Class II, Division 1 Treatment with Fränkel and Edgewise Appliances

— A Comparative Study of Mandibular Growth and Facial Esthetics

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A statistical comparison of treatment changes in twenty patients treated with a Fränkel appliance and twenty treated with the Edgewise mechanism. Both groups showed similar improvements, with no significant differences in mandibular growth.

KEY WORDS: • EDGEWISE APPLIANCE • FRÄNKEL APPLIANCE • GROWTH

Class II dental and skeletal disproportions due to mandibular retrusion have long been noted as a major type of facial aberration. The attempt to change the relationship between maxilla and mandible by reciprocally-acting forces is almost as old as orthodontics itself. At the turn of the century, ROBIN (1902) introduced his Monobloc appliance, followed by many mandibular hyperpropulsion devices that have been continually surrounded by controversy over their mode of action and the alterations that can be attributed to their use.

Some authors have claimed that functional jaw orthopedic appliances secure part of their result in the correction of Class II malocclusion through the stimulation of mandibular growth. Although the literature abounds with articles concerning mandibular growth, there are few scientific studies that clarify or substantiate the morphologic changes in the mandible resulting from orthodontic therapy. Animal experiments have provided evidence that mandibular growth can be stimulated through the application of forward-directed force on the mandible itself (BREITNER 1940, BAUME AND DERICHSWEILER 1961, STÖCKLI AND WILLERT 1971,

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McNamara 1973 and Petrovic 1975). Others have reported clinical results with similar interpretations (Fränkel 1969, Fränkel and Reiss 1970, Fränkel 1970 and Sergl 1976).

Still other investigators considered the corrections achieved to be dentoalveolar, and not related to changes in the basal relationships of the jaws (Adams 1969, Creekmore 1983 and Robertson 1983). The authors who subscribe to this latter view generally feel that correction of mandibular retrusion is linked intimately to genetically controlled differential growth rates of the facial structures, and are not influenced by local factors.

These conflicting views raise important questions about the effects of functional and fixed banded Edgewise appliances that seem to warrant further investigation.

— Materials and Methods —

This study is based on oriented sagittal roentgenographs of forty individuals before and after orthodontic treatment. Twenty were treated with Fränkel therapy and twenty with Edgewise full-banded (.018 slot) techniques. The Fränkel group consisted of nine males and eleven females, the Edgewise group seven males and thirteen females.

All subjects were from the private practices of seven faculty members of the Department of Orthodontics, Tufts University School of Dental Medicine. All were diagnosed as having Class II, division 1 (Angle) malocclusion with a retrognathic mandible, as demonstrated by cephalometric analysis of sagittal roentgenographs, facial photographs and models. The patients in both groups were selected on the basis of comparable skeletal patterns. At the end of treatment, all patients showed Class I (Angle) occlusion with acceptable treatment results.

The mean age of patients in the Fränkel group was 10yr 9mo at the beginning of treatment and 12yr 4mo at the end of treatment. In the Edgewise group the mean pretreatment age was 11yr at the start of treatment and 13yr 4mo at the end of treatment.

The FRII appliance design was used for Fränkel treatment. The data evaluated in the Fränkel group dealt only with Phase I treatment, which did not involve full banding. Those in the Edgewise group were treated with full banding, and nine required extraction of four first bicuspids.

Average treatment time was 17.5mo for the Fränkel group and 21.4mo for the Edgewise group.

Two sagittal cephalometric roentgenographs were evaluated, one before and the other at the end of treatment. All were exposed with the teeth in centric occlusion.

The cephalometric analysis for mandibular and soft tissue changes was made from tracings of outlines of bone and soft tissue structures seen on sagittal roentgenographs. Wherever two images of bilateral bony landmarks were seen, they were bisected. Acetate film tracings made by two individuals were averaged for the analysis.

The hard-tissue analytical methods of Steiner (1953, 1959 and 1960) (Fig. 1), McNamara (1981) (Fig. 2) and Wylie (1947) (Fig.3) are used. Soft tissue changes are analyzed according to the 'E' plane of Ricketts (1968) (Fig. 4) and the S line of Steiner (1960) (Fig. 1). In addition, the Mand/Occip angle in Margolis' (1947) cephalometric analysis (Fig. 5) is also used. Angular measurements are to the nearest 0.5° and the linear measurements to the nearest of 0.5mm.

