

# The effects of activator treatment on the craniofacial structures of Class II division 1 patients

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**SUMMARY** The aim of the present study was to clarify the skeletal treatment effects induced by activator treatment. Fifty actively growing patients with Class II division 1 malocclusions were treated with an activator appliance. A control group consisting of longitudinal growth data from 20 patients (untreated Class II division 1 malocclusions) was used to eliminate possible differences in growth pattern. Lateral cephalograms of each patient were taken at the start and end of treatment. Final cephalograms were taken after a mean of 16.4 ( $\pm 2.0$ ) months activator treatment, compared with a mean of 14.2 ( $\pm 2.4$ ) months for the control group. Each cephalogram was traced and digitized by the same individual. The mean and standard deviations for linear and angular cephalometric measurements were analysed statistically, and intra- and inter-group changes were evaluated by paired- and independent-sample *t*-tests.

At the end of the study period, the overjet was decreased in all patients. Ramus height, corpus length, anterior and posterior face height all increased significantly ( $P < 0.05$ ). In the treatment group, ANB angle decreased and the bite was opened. The activator appliance caused maxillary incisor lingual tipping and mandibular incisor labial tipping. The overjet was decreased as a result of the increased forward growth of the mandible and dentoalveolar changes. The results demonstrated that the activator appliance has a characteristic skeletal and dental effect on the developing craniofacial complex.

## Introduction

Class II division 1 malocclusions may be treated effectively in actively growing patients with any type of functional appliance. The principal aims of dentofacial orthopaedic treatment of skeletal Class II division 1 malocclusions with an activator are to correct the dental arch relationship and to improve the patient's facial profile by promoting favourable mandibular growth changes (Andresen and Haupl, 1945).

Several important benefits have been attributed to the treatment of Class II malocclusions: prevention of trauma to maxillary incisors associated with a large overjet, interception of the development of dysfunction, psychosocial advantages for the child during an important formative period of life, and improved prognosis for the adolescent phase of treatment (Wieslander, 1975; Doruk and Göyenc, 1999).

Numerous researchers have shown that the activator influences the dentoalveolar region (Woodside, 1973; Ahlgren and Laurin, 1976). However, there are some arguments over the orthopaedic effects of the activator. While some authors claim that the skeletal effect of activator therapy is attributed to the restriction of maxillary growth (Jakobsson, 1967; Harvold and Vargervik, 1971; Ahlgren and Laurin, 1976; Panherz, 1984; Hashim, 1991), others adopt the opinion that the activator stimulates condylar and as a result mandibular growth (Marschner and Harris, 1966; Luder, 1981; Birkebæk *et al.*, 1984; Jakobsson and Paulin 1990; Ruf

*et al.*, 2001). An influence of activator treatment on the glenoid fossa has also been reported (Birkebæk *et al.*, 1984; Ruf *et al.*, 2001).

McNamara (1981) has claimed that the most frequent skeletal problem in Class II malocclusions in pre-adolescents is mandibular retrognathia. This would suggest that an appliance with the demonstrated ability to stimulate significant mandibular growth would be an important part of the clinician's armamentarium. Animal studies have shown that appliances which position the mandible anteriorly can stimulate significant mandibular growth, primarily by an enhanced remodelling response at the condyle (Charlier *et al.*, 1969; Stöckli and Willert, 1971; McNamara, 1973).

The effects of different types of functional appliance on the dentofacial relationship of individuals with Class II division 1 malocclusions have been evaluated in a number of investigations. Many studies have used control groups to differentiate treatment effects from those of growth and development (Jakobsson and Paulin, 1990; Tulloch *et al.*, 1990; Firouz *et al.*, 1992; Windmiller, 1993; Buschang *et al.*, 1994; Doruk and Göyenc, 1999).

Tulloch *et al.* (1990) systematically reviewed the literature between 1980 and 1987 and identified 50 studies reporting the treatment of young patients with Class II malocclusions. Because of the various inherent limitations of the different investigations, they were unable to determine whether orthodontic treatment significantly influenced the growth potential of Class II patients.

Describing the skeletal abnormality that may accompany a Class II malocclusion as a skeletal 'Class II' is of limited diagnostic value (Jakobsson and Paulin, 1990; Windmiller, 1993; Buschang *et al.*, 1994). This simple description does not specify whether the mandible is normal or retruded in relation to the maxilla, or whether the maxilla is protruded or normal in relation to the mandible.

