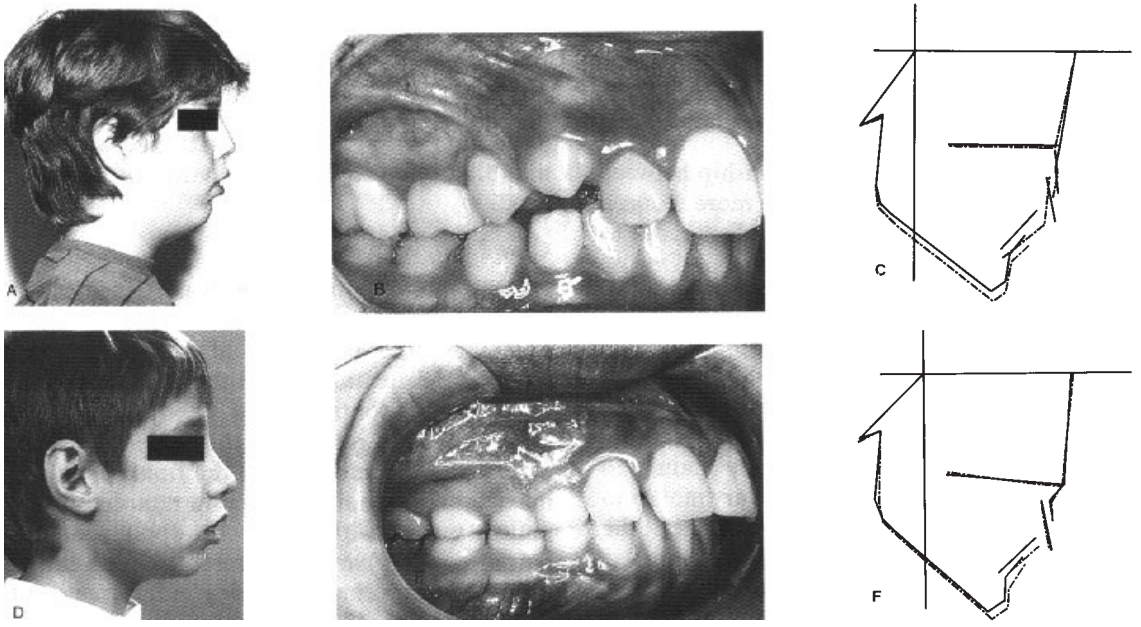

Figure 3 (Case 1) A, B, C, Herbst therapy. D, E, F, Bass therapy. Extra- and intra-oral photographs prior to start of treatment. C, F, Computer drawings from before (——) and after (-·- -) 6 months of treatment. The skeletal changes were almost the same in the two boys.