Statistical Analysis

Both angular and linear measurements were analyzed using the analysis of vari-

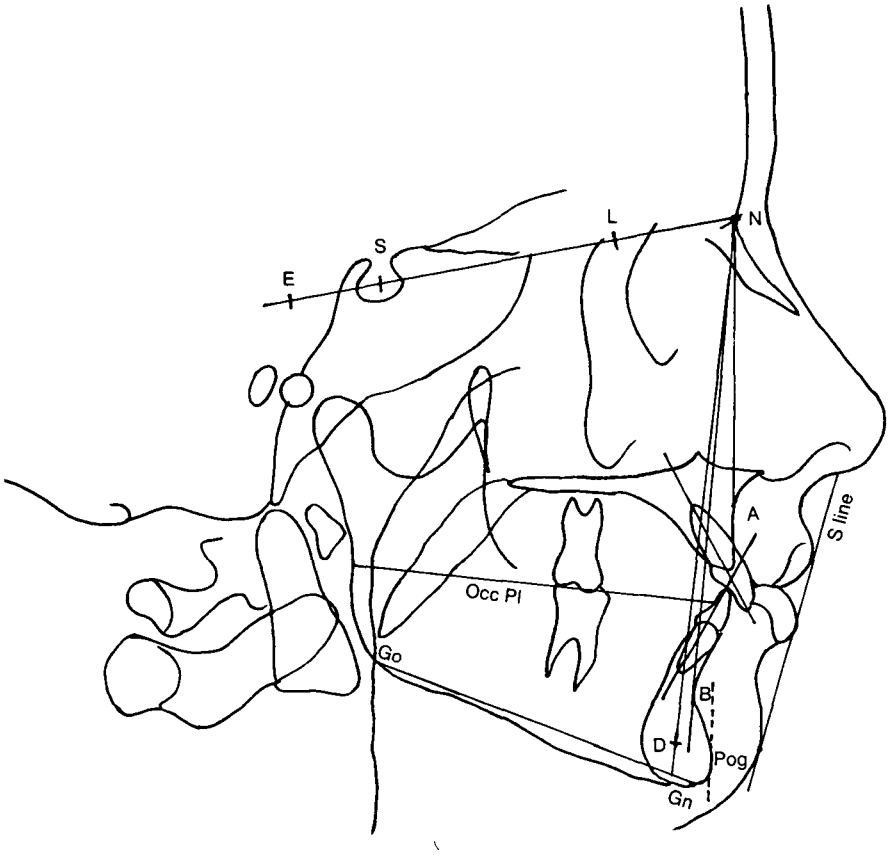

Fig. 1 Steiner's reference points used in this study

ance for mixed factorial designs. The designation "mixed" denotes the presence of both within-subject and between-subject variances.

This analysis permits an intergroup comparison in which the combined pre- and posttreatment data in the Fränkel group is compared to the combined pre- and posttreatment data for the Edgewise group. It also permits a comparison of time effects within groups, in which the combined pretreatment data for each group is compared to the corresponding combined posttreatment data.

In addition, the analysis can be used to compare the important differential time effects between groups, termed the interaction comparison. The relative difference between the pretreatment and posttreatment values for the Fränkel group is compared to those values for the Edgewise group.

