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The effect of treatment with the Bass appliance on skeletal Class II malocclusions: a cephalometric investigation

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SUMMARY The purpose of this investigation was to study the short-term effects of treatment with the Bass appliance by comparative evaluation of treated and untreated skeletal Class II malocclusions. The subjects consisted of forty-seven Class II, division 1 malocclusion cases. Twenty-seven (14 girls, 13 boys) were treated with the Bass appliance for an average of 6 months. The remaining 20 cases (6 girls, 14 boys) served as a control.

At the end of the 6 month treatment period the statistically significant treatment changes could be summarized as follows: the sagittal skeletal relationship was improved as a result of favourable growth responses in both the maxilla and the mandible. The overjet was reduced and the molar relationship was corrected as a result of the extended skeletal changes. Distal movement of the upper dentition was evident, with unchanged inclination of the maxillary incisors. Both anterior and posterior facial heights were increased without changes in the inclinations of the palatal and mandibular planes. No significant dental movement was observed in the mandible.

Introduction

An orthopaedic appliance system for the correction of severe skeletal Class II malocclusions in growing patients has been described by Bass (Bass, 1982, 1983) with the specific therapeutic intention of reducing a sagittal skeletal discrepancy and altering soft tissue function in the early intensive orthopaedic phase of a two-step treatment approach.

The effects of the Bass appliance in consecutively treated Class II, division 1 malocclusion cases have been analysed in a limited number of investigations (Bass, 1982, 1983, 1987; Malmgren and Ömblus, 1985; Malmgren *et al.*, 1987; Pancherz *et al.*, 1989; Cura and Saraç, 1990; Cura *et al.*, 1996). The relationship between the effects of Bass treatment and growth have not been considered to date. It is well known that in order to establish the effect of an appliance on growth, the best practical comparison must be undertaken with a concurrently enrolled group of untreated people having the same malocclusions as the treated patients.

Consequently, the purpose of this investigation was to study the short-term effects of treatment with the Bass appliance by a comparative evaluation of treated and untreated skeletal Class II malocclusions.

Subjects and methods

The study originally included 60 children with severe skeletal Class II malocclusions referred to the Orthodontic Department of the Dental Faculty of Istanbul University. All the subjects in the study were volunteers. The patient selection criteria were a Class II molar relationship bilaterally with an increased overjet and a minimum ANB difference of 5 degrees. The sample was randomly divided into a treatment group of 35 cases and a control group of 25 cases. However, in the course of the treatment and control periods, 13 subjects were excluded because of poor cooperation and lack of communication. Therefore, the material for this study comprised a treatment group of 27 cases (14 girls, 13 boys) and a control group of 20 cases (6 girls, 14 boys). The mean age at the

Table 1 Ages and duration of treatment and control periods.

	Treatment group					
	Mean	SD	Mean	SD	Mean	SD
	Girls and boys (n = 27)		Girls (n = 14)		Boys (n = 13)	
Age at the beginning of treatment (years)	11.99	1.60	11.86	1.62	12.11	1.64
Skeletal age at the beginning of treatment (years)	11.88	2.49	12.66	2.15	11.04	2.63
Duration of treatment (months)	6.88	0.54	6.90	0.58	6.86	0.53
	Control group					
	Girls and boys (n = 20)		Girls (n = 6)		Boys (n = 14)	
Age at the beginning of control (years)	11.85	1.28	11.74	1.53	11.89	1.21
Skeletal age at the beginning of control (years)	11.13	1.76	12.11	2.28	10.72	1.38
Duration of control (months)	6.44	0.34	6.45	0.28	6.44	0.37

beginning of the treatment was 11.86 years (SD = 1.62 years) for the girls and 12.11 years (SD = 1.64 years) for the boys. It was 11.74 years (SD = 1.53 years) for the girls and 11.89 years (SD = 1.21 years) for the boys in the control group at the beginning of the control period. In the treatment group, treatment with the Bass orthopaedic appliance was continued until a Class I molar and canine relationship was achieved.

Accordingly, treatment with the appliance was finished after 6–8 months with a mean treatment time of 6.88 months (SD = 0.54 months). Ten patients reached an optimal occlusion in this orthopaedic phase and the remaining 17 patients required fixed appliance treatment subsequent to the Bass appliance treatment. Therefore, the active orthopaedic phase was immediately followed by fixed appliance therapy or the Bass appliance was used for retention until all permanent teeth had erupted. The data evaluated in the analyses presented here was that obtained only during the Bass appliance treatment. The follow-up of the control group was kept parallel to the treatment group within the same experimental period (mean = 6.44 months; SD = 0.34 months). During that time no orthodontic treatment was performed in this group. Detailed information about the total sample is presented in Table 1.