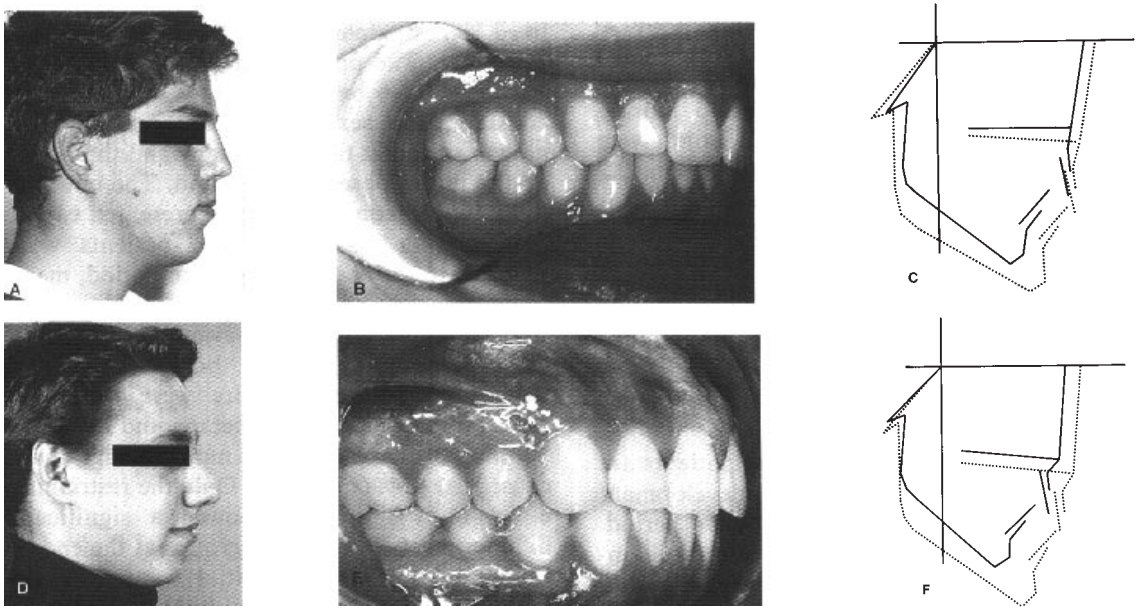

Figure 4 (Case 1) A, B, C, Herbst therapy; D, E, F, Bass therapy. Extra- and intra-oral photographs taken at the end of growth. C, F: computer drawings from before treatment (——) and at end of growth (···). The development during the whole observation period was the same in the two boys.

appliance and a backward rotation among those treated with the Herbst appliance. At follow-up a pronounced forward rotation of the mandible was observed in patients treated with the Herbst appliance (Tables 1 and 2).

In total, the sagittal jaw relationship between the maxilla and the mandible was more reduced in patients treated with the Bass appliance, due to the restraining effect on the maxilla. During follow-up the mandible was positioned more anteriorly in the Herbst group (Tables 1 and 2).

Dental effects

After the initial treatment period the correction of the sagittal molar relationship was more complete in the Herbst group due mainly to more distal movement of the maxillary molars in the maxilla and mesial movement of the mandibular molars. In the Bass group the molar correction during the initial period was due mainly to skeletal changes, most pronounced in the mandible. At follow-up the sagittal molar relationship was normalized in both groups and overall the differences in molar changes between the two groups were minimal (Table 2).

After 6 months of treatment the overjet correction was larger in the Herbst group, and at follow-up greater in the Bass group. The total overjet reduction was 4.9 mm in the Herbst group and 8.0 mm in the Bass group. During initial treatment the lower incisors were proclined 8.8 degrees in the Herbst group and 2.2 degrees in the Bass group. This difference was significant. During follow-up the inclination decreased in the Herbst group and increased in the Bass group. The difference in proclination during the total observation period was minimal (Table 1). The final overjet was the same in both groups (Table 2).

Case reports

Two pairs of Herbst/Bass treated patients are presented. Case 1 shows equal development during initial treatment and follow-up period. Case 2 represents a pair with reverse development during the total observation period.

Case 1 (Figures 3 and 4)

The initial treatment in the two boys was started in the pre-peak period. Treatment with the Herbst appliance was continued with a fixed appliance for 10 months in the lower jaw. The Bass appliance was used for a total of 12 months. Treatment was finished with fixed maxillary and mandibular appliances for 10 months. In both patients the maxilla was retarded and the mandible moved forward with an anterior rotation.

Case 2 (Figure 5 and 6)

In these two boys treatment was started in the pre-peak period. No further treatment was necessary after 6 months of Herbst therapy. After initial treatment with the Bass appliance, treatment was continued with fixed appliance for 10 months. As retention, the patient used an activator for 3 months. In the final result the maxilla and mandible are more retarded in the patient treated with the Herbst appliance. This pair of patients have been presented in an earlier article showing changes during initial treatment (Pancherz *et al.,* 1989).

Discussion

The purpose of this study was to compare the long-term effects of two treatment methods, the fixed Herbst appliance and the removable Bass appliance. The patient material was carefully selected. Four basic factors were taken into consideration: sex, skeleto-facial morphology, growth period at time of therapy and the length of the initial observation period. The effect of the initial treatment has been presented earlier (Pancherz *et al.,* 1989). The patients were followed to the end of the growth period, many years after the actual treatment.

