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Mandibular growth during initial treatment with the Bass orthopaedic appliance in relation to age and growth periods

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SUMMARY The aim of this study was to relate the initial orthopaedic effects of a Bass activator to age and growth periods at the time of therapy. The sample consisted of 54 boys with a severe Class II, division 1 malocclusion. The mean age at start of treatment was 11.4 years. Longitudinal records of standing height were used to assess the growth period during treatment. Three periods were established: pre-peak, peak and post-peak. The treatment period of each subject was assigned to one of these periods.

Lateral cephalograms were available 6 months before treatment in 22 of the boys, and at the start of treatment and after 6 months in the whole sample. No significant growth changes were observed 6 months before treatment. During the initial 6 months of treatment a small restraining effect on the maxilla and a forward growth of the mandible was observed. A significant correlation between age and forward growth of the mandible during treatment was found in the pre-peak and peak groups. This indicates a great initial orthopaedic treatment effect in young boys in the pre-peak period and in boys with an early peak. In boys 10 years of age or older not having reached the peak period of growth, the treatment response was less pronounced.

Introduction

The most suitable period for starting orthopaedic treatment of Class II malocclusions has long been discussed. Some authors claim that early treatment is most favourable (Bass, 1982; Wieslander, 1984), others that the best treatment effect is achieved at the pubertal growth spurt (Björk, 1972; Pancherz and Hägg, 1985).

The occurrence of juvenile and pubertal growth spurts in various facial dimensions has been reported. Temporary growth accelerations in a number of bones and sutures during the juvenile period were found by Nanda (1955) and Bambha (1961). Woodside *et al.* (1975) found a prepubertal acceleration in mandibular growth. There is, however, no prepubertal growth acceleration of the maxilla (Linder-Aronson *et al.* 1975). Ekström (1982) reported the occurrence of one juvenile and one pubertal growth spurt of the face, both more pronounced in boys. The juvenile facial growth spurt occurred close to the age of 9 years in both sexes and was observed in 64 per cent of the boys and in 55 per cent of the girls.

The change in relationship between the maxilla and the mandible was pronounced in patients with a Class II, division 1 malocclusion treated with a headgear-Herbst appliance when treatment was performed in the early mixed dentition (Wieslander, 1984).

Treatment of patients with the Herbst appliance close to their pubertal maximum in standing height (PHV) had a greater orthopaedic effect than that of patients treated before or after that period (Pancherz and Hagg, 1985; Hägg *et al.*, 1987). In a study by Malmgren *et al.* (1987) a greater forward growth of the mandible was found in patients, particularly boys, treated in the peak period than in those treated in the pre-peak period. The difference in forward mandibular growth between the two maturity groups was about 70 per cent in boys and 40 per cent in

