sciendo
DOI: 10.2478/aoj-1996-0011

# GUIDING OCCLUSAL DEVELOPMENT WITH FUNCTIONAL APPLIANCES

**Author:**
Ib Leth Nielsen, D.D.S.*

**Functional appliances have been used in Orthodontics since their introduction by Pierre Robin almost one hundred years ago, however, our understanding of how they bring about orthodontic correction is still limited. This article is a brief overview of their history, mode of action, advantages and disadvantages, and includes the results of a study of attempts to control and minimise their side-effects using a recent devleopment in functional appliances: the 'Teuscher Appliance'. This appliance combines a high-pull headgear with the activator, and is designed to reduce the often reported side-effects of functional appliances. The skeletal and dentoalveolar effects of treatment with the Teuscher Appliance on 40 consecutively-treated patients are reported and illustrated with four individual case reports. The results showed that the skeletal effect on the maxilla was a retardation of the normal forward and downard growth in 80 per cent of the cases, and that mandibular growth in 70 per cent of cases was forward. In patients whose mandibular growth was primarily in a vertical direction, such growth could be ascribed mainly to posterior rotation of the maxilla and/or the fact that the acrylic covering the lower posterior teeth to correct a deep bite was removed, promoting the eruption of these teeth and increasing the anterior vertical development. The dentoalveolar changes were characterised by retroclination of the maxillary incisors in 90 per cent of the patients, and were due to insufficient torque control by the built-in torque springs, which need further development. The mandibular incisors were well controlled by capping. The statistical analysis showed an inverse correlation between the initial incisor inclination and the change during treatment. This suggests that proclination of the lower incisors, as previously reported, is not a contra-indication to functional appliance treatment, provided the appliance is correctly designed. Overall, this study showed considerable individual response to treatment, and that the occlusal correction occurred through a combination of skeletal and dentoalveolar changes. (Aust Orthod J 1996;14:133-142)**

Received for publication: April, 1995.
Accepted September, 1995.

* Clinical Professor
Department of Growth and Development,
University of California,
San Francisco CA 94143-0640
U.S.A.

## Introduction

Orthodontic treatment with functional appliances has been available since the beginning of this century. One of the first known functional appliances, 'the monobloc', was introduced at a conference in Paris in 1926 by Pierre Robin.[1] This appliance had been developed at the beginning of the century for the treatment of patients with Pierre Robin syndrome. Patients with this syndrome have extreme retrognathia of the mandible at birth and, as a result, the tongue is so far back in the pharynx that there is a risk of suffocation. Several years later, the same appliance was modified by Pierre Robin himself for the treatment of patients with Class II malocclusions which were in combination with extreme overjet.

An appliance, which was fairly similar to Pierre Robin's 'monobloc', was introduced in the 1930s in Norway by Viggo Andresen. This appliance, at first called 'the Norwegian System', and later known as 'the Andresen Activator'[2,3] was designed to be used in treatment of Class II malocclusions, but later was also used for treatment of open bite and Class III malocclusion. Inspired by the success of the Andresen Activator, a number of similar appliances were later developed in Scandinavia and Germany. Of these, the best known are the Harvold-Activator,[4] the Bionator,[5] the Bimler appliance,[6] the Kinetor[7] and the Fränkel appliance[8] (also called 'the Function Regulator'. These appliances were all made on the basis of a construction bite taken with the mandible in a protruded position, which was usually equal to the degree of overjet and Class II molar relation. As a result of this protruded position of the mandible, the activity of the masticatory muscles is increased. This is particularly true for the retractor muscles; that is, the posterior part of the temporal muscles and the suprahyoid muscles that attempt to pull the mandible back to its original position. The muscle forces developed through this stretching of the retractor muscles, as well as the elastic forces resulting from the stretching of the muscles, are transferred through the appliance to the teeth in both the upper and lower jaws; as well as to the jaws.[9-10] Several studies have shown that functional appliances can influence the growth of the maxilla,[12,13] but there are still differing opinions as to the ability of these appliances to stimulate mandibular growth. This question was studied by Björk in relation to the Andresen activator. Björk[14] found that the activator had no clear influence on the growth of the jaws, but that the effect of the appliance was limited to the dentoalveolar structures. Harvold and Vargervik[15] came to a similar conclusion in their study of the influence on the growth of the jaws of the Harvold-Woodside activator in a sample of 120 patients with Class II malocclusions treated with this appliance. McNamara,[16,17] however, found increased mandibular growth of about 1 mm per year in patients treated with the Function Regulator appliance, when compared with controls. He concluded that this appliance had a stimulating effect on mandibular growth. The Function Regulator appliance differs from most other functional appliances in that it has buccal shields designed to keep the cheeks and lips away from the dental arches in order to obtain a passive width increase of the arch.[8,18] Other than the studies of the Function Regulator appliance by McNamara, there are few reports in the literature to support the

contention that functional appliances accelerate mandibular condylar growth.[19,20]

As the effects of functional appliances are closely related to the growth of the face, they are primarily used in patients who are in an active growth phase. It is also important to recognize that, besides the intensity of growth, the direction of the growth of the jaws is crucial to the effectiveness of functional appliance treatment. The direction of mandibular condylar growth, as demonstrated by Björk,[21,22] is not only closely related to the general direction of growth of the mandible, but also to its rotations. For the same reasons, it is important to use functional appliances for patients whose growth is expected to be primarily in a downward and forward direction; not in a vertical direction. Therefore, treatment with this type of appliance is not suitable for patients who exhibit a posterior growth direction of the condyles and a tendency to posterior rotation.

The side-effects that have been associated with orthodontic treatment are both skeletal and dentoalveolar. The most commonly reported skeletal side-effect is posterior or backward rotation of the maxilla and mandible.[23,25] With regard to the maxilla, this side-effect has been related to the application of excessive force to the maxillary complex as well as an unfavourable direction of force transferred through the appliance to the maxilla. With regard to the mandible, it has been reported that the anticipated forward direction of growth was, instead, expressed as vertical growth during treatment. This outcome has been attributed to a disproportionate increase in anterior facial height (AFH) in relation to the increase in posterior facial height (PFH) during the treatment period. The increase in anterior facial height is the result of the eruption of the upper and lower posterior teeth and vertical sutural growth of the maxilla. The increase in posterior facial height is primarily the result of condylar growth, and also of the lowering of the lateral cranial base together with the articular fossa during the growth period. Disproportionate increases in AFH and PFH, respectively, result in either anterior (forward) or posterior (backward) rotation of the mandible which, in turn, results in a positive or a negative effect on mandibular displacement respectively.[26] As well as the side-effects of functional

