The Mandibular Plane Angle in Activator Treatment

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It is generally accepted that the prognosis of treating Class II malocclusions is dependent, among other things, on the mandibular plane angle.[1-4] Low angle cases, usually having a more favourable horizontal growth pattern, are easier to treat and retain than high angle cases in which growth often is vertical or unfavourable.

In treating Class II malocclusions with fixed appliances in combination with Class II elastics or cervical headgear the mandibular plane angle may increase.[2-6] In high angle cases this may lead to treatment failure and should be avoided.[2,4]

Activator treatment has also been reported to cause a backward rotation of the mandible.[7-10] This, however, has been refuted in other studies.[11-13]

The purpose of the present investigation was to analyze biometrically and cephalometrically the long-term results of activator treatment in subjects with a small or large pretreatment mandibular plane angle. The investigation attempted to answer the following questions:

1. Do cases with a small mandibular plane angle exhibit a better and more stable treatment result in the sagittal and vertical incisor relationships and mandibular anterior dental arch configuration than cases with a large mandibular plane angle?

2. Does growth influence the treatment result in subjects with either a small or a large mandibular plane angle?

MATERIAL

From follow-up material[12] of patients treated with activator appliances, 28 patients were selected with respect to a small or large pretreatment mandibular plane (NSL/ML) angle:

Small angle group—NSL/ML $\leq 29.0°$ ($\bar{X} = 26.7°$, S.D. $= 3.2°$). The group consisted of 15 subjects (7 males and 8 females).

Large angle group—NSL/ML $> 34.0°$ ($\bar{X} = 37.2°$, S.D. $= 3.1°$). The group consisted of 13 subjects (4 males and 9 females).

All 28 patients had, before treatment, a Class II or Class I malocclusion with a large overjet. The average treatment age was between 11 and 14 years of age. The follow-up examination was performed 10-20 years later at an average age of 29 years. The activators used in treating the patients had been constructed and adjusted according to the principles of Andrésen et al.[14] The construction bite for the activators was taken with the mandible in Class I molar relationship and approximately 5 mm anterior bite opening. All appliances contained a screw or a Coffin spring for transverse expansion. Figure 1 shows the type of activators used.

METHODS

Biometric investigation

Measurements were made on dental casts before treatment, after treatment, and at follow-up examination according to the methods used by Pancherz.[12]

The following variables have been investigated:

1. Overjet and overbite. The overbite was also classified according to Figure 2.
2. Arch width between the mandibular canines. The crown tips were used as measuring points.
3. Crowding in the mandibular incisor segment. Crowding was registered when there was lack of available space between the mesial surfaces of

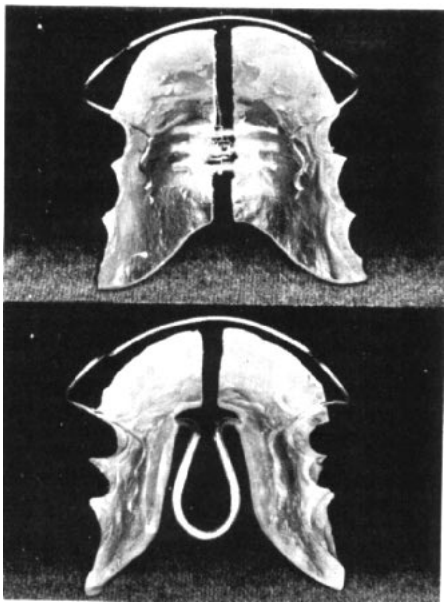


Fig. 1 Different views of activators, above with a screw, and below with a Coffin spring. Note the upper bow and the guiding furrows for the premolars and molars in the maxilla and mandible.

the mandibular canines. Sufficient or excess of available space was designated as no crowding.

The follow-up results of overjet, overbite and arch width were classified as to their stability during the period after treatment-follow-up into the following four categories:

Stable result, occlusal conditions, seen at the follow-up examination, were the same (or better) than after treatment.

Relapse, original occlusal conditions reoccurred at the time of follow-up examination.

Total relapse, occlusal conditions at the follow-up examination were the same (or worse) than before treatment.