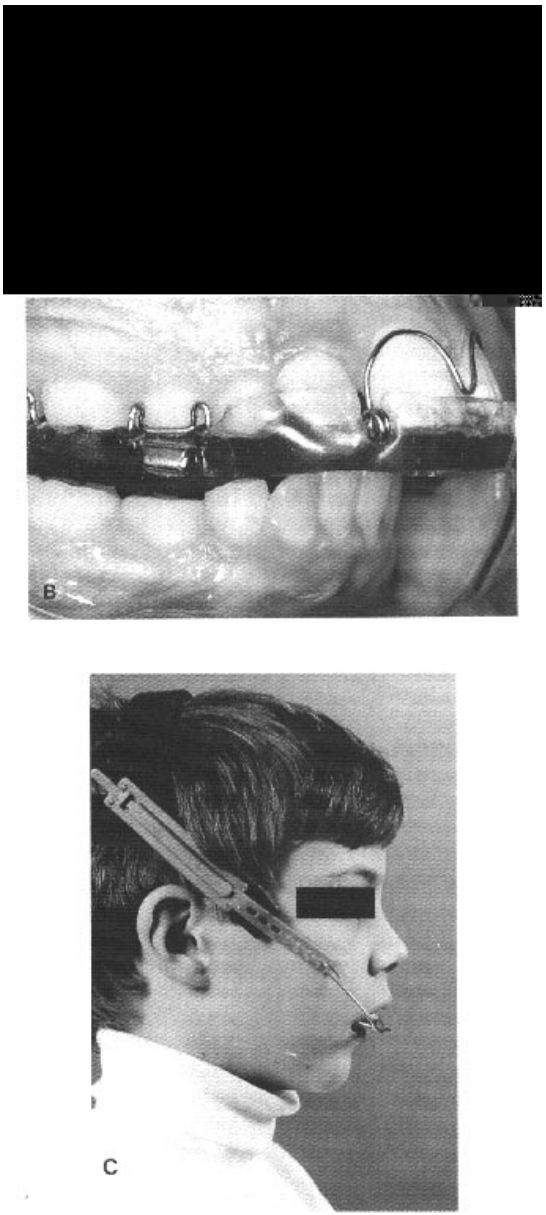


Figure 1 (A) The modified construction of the orthopaedic appliance used in the 22 boys treated most recently. (B) The Bass activator. (C) High-pull headgear fixed to the tubes of the appliance.

girls. However, four of the youngest boys at the pre-peak stage showed a treatment response which was as great as for the boys close to the peak, but the study included only a few boys under 10 years of age. The treatment response during early juvenile growth has not been evaluated or compared with the effects during the late juvenile period or the pubertal growth spurt.

Treatment with orthopaedic appliances often lasts for several years. This makes the effect of growth acceleration periods during treatment difficult to discover. If the study covers a short standardized period of treatment of equal length in all patients, this drawback can be overcome.

The aim of the present study was to relate the initial orthopaedic treatment effects of a Bass activator to age and different growth periods.

Subjects and methods

The sample consisted of 56 boys with severe Class II, division 1 malocclusions (ANB mean 7.4, SD 1.3) consecutively treated with a modified activator (Bass, 1982). The age of the patients at the start of treatment varied from 8.4 to 16.2 years (mean 11.4, SD 1.9). Thirty-two of the 56 boys have been described in an earlier study (Malmgren *et al.*, 1987).

After an initial period of 2 weeks, to allow the patients to become accustomed to the appliance, co-operation was evaluated by questioning the patients and their parents. Two uncooperative patients were excluded from the study. The treatment results are based on analyses of the remaining 54 patients.

In 22 boys recordings with study models, extra- and intra-oral photographs and cephalograms were performed 6 months before, at the start of treatment and after 6 months. In the remaining 32 boys the recordings were made directly before and after 6 months of treatment.

Appliance design and treatment procedure

The orthopaedic appliance used has been described earlier (Malmgren and Ömblus, 1985; Malmgren *et al.*, 1987). To make the appliance easier to wear, the construction was modified in the 22 boys treated most recently so that the maxillary splint did not cover tbe whole palate, and the mandibular bar was inserted in palatal tubes on the maxillary splint (Figure 1A and B). A metal tube was used as a stop on the lingual bar when the appliance was activated. High-pull headgear was used with a force adapted to each

case in relation to the maxillary skeletal deviation (Figure 1C).

Analyses of growth records

Longitudinal growth records were available for all patients. They were obtained from the child welfare clinics and school health clinics during the period before orthodontic treatment. Growth was recorded at the clinics at intervals of 1–3 years, to the nearest 0.5 cm. Data from these records were included in the analyses only before the patients were measured at the orthodontic department. During the period of orthodontic treatment, standing height was measured to the nearest 1 mm every third month. The annual standing height measurements were plotted on a special chart (Figure 2) and the actual growth period during which the patient was observed/treated was assessed using a technique devised by Karlberg *et al.* (1992). With this technique, it was possible to assess whether the patients had reached the adolescent growth spurt period. In patients who had already reached this period, it was also possible to assess or extrapolate the age at peak. Three growth periods were established: pre-peak, peak (age at peak ± 1 year) and post-peak. The treatment period of each subject was assigned to one of these periods. If the treatment period coincided with more than one growth period, the patient was assigned to the period that covered most of the treatment period. The distribution of the patients in relation to growth periods and age intervals is shown in Table 1.