Records that included study models, photographs, lateral cephalograms and hand–wrist radiographs were obtained at the beginning and the end of both the treatment and control periods.

Appliance design

The Bass appliance is a removable bite-jumping appliance combined with a high-pull heavy force headgear (Bass, 1982, 1983). The appliance has three separate mechanisms described as (i) the maxillary mechanism—the maxillary root-torquing removable splint; (ii) the mandibular mechanism—lingual pads constructed as an extension of the maxillary splint; and (iii) soft-tissue screens—buccal and labial shields (Figure 1). The design of the appliance used in the present study has been previously described in detail by Bass (1987). No labial shields were used in this study in order to facilitate the use of the appliance. It has already been found (Malmgren and Ömblus, 1985) that during treatment with the Bass appliance the lower lip is prevented by the maxillary splint from adopting an unfavourable position behind the upper incisors. Preformed (Orthomodules, London, UK), 1.25 mm headgear tubes, housing modules (made from housing of stainless steel tubing, with friction-fit sliding components forming the lingual pads and side screens) and buccal screens in stainless steel were used in construction of the appliance (Bass, 1987).

During the construction of the upper base plate, before the resin set, the articulator was closed down to produce shallow identations of the lower incisors according to the forward construction bite. These were used to train the patients' musculature at the beginning of treatment.

The mandibular mechanism, lower acrylic pads, was constructed to a protrusive working bite, 4–5 mm anterior to the centric relation with 2–3 mm of posterior bite opening. During the treatment period, lingual pads were re-activated forward every 6–8 weeks by about 2 mm, by sliding the pads anteriorly. The sliding tube was then gently squeezed with small pliers to prevent retraction. The face-bow was inserted into the buccal tubes fixed to the appliance in the first premolar area. A high-pull headgear was used with a heavy extra-oral force of about 1000 g on each side.

Appliance delivery

The patients were first given the maxillary splint with buccal shields and instructed to place the lower incisors into the anterior training grooves. This begins the adaptation to a forward mandibular posture. Maximum wear was prescribed. At the next visit, 2 or 3 weeks later, the lower lingual pads (mandibular mechanism) were positioned. The headgear was also given at this second visit in accordance with patient cooperation. Where the cooperation was poor it was postponed 1 week. Light force was used first and the patients were instructed to increase this gradually to 1000 g on each side in successive stages. The patients were advised to wear the headgear, usually after school hours, for approximately 12–14 hours daily and the intraoral appliance on a full time basis, apart from meal times (approximately 20–22 hours).

Analysis of hand–wrist radiographs

Skeletal development was assessed by the

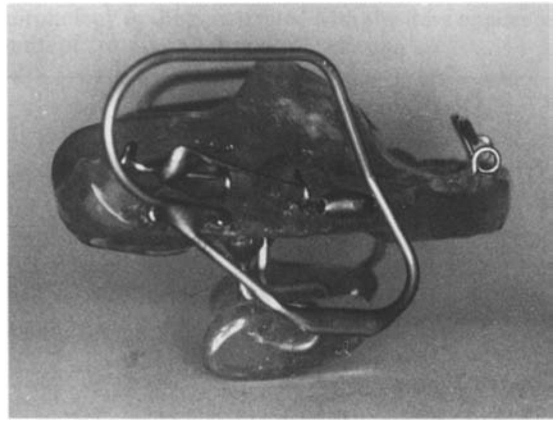

Figure 1 The Bass appliance.

Tanner-Whitehouse 2-Rus (TW2) method (Tanner *et al.*, 1983) on hand–wrist radiographs of the left hand taken at the beginning and end of both the treatment and control periods. Each of the selected bones (carpal bones, radius, ulna, and short bones of the hand and wrist) were classified separately into one of eight or nine stages, to which scores were assigned. These scores were summed to obtain the skeletal maturity at the beginning and end of both the treatment and control periods.

