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Dental changes in the mandible during initial Bass appliance therapy

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SUMMARY The aim of this study was to analyse movements of lower molars and incisors during 6 months of Bass appliance therapy and to evaluate the dental arch space attained. The sample consisted of 53 patients with severe Class II, division 1 malocclusions. The analyses were performed on lateral cephalograms and dental casts. Sixteen of the patients were followed for 6 months before treatment. Dental space in the lower jaw decreased 0.7 mm (n = 16) during the observation period and increased 1.8 mm (n = 53) during the 6 months of treatment. The molars moved posteriorly a total of 0.7 mm and tipped distally 2.4 degrees during treatment. The incisors moved anteriorly 0.3 mm and tipped mesially 0.5 degrees.

Introduction

The use of activators to correct Class II malocclusions is well documented. During treatment mesial migration of mandibular teeth (Björk, 1951; Freunthaller, 1967; Demisch, 1972; Reey and Eastwood, 1978) and forward tipping of lower incisors (Ahlgren and Laurin, 1976; Reey and Eastwood, 1978; van Beek, 1982; Remmelink and Tan, 1991; Nelson *et al*., 1993) have been reported. The mesial movements were greater than those associated with normal growth. The Herbst appliance, which is a fixed appliance, has been shown to be effective in treatment of Class II malocclusions. In an earlier comparative study of Bass and Herbst therapy the more complete correction of overjet and sagittal molar relationship in the Herbst patients (Pancherz *et al*., 1989) was attributed to greater dental changes during therapy. The lower molars and incisors seemed to move mesially. This is in contrast to findings in studies of patients treated with the Bass appliance (Malmgren and Ömblus, 1985; Malmgren *et al*., 1987; Pancherz *et al*., 1989) in which the lower molars in many patients seemed to move posteriorly. The effect on the inclination of the lower incisors varied greatly. Clinically, increased spacing was observed during treatment.

The aim of this study was to analyse movements of lower first molars and incisors during the initial 6 months of Bass appliance therapy and to evaluate the development of dental arch space in the lower jaw.

Subjects and methods

The subjects were 53 patients, 46 boys and seven girls, with severe Class II division 1 malocclusions treated with Bass appliances. The mean age at the start of treatment was 11.5 years (SD 1.9). All patients had a retrognathic mandible. The ANB angle was on average 7.3 degrees (SD 1.4) and the SN/ML angle 32.6 degrees (SD 5.3). The patients were selected from an original sample of 78 consecutively treated patients (Malmgren and Ömblus, 1985; Malmgren *et al*., 1987; Ömblus *et al*., 1997). All patients from the original sample who were treated without extraction of primary or permanent teeth, and without a mandibular fixed appliance during the initial 6 months were included in the study. To evaluate skeletal and dental changes occurring in the absence of therapy, 16 boys were followed for 6 months before treatment. These patients are presented separately as Group A and the remaining 37 patients

Table 1 Analysis of measurements of lower incisors and molars on cephalograms 6 months before and after 6 months of treatment.

Group	Number of patients	Observation period				Treatment period			
	n	Incisors		Molars		Incisors		Molars	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Linear measurements (mm)[a]									
A	16	0.0	0.5	0.3	0.8	0.3	1.1	–0.5	0.9
B	37	–	–	–	–	0.2	1.0	–0.8*	0.9
Total	53					0.2	1.0	–0.7	0.9
Angular measurements (°)[b]									
A	16	0.0	1.3	0.6	1.5	1.0	2.4	–2.2*	1.5
B	37	–	–	–	–	0.1	2.7	–2.5*	3.2
Total	53					0.5	2.6	–2.4*	2.5

[a]A negative value indicates distal movement.
[b]A negative value indicates uprighting.
*$P < 0.05$.

Table 2 Analysis of mandibular dental arch space on dental casts 6 months before and after 6 months of treatment.

Group	Number of patients	Observation period				Treatment period			
	n	Lateral regions		Anterior regions		Lateral regions		Anterior regions	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Linear measurements (mm)[a]									
A	16	–0.7	0.4	0.0	0.3	1.7*	1.2	0.3	0.7
B	37	–	–	–	–	1.2*	1.0	0.5*	0.8
Total	53					1.4*	1.1	0.4*	0.7

[a]A negative value means decreased space.
*$P < 0.05$.

as Group B (Tables 1 and 2). The analyses were performed on lateral cephalograms and dental casts.

Analyses of lateral cephalograms

Sagittal changes of the position (linear measurements) and the inclination (angular measurements) of lower molars and incisors within the jaw were analysed on cephalograms. The radiographic enlargement was 10 per cent in the median plane.