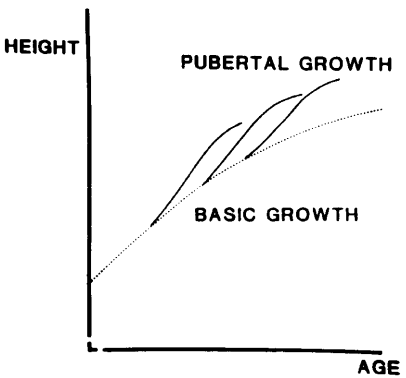


Figure 2 Growth height chart.

Table 1 Somatic maturation groups and age intervals in 54 boys.

Somatic maturation groups	No. of patients	Age intervals in years
Pre-peak	34	8.4–12.1
Peak	15	10.6–14.1
Post-peak	5	13.4–16.2

Analyses of the treatment result

The cephalograms were analysed with a computer system (Bergin *et al.*, 1978). Thirty-one reference points defined earlier (Malmgren and Ömblus, 1985) were used for the schematic illustrations drawn by the computer. The computer visualized the results by drawing a schematic figure of the same size as the original radiograph. This was superimposed on the radiograph to test the precision of the recording. The cephalometric changes were analysed 6 months before treatment in 22 boys, and at the start and after 6 months of treatment in all 54. The reference points used in this study are illustrated in Figure 3.

Statistical methods

t-tests for paired samples were performed to

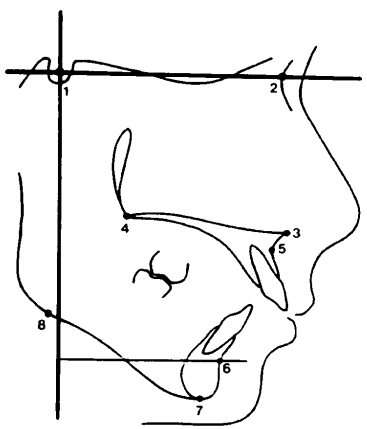


Figure 3 Reference points on the radiograph. 1. S, centre of sella turcica. 2. n, nasion. 3. SP, spina nasalis anterior. 4. pm, pterygomaxillare. 5. A(ss), subspinale. 6. B(sm), supramentale. 7. gn, gnathion. 8. Point where mandibular line touches distal part of lower border of mandible.

Table 2 Skeletal morphology before treatment, and growth changes during 6 months before treatment and during the initial 6 months of treatment with the Bass appliance in 22 boys.

Measurements	Start of treatment		Changes during 6 months			
			Before treatment		During treatment	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Angles in degrees						
SNA	81.8	3.1	0.1	0.6	–0.5*	0.7
SNB	74.8	2.9	0.0	0.5	1.2*	0.7
ANB	7.0	1.5	0.1	0.5	–1.7*	0.9
ML/SN	32.6	6.0	–0.2	0.7	–0.4	0.8
ML/NL	27.3	4.7	–0.2	1.1	–0.5	1.2
Linear measurements (in mm)						
A-SNP	60.2	4.8	0.1	0.4	–0.2	0.6
B-SNP	44.4	6.7	–0.1	0.6	1.7*	1.1

*$P < 0.05$.

Table 3 Skeletal morphology at start of treatment, and changes during the initial 6 months of treatment in the pre-peak, peak and post-peak periods in 54 boys treated with the Bass appliance.

Measurement	Start of treatment		Changes during 6 months					
	$n = 54$		Pre-peak, $n = 34$		Peak, $n = 15$		Post peak, $n = 5$	+
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Angles in degrees								
SNA	81.8	3.3	–0.5*	0.9	–0.4*	0.5	–1.0	1.0
SNB	74.4	3.1	1.2*	0.9	1.7*	0.8	0.9	0.8
ANB	7.4	1.3	–1.7*	0.9	–2.1*	1.1	–1.9*	0.8
ML/SN	33.3	5.5	0.5*	0.9	–0.9*	1.1	–0.9	0.9
ML/NL	27.7	5.0	–0.8*	1.1	–1.1*	1.6	–0.5	1.5
Linear measurements (in mm)								
A-SNP	60.3	4.3	-0.1	0.8	–0.1	0.6	–0.8	1.0
B-SNP	44.2	6.2	1.8	1.3	2.3	1.4	1.3	0.9
Age in years	10.2	1.1	12.8	1.1	14.9	1.1		
Correlation (r): age/B-SNP	–0.3*		–0.6*		–0.2			