Partial relapse, occlusal conditions at the follow-up examination were between those conditions seen before treatment and after treatment.

Cephalometric investigation

Measurements were made on profile roentgenograms from before treatment and at follow-up examination. The points and reference planes used are shown in Figure 3.

Results

Biometric investigation

Before treatment, overjet was significantly greater ($\bar{X}$ = 1.4 mm $p < 0.05$) in subjects with a large pretreatment mandibular plane angle than in subjects with a small pretreatment mandibular plane angle (Table I). After treatment and at follow-up examination, however, no significant differences were found between the groups.

Before treatment, overbite was greater, but not significantly, in the large angle group than in the small angle group (Table I). Overbite reduction during the period before treatment-follow up was significant ($\bar{X}$ = 1.3 mm, $p < 0.01$) in the large angle patients. In the small angle patients overbite

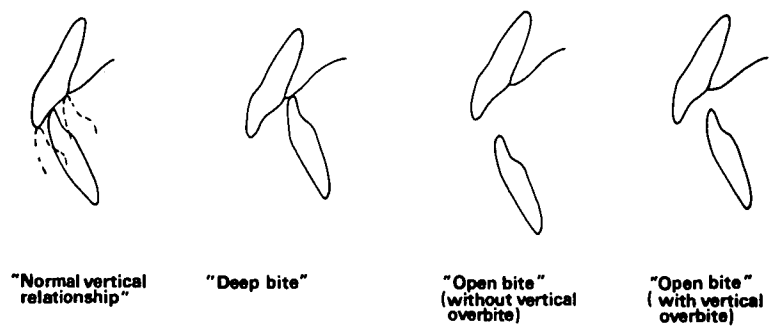


Fig. 2 Diagram of occlusion in the vertical dimension.

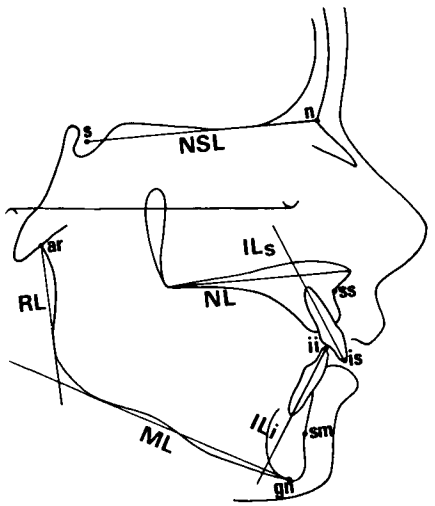


Fig. 3 Reference points and planes used in the cephalometric analysis.

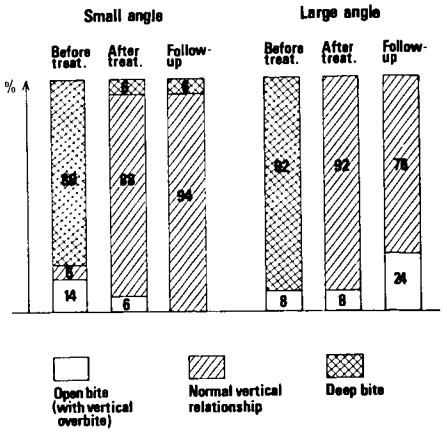


Fig. 4 Classification of occlusion in the vertical dimension in patients treated with activators. Patients divided into groups with small (n = 15) and large (n = 13) pretreatment mandibular plane angles.

was, on the average, almost unchanged during that period. In most subjects from both small and large angle groups the deep overbite seen before treatment was permanently treated to a normal vertical relationship (Fig. 4). In the small angle group the frequency of open bite decreased from 14% to 0% during the period before treatment follow-up. In the large angle group, however, there was an increase of the open-bite frequency from 8% to 24% during the same period. All patients diagnosed as open bite had a vertical overbite (Fig. 3) at all three times of examination.

The relapse of overjet (Fig. 5) during the period after treatment-follow up was greater in the large angle group than in the small angle group (31% and 26%, respectively). The relapse of overbite (Fig. 5), on the other hand, was more frequent in the small angle than in the large angle group (50% and 23%, respectively).