Analysis of cephalograms

Lateral cephalometric radiographs in centric occlusion of each patient were traced to verify anatomical outlines and landmark placements. Each cephalogram was traced and measured by one investigator (N.C.). All measurements were repeated after a period of 15 days and the mean value of the two measurements was used. The treatment effect was determined by using a conventional cephalometric analysis and 'Class II correction analysis' (Pancherz, 1982).

The landmarks and constructed lines–points used in both analyses are indicated in Figures 2 and 3.

In 'Class II correction analysis', for all linear measurements on before and after examination tracings, the occlusal line (OL) and occlusal line perpendicular (OLp) from the first head film were used as a reference grid for sagittal registrations (Figure 3). The grid was transferred from the first tracing to the following one by

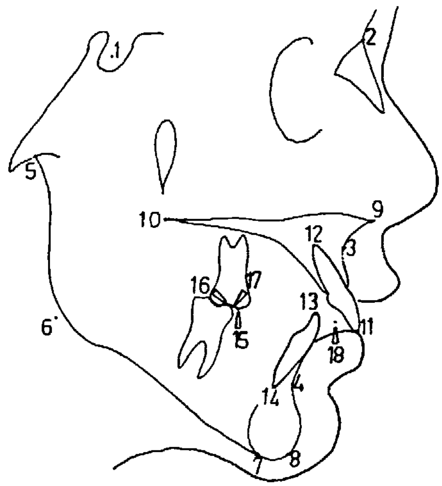

Figure 2 Landmarks and their definitions used in conventional cephalometrics. (1) S (sella); (2) N (nasion); (3) A (point A); (4) B (point B); (5) Ar (articulare); (6) Go (gonion, constructed on the outline of the mandible by bisecting the ramus and corpus planes); (7) Me (menton); (8) Gn (gnathion); (9) ANS (anterior nasal spine); (10) PNS (posterior nasal spine); (11) tip of the crown of the most anterior maxillary central incisor; (12) root apex of the most anterior maxillary central incisor; (13) tip of the crown of the most anterior mandibular central incisor; (14) root apex of the most anterior mandibular central incisor; (15) tip of the mesiobuccal cusp of the maxillary permanent first molar; (16) tip of the mesiobuccal cusp of the mandibular permanent first molar; (17) midpoint of the line connecting 15 and 16; (18) midpoint of the line connecting 11 and 13.

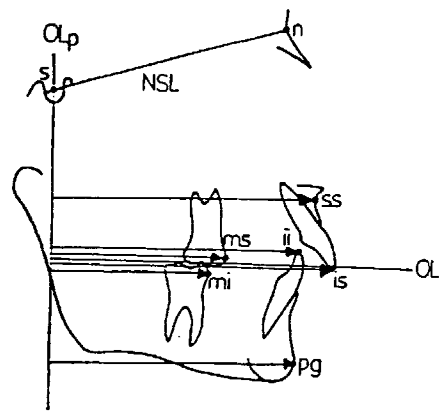

Figure 3 Measuring and reference points and their definitions used in 'Class II correction' analysis. The nasion–sella line (NSL) and the reference grid (OL and OLp) are shown. ii (incision inferius, the incisal tip of the most prominent mandibular central incisor); is (incision superius, the incisal tip of the most prominent maxillary central incisor); mi (molar inferius, the mesial cotact point of the mandibular permanent first molar determined by a tangent perpendicular to OL); ms (molar superius, the mesial contact point of the maxillary permanent first molar determined by a tangent perpendicular to OL); pg (pogonion, the most anterior point on the bony chin, determined by a tangent perpendicular to OL); n (nasion); s (sella); OL (occlusal line, a line through is and the distobuccal cusp of the maxillary permanent first molar); OLp (occlusal line perpendiculare, a line perpendicular to OL through s); NSL (nasion–sella line) (Pancherz, 1982).

superimposition of the tracings on the nasion–sella line (NSL) with sella (s) as the registration point.

The linear and angular measurements used in both analysing methods are shown in Tables 2–5.

Statistical methods

The arithmetic mean and SD were calculated for each variable at both time periods. Initially, measurements for each sex were examined separately for the treatment and control groups. A Mann–Whitney *U*-test was performed to determine whether statistically significant sex-related differences existed in the changes which occurred in both groups. Since no significant sex-related differences could be determined [except for two parameters, NSAr (degrees) and S-Ar (mm)], the boys and girls were pooled for further analyses.