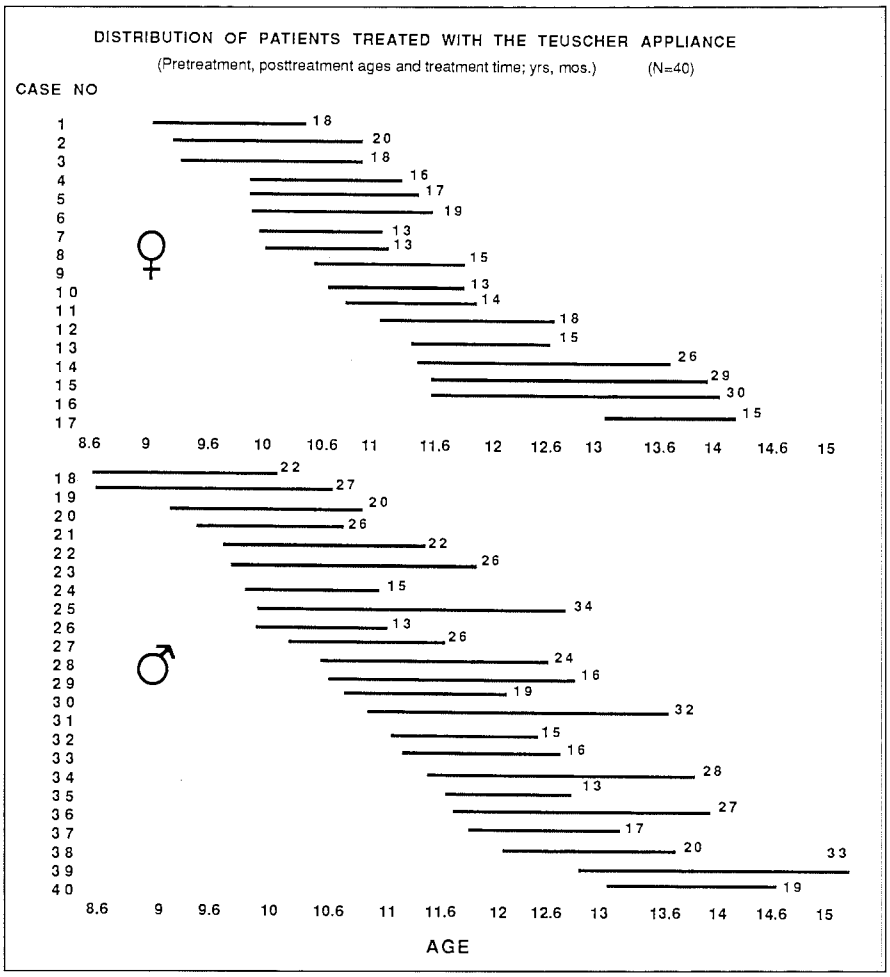


*Fig. 1. Age and sex distribution in 40 patients treated with the Teuscher Activator appliance. The individual treatment times are indicated in months.*

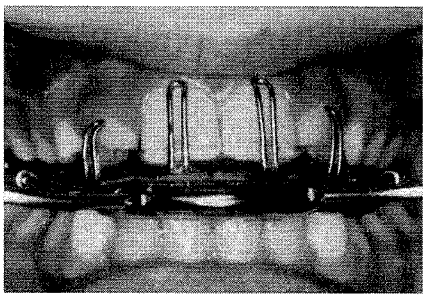

*Fig. 2A. Intra-oral photograph of a patient with a Teuscher Activator. The torque springs at the incisors are placed to control the inclination of these teeth. Note the intra-oral part of the headgear is bent up behind the molar tubes to prevent the patient from using the appliance without the headgear.*

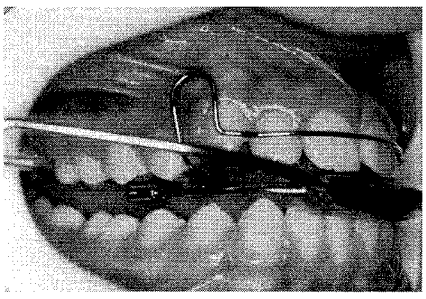

*Fig. 2B. The Teuscher Activator with conventional Hawley labial wire. This design is used when the maxillary incisors are proclined, pre-treatment.*

appliances on the growth of the jaws, undesirable effects of these appliances are also seen on the dentoalveolar structures. The most common side-effect here is retroclination of the maxillary incisors and proclination of the mandibular incisors, which may prevent forward growth of the mandible during treatment.[25]

In an attempt to prevent unwanted skeletal and dentoalveolar effects, appliances have been developed during the last decade that combine either a cervical or a high-pull headgear with the activator appliance. This appliance combination has been described by Pfeiffer and Grobety[27] and, in a different modification, by Teuscher.[28] The intent with these combination appliances is, first, to minimise the tendency to downward and forward growth of the maxilla; second, to control the eruption

| Variable | Girls (N = 17) | | | (Boys (N = 23) | | | |
|---|---|---|---|---|---|---|---|
| (Horizontal) (degrees) | Mean | SD | Range | Mean | SD | Range | Sign.Diff. |
| s-n-ss | 81.8 | 3.3 | 76.0-88.5 | 81.0 | 2.7 | 76.0-86.0 | N.S. |
| s-n-pg | 77.4 | 2.4 | 71.0-80.5 | 75.8 | 2.8 | 70.0-81.5 | N.S. |
| s-n-sm | 76.2 | 2.6 | 70.0-80.0 | 74.9 | 2.8 | 69.5-81.0 | N.S. |
| ss-n-pg | 4.5 | 2.1 | 1.0-8.0 | 5.2 | 2.2 | 2.0-9.0 | N.S. |
| ss-n-sm | 5.9 | 1.7 | 2.5-8.5 | 6.1 | 2.1 | 2.5-10.0 | N.S. |
| NL-ILs | 113.9 | 5.4 | 103.0-122 | 113.0 | 4.3 | 106.0-121 | N.S. |
| NSL-ILs | 108.5 | 6.1 | 96.0-118 | 106.4 | 4.9 | 95.0-114 | N.S. |
| ML-ILi | 96.2 | 5.6 | 84.0-103 | 95.7 | 5.9 | 80.5-106.5 | N.S. |
| Vertical (degrees) | | | | | | | |
| NSL-NL | 5.9 | 2.7 | 1.5-12.0 | 6.3 | 2.6 | 1.0-11.0 | N.S. |
| NSL-ML | 33.6 | 5.1 | 26.0-44.0 | 32.9 | 4.1 | 23.5-40.0 | N.S. |
| NL-ML | 27.6 | 5.0 | 18.0-37.5 | 26.5 | 4.5 | 17.5-36.5 | N.S. |
| NL-OLs | 13.1 | 3.4 | 6.0-19.0 | 13.1 | 3.0 | 7.0-19.5 | N.S. |
| ML-OLi | 19.9 | 3.3 | 14.0-25.0 | 17.5 | 2.6 | 13.5-22.0 | * |
| ILs-ILi | 120.5 | 6.1 | 113.0-134.0 | 121.4 | 5.9 | 108.0-132 | N.S. |

*P<.05 **P<.01 ***P<.001

*Table I. Pre-treatment facial morphology in girls-boys (N=40) (angular measurements).*

of the maxillary posterior teeth in order to maximise forward growth of the mandible; and third, to control the inclination of the maxillary and mandibular incisors.[28,29] In order to achieve these criteria, several of these appliances have built-in torque springs to maintain the inclination of the maxillary incisors where indicated. The position of the mandibular incisors is maintained by capping these teeth: acrylic is placed, both incisally and labially, to prevent them from tipping forward during treatment. Among the functional appliances that combine a headgear with an activator is the 'Teuscher Activator'; this appliance has gained great popularity in recent years because it is designed to prevent the previously described undesirable side-effects of some functional appliances.[28,29]

The purpose of the present study is, first, to analyse the skeletal and dentoalveolar changes in a group of consecutively-treated patients treated with the Teuscher Activator appliance; and second, to illustrate individual variations in response to treatment of selected patients treated with this appliance.

## Material and method

The material for this study consisted of lateral head films and study casts taken before and after treatment of 40 consecutively-treated patients from the Public Orthodontic Clinic in Halmstad, Sweden. The patients included 17 girls (from 9 years, 1 month to 13 years) and 23 boys (from 8 years, 4 months to 13 years, 1 month) (Fig. 1). The average age at the beginning of treatment was the same for both groups (namely, 10 years, 5 months). The average treatment time was 1 year and 5 months for the girls and 1 year and 8 months for the boys. All patients were treated by the same orthodontist and had had no other orthodontic treatment prior to treatment with the functional appliance. All the patients in this study had a Class I malocclusion with an increased overjet irrespective of the degree of overbite prior to treatment.