The arch width between the mandibular canines was on the average somewhat greater in patients with a small pretreatment mandibular plane angle than in patients with a large angle (Table I). This was true before treatment, after treatment, and at follow-up examination. However, no statistically significant differences were found be-

TABLE I

Measurements from dental casts in patients treated with activators. Patients divided into groups with small (n = 15) and large (n = 13) pretreatment mandibular plane angle.

Variable in mm		Before treatment $\bar{X}$	Before treatment S.D.	After treatment $\bar{X}$	After treatment S.D.	Follow-up $\bar{X}$	Follow-up S.D.
Overjet	Small angle	6.3	1.9	4.4	1.3	4.2	1.4
	Large angle	7.7	1.2	4.4	0.6	4.4	1.2
Overbite	Small angle	3.9	1.3	3.8	1.1	3.8	1.1
	Large angle	4.3	1.0	3.8	1.2	3.0	1.9
Mandibular canine arch width	Small angle	27.1	2.7	26.4	2.9	25.6	3.0
	Large angle	25.6	1.5	25.2	3.6	24.4	3.8

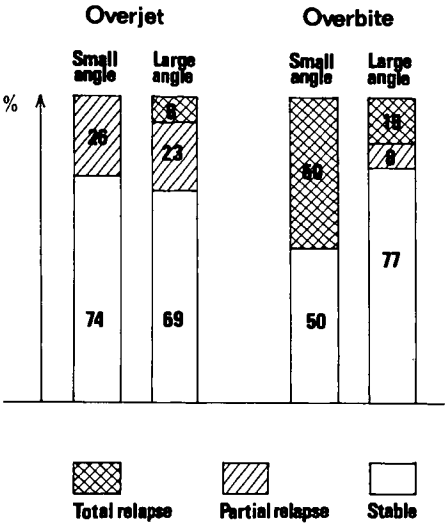


Fig. 5 Classification of the stability of overjet and overbite after activator treatment.

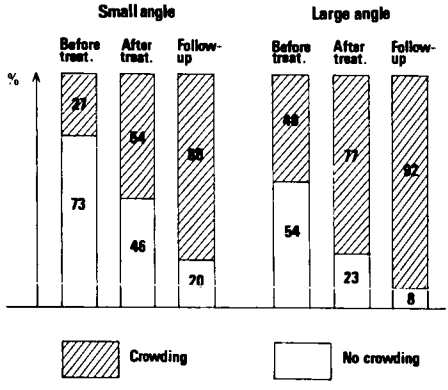


Fig. 6 Frequency (%) of patients with crowding in the mandibular incisor segment.

tween the groups. Arch width reduction during the period before treatment-follow-up was statistically significant in both the small angle ($p < 0.05$) and the large angle ($p < 0.01$) groups. Total relapse of intercanine arch width occurred in 100% of the patients in the large angle group, e.g., all patients at the time of follow-up examination had a mandibular intercanine arch width which was smaller than that seen before treatment. In the small angle group total relapse occurred in 86% of the patients while the others exhibited a stable intercanine arch width.

The frequency of crowding in the mandibular incisor segment was greater in the large angle than in the small angle group (Fig. 6). This was the case at all three times of examination.

Cephalometric investigation

Subjects with a large pretreatment mandibular plane angle had on the average more retrognathic faces (small angles SNA and SNB) both before treatment ($p < 0.001$) and at follow-up examination ($p < 0.01$) when compared with subjects with a small mandibular plane angle (Table II). The sagittal jaw relationship (ANB), however, did not differ significantly between the groups.

During the period before treatment-follow-up maxillary prognathism (SNA) was unchanged while mandibular prognathism (SNB) increased in both groups. The increase was significant ($p < 0.05$) in the small angle group but not in the large angle group. During the same period there was more mandibular rotation (NSL/ML) anteriorly, on the average, in small angle subjects ($p < 0.001$) than in large angle subjects (N.S.). However, four patients (31%) from the large angle group and two patients (14%) from the small angle group exhibited a posterior rotation of the mandible during that period (Fig. 7).