For these joined groups, to assess the statistical significance of changes occurring during the different observation periods in both Bass and control samples, *t*-tests for paired samples were performed. To compare the changes observed in both groups, *t*-tests for independent samples were performed. The levels of significance used were $P < 0.001$, $P < 0.01$ and $P < 0.05$. $P \geq 0.05$ was considered non-significant.

Results

Skeletal development (Table 1)

The patients' maturation level at both time periods in the treatment and control groups are presented in Table 1.

Cephalometric changes (Table 2–5)

Cephalometric details of the dentofacial morphology in both Bass and control samples,

Table 2 Cephalometric records describing dentofacial morphology in subjects treated with the Bass appliance and the control group (registrations before and after 6 months of treatment and control periods).

Variables	Treatment group (*n* = 27)				Control group (*n* = 20)			
	Before		After		Before		After	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Cranial base								
S–N (mm)	69.15	4.27	68.09	4.05	67.33	3.30	67.10	3.13
S–Ar (mm)	33.72	3.64	34.18	3.70	33.65	3.10	34.63	3.30
NSAr (°)	126.68	5.76	126.83	5.88	126.38	5.94	125.95	6.43
Maxilla								
SNA (°)	81.46	4.33	80.74	4.33	81.47	3.56	82.00	3.99
NSL/NL (°)	8.46	3.57	8.98	3.34	8.55	3.26	8.70	3.23
Mandible								
SNB (°)	73.83	3.37	75.89	3.68	74.77	3.39	75.50	3.60
SArGo (°)	145.51	7.06	143.44	6.69	144.73	6.12	145.58	6.25
ArGoMe (°)	123.30	5.85	124.15	6.00	123.78	7.08	123.20	5.86
NSGn (°)	71.11	3.71	70.20	3.85	70.63	3.13	70.13	3.14
NSL/ML (°)	35.24	5.22	34.18	5.59	35.25	5.34	34.23	5.39
Go–Me (mm)	65.74	4.32	68.67	4.81	66.50	5.00	67.40	5.05
Intermaxillary relation								
ANB (°)	7.63	2.03	4.85	2.21	6.70	1.74	6.50	2.00
NL/ML (°)	26.81	6.27	25.44	5.51	26.68	6.12	26.00	6.47
Dentoalveolar relation								
NSL/OL (°)	20.24	4.56	18.72	4.66	20.05	4.17	19.62	3.83
NSL/ILs (°)	110.09	6.92	108.63	7.64	108.55	5.41	108.63	5.23
ML/ILi (°)	98.19	5.20	97.91	5.88	95.75	6.75	96.75	6.82
ILs/ILi (°)	117.24	6.90	122.83	8.04	120.83	7.21	119.68	6.80
Vertical dimension								
N–Me (mm)	113.15	5.08	116.52	5.29	112.45	5.93	112.98	5.02
S–Go (mm)	72.87	4.79	77.00	5.93	72.35	5.82	73.35	5.81
S–Go/N–Me (%)	65.06	4.24	66.47	4.60	64.35	4.24	64.94	4.50
Ar–Go (mm)	43.26	3.55	47.13	4.95	43.25	4.61	42.77	4.81

before and after the observation periods, are shown in Tables 2 and 4. The cephalometric changes and their significance are presented in Tables 3 and 5. The intergroup differences for the changes are also included in these tables. The significant group differences for the different variables are considered to represent the treatment effects of the Bass appliance.

The results from the analysis of 6 months treatment versus control data indicate that the sagittal skeletal relationship was improved during the Bass treatment. Changes in the position of the apical bases led to this finding. According to Tables 3 and 5, both points A (or ss) and B (or pg) were found to be displaced during treatment. Angular changes were also significant as well as the positional changes. The point ss moved 1.44 mm in a posterior direction, whereas point pg was displaced 2.56 mm anteriorly. The SNA angle reduced 1.25 degrees whereas the SNB angle increased 1.33 degrees, resulting in a 2.58 degrees improvement in the sagittal relationship between the apical bases during treatment.

Treatment over a 6 month period also resulted in a reduced overjet, an improved molar relationship, and a more posterior positioning of the maxillary molars and incisors. No significant dental change in the mandible was observed. The relationship between skeletal and dental changes contributing to Class II correction in the incisor and molar segments is seen in Figures 4 and 5.

Table 3 Changes in cephalometric records describing dentofacial morphology in subjects during 6 months of treatment and the control periods.