The long-term effects were difficult to evaluate. Varying effects both within and between the original pairs were observed. Different growth pattern, therapy and length of treatment, after the initial 6 months, might have caused the great variability. Only the restraining effect on the maxilla showed a significant difference between the two groups at the end of follow-up. During the initial 6 months the maxilla was restrained in both groups. At follow-up this effect increased more in the Bass than in the Herbst group. Corresponding results after treatment of young patients with the Herbst appliance followed by activator treatment have

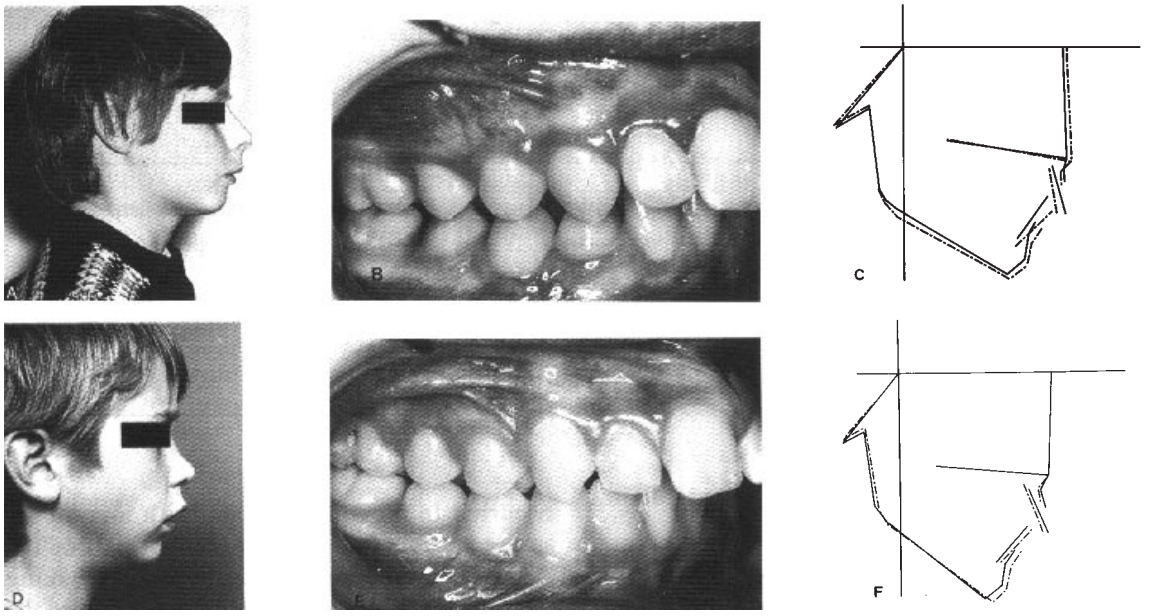

Figure 5 (Case 2) A, B, C, Herbst therapy; D, E, F, Bass therapy. Extra- and intra oral photographs prior to starting treatment. C, F: Computer drawings from before (——) and after (-·- -) 6 months of treatment.