Linear measurements (Figure 1)

The analysis has been described in an earlier study by Pancherz (1982). The occlusal line (OL) and the occlusal line perpendicular (OL_P) from the first radiograph were used as a reference grid

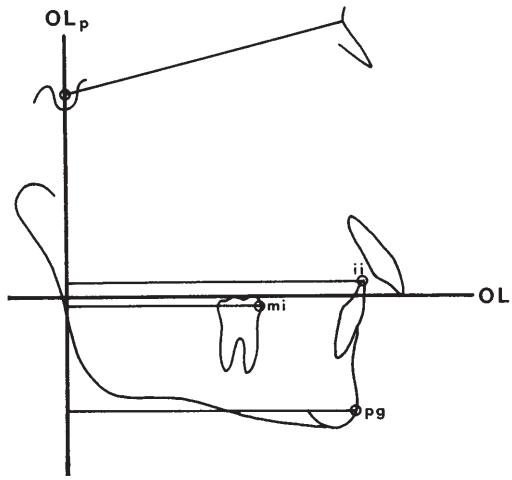

Figure 1 Measuring points used in the cephalometric analysis for linear measurements.

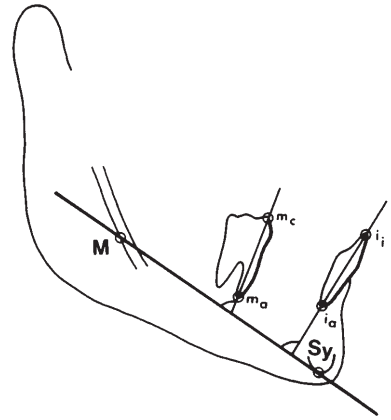

Figure 2 Measuring points used in the cephalometric analysis for angular measurements. Natural reference structures in the mandible: Sy, a point identified on the inner cortical structure of the inferior border of the symphysis; M, a point identified on the contour of the mandibular canal. A line between these points was transferred from the first radiograph to the second. Long axes of lower molars and incisors: the mesial outline of the lower molars and the buccal of the lower incisors were identified and the long axes were transferred from the first radiograph to the second by superimposing on the outlines.

for sagittal recordings. The grid was transferred from the first to the following tracings by superimposition on stable structures in the anterior cranial base (Björk and Skieller, 1983). Changes in the landmark position of the mesial contacts of the first molars (mi), the edges of the incisors (ii), and pogonion (pg) to the perpendicular were calculated. To differentiate dental and skeletal changes, the distance pg/OL_P was subtracted from changes in the position of the molars (mi/OL_P) and the incisors ii/OL_P.

Angular measurements (Figure 2)

The analysis was performed by superimposition on natural reference structures in the mandible (Björk, 1963). One point (Sy) was identified on the inner cortical structure of the inferior border of the symphysis and another on the contour of the mandibular canal (M). These points were transferred from the first radiograph to the following one by superimposition. A line between the points was used as a reference line. The mesial outline of the molars and the labial surfaces of the most prominent incisor were identified. The long axes of the molars (m_c/m_a) and the incisors (i_i/i_a) were transferred to the following radiographs by superimposition on the mesial contours of the molars and incisors. Angular measurements were performed between these long axes and the reference line.

Analyses of dental casts (Figure 3)

Measurements with a digital caliper were made sectionally on the dental casts between:

1. The mesial surfaces of the first molars to the distal surfaces of the second incisors.
2. The distal surfaces of the second incisors to the mesial surfaces of the first incisors.
3. The mesial surfaces of the first incisors if there was a diastema.

All measurements were performed twice and the mean values were calculated.

Statistical methods

The mean and standard deviations were calculated. Mean changes were considered to be significant if the Student's *t*-test for paired samples indicated a mean difference from zero at $P < 0.05$.

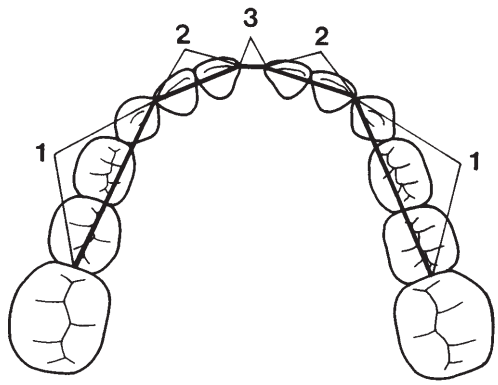

Figure 3 The distances measured on dental casts. (1) The mesial surfaces of the first molars to the distal surfaces of the second incisors. (2) The distal surfaces of the second incisors to the mesial surfaces of the first incisors. (3) The mesial surfaces of the first incisors if there was a diastema.