The construction bite for the headgear-activator appliance was taken with the mandible advanced from 3-6 mm; in no patient was the advancement greater than 6 mm. In patients in whom a correction greater than 6 mm was necessary, a new appliance was constructed when it could clinically be determined that the initial appliance was no longer active. The maximal bite opening with the activator was 4 mm. No adjustment of the acrylic covering the occlusal surfaces of the posterior teeth was carried out at the insertion of the appliance. In patients with a deep bite, the acrylic over the mandibular posterior teeth was removed at their second or third subsequent visit; this was done in order to obtain correction of the deep bite by allowing the mandibular posterior teeth free eruption when the appliance was in the mouth. All patients included in this study wore the appliance to a greater or lesser extent, and only patients in whom it could be ascertained clinically that the appliance had not been used at all were excluded from the study. The method used for clinically determining whether the patient had worn the appliance was described in a previous article.[30] A detailed evaluation of actual individual co-operation has not been made in this study.

The details of appliance design and construction have previously been described by Teuscher[28] and Stöckli and Teuscher[29] so this author will add only that the appliance was constructed as originally described with some slight modifications.[30] The torque springs, seen in Figure 2A, were used in 32 patients; whereas, in eight patients, the maxillary incisors were so proclined that a conventional Hawley wire (Fig. 2B) was used instead, in order to promote uprighting of these teeth during treatment. The torque springs were intended to maintain the inclination of the maxillary incisors and to prevent a tendency to retroclination often observed during treatment with conventional activator appliances. The maxillary incisors were capped by acrylic both lingually and incisally to prevent undesirable extrusion and retroclination. The inclination of the mandibular incisors also was maintained by capping these teeth with acrylic lingually, incisally and labially. The outer arms of the occipital headgear were adjusted to provide a direction of pull that was upward and backward, and between the centre of resistance of the maxillary dentition and the maxilla proper (Fig. 3). The force used was approximately 300 gf., which was adjusted and, if necessary, increased at subsequent visits. All patients were told to use the appliance at night and their treatment progress was monitored at monthly visits to the orthodontic office.

| Measurement (Sagittal Angular) | Mean | SD | Min | Max | Diff |
|---|---|---|---|---|---|
| Maxillary Position s-n-ss | -0.6 | 1.1 | -3.0 | 1.5 | ** |
| Mandibular Position s-n-pg | 0.7 | 1.0 | -1.5 | 3.0 | *** |
| Mandibular Apical Base Position s-n-Pt.B | 0.6 | 0.9 | -2.0 | 2.5 | *** |
| Sagittal Jaw Relation ss-n-pg | -1.3 | 1.2 | -5.0 | 1.0 | *** |
| Sagittal Apical Base Relation A-N-B | -1.2 | 1.1 | -3.5 | 1.5 | *** |
| Maxillary Incisor Inclination NL-ILs | -6.6 | 5.3 | -20.0 | 3.0 | *** |
| Maxillary Incisor Inclination/Cranial Base NSL-ILs | -7.2 | 5.2 | -21.5 | 2.5 | *** |
| Mandibular Incisor Inclination ML-ILi | 0.5 | 4.5 | -7.0 | 16.5 | N.S. |

*P<.05 **P<.01 ***P<.001

*Table IIA. Pre-Post Treatment Differences.*

| Measurement Vertical Angular) | Mean | SD | Min | Max | Diff |
|---|---|---|---|---|---|
| Maxillary Inclination NSL-NL | 0.9 | 1.2 | -1.5 | 3.0 | *** |
| Mandibular Inclination | 0.1 | 1.4 | -2.5 | 3.5 | N.S. |
| Vertical Jaw Relation NL-ML | 0.6 | 1.7 | -4.0 | 3.0 | * |
| Maxillary Zone NL-OLs | 0.3 | 2.3 | -5.0 | 5.0 | N.S. |
| Mandibular Zone ML-OLi | 0.3 | 2.6 | -6.0 | 5.0 | N.S. |
| Interincisor Angle ILs-ILi | 7.8 | 7.5 | -7.0 | 26.0 | *** |

*P<.05 **P<.01 ***P<.001

*Table IIB. Pre-Post Treatment Differences (Teuscher)*





At these visits the appliance was examined for its use as previously described.[30] The torque springs were checked for correct placement and, if necessary, activated to contact the maxillary incisors passively near the gingival level. The activation of the headgear was checked last of all and the force adjusted as required.

Study casts and lateral cephalometric head-films were taken before and after treatment with the Teuscher Activator appliance. In several patients, additional treatment with fixed appliances was found necessary to obtain an ideal occlusion of the teeth. This phase of treatment, however, is not included in this study.

Analysis of the lateral head-films was carried out by digitising tracings of the original head-films on a Hi-Pad™ digitiser and by subsequent computer analysis. The morphological analysis, before and after treatment, included a series of measurements conventionally used in the cephalometric analysis described by Björk (Fig. 4).[31] The data analysis was carried out by means of a computer program (TIOPS™)* especially developed for cephalometeric morphological analysis and growth analysis. An IBM™ (Model PS 2-386) computer connected to a printer (IBM™ Graphics Printer) was used in addition to a Hewlett Packard™ (Model 7475) which yielded plots of the individual films as well as superimpositions that served as plot checks for correct input during the digitisation of the films.

The data analysis was carried out using the computer program 'Statview™' which permits statistical analysis on the Macintosh™ computer. The paired t-test was used to analyse the significance of the differences between pre- and post-treatment measurements. Simple regression analysis was applied to selected measurements.

## Results

Analysis of the patients' facial morphology before treatment showed no statistical differences between the girls and the boys with respect to their sagittal angular measurements (Table I). The author also found no statistically significant differences between the girls and boys in their vertical angular measurements; except for the mandibular zone which was significantly greater in the boys ($p \leq .05$). The analysis further showed that both groups of patients, on average, were characterised by normal maxillary protrusion and mandibular retrognathism resulting in an increased sagittal jaw relation. The maxillary incisors were, on average, proclined in relation to the maxilla, as well as to the cranial base. The mandibular incisors were similarly proclined in relation to the mandible in both groups. Because of the great similarity between the two groups, the morphological measurements were combined for subsequent analysis of the changes during treatment.

Comparison of the sagittal morphological measurements before and after treatment showed statistically significant changes of all sagittal measurements; with the exception of the inclination of the lower incisors (Table IIA and Figure 8). The maxilla was, on average, slightly more retruded following treatment

* TIOPS™ Developed by Dr. Jens Björn-Jörgensen, Roskilde, Denmark

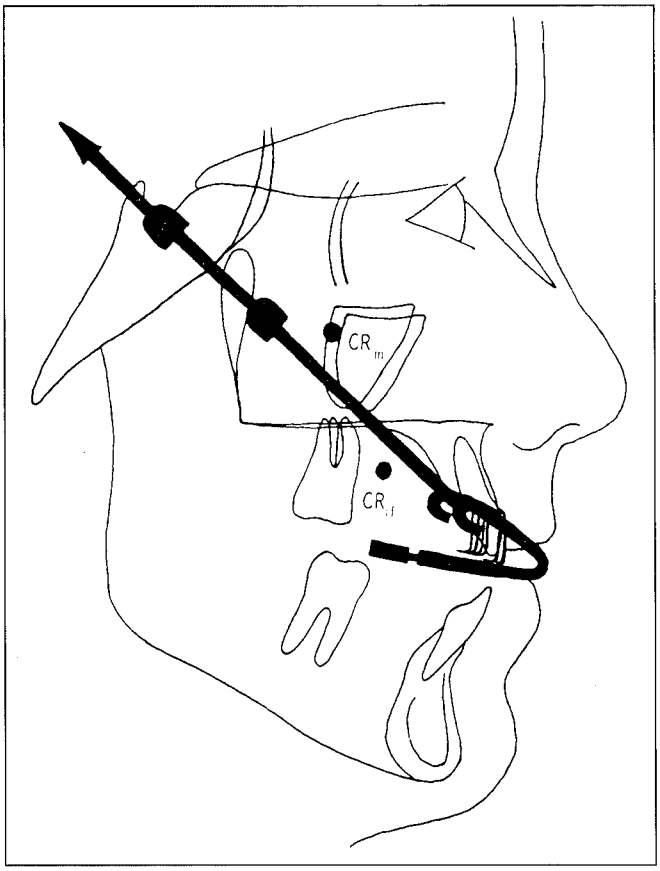


*Fig. 3. Direction of pull of the extra-oral occipital traction. Note that the outer arms are placed between the centre of resistance of the maxillary dentition ($CR_d$) and the centre of resistance of the maxilla proper ($CR_m$) to prevent undesirable tipping of the maxilla and the maxillary dentition.*