Isaacson *et al.* (1977) summarized the process of mandibular rotation and translation relative to the anterior cranial base by describing the total displacement of the mandible as a circular movement around a centre, the localization of which is dependent not only on the direction of condylar growth but also on the 'proportionality' of vertical growth.

It therefore remains unclear whether the activator appliance is able to alter the underlying mandibular growth pattern or whether it simply leads only to dentoalveolar changes. The purpose of this study was therefore to cephalometrically evaluate the overall changes that occur during treatment with an activator, evaluate the treatment effects of the activator by comparison with an untreated Class II division 1 control group, and compare the findings with previously published results.

## Subjects

The study comprised 70 children with skeletal Class II malocclusions. Twenty-six male and 24 female patients treated between 1998 and 2001 at the Orthodontic Department of Selçuk University, Konya were selected as the treatment group. Fifty patients with an ANB > 4 degrees and an overjet greater than 7 mm were randomly selected for this study. All were Caucasian and their ages ranged from 11.4 to 13.6 years ( $12.55 \pm 1.08$  years). All were treated exclusively with an activator appliance.

The remaining sample formed the untreated control group, which consisted of 10 boys and 10 girls, with similar Class II division 1 malocclusions (ANB > 4 degrees) and an overjet greater than 5 mm. All were Caucasian with ages ranging from 11.6 to 13.6 years ( $12.63 \pm 0.98$  years). The subjects in the control group were informed about orthodontic therapy but refused treatment.

The activator appliance consisted of a maxillary block of acrylic with an upper labial wire (0.8 mm) passively contacting the incisal third of the upper central incisors. Acrylic capping covered the incisal third of the mandibular incisors in an attempt to avoid labial tipping of these teeth. The acrylic extended down to the lower lingual sulcus to provide stability and anchorage. The construction bite was taken with the mandible protruded by 4–5 mm and with an interocclusal space of 2–3 mm in the molar region. The interocclusal acrylic in the molar area was not trimmed until improvement of the sagittal jaw relationship was achieved. At the final

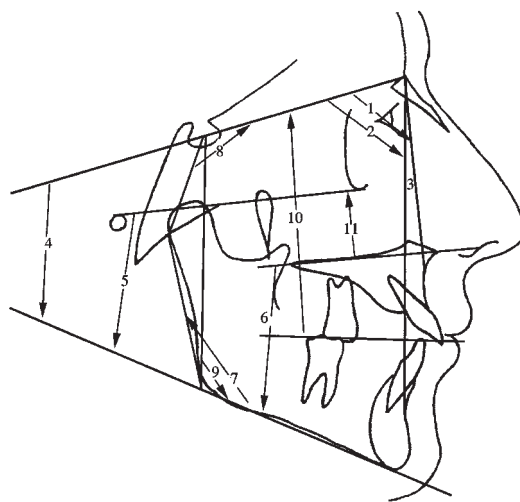
stage, it was trimmed selectively, according to the desired occlusal movements of the lower molars. The patients were advised to wear the appliance 18 hours a day, but no active effort was made to measure co-operation.

Individual tooth movements are difficult with functional appliances. Therefore, in some cases at the final phase fixed appliances were used to achieve bodily and rotational tooth movements and optimal functional occlusion.

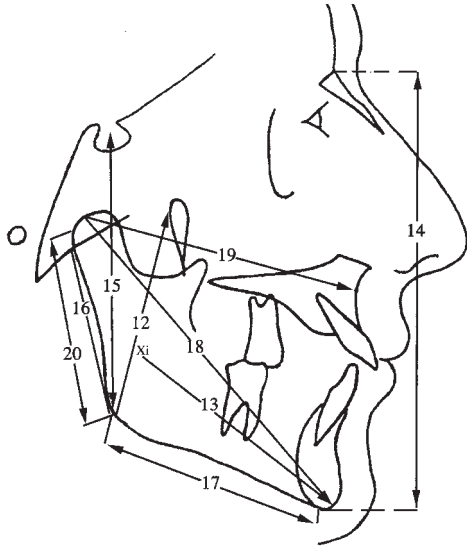
## Methods

Standardized lateral cephalograms were taken of each patient in centric occlusion at the start and end of the study period. Final cephalometric radiographs were taken at a mean of 16.4 ( $\pm 2.0$ ) months into treatment, compared with a mean of 14.2 ( $\pm 1.8$ ) months for the control group. All radiographs were traced, digitized, and evaluated with the JOE program (Rocky Mountain Orthodontics JOE Version 5.0; Denver, USA). Sixteen angular and 13 linear cephalometric measurements were determined.