Variables	Treatment group (n = 27)		Control group (n= 20)		Difference (treatment – control)
	Mean	SD	Mean	SD	Mean
Cranial base					
S–N (mm)	–1.06	1.24***	–0.23	1.37	–0.83*
S–Ar (mm)	0.46	1.85	0.98	2.07*	–0.52
NSAr (°)	0.15	2.72	–0.43	3.03	0.58
Maxilla					
SNA (°)	–0.72	1.81*	0.53	1.66	–1.25*
NSL/NL (°)	0.52	1.93	0.15	2.20	0.37
Mandible					
SNB (°)	2.06	1.61***	0.73	1.89	1.33*
SArGo (°)	–2.07	3.36**	0.85	4.79	–2.92*
ArGoMe (°)	0.85	2.21	–0.58	6.47	1.45
NSGn (°)	–0.91	1.34**	–0.50	2.49	–0.41
NSL/ML (°)	–1.06	2.14*	–1.03	4.12	–0.57
Go–Me (mm)	2.93	2.13***	0.90	1.45*	2.03***
Intermaxillary relation					
ANB (°)	–2.78	1.27***	–0.20	1.13	–2.58***
NL/ML (°)	–1.37	2.05**	–0.68	3.52	–0.69
Dentoalveolar relation					
NSL/OL (°)	–1.52	2.40**	–0.43	4.17	–1.09
NSL/ILs (°)	–1.46	2.96*	0.08	2.49	–1.54
ML/ILi (°)	–0.28	3.26	1.00	3.48	–1.28
ILs/ILi (°)	5.59	4.68***	–1.13	3.11	6.72***
Vertical dimension					
N–Me (mm)	3.37	2.14***	0.53	5.27	2.84*
S–Go (mm)	4.13	2.89***	1.00	2.08*	3.13***
S–Go/N–Me (%)	1.41	4.10	0.59	2.75	0.82
Ar–Go (mm)	3.87	3.34***	–0.48	3.26	4.35***

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

The improvements in sagittal incisor and molar relationships were due to an extended amount of skeletal changes. The overjet was reduced by an average of 6.03 mm. This was accomplished by a 2.56 mm anterior positioning of the mandible (Table 5, variable 4) and a 1.44 mm posterior positioning of the maxilla (Table 5, variable 3) in combination with 1.97 mm distal movement of the maxillary incisors (Table 5, variable 9). The sagittal molar relationship was improved by an average of 5.75 mm. This was a result of the favourable positional changes in both the maxilla and the mandible, in combination with a 1.70 mm distal movement of the maxillary molars (Table 5, variable 11). Although no significant difference was observed between the groups in the inclination of the upper and lower incisors, the interincisal angle was significantly increased in the treatment group.

An accelerated increment of mandibular body length was observed in the treatment group. Whereas mandibular body length in the control group was increased on average 0.90 mm, in the Bass appliance group it was increased on average 2.93 mm. There was also a significant decrease in the articular angle in the treated group.

The sella–nasion distance was significantly reduced in the treated subjects.

In the vertical dimension, significant increases were found in total–anterior and total–posterior facial heights of 2.84 mm and 3.13 mm respectively, with a 4.35 mm increase in ramus

Table 4 Class II correction analysis; cephalometric records in subjects treated with Bass appliance and the control group; registrations before and after 6 months treatment and control periods.

Variables (mm)	Treatment group (n = 27)				Control group (n = 20)			
	Before		After		Before		After	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
(1) Overjet (is/OLp–ii/OLp)	10.53	1.80	4.68	1.75	9.72	2.02	9.90	2.53
(2) Molar relation* (ms/OLp–mi/OLp)	+2.96	1.48	–2.84	1.27	+1.83	0.95	+1.78	1.13
(3) Maxillary base (ss/OLp)	75.92	3.79	74.98	3.97	74.70	4.93	75.20	4.93
(4) Mandibular base (pg/OLp)	74.13	4.64	76.59	4.74	74.98	5.83	74.88	6.07
(5) Maxillary incisor (is/OLp)	86.03	4.39	82.70	5.30	84.67	5.48	84.75	5.77
(6) Mandibular incisor (ii/OLp)	75.50	4.91	78.02	5.26	74.95	5.86	74.85	6.10
(7) Maxillary molar (ms/OLp)	52.85	3.51	50.31	4.62	51.58	5.44	52.18	5.47
(8) Mandibular molar (mi/OLp)	49.89	3.68	53.15	4.22	49.75	5.78	50.40	5.76

* + indicates a distal molar relation; – indicates a normal molar relation.