The mandibular incisors were significantly more proclined (IL_i/ML) in the small angle group than in the large angle group. This was true both before treatment ($p < 0.001$) and at follow-up examination ($p < 0.01$). However, when measuring the position of the lower incisors in relation to a line from nasion to supramentale (ii/nsm) no statistically significant differences were found between the groups. During the

TABLE II

Measurements from profile roentgenograms in patients treated with activators.
Patients divided into groups with small (S) and large (L) pretreatment mandibular plane angle.

Variable in degrees or mm	Small angle (S) (n = 15)				Large angle (L) (n = 13)						
	Before treatment		Follow-up		Before treatment	Follow-up				Before treatment S . L	Followup S - L
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	p[a]	$\bar{X}$	S.D.	$\bar{X}$	S.D	p[a)]	p[b)]	p[b)]
s-n-ss (SNA)	83.1	3.1	83.5	4.1	N.S.	77.3	3.7	77.8	4.0	N.S.	< 0.001	< 0.001
s-n-sm (SNB)	79.1	3.7	80.4	5.0	< 0.05	74.3	2.8	75.4	2.7	N.S.	< 0.001	< 0.01
ss-n-sm (ANB)	4.0	2.1	3.1	2.8	N.S.	3.0	2.5	2.4	2.5	N.S.	N.S.	N.S.
IL_s/NL	113.8	7.0	108.7	9.8	< 0.05	116.0	6.4	109.7	7.0	< 0.01	N.S.	N.S.
IL_i/ML	99.3	5.7	101.1	7.0	N.S.	91.2	5.5	93.0	6.1	N.S.	< 0.001	< 0.01
i_s/nss (mm)	4.7	2.1	3.8	3.8	N.S.	7.7	3.2	7.0	3.6	N.S.	< 0.01	< 0.05
i_i/nsm (mm)	2.9	1.8	3.5	1.9	< 0.05	3.5	2.0	4.7	2.3	< 0.05	N.S.	N.S.
NSL/ML	26.7	3.2	24.2	4.2	< 0.001	37.2	3.1	36.1	4.2	N.S.	< 0.001	< 0.001
NL/ML	19.7	4.2	17.2	3.5	< 0.01	29.4	3.8	29.1	3.9	N.S.	< 0.001	< 0.001
RL/ML	124.6	4.5	120.2	5.0	< 0.001	130.0	5.5	126.7	4.7	< 0.01	< 0.01	< 0.01

a) t-test between difference of means in paired samples.
b) t-test between difference of means in independent samples.

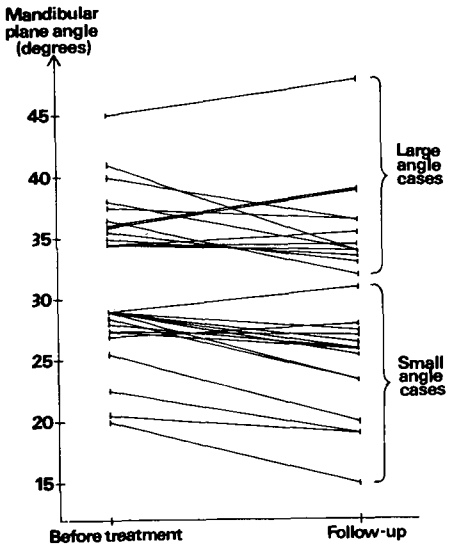


Fig. 7 Changes in the mandibular plane angle (NSL/ML) in patients treated with activators.