*$P < 0.05$.

assess the statistical significance of changes occurring during different observation periods, and for independent samples to assess group differences ($P < 0.05$). The relation between changes during 6 months of treatment, the initial inclination of the mandible and age, in the various maturation groups, was analysed with the correlation coefficient ($P < 0.05$).

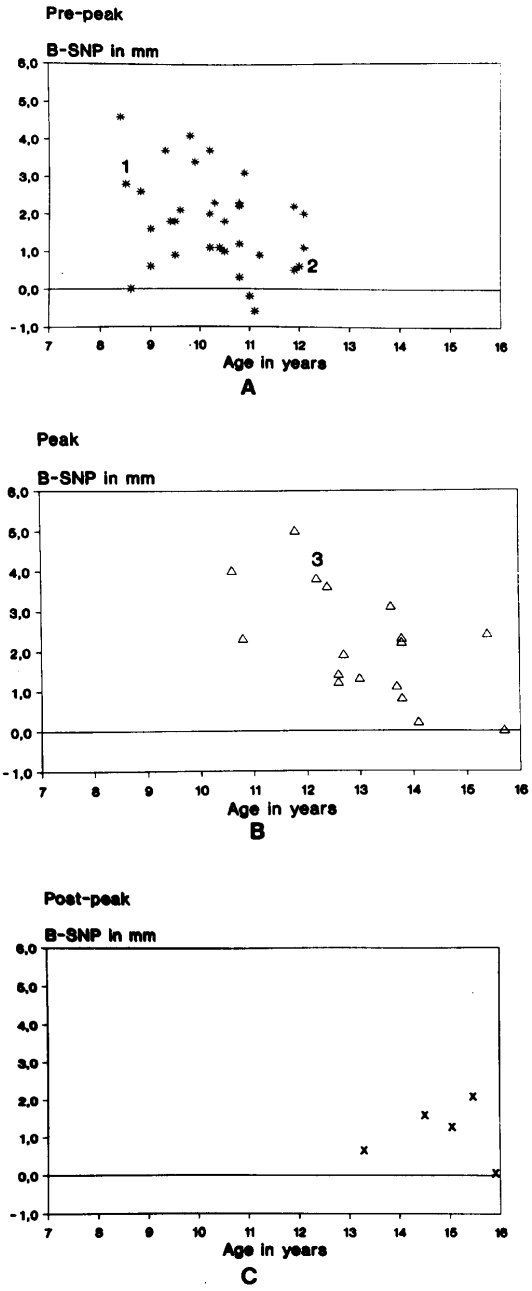


Figure 4 Changes of point B (B/SNP) after 6 months of treatment in relation to age at start of treatment. The changes are calculated on the distance from point B to a perpendicular to the sella–nasion line through the sella (B/SNP). (A) Boys treated in pre-peak period. (B) Boys treated in peak period. (C) Boys treated in post-peak period. Three patients (cases 1, 2 and 3) are presented in Figs 5, 6 and 7 respectively.

The size of the combined method error in locating the landmarks and the measuring procedure have been described earlier (Malmgren *et al.*, 1987). The method error did not exceed 0.6 mm or degrees for any of the actual measurements.

Results

The skeletal morphology before treatment, and the growth changes during the 6 months before and during the initial 6 months of treatment for the 22 boys are presented in Table 2 and for the whole group in Table 3 and Figure 4.