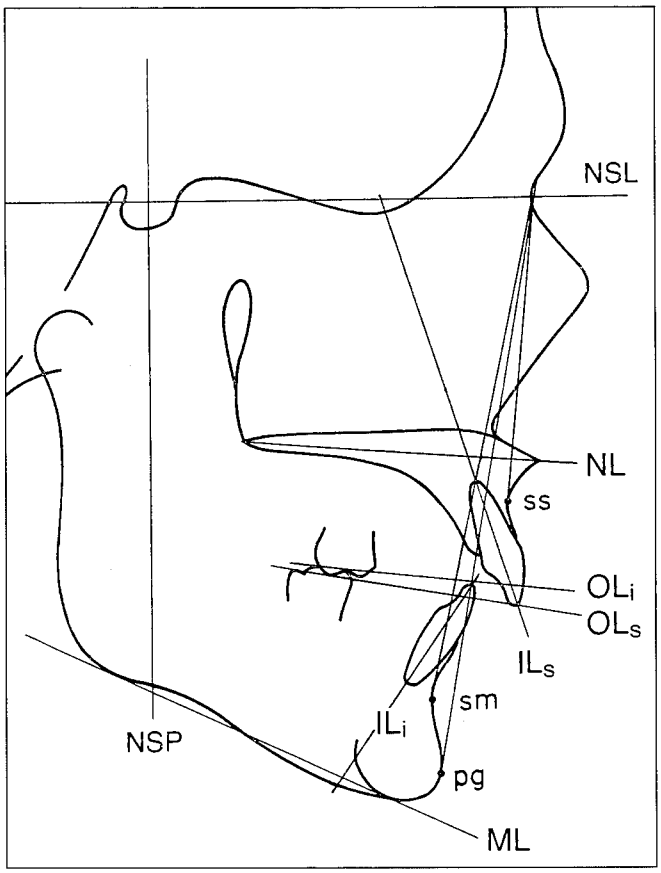


*Fig. 4. Reference points and lines used in the analysis of the lateral head-film.*



(Mean s-n-ss -0.6° ± 1.1), but with great individual variation. In 60 per cent of the patients the maxilla was more retruded after treatment; the protrusion remained unchanged in 25 per cent. After treatment only two patients had a more protruded maxilla (≤ 1.5°) (Fig. 5). Mandibular prognathism improved in approximately 70 per cent of the patients, remained unchanged in five patients (12 per cent) and deteriorated in four patients (10 per cent) This reduction in mandibular prognathism in these patients, however, did not exceed 1.5 degrees (Figure 6).

The changes in maxillary and mandibular incisor inclination during treatment also are of interest. The author's analysis showed that the maxillary incisors, on average, were retroclined 6.6 degrees (±5.3) during treatment. Of particular interest is the fact that this retroclination was seen in 90 per cent of the patients (Fig. 7) of which 25 per cent showed a change greater than 10 degrees. Only two patients showed a slight proclination of the teeth during treatment (2.5°). No statistically significant change was observed in mandibular incisor inclination (Table II A). In 50 per cent of the patients, a proclination could be observed and in 35 per cent there was a retroclination of the incisors. The proclination in one patient was as much as 16 degrees; however, this patient had severely retroclined mandibular incisors prior to treatment (Figure 8). The change in inclination in all other cases was moderate (≤±5°). Comparison of pre-treatment mandibular incisor inclination with the changes brought about during treatment showed that the incisors which were retroclined prior to treatment became more proclined. The incisors that were proclined before treatment were less proclined post-treatment (Fig. 9). The correlation diagram illustrates the association between the pre-treatment inclination of the mandibular incisors and the change during treatment with an R2 value of 0.57.

The vertical measurements seen in Table IIB show that the maxilla became slightly more posteriorly inclined with an average increase in inclination of 1 degree (SD ±1.2). The individual changes in maxillary inclination are illustrated in Figure 10 where it is seen that in about 60 per cent of the patients the maxilla tipped posteriorly (≤1.5°). The inclination of the mandible, on average, remained unchanged; but with some individual variation. As these changes are of practical clinical importance, especially in patients in whom a further increase in anterior facial height is undesirable, the author examined the individual changes in inclination. As seen in Figure 11, the incidence of increase in mandibular inclination was as great as the incidence of decrease. Of even greater importance is the fact that the change in mandibular inclination showed no association with the inclination pre-treatment as seen in the correlation diagram shown in Figure 12 ($R^2$ -.002). In other words, patients with an increased anterior facial height pre-treatment did not necessarily experience a further increase in facial height during treatment with this appliance.

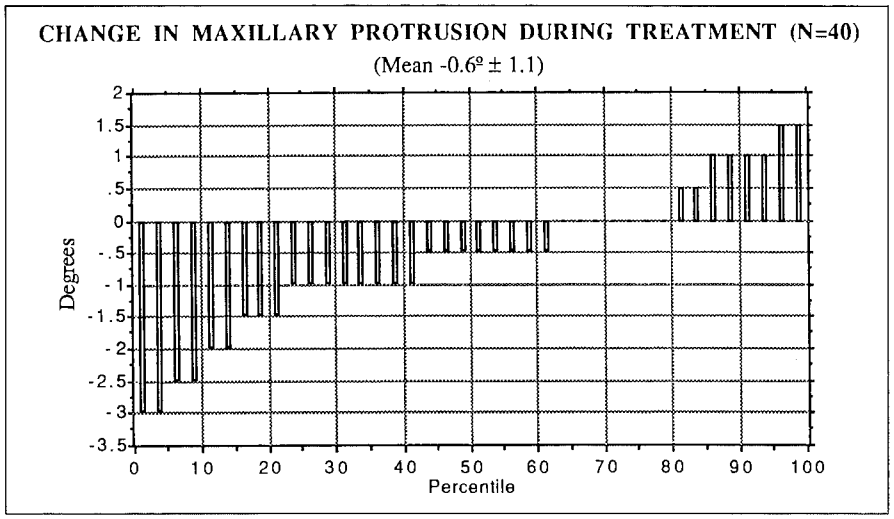


*Fig. 5. Average change and variations in maxillary protrusion. Each vertical column represents the individual change in protrusion in one patient during the treatment period. Negative values represent a decrease; positive values, an increase in protrusion. Note that seven patients showed no change in protrusion during treatment.*

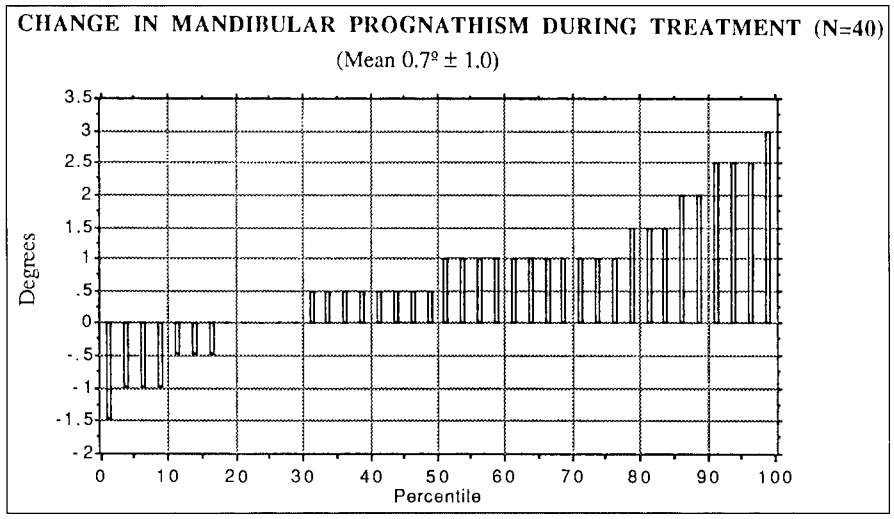


*Fig. 6. Average change and individual variations in mandibular prognathism in 40 patients treated with the Teuscher Activator. The columns indicate individual changes.*