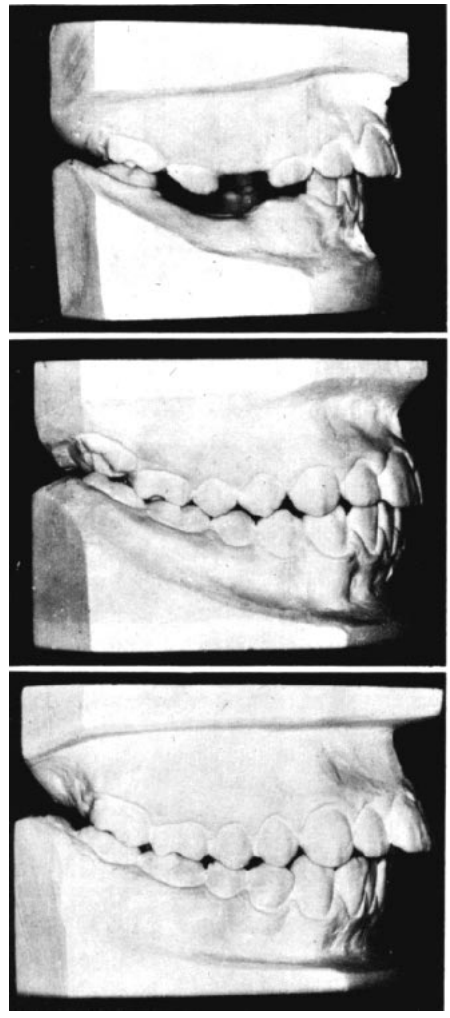
period before treatment-follow-up the mandibular incisors in both groups proclined ($IL\bar{i}/ML$, N.S.) and were positioned more anteriorly (ii/nsm, $p < 0.05$).

Case Presentation

Plaster casts and cephalograms from two cases with Class II, Division 1 malocclusion are presented. Both cases had the same pretreatment mandibular plane angle. Case 1 (Fig. 8) exhibited a posttreatment relapse of overjet and open bite, while Case 2 (Fig. 9) remained stable.

Discussion

Activator treatment has been shown to be especially effective in Class II cases where a good growth potential is



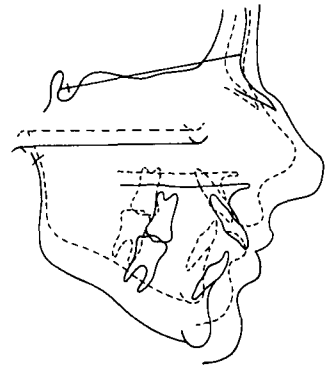
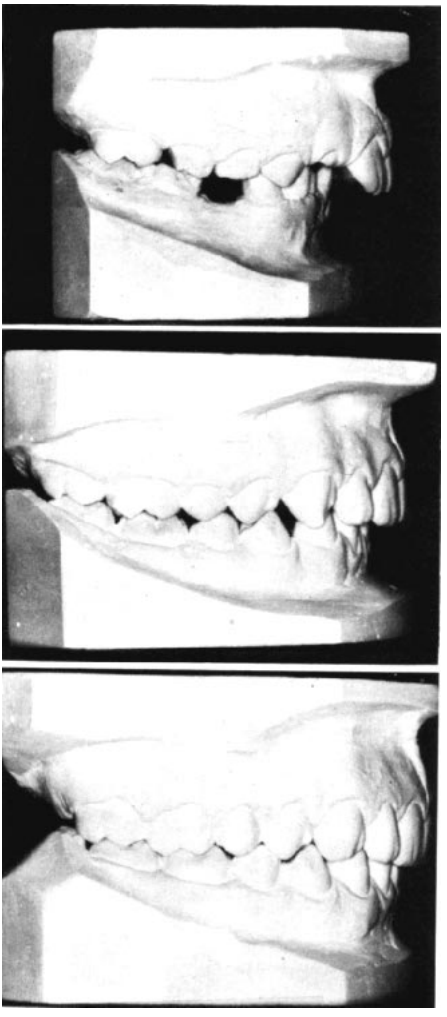


Fig. 8 Case 1. Plaster casts before treatment (top), after treatment (middle) and at follow-up (below). Cephalograms superposed on SN. Relapse of overjet and open bite resulted mainly from a posterior rotation of the mandible during growth in combination with a tongue-thrust habit.



present and the malocclusion is combined with a deep overbite and proclined upper incisors.[7-12,15,16] In Class II patients with a high mandibular plane angle, however, it has been claimed by several authors[7,8,10] that activator treatment is contraindicated. Treatment is said to increase the lower face height by a backward rotation of the mandible which in high angle cases is detrimental. The results found in this study, however, are not quite so pessimistic as to condemn activator treatment in cases with a large mandibular plane angle. It must be pointed out when comparing results from this investigation with those from other studies that many of the present cases with a large pretreatment mandibular plane angle were *mild* high angle cases.