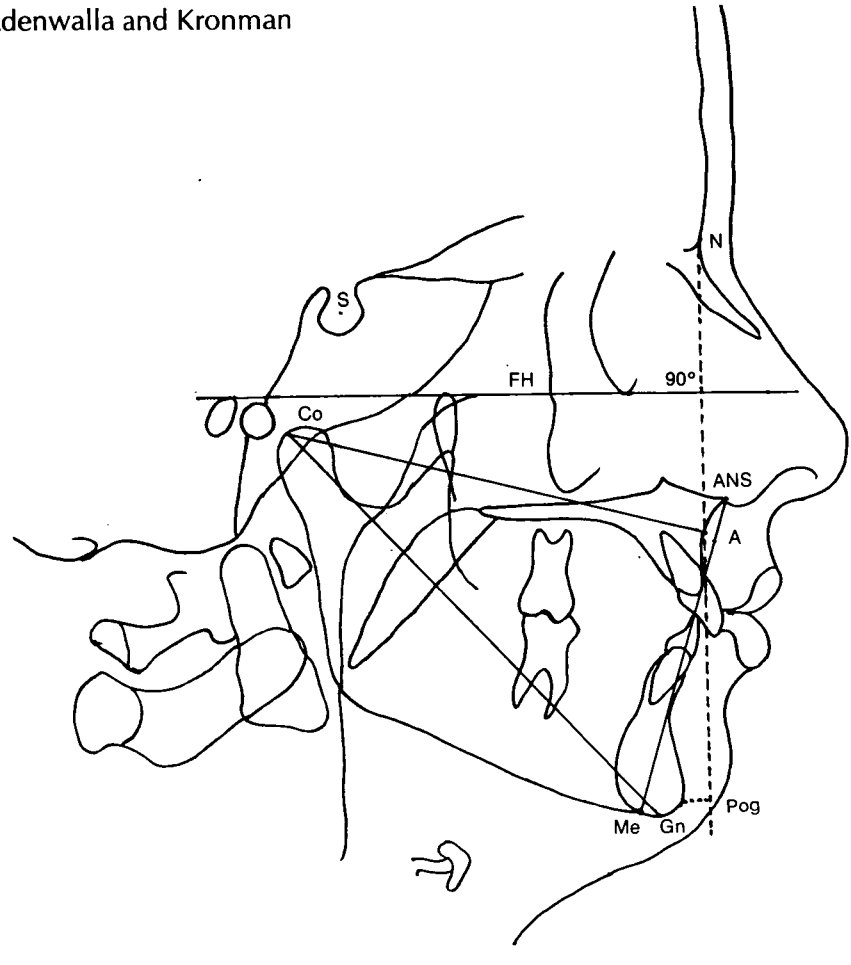

Fig. 2 McNamara's reference points and measurements used in this study

— Findings —

Summaries of the statistical results are shown in Tables 1 and 2.

Intergroup Comparison

The intergroup comparisons (disregarding time) are significant only for the following four measurements.

1. S–E(mm) (P = .016)

This measurement relates the mesiodistal position of the condyle in relation to Sella. The values in the Fränkel group are 19.67mm before treatment and 20.05mm after, showing a mean increase of 0.38mm over the treatment period. The correspnding values in the Edgewise group are 21.92mm before treatment and 22.10mm after, representing a mean increase of 0.18mm over the treatment period.