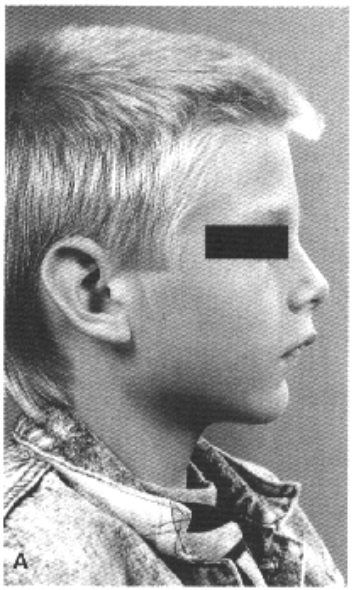
Growth changes 6 months before and during initial treatment (n = 22) (Table 2)

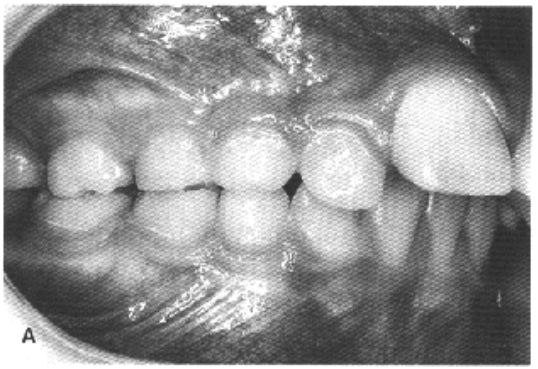
Before treatment the maxilla was in a normal position and the mandible retrognathic. No significant growth changes were seen during the observation period before treatment, irrespective of the growth period to which the patients were assessed. During the initial 6 months of treatment significant changes were observed in the angles SNA, SNB and ANB, and in the distance B-SNP, indicating a small restraining effect on the maxilla and a forward growth of the mandible. The mandible rotated slightly anteriorly.

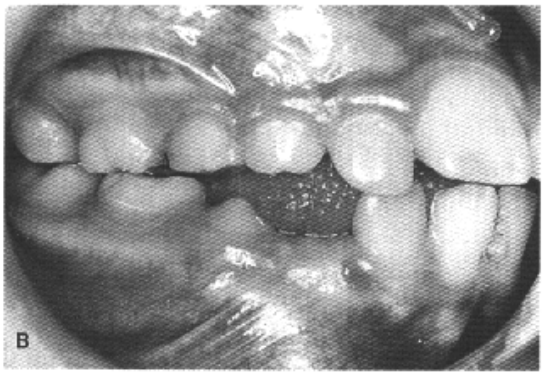
Growth changes during 6 months of initial treatment in relation to maturation periods and age (n = 54) (Table 3)

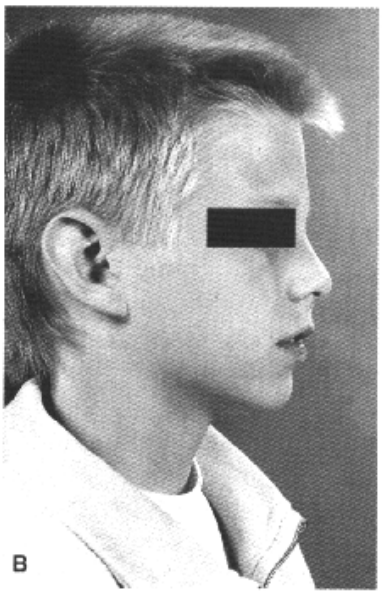
The influence of treatment on the maxilla was similar in the pre-peak and peak groups and somewhat more pronounced in the post-peak group. There was no change in the inclination of the palatal plane. The forward growth of the mandible was greatest in the peak group, smaller in the pre-peak group and smallest in the post-peak group. The differences, however, were not significant. The mandible rotated slightly anteriorly.