In this study, the cephalometric landmarks shown in Figures 1–3 were used.



**Figure 1** Angular skeletal measurements. 1: SNA (deg), the angle formed by the planes sella–nasion and nasion–point A; 2: SNB (deg), the angle formed by the planes sella–nasion and nasion–point B; 3: ANB (deg), the angle formed by the planes nasion–point A and nasion–point B; 4: SN–GoGn (deg), the angle formed by the lines sella–nasion and gonion–gnathion; 5: FH–MP (deg), the angle formed by the mandibular plane and Frankfort Horizontal; 6: PP–MP (deg), the angle formed between the palatal (ANS–PNS) and mandibular plane; 7: Gn–Go–Ar (deg), the angle formed by the lines gonion–gnathion and gonion–articular; 8: Ar–S–N (deg), the angle formed by the lines articulare–sella and sella–nasion measured from sella; 9: Me–Go–S (deg), the angle formed by the lines menton–gonion and gonion–sella at gonion; 10: OP–SN (deg), the angle formed between the occlusal plane and sella–nasion; 11: maxillary plane angle (deg), the angle formed by the palatal plane and Frankfort Horizontal.



**Figure 2** Linear skeletal measurements. 12: ramus height (mm), measured from point CF (the intersection between Frankfort Horizontal and vertical pterygoid) to gonion; 13: corpus length (mm), measured along the corpus axis from Xi point to pogonion; 14: anterior face height (N-Me) (mm), measured by the distance from nasion to menton; 15: posterior face height (S-Go) (mm), measured by the distance from sella to gnathion; 16: Go-Ar (mm), the distance between gonion and articulare; 17: Go-Me (mm), distance between gonion and menton; 18: Co-Gn (mm), measured from condyion to gnathion; 19: Co-A (mm), measured from condyion to point A; 20: Go-PC (mm), the distance between gonion and the most posterior point of the condylar head.

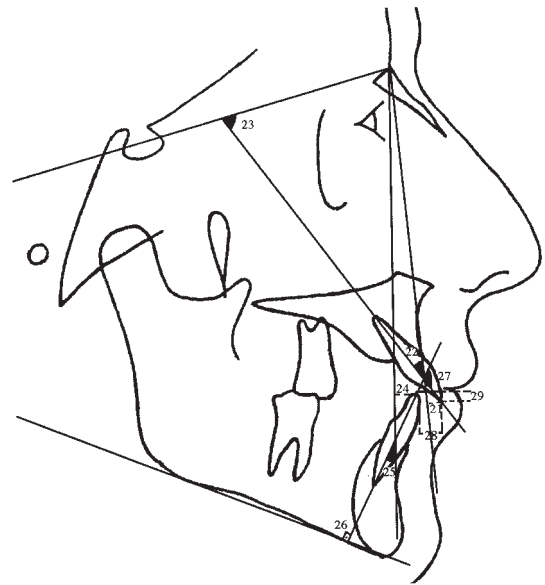
### Statistical analysis

All statistical analyses were performed using the SPSS software package (SPSS for Windows 98, version 10.0; SPSS Inc., Chicago, IL, USA). For each variable, the arithmetic mean and standard deviation (SD) were calculated. A paired-sample *t*-test was used to evaluate the treatment changes within each group. To compare the changes observed in both groups, an independent-sample *t*-test was performed (Kirkwood, 1996).

Two weeks after the first measurements, 30 radiographs were selected at random and retraced and redigitized, and a paired-sample *t*-test was applied to the first and second measurements. It was found that the difference between the first and second measurements of the 30 radiographs was insignificant. Correlation analysis applied to the same measurements showed the highest *r* value (0.99) for overbite, and the lowest *r* value (0.93) for FH-MP (Houston, 1983).