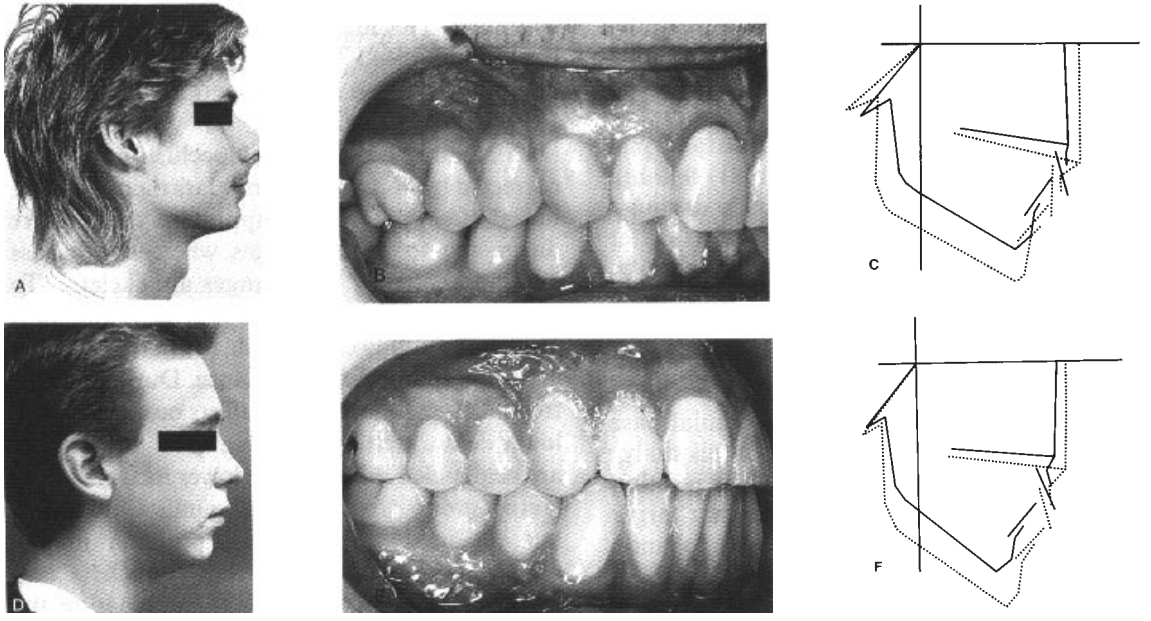

Figure 6 (Case 2) A, B, C, Herbst therapy; D, E, F, Bass therapy. Extra- and intra oral photographs taken at the end of growth.C, F: Computer drawings from before treatment (——) and at end of growth (· · ·). The development during the whole observation period was different in this pair. The maxilla and mandible are more retarded in the patient treated with the Herbst appliance.

Table 3 Clinical advantages and disadvantages of the Herbst and the Bass appliances.

Appliance	Advantages	Disadvantages
Herbst	Fixed appliance, no co-operation problem	Retention with an activator is often required
	Rapid distal movement of upper molars	Side effects on teeth in upper and lower jaw
Bass	No direct force to the teeth	Removable appliance
	The same appliance can be used as retention and successively less used	
	Can be used during the whole mixed dentition period	

been reported by Wieslander (1993), who proposed that the activator might reduce forward maxillary growth. In contrast, Melsen (1978) reported a contradictory result for the restraining effect on the maxilla after cervical headgear treatment: the reduced forward maxillary growth during headgear treatment was reversible. The greater posterior effect on the maxilla in the Bass group in this study could be due to the extra-oral force during initial treatment. It is not possible to determine whether the effect on the maxilla in the Herbst group is due to the initial Herbst treatment or the activator therapy used during retention, or a combination of both. Pancherz (1981) found a relapse in the position of the maxilla during a post-treatment period of 12 months after treatment with the Herbst appliance. It must be considered, however, that growth changes at Nasion can influence the angles SNA and SNB. The risk is greater for the angle SNA than SNB (Pancherz and Sack, 1990). To minimize the influence, stable structures in the cranial base were used for the superimpositions in this study.

The effect on the sagittal mandibular position in an anterior direction was somewhat larger after initial treatment with the Bass appliance. During follow-up this difference was equalized. The activator treatment in seven of the patients in the Herbst group influenced the mandible in an anterior direction. Furthermore, the mandible rotated anteriorly. This rotation moved the pogonion forward. During normal growth Björk and Skieller (1972) found that forward rotation occurred in most individuals, with a compensatory apposition below the anterior part of the lower border of the mandible, partly masking the rotation of the mandible. In consequence the anterior rotation of the mandible is greater than found with conventional cephalometry.

The inclination of the mandible (SN/ML) was somewhat larger in the Bass group and the SNB angle larger in the Herbst group at the start of treatment. This might be another explanation of the pronounced forward rotation of the mandible at follow up in patients treated with the Herbst appliance.

Clinically, Class II malocclusion can be corrected by both Herbst and Bass therapies. The initial effects of Herbst appliance therapy are due mostly to dental changes, whereas with Bass appliance therapy the changes are skeletal. To reach an optimal treatment goal both methods need to be followed-up with further treatment: activator and/or fixed appliance. During Herbst treatment undesirable side effects occurred in the lower dental arch. In Bass treatment these effects are negligible (Table 2). The lower incisors in the Herbst group proclined during initial treatment, but regained their original position during follow-up, as described earlier (Pancherz and Hansen, 1986, 1988). At final examination the sagittal molar relationship had normalized in both groups.

Both treatment methods are most useful in correction of severe Class II malocclusions. It was, however, difficult to find possible differences

in treatment effects between the two methods due to great individual variations of growth.

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