Error of methods

The size of the combined error of landmark location, superimposition, and measurement of changes on the lateral cephalograms was analysed by double determination. The error of method did not exceed ±0.6 mm for the linear or ±0.3 degrees for the angular measurements. It was found that the error of the variance was less than 3 per cent of the total biological variance for all measurements.

Results

Analyses on lateral cephalograms (Table 1)

Group A. The distance from the lower incisors to the perpendicular to the occlusal line ii/OL_P was unchanged on average during the observation period (mean 0.0; SD 0.5). During initial treatment the distance increased 0.3 mm (SD 0.8). The lower molars (mi/OL_P) moved anteriorly an average of 0.3 mm (SD 0.8) during the observation period and posteriorly 0.5 mm during treatment (SD 0.9).

On average the inclination of the incisors did not change during the observation period (mean 0.0; SD 1.3), but a proclination of 1.0 degree (SD 2.4) was observed during initial treatment. The molars tipped slightly anteriorly during the observation period (mean 0.6 degrees; SD 1.5) and during initial treatment posteriorly 2.2 degrees (SD 1.5).

Group B. On average the incisors moved anteriorly 0.2 mm (SD 1.0) and the molars 0.8 mm posteriorly (SD 0.9) during treatment. There was no change in the inclination of the incisors (mean 0.1; SD 2.7), but the molars were uprighted (mean 2.5 degrees; SD 3.2)

Analyses of dental casts (Table 2)

Group A. During the observation period the distances between the mesial surfaces of the molars and the distal surfaces of the second incisors decreased by an average of 0.3 and 0.4 mm (SD 0.4 and 0.5), on the right and left sides. During treatment the distances increased 0.9 mm (SD 0.6) on the right side and 0.8 mm (SD 0.7) on the left side. In the anterior region the distances between the distal surfaces of the second incisors on both sides were unchanged during the observation period, but increased by 0.4 mm (SD 0.7) during initial treatment.

Group B. The distances on the right and left sides increased on average 1.2 mm (SD 1.0). The space in the anterior region between the distal surfaces of the second incisors increased 0.5 mm (SD 0.8).

Discussion

During treatment with the Bass appliance the space in the lower jaw has been found to increase in most patients. In contrast to treatment with activators and with the Herbst appliance the lower first molars are uprighted and move slightly backwards and the incisors move forward with minimal tipping. Although minor, the movements are of clinical importance compared with changes during normal growth. Further treatment with the Bass appliance will allow alignment of the teeth with a fixed mandibular appliance without the need for extractions (Figure 4).

When using Björk's anatomic reference structures for superimposition, Cook and Gravely (1988) showed that horizontal changes in tooth position were regarded as relatively reliable.