### Results

The data from skeletal and dental measurements of the pre- and post-treatment and pre- and post-control lateral cephalograms are summarized in Tables 1 and 2.



**Figure 3** Dental measurements. 21: U1-NA (mm), the distance between the tip of the upper incisor and a line from nasion to point A; 22: U1-NA (deg), the angle formed by the long axis of the upper incisor to a line from nasion to point A; 23: U1-SN (deg), the angle from the upper incisor to the sella-nasion plane; 24: L1-NB (mm), the distance between the tip of the lower incisor and a line from nasion to point B; 25: L1-NB (deg), the angle formed by the long axis of the lower incisor to a line from nasion to point B; 26: IMPA, the angle formed by the long axis of the lower incisor and the mandibular plane; 27: interincisal angle, the angle formed by the long axis of the upper and lower incisors; 28: overjet, measured from the tip of the lower incisor to the tip of the upper incisor along the occlusal plane; 29: overbite, measured from the tips of the upper and lower incisors perpendicular to the occlusal plane.

### Pre- and post-treatment skeletal differences

**Activator group.** The difference between the means of the pre- and post-treatment measurements of SNB ( $1.42 \pm 2.09$ ), ramus height ( $3.65 \pm 3.22$ ), corpus length ( $3.88 \pm 2.94$ ), N-Me ( $6.27 \pm 4.29$ ), S-Go ( $4.19 \pm 3.06$ ), Go-Ar ( $3.08 \pm 3.26$ ), Go-Me ( $3.78 \pm 3.13$ ), Co-Gn ( $6.66 \pm 3.70$ ), and Go-PC ( $3.12 \pm 3.27$ ) increased ( $P < 0.001$ ). The difference between the means of the pre- and post-treatment measurements of Ar-S-N ( $-1.06 \pm 2.84$ ) decreased ( $P < 0.05$ ), while ANB ( $-1.63 \pm 1.34$ ) also decreased ( $P < 0.001$ ) (Table 1).

**Control group.** The difference between the means of the pre- and post-control measurement of Go-Ar ( $0.90 \pm 1.59$ ), Go-Me ( $0.88 \pm 1.57$ ), N-Me ( $0.50 \pm 0.31$ ), and Co-Gn ( $1.47 \pm 2.60$ ) increased ( $P < 0.05$ ), and for S-Go ( $1.04 \pm 0.63$ ) ( $P < 0.001$ ) (Table 1).

**Intergroup comparisons.** The mean differences in the study group were compared with the mean differences in the control group using the Student's *t*-test for unpaired samples. The mean difference for the study group was larger than that for the control group for

**Table 1** Descriptive statistics, mean changes and *P* values for skeletal measurements of activator and control groups.