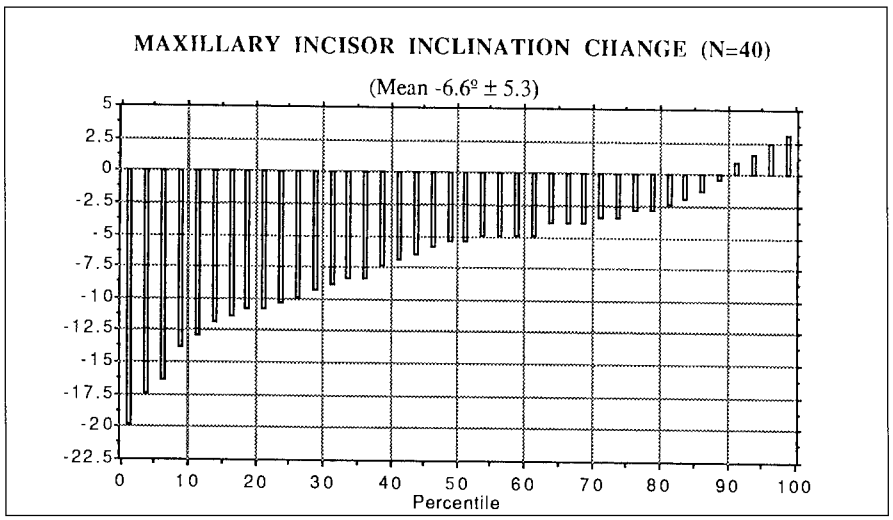


*Fig. 7. Average change in maxillary incisor inclination. Note that 90 per cent of the patients experience a reduction in incisor inclination during treatment.*

The vertical analysis also showed no significant changes in vertical dentoalveolar development within the maxilla and mandible both of which were measured in this study as the maxillary and mandibular zones (Table IIB).[31]

## Case reports

The following case reports are shown to illustrate the above individual variations in treatment response with the use of the Teuscher Headgear-Activator appliance.

CASE 3: a boy aged 9 years, 4 months, treated with the Teuscher appliance from 9 years, 4 months of age until 10 years, 10 months of age. The appliance had torque springs for maxillary incisor control, as previously described, and was used only at night. The growth and treatment analysis shows mainly vertical growth in the maxilla. Mandibular growth was also vertical, with very limited forward growth. The good control of the maxillary molars, which were prevented from migrating mesially by the appliance, and which erupted vertically to only a limited degree, should be noted. It should also be noted that the maxillary incisors tipped lingually during treatment, despite the torque springs. The occlusal correction was achieved through a combination of limited forward growth of the mandible and some mesial migration of the lower posterior teeth (Figure 13).

CASE 4: a girl aged 9 years, 11 months. This patient illustrates a vertical growth pattern during the treatment period: both the maxilla and mandible grew vertically during the 19 months treatment period with a resulting increase in anterior facial height. The maxillary molars moved distally whereas the mandibular molars moved mesially. The pronounced retroclination of the maxillary incisors while the mandibular incisors maintained their initial inclination, should be noted (Figure 14).

CASE 16: a girl aged 11 years, 6 months. This patient was treated for 30 months with the Teuscher Activator appliance. The superimpositions of this patient's head-films show that maxillary growth was downward and forward and of moderate intensity. Mandibular growth also was downward and forward but of greater intensity. The initial Class II occlusion changed to a Class I occlusion,

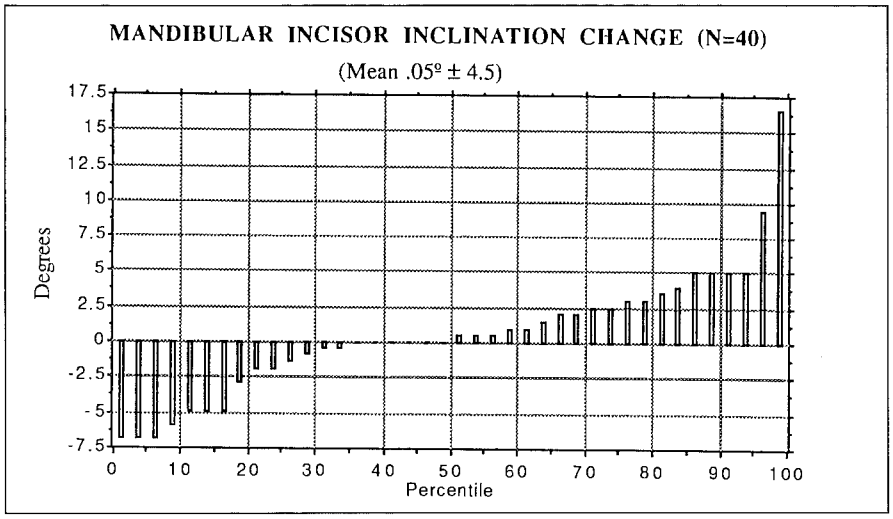


*Fig. 8. Average change and individual variations in mandibular incisor inclination. Only two patients showed a change greater than +5°.*

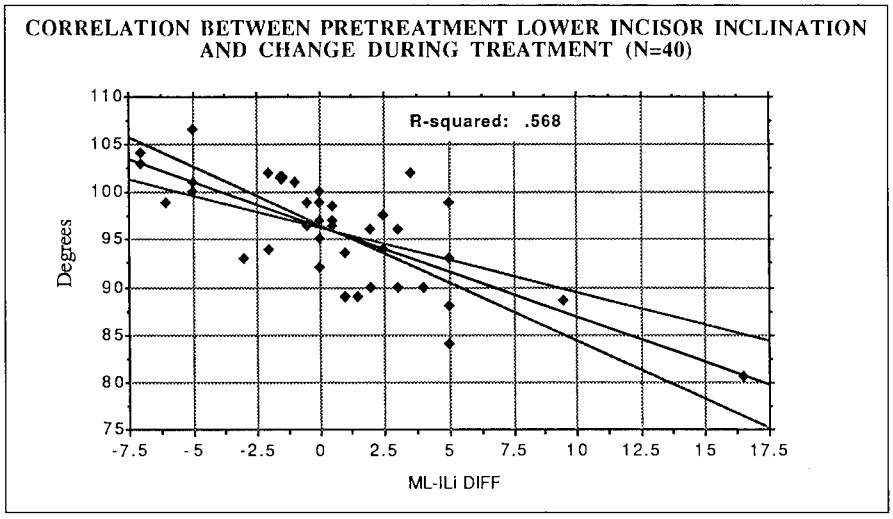


*Fig. 9. Correlation diagram showing the association between lower incisor inclination pre-treatment and the change during treatment. Note that patients with proclined teeth pre-treatment, in several cases showed a reduction in incisor inclination, whereas patients with retroclined incisors showed a tendency to proclination.*