Table 5 Class II correction analysis; changes in cephalometric records in subjects during 6 months of treatment with the Bass appliance and the control periods.

Variables	Treatment group (n = 27)		Control group (n = 20)		Difference (treatment – control)
	Mean	SD	Mean	SD	Mean
(1) Overjet (is/OLp(d)–iiOL/p(d))	–5.85	2.12***	0.18	1.79	–6.03***
(2) Molar relation (ms/OLp(d)–mi/OLp(d))	–5.80	1.88***	–0.05	0.76	–5.75***
(3) Maxillary base (ss/OLp(d))	–0.94	2.31*	0.50	1.22	–1.44*
(4) Mandibular base (pg/OLp(d))	2.46	2.54***	–0.10	2.76	2.56**
(9) Maxillary incisor (is/OLp(d)–ss/OLp(d))	–2.39	1.61***	–0.42	1.99	–1.97***
(10) Mandibular incisor (ii/OLp(d)–pg/OLp(d))	0.06	1.47	0.00	1.51	0.06
(11) Maxillary molar (ms/OLp(d)–ss/OLp(d))	–1.60	2.18***	0.10	2.14	–1.70*
(12) Mandibular molar (mi/OLp(d)–pg/OLp(d))	0.80	2.13	0.75	2.07	0.05

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

height. Total–posterior facial height was increased an average of 1 mm in the control sample. No significant differences were observed between the groups with regard to palatal plane angle (NSL–NL) and mandibular plane angle (NSL–ML).

Discussion

The purpose of this study was to evaluate the short-term effects of the Bass appliance in relation to growth represented by records obtained from untreated subjects exhibiting the same malocclusion as the treatment group. In this particular study, the Bass and control samples were comparable with respect to age, length of the examination periods (Table 1) and dentofacial morphology (Tables 2–4). As shown in Table 1, the mean ages at the beginning of the examination period were 11.99 years in the Bass group and 11.85 years in the control group. The mean value of the ANB angle, representing the sagittal skeletal relationship, was 7.60 degrees in

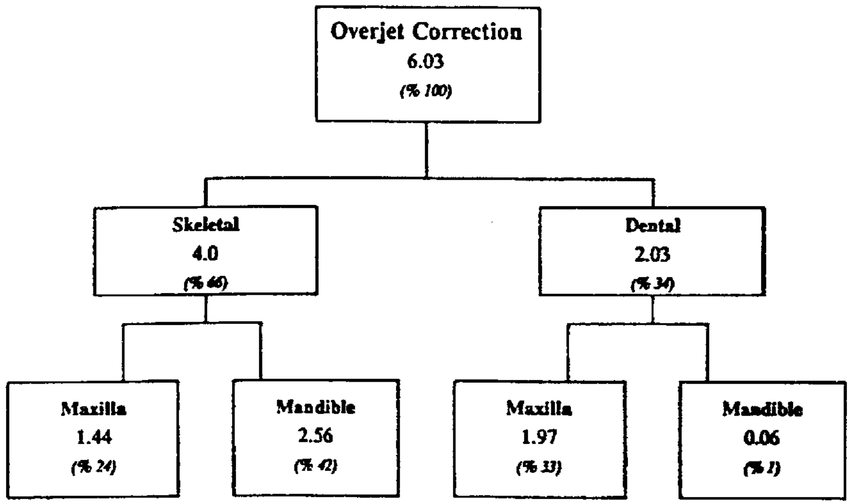

Figure 4 Maxillary and mandibular skeletal and dental changes (Table 4) contributing to overjet correction in 27 cases treated for 6 months with the Bass appliance.