A significant correlation between age and forward growth of the mandible (B-SNP) was found in the pre-peak and peak groups. This correlation indicates that the treatment effect on the mandible was greater in younger boys who were both in the pre-peak period and in the peak period. A small effect was found for boys 11–12









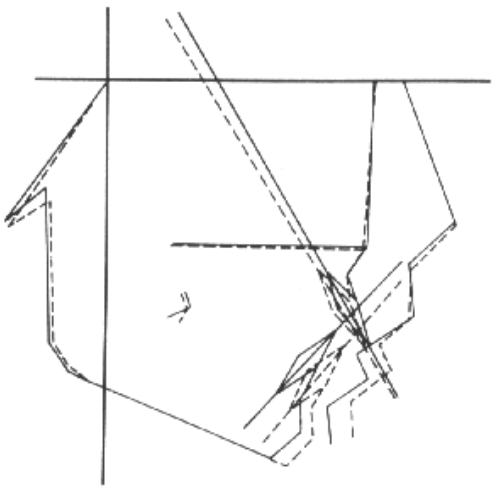


Figure 5 Good treatment effect at early pre-peak (case 1, Fig. 4A). (A) Start of treatment at 8.5 years of age. (B) After 6 months of treatment. (C) Computer drawing from before (—) and after (....) 6 months of treatment. The skeletal relationship was improved and a treatment effect was observed on the maxilla and the mandible. The activator was gradually worn less after 6 months of treatment. Treatment was continued with fixed appliance.