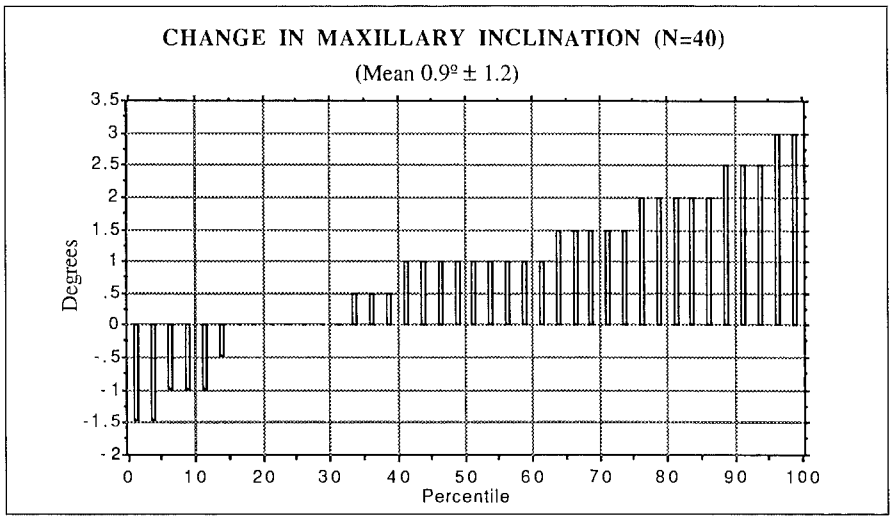


*Fig. 10. Average change and individual variations in maxillary inclination during treatment. Positive values indicate a more posterior inclination; negative values, a more anterior inclination.*

primarily as a result of mandibular growth which brought the mandibular molars forward. The excellent torque control of the maxillary as well as the mandibular incisors should be noted. The maxillary molars also moved mesially during treatment concomitant with the mesial movement of the mandibular molars (Figure 15).

CASE 21: a girl aged 9 years, 5 months. The correction in this patient's malocclusion mainly took place through distal movement of the maxillary teeth in combination with some mesial movement of the mandibular teeth. The good torque control of both maxillary and mandibular incisors should be noted (Figure 16).

## Discussion

Treatment of Class II malocclusion, where the malocclusion is due to a skeletal discrepancy between the maxilla and mandible, has traditionally been based on a treatment principle called 'growth adaptation'. Treatment is intended, according to this principle, to modify the normal downward and forward growth of the maxilla; at the same time, forward growth of the mandible is promoted as much as possible thereby resulting in an improvement in the occlusion. This type of correction can be achieved with the use of fixed appliances in combination with inter-maxillary elastics; or with the use of extra-oral traction; or with functional appliances. Each of these appliances has advantages and disadvantages; therefore, it is important that the clinician has a good knowledge of the effects and side-effects of each before orthodontic treatment is initiated.

A disadvantage of most orthodontic appliances is their tendency to increase anterior facial height, which is often undesirable – especially where this dimension is already greater than normal prior to treatment. This increase is often associated with little or no forward growth of the mandible. The vertical increase is, in most instances, the result of a treatment-induced posterior or backward rotation of the mandible.[23,24,32] A similar posterior or backward rotation of the maxilla can also contribute to an increase in anterior facial height. The results of the present investigation, in which special emphasis was focused on the effects of the Teuscher Activator appliance on the direction of growth of the maxilla and mandible, showed that the maxilla in 80 per cent of the patients was prevented from achieving normal

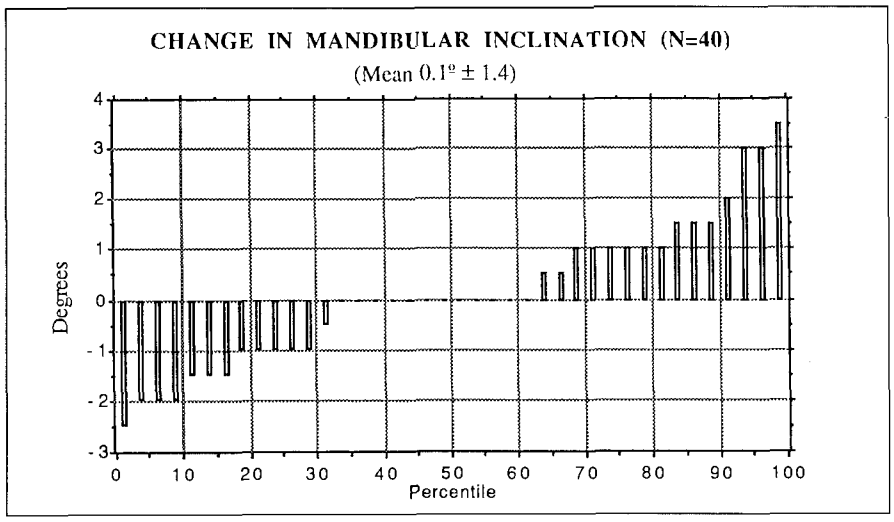


*Fig. 11 Average change and individual variations in mandibular inclination during treatment. Positive values indicate an increase in inclination: negative values, a decrease. Note that only three patients showed an increase in inclination equal to, or greater than, 3 degrees.*

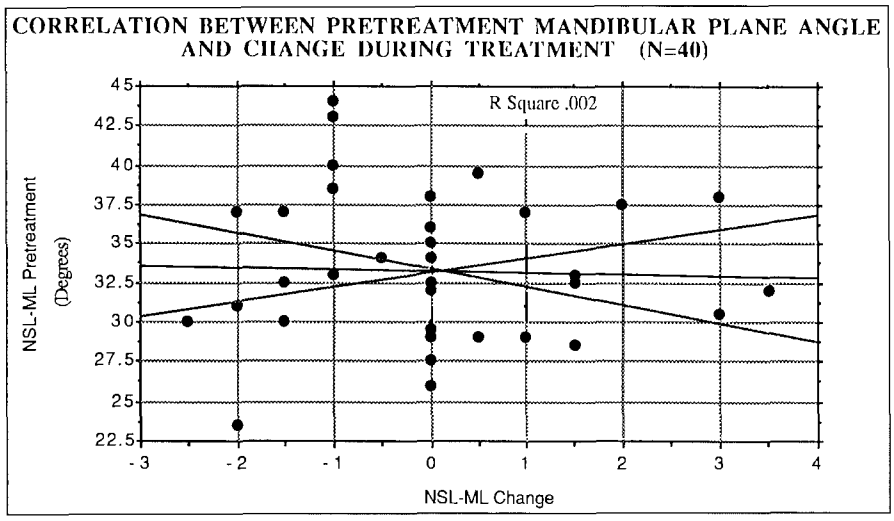


*Fig. 12 Correlation diagram showing the association between pre-treatment mandibular inclination and the change during treatment. The diagram shows no association between mandibular inclination pre-treatment and the change during treatment.*

downward and forward growth; while in 70 per cent of patients the mandible grew forward to some degree. These skeletal changes result in an improvement of the sagittal jaw relation in most of the patients. However, there was great individual variation in the direction and amount of growth of the jaws during the treatment period.

Use of the high-pull headgear in combination with an activator was, as emphasised by Teuscher,[28] intended to influence the growth direction of the maxilla to a maximum; which in this study was achieved in the majority of patients. The sagittal effects on the maxilla were, however, connected with a posterior or backward rotation which in 25 per cent of the patients was greater, or equal to, 1.5 degrees. Mandibular prognathism remained unchanged in 12 per cent of the patients, and 18 per cent showed no change, or a reduction in prognathism. The lack of improvement in mandibular prognathism can, first, be ascribed to limited jaw growth during the treatment period and, second, to the fact that the lower posterior teeth were allowed to erupt because the acrylic over these teeth had been removed to correct the deep bite.