The combined before- and after- values of 39.72mm (19.67 + 20.05) in the Frän-

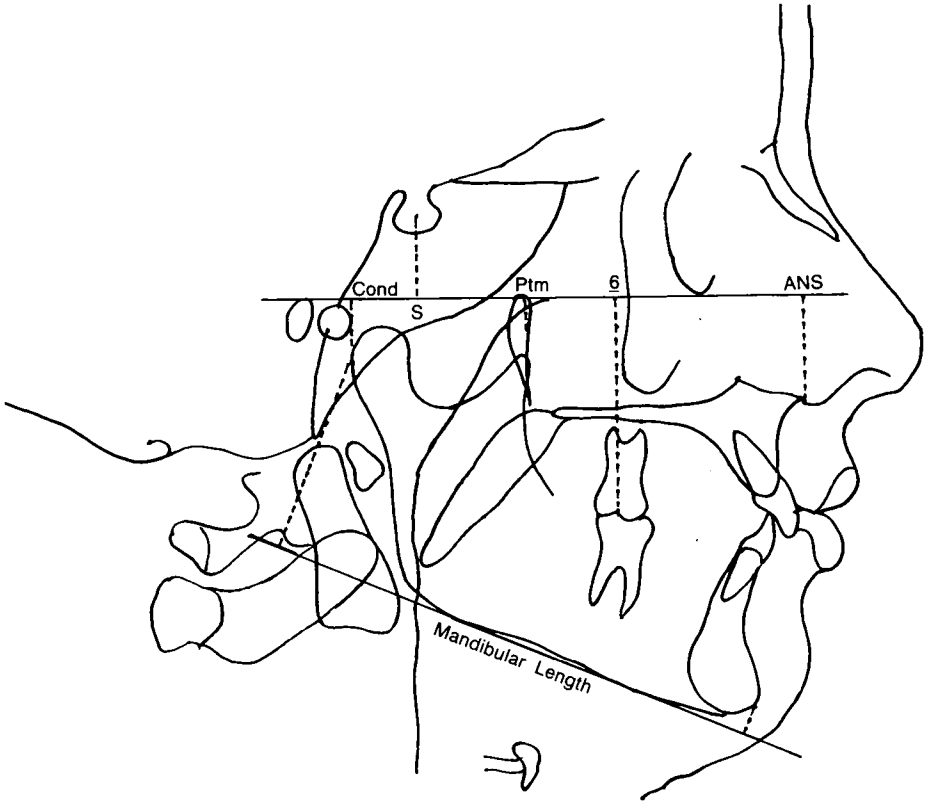

Fig. 3 Wylie's reference points used to measure horizontal distances on the Frankfort horizontal and mandibular length on the mandibular plane

kel group and 44.02mm (21.92+22.10) in the Edgewise group, were found to represent a significant intergroup difference (P=.016).

2. Lower lip to S line (mm) (P=010)

This measurement represents the anteroposterior position of the lower lip in relation to S line of Steiner. There was an average decrease of 1.42mm (from 2.22 to 0.80) in the Fränkel group during the treatment period. The Edgewise group showed a decrease of 2.59mm (from 0.97 to −1.62) during the treatment period.

The combined before and after values of 3.02mm (2.22+0.80) for the Fränkel group and −0.65mm (0.97−1.62) for the Edgewise group are also a significant intergroup difference (P=.010).

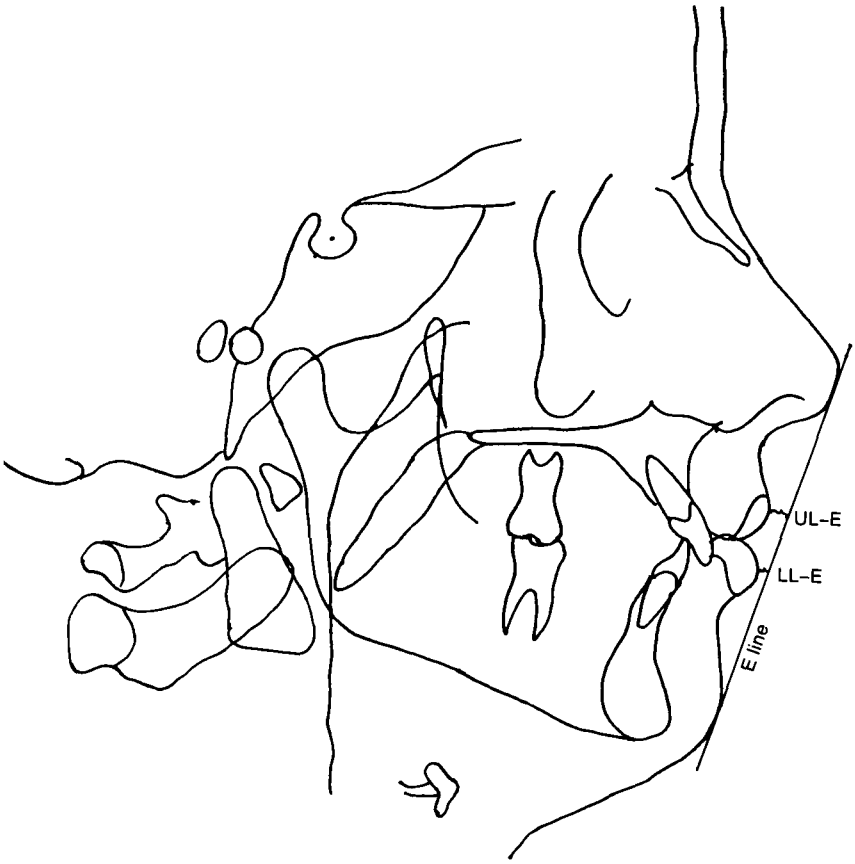

Fig. 4 Ricketts's E-line measurements to upper and lower lip

3. Perpendicular plane to Pogonion (mm) (P=.039)

This linear measurement used in McNamara's analysis shows the anteroposterior position of Pogonion in relation to a perpendicular drawn from Frankfort horizontal through Nasion. During the treatment period, a mean retrusion of 2.25mm (from −13.45 to −15.70) was seen in the Fränkel group, while the Edgewise group showed a slight average protrusive change of 0.80mm (from −9.12 to −8.32).