When analysing the patients in the large and small angle groups a general improvement in the sagittal and vertical incisor relationship was found in most cases. The relapse found in the patients may be looked upon partly as a recovery process after treatment. Adverse growth, unstable occlusion, and unbalanced muscle function are certainly also factors of importance. The mandibular plane angle, *per se,* did not seem to be a primary factor for treatment success or failure. The growth direction of the mandible during and after activator treatment, on the other hand, was more important.[11,12,16,17] A posterior rotation of the mandible was found in four cases from the large angle group and in two cases from the small angle group. When examining the present patients clinically at the

Fig. 9 Case 2. Plaster casts before treatment (top), after treatment (middle), and at follow-up (below). Cephalograms superposed on SN. A favourable growth pattern with an anterior rotation of the mandible contributed to the stable treatment result.

time of follow-up examination, tongue thrust in the large angle group was present in three of the four patients exhibiting a posterior rotation of the mandible. In the small angle group none of the subjects showed such atypical tongue function. These findings may explain the differences found in the relapse of the sagittal and vertical incisor relationships in the large and small angle subjects. The results were also in agreement with other investigations where a connection was found between open bite-overjet relapse and tongue thrust[17-20] especially when combined with a backward rotation of the mandible.[4,17,21,22] However, the cause and effect relationship between mandibular growth direction, tongue dysfunction, and relapse is obscure.

A continuous arch width reduction and increase in crowding frequency was seen in both groups, but more pronounced in the large angle group. This may result from normal age changes.[23,24] It cannot be excluded, however, that the increase of crowding during and after activator treatment was an effect of the treatment procedure.[10-12] The activator constitutes a form of Class II intermaxillary mechanism with a mesially-directed force vector on the lower dentition. The group differences found for arch width and crowding frequency may be due to the common finding that available dental arch space and arch width growth primarily are less in dolichofacial patients. An increased tension in the perioral tissues during lip closure as a result of a greater anterior face height in the patients with large mandibular plane angles may also help to explain the differences seen in the groups.

The difference found in lower incisor inclination (IL$\bar{1}$/ML) and position (ii/nsm) in the large and small angle groups both before treatment and at follow-up examination may be a result of the different facial morphology found in the groups. This is in agreement with Hasund and Sivertsen[25] who found that protruding lower incisors were accompanied by a small mandibular plane angle. A strong positive correlation between the distance ii/nsm and the mandibular plane angle has also been demonstrated.[26]

During the examination period the mandibular incisors proclined. This may be due to the effect of activator treatment. However, in an earlier study Pancherz[12] found that the amount of incisor proclination corresponded, in general, to the amount of anterior mandibular rotation. Björk and Skieller[27] also demonstrated that the inclination of the lower incisors in relation to the nasion-sella line remained unchanged even though the mandible rotated forward considerably. Thus the changes in mandibular incisor inclination seen in this investigation may be explained by compensatory adaptive mechanisms in connection with growth of the mandible, e.g., tongue and lip function tended to maintain the incisor position in relation to the face irrespective of the rotation of the mandible.

Summary

The long-term results of activator treatment were investigated in 15 subjects with a small and 13 subjects with a large pretreatment mandibular plane angle.

The results of the investigation revealed the following:

1. Activator treatment resulted in a general improvement in the sagittal and vertical incisor relationship in both large and small angle cases.
2. Overjet relapse was more frequent and overbite relapse less frequent in large angle cases than in small angle cases.

3. During the period before treatment follow-up examination the frequency of patients with open bite increased in the large angle group and decreased in the small angle group.
4. The mandibular intercanine arch width was smaller and the frequency of crowding in the mandibular incisor segment was higher in the large angle group than in the small angle group.
5. A large pretreatment mandibular plane angle, *per se,* was not a primary factor in treatment failure. However, an unfavourable mandibular growth in combination with an atypical tongue function seemed to be the main reason for the relapse found in the large angle subjects.

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