This study showed that the Teuscher Activator appliance was unable to control the inclination of the maxillary incisors during treatment: 90 per cent of the patients showing retroclination of these teeth. Although a conventional Hawley wire was used in the four patients in whom the maxillary incisors were severely proclined prior to treatment, the amount of retroclination after treatment was undesirable for most of them. This lack of torque control is remarkable as the springs were carefully adjusted at each visit by the clinician; it suggests the necessity of improving the design of these springs. (Bass[33] designed torque springs for the control of maxillary incisors which may control the tipping of these teeth; however, further studies of their effects are needed.) Although the mandibular incisors, on average, remained unchanged during treatment, it should be remembered that individual patients may show uprighting or proclination during treatment. The finding of an inverse correlation between the initial inclination of the mandibular incisors and the change during treatment has not been reported previously, and is a favourable observation suggesting that proclination of the mandibular incisors prior to treatment is not necessarily a contra-indication to treatment with functional appliances; provided the lower incisors are capped incisally and labially with acrylic.

## Conclusions

The results of this study of 40 patients treated with the Teuscher Activator appliance show that treatment with this appliance influences maxillary growth as well as dentoalveolar development; however, the influence on mandibular growth is still unknown. Although the results show that the general tendency is for the appliance to restrain forward maxillary growth, there was considerable variation in response to treatment. The growth direction of the mandible also varied considerably. Several cases showed mainly vertical growth which, in general, is undesirable. The control of the inclination of the mandibular incisors, with some uprighting of proclined incisors in several cases, was generally favourable; on the other hand, the control of maxillary incisor inclination was unsatisfactory and the use of torque springs did not prevent retroclination of these teeth in most patients. The results of this study show that further development of the torque springs is necessary to adequately control the inclination of these teeth. Further studies are needed to examine the factors responsible for unfavourable facial development in patients who exhibit vertical growth of the mandible during treatment.

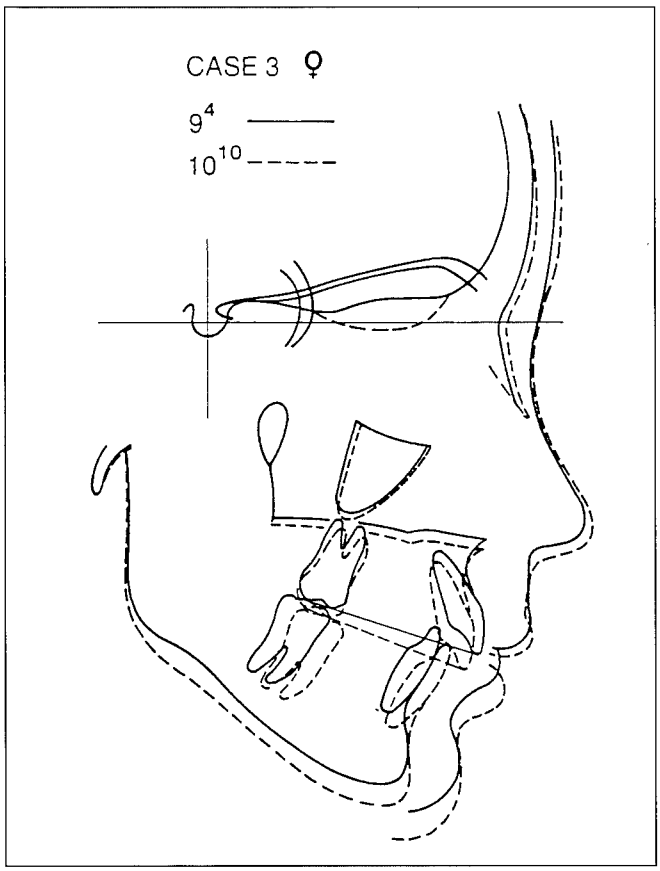


*Fig. 13. Case 3: a boy aged 9 years, 4 months, treated with the Teuscher Activator appliance for 18 months. The superimposition on stable structures in the anterior cranial base shows a mainly vertical growth pattern during the treatment period. Note the stable position of the mandibular incisors; whereas the maxillary incisors became more retroclined during treatment.*

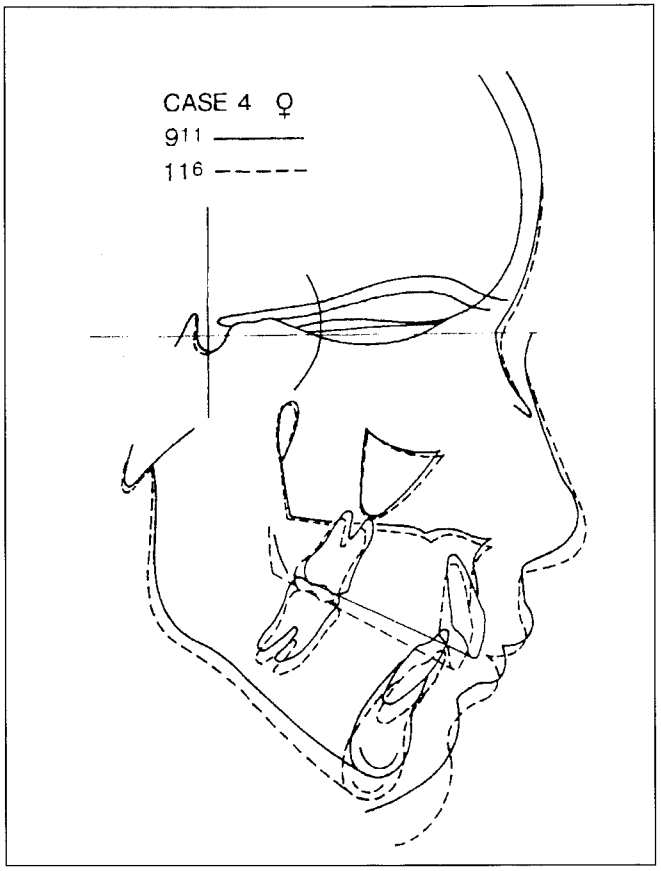


*Fig. 14. Case 4: a girl aged 9 years, 11 months, treated for 19 months with the Teuscher Activator appliance. The superimposition shows vertical growth of both maxilla and mandible. The occlusal correction took place through a combination of distal movement of the maxillary molars and mesial movement of the mandibular molars. Note the undesirable increase in anterior facial height. Note also the considerable amount of retroclination of the maxillary incisors; whereas, the lower incisor inclination remained unchanged.*



## References


1 Izard G. "Orthodontie" ed. 3. Masson & Cie, Paris, 1950.

2 Andresen V, Häupl K. Funktions-Kieferorthopädie. Die Grundlagen des Norwegischen Systems, ed. 2, Leipzig, 1942, Hermann Meusser.

3 Andresen V, Häupl K, Petrik L. Funktionskieferorthopedie. Ed. 6. Munich, 1957, JA Barth.

4 Harvold EP. The activator in interceptive orthodontics. The CV Mosby Company Saint Louis, 1974.

5 Ascher F. Praktische Kieferorthopädie. Urban and Schwarzenberger, München, 1968.

6 Bimler HP. Die elastischen Gebissformer, Zahnärztl Welt 1949; 19: 499-503.

7 Stockfisch H. Possibilities and limitations of the kinetor. Trans Eur Orthod Soc 1973: 457-460.

8 Fränkel R. Technik und Handhabung der Funktionregler. Berlin: VEB Verlag Volk und Gesundheit, 1973.

9 Ahlgren J. An electromyographic analysis of the response to activator (Andresen-Häupl) therapy. Odontol Revy 1960; 11: 125-151.

10 Ahlgren J. The neurophysiologic principles of the Andresen method of functional jaw orthopedics. A critical analysis and new hypothesis. Swed Dent J 1970; 63: 1-9.

11 Ahlgren J. Early and late electromyographic response to treatment with activators. Am J Orthod 1978; 74: 86-93.

12 Wieslander L, Lagerström L. The effect of activator treatment of Class I malocclusions. Am J Orthod 1979; 75: 20-26.

13 Williams S, Melsen B. The interplay between sagittal and vertical growth factors: An implant study of activator treatment. Am J Orthod 1982; 81: 327-332.