Skeletal measurements	Activator group							Control group						
	Pre-treatment		Post-treatment		Difference		<i>P</i> value	First observation		Second observation		Difference		<i>P</i> value
	Mean	SD	Mean	SD	Mean	SD	Paired-sample <i>t</i> -test	Mean	SD	Mean	SD	Mean	SD	Paired-sample <i>t</i> -test Independent-sample <i>t</i> -test
Angular measurements														
1 SNA (deg)	80.31	3.92	80.08	3.76	-0.22	2.27	NS	80.46	3.06	80.35	3.11	-0.11	1.70	NS
2 SNB (deg)	74.34	3.54	75.76	3.47	1.42	2.09	0.000***	74.58	3.08	74.99	3.36	0.41	1.64	NS
3 ANB (deg)	5.96	1.68	4.33	1.87	-1.63	1.34	0.000***	5.86	1.40	5.36	1.51	-0.50	1.24	NS
4 Sn-GoGn (deg)	35.33	6.03	35.70	5.90	0.37	2.66	NS	35.63	5.85	35.29	6.09	-0.34	1.90	NS
5 FH-MP (deg)	27.15	5.13	27.56	6.45	0.41	4.48	NS	26.44	5.04	26.25	5.73	-0.20	3.19	NS
6 PP-MP (deg)	27.63	4.69	27.94	5.15	0.31	2.45	NS	28.63	5.81	28.06	5.87	-0.57	2.40	NS
7 Gn-Go-Ar (deg)	125.98	5.61	126.24	5.94	0.27	2.58	NS	124.34	5.80	124.62	6.60	0.29	2.12	NS
8 Ar-S-N (deg)	125.95	4.63	124.89	4.70	-1.06	2.84	0.028*	128.36	4.23	127.84	4.84	-0.52	2.65	NS
9 Me-Go-S (deg)	110.20	5.19	110.55	5.12	0.35	1.09	NS	108.62	5.76	108.92	5.82	0.31	1.32	NS
10 OP-SN (deg)	16.68	4.77	16.81	5.00	0.13	3.28	NS	16.98	4.76	16.49	4.77	-0.49	1.57	NS
11 MaxP Ang. (deg)	-0.49	3.12	0.13	3.43	0.62	2.99	NS	-2.20	2.73	-1.83	2.87	0.38	2.88	NS
Linear measurements														
12 Ramus height (mm)	60.59	4.29	64.24	5.21	3.65	3.22	0.000***	60.76	5.24	61.51	4.88	0.75	2.54	NS
13 Corpus length (mm)	64.69	3.64	68.57	3.74	3.88	2.94	0.000***	65.14	3.78	65.57	3.33	0.43	0.99	NS
14 N-Me (mm)	116.37	6.22	122.64	6.91	6.27	4.29	0.000***	117.15	7.41	117.67	7.39	0.50	0.31	0.004**
15 S-Go (mm)	75.52	5.50	79.68	6.17	4.16	3.06	0.000***	75.64	5.07	76.68	4.91	1.04	0.63	0.000***
16 Go-Ar (mm)	45.01	4.45	48.10	5.35	3.08	3.26	0.000***	45.62	2.94	46.52	3.15	0.90	1.59	0.020*
17 Go-Me (mm)	65.26	4.81	69.03	5.23	3.78	3.13	0.000***	67.86	4.16	68.74	3.92	0.88	1.57	0.022*
18 Co-Gn (mm)	107.64	5.33	114.30	6.29	6.66	3.70	0.000***	109.55	6.15	111.01	6.27	1.47	2.60	0.021*
19 Co-A (mm)	84.14	4.38	84.87	3.96	0.73	2.43	NS	85.02	3.70	85.47	4.21	0.45	2.48	NS
20 Go-PC (mm)	50.05	4.33	53.17	5.32	3.12	3.27	0.000***	50.26	3.43	50.80	3.55	0.54	1.69	NS

\* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ ; NS, not significant.

**Table 2** Descriptive statistics, mean changes and *P* values for dental measurements of activator and control groups.

Dental measurements	Activator group							Control group						
	Pre-treatment		Post-treatment		Difference		<i>P</i> value	First observation		Second observation		Difference		<i>P</i> value
	Mean	SD	Mean	SD	Mean	SD	Paired-sample <i>t</i> -test	Mean	SD	Mean	SD	Mean	SD	Paired-sample <i>t</i> -test Independent-sample <i>t</i> -test
1 U1-NA (mm)	5.79	2.34	3.97	2.10	-1.81	2.04	0.000***	5.70	2.25	5.90	2.47	0.20	1.40	NS
2 U1-NA (deg)	26.76	5.55	20.71	5.77	-6.05	6.00	0.000***	22.65	7.41	24.00	7.53	1.35	3.87	NS
3 U1-SN (deg)	72.97	6.59	79.00	5.48	6.03	6.03	0.000***	78.00	7.20	7.10	6.73	-0.90	3.09	NS
4 L1-NB (mm)	4.68	1.90	5.26	1.60	0.58	1.17	0.004**	5.15	1.90	5.00	1.97	-0.15	1.56	NS
5 L1-NB (deg)	27.18	5.73	28.47	6.84	1.29	5.71	NS	24.70	5.50	24.40	5.74	-0.30	3.74	NS
6 IMPA (deg)	97.53	5.62	97.05	6.83	-0.47	5.51	NS	94.65	5.71	94.20	6.51	-0.45	4.36	NS
7 Interincisal angle	120.16	6.40	126.53	7.66	6.37	9.05	0.000***	126.75	9.29	126.25	8.10	-0.50	5.41	NS
8 Overjet (mm)	9.70	2.32	2.87	1.03	-6.84	2.08	0.000***	8.47	3.52	8.33	3.12	-0.13	0.78	NS
9 Overbite (mm)	2.95	1.41	1.61	0.91	-1.35	1.01	0.000***	3.05	2.00	3.11	2.07	0.06	0.39	NS

\*\* $P < 0.01$ ; \*\*\* $P < 0.001$ ; NS, not significant.



ramus height, Go–Ar, and Go–PC ( $P < 0.01$ ), corpus length, N–Me, S–Go, Go–Me, and Co–Gn ( $P < 0.001$ ), but smaller for ANB ( $P < 0.05$ ) (Table 1).