A significant intergroup difference was found, based on the combined pre- and posttreatment values of −29.15mm in the Fränkel group, and −17.44mm in the Edgewise group.

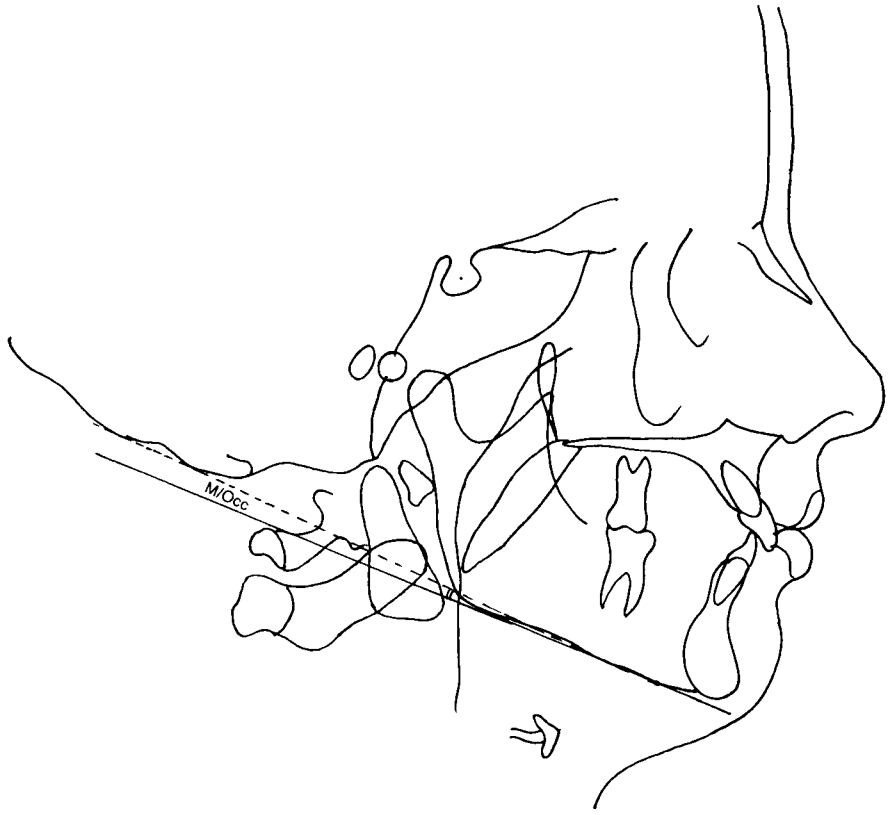

Fig. 5 Margolis's mandible to occipital bone angle

4. Mandibular length (Wylie) (P=.049)

The mean mandibular length according to Wylie's analysis increased during the treatment period in both groups. The mean increase in the Fränkel group was 5.95mm (from 102.07 to 108.02); in the Edgewise group it was 6.22mm (from 104.75 to 110.97).

Intergroup comparison of the combined pre- and posttreatment values of 210.09mm (102.07+108.02) in the Fränkel group to the 215.22mm value (104.75+110.97) in the Edgewise group was also found to be significant (P=.049).

Time Effects

Time effects are nonsignificant for S-E, N-B to Pogonion, and Perpendicular Plane to Pogonion. Combined Fränkel and Edgewise pretreatment and posttreatment values were:

S-E —
Pretreatment, 41.59mm
Posttreatment, 42.15mm

N-B to Pogonion —
Pretreatment, 5.25mm
Posttreatment, 5.82mm

Perpendicular plane to Pogonion
Pretreatment, −22.57
Posttreatment, −24.02

Interaction Comparison

The interaction comparison was done to identify any clinically important differential time effect between the Fränkel and Edgewise groups. Statistical analyses for interaction comparison were nonsignificant for all measurements.

— Discussion —

This study was undertaken in an effort to define effects of the FRII Fränkel appliance and to determine whether its effects on craniofacial structures differed in any identifiable way from the effects of full-banded Edgewise therapy. Since Roentgenographic cephalometry is generally accepted as the most accurate method of recording changes due to facial growth and orthodontic therapy, this method was used for recording the treatment results.