14 Björk A. The principles of the Andresen method of orthodontic treatment: A discussion based on cephalometric x-ray analysis of treated cases. Am J Orthod 1951; 37: 437-458.

15 Harvold EP, Vargervik K. Morphogenetic response to activator treatment. Am J Orthod 1971; 60: 320-337.

16 McNamara J. On the Fränkel Appliance. Biological basis and appliance design. Part I, J Clin Orthod 1982; 16: 320-337.

17 McNamara J. On the Fränkel Appliance. Clinical management. Part II, J Clin Orthod 1982; 16: 320-337.

18 Fränkel R. Treatment of Class II, Division 1 malocclusion with functional correctors. Am J Orthod 1969; 55: 265-275.

19 Righellis EG. Treatment effect of Fränkel, Activator and Extraoral Traction appliances. Angle Orthod 1983; 53: 107-121.

20 Owen AH. Morphological changes in the sagittal dimension using the Fränkel appliance. Am J Orthod 1981; 80: 573-603.

21 Björk A. Variations in growth pattern of the human mandible: Longitudinal radiographic study by the implant method. J Dent Res 1963; 42: 400-411.

22 Björk A, Skieller V. Facial development and tooth eruption. Am J Orthod 1972; 62: 339-383.

23 Creekmore TD. Inhibition and stimulation of the vertical growth of the facial complex, its significance to treatment. Angle Orthod 1967; 37: 285-297.

24 Nielsen IL. Facial growth during treatment with the function regulator appliance. Am J Orthod 1984; 85: 401-410.

25 Teuscher UM. A growth-related concept for skeletal Class II treatment. Am J Orthod 1978; 74: 258-275.

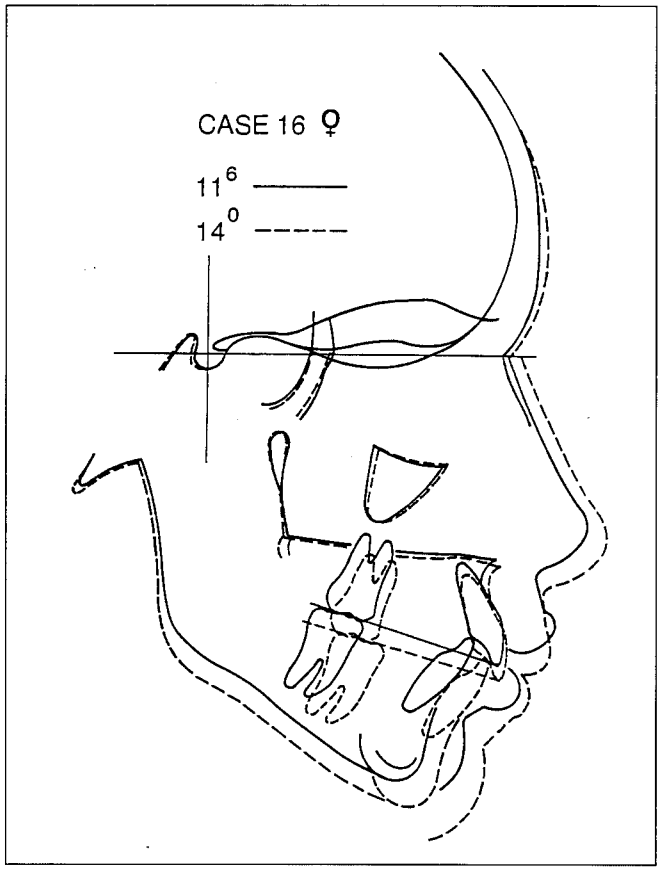


*Fig. 15. Case 16: a girl aged 11 years, 6 months treated for 30 months with the Teuscher Activator. The growth direction of the maxilla was downward and forward. The growth of the mandible was similar: downward and forward, but of greater intensity, resulting in an improvement in the sagittal jaw relations. The correction of the occlusion was mainly the result of the greater amount of forward growth of the mandible than of the maxilla. Note also the stability of both the maxillary and mandibular incisors.*

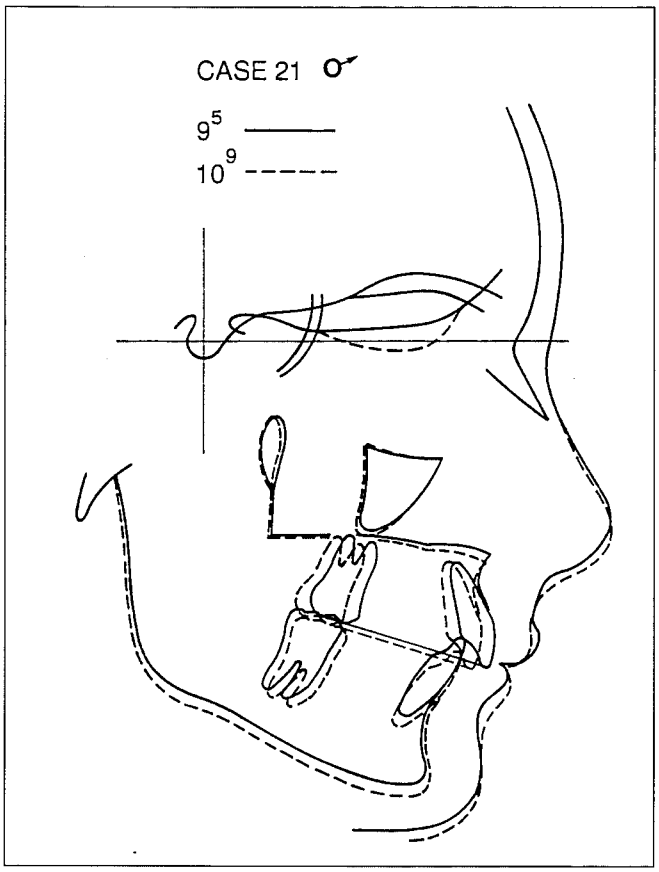


*Fig. 16. Case 21: a girl aged 9 years, 5 months. The occlusal correction in this patient was primarily the result of the distal movement of the maxillary teeth in combination with some mesial movement of the mandibular teeth. Note the torque control of both the maxillary and mandibular incisors.*




26 Hultgren BW, Isaacson RJ, Erdman AG, Worms FW. Mechanics, growth and Class II correction. Am J Orthod 1984; 74: 388-395.

27 Pfeiffer JP, Groberty D. A philosophy of combined orthopedic-orthodontic treatment. Am J Orthod 1982; 81: 185-201.

28 Teuscher UM. Direction of force application for Class II, Division 1 treatment with the headgear-activator combination. Studieweek 1980: 193.

29 Stöckli PW, Teuscher UM. Combined activator headgear orthopedics. In: Graber TM Swain BF eds. Current Orthodontic Principles and Techniques. St. Louis: CV Mosby Company, 1985; 405-483.

30 Lagerström LO, Nielsen IL, Lee R, Isaacson RJ. Dental and skeletal contributions to occlusal correction in patients treated with the high-pull headgear-activator appliance. Am J Orthod 1990; 6: 495-504.

31 Björk A. The relationship of the jaws to the cranium. In: Lundström A ed. Introduction to Orthodontics. London: McGraw-Hill, 1961; 237-250.

32 Nielsen IL. Functional appliance therapy. In: : Wei Shy ed. Total patient care. Philadelphia: Lea & Fibiger 1988; 491-524.

33 Bass, NM. Innovation in skeletal Class II treatment including effective incisor root torque in preliminary removable appliance phase. Br J Orthod 1976; 3: 223-230.



**Address for correspondence and reprints:**

Ib Leth Nielsen, D.D.S.
Clinical Professor,
Department of Growth and Development.
University of California, San Francisco
CA 94143-0640
U.S.A.



[This article was originally published in Volume 14, No.1 of the *Australian Orthodontic Journal.*
It is being re-published because of the inadvertant omission of several diagrams in the original publication.]