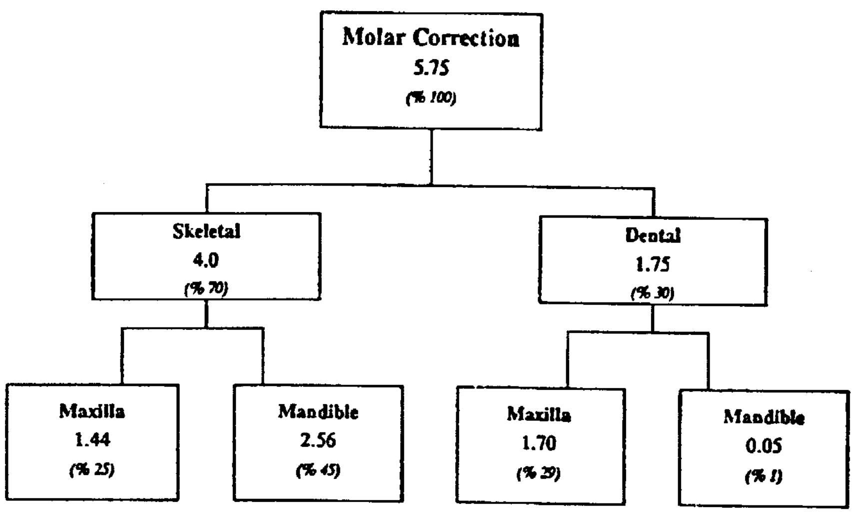

Figure 5 Maxillary and mandibular skeletal and dental changes (Table 4) contributing to sagittal molar correction in 27 cases treated for 6 months with the Bass appliance.

the Bass group and 6.70 degrees in the control group. The mean initial values of the overjet, measured on lateral cephalometric headfilms, were found to be close: 10.53 mm and 9.72 mm in the two groups respectively (Tables 2 and 4). In all treated patients it was possible to achieve the desired dental sagittal relationship during the sixth to eighth months of treatment. The mean treatment duration was 6.88 months and it was again comparable with the mean observation time of the control group, 6.44 months (Table 1).

It has been pointed out that the level of somatic development, influences the outcome of dentofacial orthopaedic treatment (Wieslander, 1975; Pancherz and Hägg, 1985; Malmgren *et al.*, 1987; Hägg and Pancherz, 1988). The pubertal growth spurt is considered as the most suitable period for growth intervention in orthodontic treatment and is frequently taken into consideration in the planning of treatment (Graber, 1969; Björk, 1972; Hägg and Taranger, 1982). Due to the lack of longitudinal growth data related to the present material, the skeletal maturation was assessed by hand–wrist radiographs, taken at the beginning and the end of both the treatment and control periods, using the TW2 method. According to the results obtained from these hand–wrist radiographs, it could be concluded that all of the subjects were in the pubertal growth spurt during the examination period.

The extraoral force, as a part of the Bass treatment, caused a significant inhibition of maxillary forward growth since the displacement of point ss (Table 5) and the reduction of the SNA angle (Table 3) were found to be significantly different from the controls. Similar results have been reported in previous studies of treatment, either with headgear only (Wieslander, 1963) or with the appliances combined with headgear (Joffe and Jacobson, 1979; Caldwell *et al.*, 1984; Wieslander, 1984).

No change was observed in the inclination of the palatal plane since the change of the palatal plane angle in the treatment group was comparable to the non-treated control group. This result supports the opinion that using a high-pull headgear with a vertically directed force will avoid tipping of the palatal plane (Thurow, 1975; Teuscher, 1978; Stöckli and Teuscher, 1985).

There was a significant increase in facial height in the treated group. However, the mandibular plane was not significantly affected by treatment with the Bass appliance, thus avoiding the undesirable tendency to posterior mandibular rotation during treatment.

In this study there was a significant decrease in the length of cranial base (S–N) in the treatment group. In the Bass treatment, the maxillary part of the appliance converts the entire maxilla into a rigid unit to which heavy extraoral forces are applied. In experimental studies (Droschl, 1973; Elder and Tuenge,1974; Trifthauser and Walters, 1976) it has been shown that heavy extraoral force application by means of headgear affects not only the dentition but also the maxilla, and the related midfacial bones with resorption at all articulations of the maxilla. Koch and Witt (1977) showed that the growth of the anterior cranial base was decreased with the effect of cervical headgear. When this was compared with the control group a lesser increase in the length of the S–N line was observed. The results obtained relating to the cranial base were in accordance with the those of the aforementioned studies.

When the dental changes in the maxilla were concerned, distal movement of the dentoalveolar area was observed (Table 5), despite the attempt to transfer as much force as possible to the base of the maxilla with a splint. Distal movement of the upper dentition was also evident in previous studies with maxillary orthopaedic splints (Joffe and Jacobson, 1979; Caldwell *et al.*, 1984). This distal movement of the maxillary dentition assisted the reduction of the overjet (Figure 4), and correction of the Class II molar relationship (Figure 5).