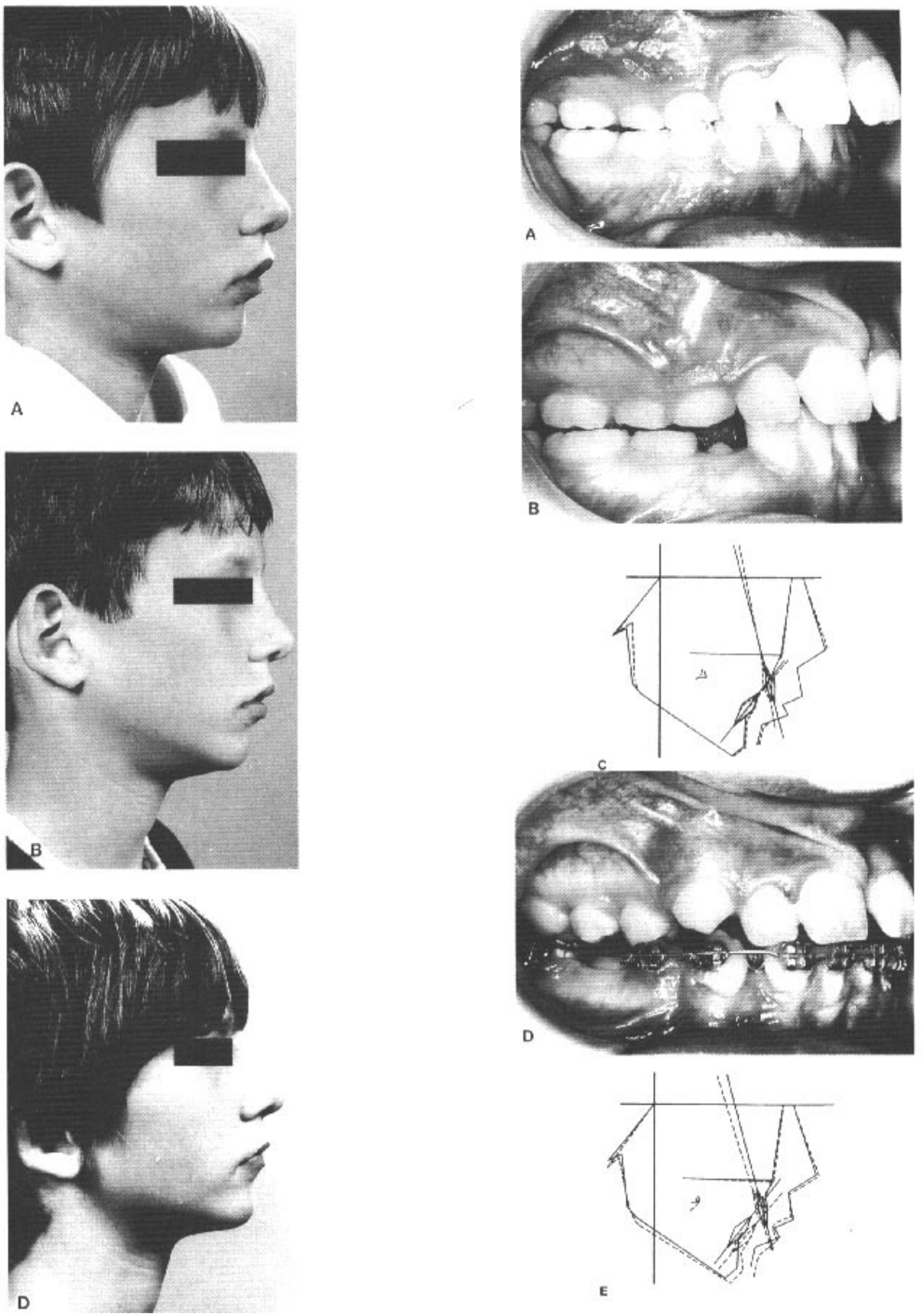
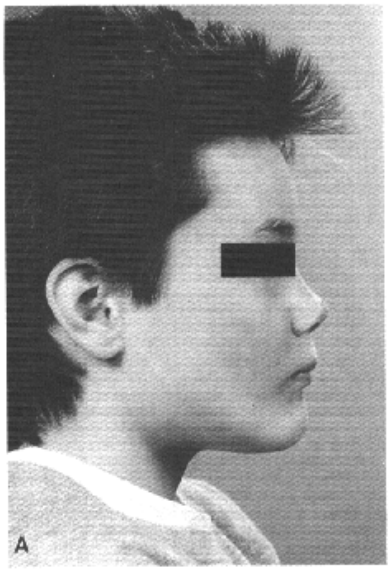
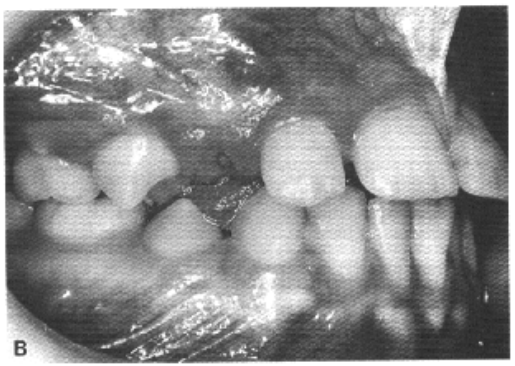
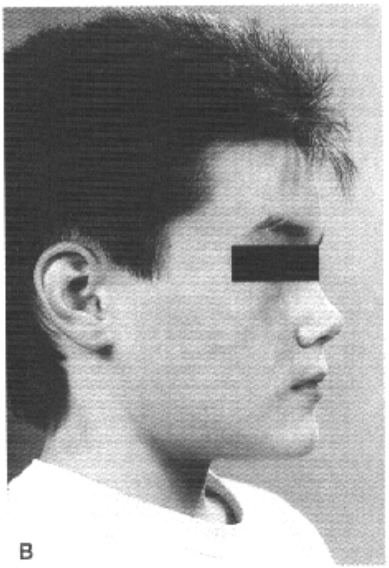


Figure 6 Minimal treatment effect at late pre-peak (case 2, Fig. 4A). (A) Start of treatment at 12 years of age. (B) After 6 months of treatment. (C) Computer drawing from before (—) and after (...) 6 months of treatment. A minimal effect on the mandible was achieved. (D) After 14 months of treatment. (E) Computer drawing from before (—) and after (...) 14 months of treatment. The skeletal relationship was improved and a treatment effect was observed on the maxilla and the mandible. The activator was then gradually worn less. Treatment was continued with a fixed appliance.