#### *Pre- and post-treatment dental differences*

**Activator group.** There was a difference between the means of the pre- and post-treatment measurements of U1–NA (mm) ( $1.81 \pm 2.04$ ), U1–NA ( $^{\circ}$ ) ( $6.05 \pm 6$ ), U1–SN ( $6.03 \pm 6.03$ ), interincisal angle ( $6.37 \pm 9.05$ ), overjet ( $6.84 \pm 2.08$ ), and overbite ( $1.35 \pm 1.01$ ), which all decreased ( $P < 0.001$ ), whilst that for L1–NB ( $0.58 \pm 1.17$ ) increased ( $P < 0.01$ ) (Table 2).

**Control group.** The means of the pre- and post-control of all dental measurements showed no statistically significant difference.

**Intergroup comparisons.** The mean differences in the study group were compared with those in the control group using the Student's *t*-test for unpaired samples. The mean difference in the study group was smaller than in the control group for U1–NA (mm), U1–NA ( $^{\circ}$ ), U1–SN, overjet and overbite ( $P < 0.001$ ), but larger for interincisal angle ( $P < 0.01$ ) (Table 2).

#### **Discussion**

The results of the present investigation confirm previously held opinions that the activator appliance is capable of producing both skeletal and dental treatment effects in the growing craniofacial complex. The changes observed during treatment reflect the combined effects of treatment and individual growth. Ideally, a matched or at least a comparable control group should be included for identifying the changes due to growth (Dermaut *et al.*, 1992; Cura *et al.*, 1996; Doruk and Göyenc, 1999; Ruf *et al.*, 2001). A control group consisting of longitudinal growth data of untreated Class II division 1 malocclusion subjects to eliminate possible differences in growth pattern was used in the present investigation.

The activator appliance clearly results in characteristic skeletal and dental effects on the growing craniofacial complex, whether analysed conventionally or geometrically. However, the effects of treatment are not uniformly distributed throughout the craniofacial region; treatment affects some regions of the face more than others.

These results appear to support previous investigations (Freunthaller, 1967; Harvold and Vargarik, 1971; Pfeiffer, 1978; Teuscher, 1978; Bass, 1982; Lehman *et al.*, 1988), in that decreases in overjet, overbite, and ANB angle, as well as an increase in mandibular length, ramus height, and SNB angle were found.

According to the particular cephalometric landmarks used, the treatment had either little or no effect on the maxillary skeletal structures. These results are similar to the findings of earlier studies (McNamara *et al.*, 1985;

Chang *et al.*, 1989; Dermaut *et al.*, 1992; Cura *et al.*, 1996; Ruf *et al.*, 2001).

Pancherz (1984) noted, when comparing activator subjects with norms derived from the Bolton standards, that the treatment effects were focused on the dentition and the changes in skeletal structure. He found a significantly larger posterior displacement of Ar and anterior positioning of pogonion in the activator sample compared with the Bolton standards, but the influence of the activator on mandibular growth was limited and the change in mandibular jaw base position and dimensions (corpus length, ramus height) could be mainly ascribed to normal growth changes. In the present study, it was found that normal growth changes and treatment results were different.

As the appliance was used only 18 hours a day, the threshold for adaptive remodelling in the condyles may not occur in some individuals. When the mandible is kept continuously protruded, as occurs with the Herbst appliance, mandibular growth appears to be increased (Pancherz, 1979, 1981, 1982). When comparing the activator subjects with the control sample in this investigation mandibular growth appeared significantly increased.