The inclination of the maxillary incisors was not changed significantly during the treatment period. This result confirms the opinion (Bass, 1982, 1983; Stöckli and Teuscher, 1985; Kigele, 1987) that, by using appliances with torquing springs on the maxillary incisors, the axial inclination of these teeth is better controlled.

In the Bass subjects the mandible was progressively positioned in an anterior direction by reactivation of the mandibular mechanism of the appliance. At the end of the 6 month treatment period there was a significant anterior displacement of point pogonion (Table 5), an increase in both SNB angle and mandibular body length (Table 3), and a decrease in articular angle compared with the control sample. These results led to the conclusion that mandibular forward growth was enhanced during the treatment with the Bass appliance. In animal experiments (Charlier *et al.*, 1969; Stöckli and Willert, 1971; McNamara, 1973, 1980; McNamara and Carlson, 1979) it has been shown that condylar growth could be stimulated. On the other hand, the forward positioning of the mandible might also be a result of a remodelling processes in the articular fossa (Stöckli and Willert, 1971; Pancherz, 1979, 1982; Wieslander, 1984). It has been also pointed out that this tissue response is probably due to an initial neuromuscular adaptation to the altered protrusive occlusion. These initial neuromuscular changes have been considered as a trigger for the mandible to attain a new functional position that subsequently leads to morphologic changes (McNamara, 1973; Pancherz, 1979, 1981, 1982, 1985; Hinton and McNamara, 1984; Carels and Van Steenberghe, 1986; Ingervall and Bitsanis, 1986). This also seemed to be confirmed in a previous electromyographic investigation (Cura and Saraç, 1990) using the same sample presented in this particular study.

In this study, a rapid and significant favourable treatment response was observed similar to those obtained in previous studies with Bass appliance (Bass, 1982, 1983; Malmgren and Ömblus, 1985; Malmgren *et al.*, 1987; Pancherz *et al.*, 1989), Herbst (Pancherz, 1979, 1981, 1982, 1985) and Herbst–HG combination appliances (Wieslander, 1984). This may be due to the pronounced effect during the pubertal growth spurt as found by Pancherz and Hägg (1985) and Malmgren *et al.* (1987), or to the continuous and progressive activation of the forward posturing of the mandible as suggested by Malmgren and Ömblus (1985) and Pancherz *et al.* (1989), in close agreement with the results of previous experimental studies (Stöckli and Willert, 1971; McNamara and Carlson, 1979).

In this present study, treatment effects on the dental changes in the mandible were not significant. It is possible to explain this finding by considering the design of the appliance. The mandibular mechanism of the appliance consists of acrylic pads which contact with the lingual mucosa only. Thus, there is no force acting on the lower dentition causing a tooth movement.

The findings in this study revealed that the Bass appliance was an effective treatment tool in the correction of skeletal sagittal discrepancies in growing patients. The sagittal improvement of points A (or ss) and B (or pg) reflected a predominantly skeletal effect in the treatment group (Figures 4 and 5). However, changes in the sagittal jaw relationship after a short intensive treatment period are beneficial only if they prove to remain stable during and after the retention period. The purpose of this study was to evaluate the short-term effects of Bass treatment, so the results should be interpreted cautiously by taking the following points into consideration: according to previous studies, of minor importance is the growth period in which the patients are treated (Hansen *et al.*, 1991), the long-term stability seems mainly to depend on a favourable post-treatment growth pattern (Hansen *et al.*, 1991) and a stable cuspal interdigitation (Pancherz and Hansen, 1986; Pancherz, 1991). Additionally, DeVincenzo (1991) found that the greater the orthopaedic effect during treatment on the mandible, the greater the likelihood of relapse after treatment. Therefore, long-term evaluation after intensive treatment would be of great interest for a comprehensive assessment of the value of Bass treatment.

Conclusion

Treatment of skeletal Class II malocclusions in growing patients by means of the Bass appliance can be expected to result in: (i) an improvement in sagittal skeletal relationship as a result of favourable growth responses both in the maxilla and in the mandible; (ii) correction of the overjet and molar relationship as a result of extended skeletal changes; (iii) distal movement of the maxillary dentition; (iv) no significant dental changes in the mandible; (v) an unchanged inclination of the maxillary incisors; and (vi) increased facial height without changes in the inclinations of the palatal and mandibular planes.

This investigation was concerned with the short-term results of Bass treatment; the long-term implications of this treatment method need further consideration.

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