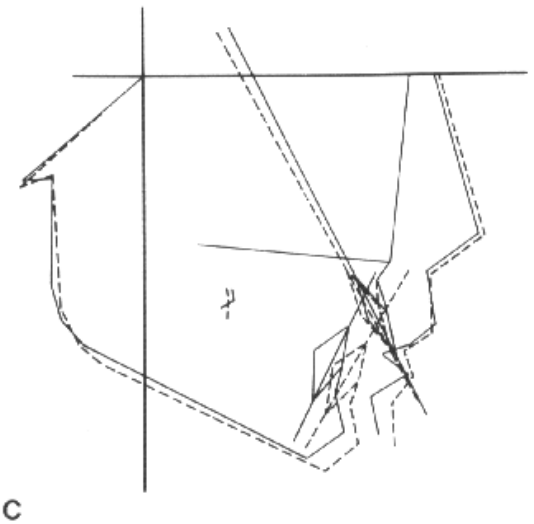


Figure 7 Good treatment effect at early peak (case 3, Fig. 4B). (A) Start of treatment at 12.2 years of age. (B) After 6 months of treatment. (C) Computer drawing from before (—) and after (...) 6 months of treatment. The skeletal relationship was improved and a treatment effect was observed on the maxilla and the mandible. The patient continued orthopaedic treatment for a further 6 months and then the activator was gradually worn less. Treatment was continued with a fixed appliance.

years old who were not at the peak stage, and a large effect for those who were. No significant correlation between forward growth of the mandible (B-SNP) and the inclination of the mandible (ML/SN; ML/NL) at the start of treatment was found. Different treatment responses are illustrated in Figures 5–7.

Discussion

The aim of the study was to analyse the initial orthopaedic treatment effects of a Bass activator in relation to age and different growth periods. Because the growth acceleration periods of the face are more pronounced in boys, only male subjects were included

Usually treatment of Class II malocclusions with activators is indicated in the mixed dentition and in the early permanent dentition. Therefore only five of the boys belonged to the post-peak period in this study. Conclusions from the statistical analyses can consequently only be drawn from the boys treated in the pre-peak and peak periods.

There is a close relationship between the growth of the face and standing height during puberty (Björk, 1972; Hägg *et al.*, 1987). For this reason the patients' maturity was assessed with distance curves of standing height. The accuracy of this method has been shown by Karlberg *et al.* (1992) to be high.

During the observation period before treatment, 11/22 patients were judged to be in the juvenile period. Three showed forward mandibular growth. This is in contrast to earlier studies (Nanda, 1955; Bambha, 1961; Woodside *et al.*, 1975; Ekström, 1982) which reported more frequent growth spurts of the face. However, the present study had a short observation period.

The differences in mandibular changes between the observation period and the initial 6 month treatment period must be regarded as an effect of treatment. Great forward mandibular change was observed in some boys treated in the early juvenile period. Thus treatment in the early juvenile period can produce the same effect as treatment in the peak period.

In the late juvenile period the effect on mandibular growth is less and similar to the effect in the late peak and post-peak periods.

In an earlier study, a relationship between age and treatment changes was found in 72 boys (11–19 years of age) treated with the Herbst appliance for 7 months (Hägg *et al.*, 1987). The mandibular growth was about 30 per cent greater at 13–15 than at 11–12 years of age. Hägg *et al.* (1987) observed in 23 boys with Class II, division 1 malocclusion (10–14 years old) twice as much mandibular growth (pogonion–condylion distance) during the pubertal maximum period as in the pre-peak period. None of the patients in these two studies were under 10 years of age.

There was a great variation of the inclination of the mandible at the start of treatment (ML/SN, ML/NL, SD 5.5 and 5.0). However, this did not significantly influence the forward growth of the mandible. The patients with a steep mandibular plane showed a treatment response similar to those with normal or low angles.

Conclusions

Treatment of boys with an orthopaedic appliance at 8–10 years of age can give the same good skeletal effect on the mandible as treatment during the peak period. Thus, early treatment is indicated in young boys with a large overjet. Early treatment will also reduce the risk of traumatic injuries of the maxillary incisors, which are common in young boys with increased overjet (Järvinen, 1978, 1979).

On average, in male patients with Class II, division 1 malocclusion, 10 years and younger, or 10–12 years and close to the period of peak growth, a pronounced mandibular forward growth is to be expected. On the other hand, in those boys 10 years and older not having reached the peak, the treatment response is expected to be less pronounced.

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