The mandibular changes seen in this study were more significant in the treated group than in the control group. Whilst the lower arch showed both vertical and sagittal growth in both groups, ramus height was greater in the treatment group. This treatment effect has been considered in previous investigations using the activator (Remmer *et al.*, 1985). The mandible grew further forward in the treatment group when compared with the controls. The vertical component of mandibular length (Co–Gn) contributed to this by increasing four-fold in the control group. The mandibular length changes seen in the present study were similar to those reported with the acrylic splint Herbst appliance (Windmiller, 1993).

An increase in condylar growth has been shown histologically in experimental animal studies due to hyperpropulsion of the mandible (McNamara and Carlson, 1979). Cephalometrically, there seems to be increased mandibular growth in the sagittal plane, which assists in correcting Class II malocclusions by virtue of forward mandibular growth that is greater than that anticipated from natural growth increments (Owen, 1981). The present findings were similar to these investigations, with all patients exhibiting condylar/ramus growth greater than that seen in the controls. These results showed a statistically significant increase in ramus height, corpus length, corpus growth, and chin position. Analysis of the overall growth changes in the activator group revealed increased condylar growth (Co–Gn  $6.66 \pm 3.70$  mm), ramus height ( $3.65 \pm 3.22$  mm), corpus length ( $3.88 \pm 2.94$  mm) and chin position (SNB  $-1.42 \pm 2.09$ ). These changes are most likely to be the

result of a stimulation of condylar growth (Harris, 1962; Marschner and Harris, 1966; Meach, 1966; Hultgren *et al.*, 1978; Birkebæk *et al.*, 1984). Other investigators, however, maintain that the use of an activator does not cause a significant increase in mandibular length (Björk, 1951; Harvold, 1968; Jakobsson and Paulin, 1990).

Chabre (1990) described the activator appliance as creating a force system passing behind the centres of resistance of both the maxilla and the upper alveolar process, which generated negative moments that resulted in clockwise rotation of both the palatal and occlusal planes. In the present study, however, OP–SN angle showed neither clockwise nor counter-clockwise rotation.

Some investigators have observed significant dento-alveolar changes with activator treatment (Björk, 1951; Wieslander and Lagerström, 1979; Pancherz, 1984). A Class I occlusion was achieved through distal tipping of the maxillary teeth and a mesial, vertical movement of the mandibular dentition.

Harvold and Vargervik (1971) reported that the appliance also caused 1.4 mm of maxillary incisor lingual tipping and 0.5 mm of mandibular incisor labial tipping. They concluded that the appliance achieved a Class I occlusion by inhibiting maxillary dentoalveolar development, while encouraging mandibular dentoalveolar mesial development. Pancherz (1984) found that more than 70 per cent of the overjet was corrected by incisor tipping. Approximately 50 per cent (2.5 mm) of the overjet was reduced by lingual movement of the maxillary incisor, and 22 per cent (1.1 mm) by mandibular incisor flaring.

Retroclination of the upper incisors during the course of activator treatment was found in the present study. Axial inclination of the upper incisors to the cranial base (U1–SN) retroclined significantly in the treatment group, but not in the control group. The antero-posterior position of the upper incisors relative to the NA line retroclined  $6.05 \pm 6$  degrees and retruded  $1.81 \pm 2.04$  mm in the treatment group. These measurements did not show significant positional changes in the control group.

When both activator and control groups were compared, lower incisor positions did not show statistically significant changes.

The overjet in the activator group was found to be reduced ( $6.84 \pm 2.08$  mm). This finding is supported by other activator studies (Meach, 1966; Van Beek, 1982; Lehman *et al.*, 1988).

## Conclusions

This study compared 50 patients treated with an activator appliance with a matched untreated control group. A 16-month treatment period with the activator appliance was found to have significant effects on

specific skeletal dimensions of growing individuals. The main findings were:

1. The treatment resulted in a transformation of the Class II molar relationship into a Class I molar relationship.
2. The appliance had little or no effect on the maxillary skeletal structures. No significant differences were observed according to the landmarks considered in both control and treated groups.
3. The growth in mandibular length, ramus height, and corpus length appeared to be significantly influenced by activator treatment.
4. The overjet was decreased by the increased forward growth of the mandible and dentoalveolar changes. Lingual tipping of the maxillary incisors and labial proclination of the mandibular incisors resulted in a significant reduction in overjet for the treated patients.
5. In terms of stability, the achieved results should be evaluated long-term.

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