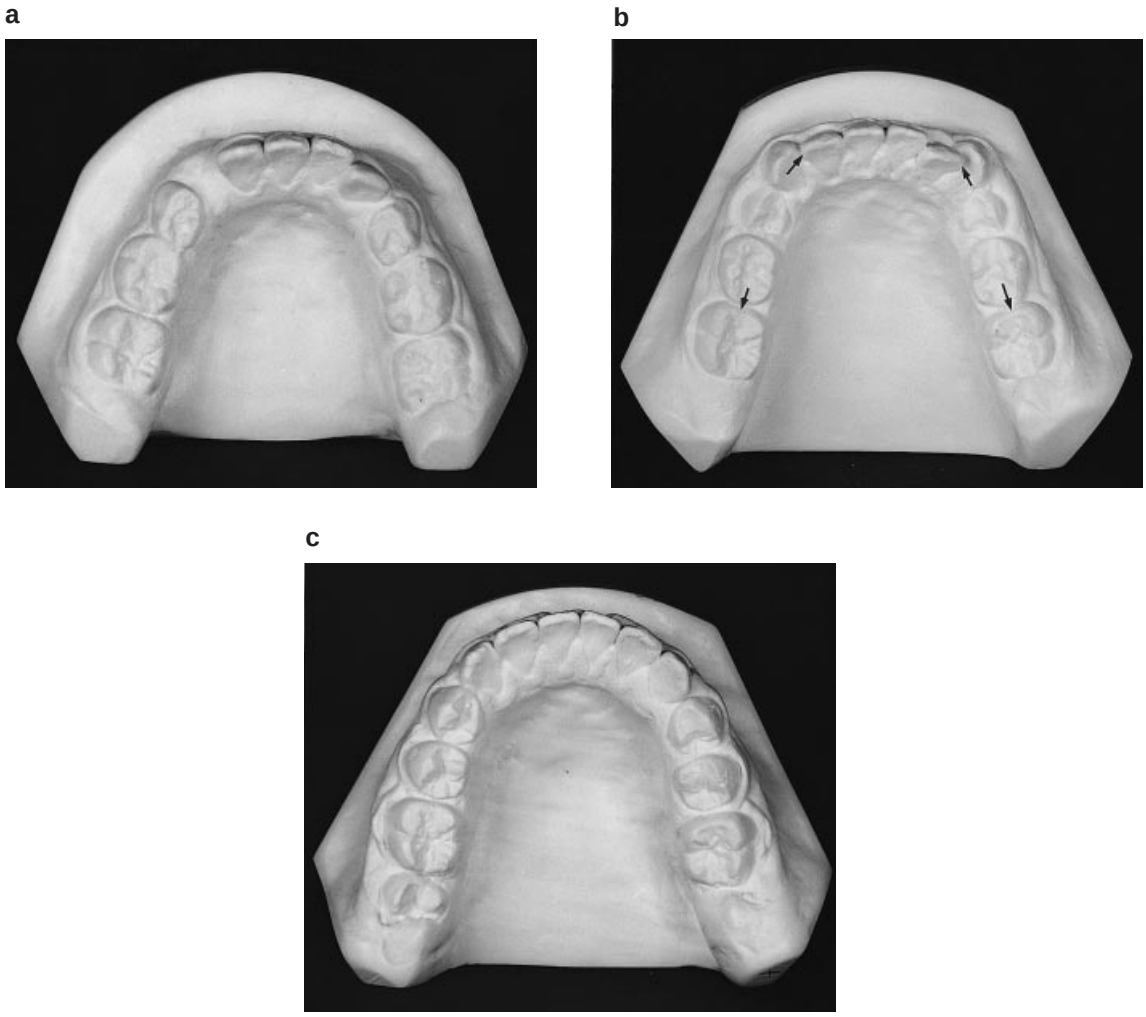

Figure 4 After 6 months of treatment with the Bass appliance the space in the lower jaw between the arrows increased 2.6 mm on the right side and 1.8 mm on the left side. (a) At the start of treatment. (b) After 6 months of treatment. (c) At the end of treatment.

Treatment of patients with cervical headgear, high-pull headgear and activators of the Harvold type has been reported by Ben-Bassat *et al.* (1986). They found distal crown tipping of lower molars and suggested the possible contributory effect of occlusal interactions during treatment.

In order to retard maxillary growth, Joffe and Jacobson (1979) used a maxillary orthopaedic splint with a high-pull extra-oral traction in Angle Class II division 1 patients. The appliance was worn 20–22 hours per day. They reported that the lower molars were uprighted and/or moved distally, but the results are based on only a few case reports and there was no discussion of the phenomena.

In the present study the molars were uprighted and moved slightly posteriorly. The reason might be that the molars in most of the patients at the start of treatment had contact with the appliance only on the distal cusps. When the mandible moved mesially during treatment, this contact was maintained, and, in turn, created uprighting forces and prevented the mesial movements described as the result of conventional activator treatment.

To evaluate tranversal changes, measurements between the mesio-lingual cusps of the first lower molars were made on the dental casts. On average the distances decreased during the observation period 0.3 mm (SD 2.2) and increased 0.5 mm (SD 2.2) during treatment. This expansion could have assisted in creating additional space.

Joffe and Jacobson (1979) have shown in case reports that the lower incisors tipped labially during treatment with a maxillary orthopaedic splint. This could be due either to contact of the incisors with the surface of the splint or the relief of the adaptive lower lip function.

Björk (1951) observed that activator treatment had an effect on the growth of the apical base in the incisor area during the deciduous and mixed dentition periods. An anterior movement of the lower incisors during activator treatment has also been reported by Jakobsson (1967). This anterior movement was assumed to have occurred as a bodily movement rather than forward tipping of the incisors.

The orthopaedic appliance used in the present study prevents the lower lip from assuming an unfavourable position behind the upper incisors. In addition, the pressure on the alveolar process of the mandible decreases. The elimination of the lip pressure allows the incisors to move forward when the apical base is allowed to grow anteriorly. This might explain the anterior movement of the lower incisors. The corrected function of the lower lip allows anterior positioning of the incisors in the mandible.

Although the movements of the lower molars and incisors in this study were minor, with individual variation, the space in the lower jaw increased due to distal movement of the lower first molars and a more anterior position of the lower incisors. The distal movement of the molars was small, but in relation to normal mesial migration during growth, these changes offer a clinical advantage.

Conclusion

During treatment of Class II division 1 malocclusions with a Bass appliance, the dental arch space within the lower dentition is increased, due to uprighting of the lower molars and forward movement of the lower incisors.

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