Class II[1] deep bite cases treated with the functional regulator of Fränkel are compared with similar types of cases treated with the standard full banded Edgewise technique. The measurements

Table 1

Statistical Summary
Measurements Before and After Treatment

	Fränkel		Edgewise		Significance	
	Before	After	Before	After		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Inter-Group	Time Effects
S–N–B °	74.9±3.3	75.8±3.7	75.8±1.9	76.3±2.8	NS	.0233
S–N–D °	72.7±3.3	73.6±3.8	73.8±2.0	74.7±2.6	NS	.0004
S–L mm	48.5±6.6	50.7±8.1	49.7±5.1	51.7±6.6	NS	.0006
S–E mm	19.7±3.4	20.1±2.9	21.9±2.3	22.1±2.5	0.016	NS
Go–Gn/S–N °	33.1±4.5	33.1±4.8	31.6±3.9	32.5±4.9	NS	NS
N–B to Pog mm	2.3±1.6	2.4±1.5	3.0±1.7	3.5±1.9	NS	NS
Mand/Occip °	0.6±2.9	1.3±3.5	2.1±3.0	3.4±4.2	NS	.0013
U Lip–S line mm	1.8±2.2	0.2±2.1	1.9±2.5	−1.3±2.2	NS	.0001
L Lip–S line mm	2.2±2.9	0.8±2.5	1.0±2.7	−1.6±2.4	0.010	.0002
U Lip–E line mm	−0.3±2.1	−2.4±2.3	−0.3±2.9	−4.0±2.8	NS	.0001
L Lip–E line mm	0.3±3.3	−1.2±2.6	−0.4±2.8	−3.5±2.9	NS	.0001
Co–Gn mm	107.4±4.5	113.2±6.0	109.7±4.6	115.5±5.0	NS	.0000
ANS–Me mm	64.6±5.7	67.7±5.9	63.5±4.8	67.6±5.6	NS	.0000
Perp Pl–Pog mm	−13.5±9.8	−15.7±12.2	−9.1±6.4	−8.3±7.7	0.038	NS
Cond–S mm	17.0±3.5	18.1±3.1	18.6±2.6	18.7±3.0	NS	.0358
Mand Length mm	102.1±4.1	108.0±6.0	104.8±4.0	111.0±5.2	0.049	.0001

NS = Nonsignificant

employed were selected to demonstrate changes in the horizontal and vertical dimensions of the face and oral structures, with four different measurments used to compare changes in mandibular size.

All patients selected demonstrated Class II[1] deep bites with skeletal and dental discrepancies, and still had remaining growth potential. Strictures of time and limited availability of patient records limited the sample to less than the number required for an ideal design, and demanded a broadening of the acceptance criteria. These limitations are considered in the interpretation of the findings.

The following discussion is divided to give separate consideration of mandibular, vertical and soft tissue changes.

Mandibular Changes

The measurements in this category consisted of angular measurements S-N-B and S-N-D, and linear measurements S-L, S-E, N-B to Pogonion, Condylion to Gnathion, Perpendicular Plane to Pogonion, Condyle to S, and Mandibular Length according to Wylie's analysis.

The angles S-N-B and S-N-D indicate the anteroposterior position of the mandible in relation to the cranial base plane (S-N). The pretreatment values of S-N-B and S-N-D angle in this study are below Steiner's guideline values of 80° and 76°, indicating a relative deficiency in the anteroposterior growth of the mandible. Thus, the patients in both groups had somewhat retrusive mandibles at the beginning of treatment which may have contributed to their Class II[1] malocclusions.

At the end of the treatment, there was an increase in the average value of these angles in both groups. The increases were small; in the S-N-B angle it was 0.9° in the Fränkel group and 0.5° in the Edgewise group. The mean increase in the S-N-D angle was 0.9° for both groups. The difference between the increases in these angles in the Fränkel and Edgewise groups was not statistically significant.

The changes seen in the S-N-B and S-N-D angles could be explained by the fact that the position of point B and point D can be influenced by orthodontic treatment and/or growth. the position of point B can be influenced by the position of the mandibular incisors and/or growth. In order to relocate the position of point B more anteriorly by tooth positioning, the mandibular incisor roots must be moved forward. This effect was seen in this study, and it will be discussed later. The other mechanism for anterior positioning of point B is growth of the mandible. Thus, the increase in the S-N-B angle could be due to normal growth and/

Table 2

Mean Differences
Before and After Treatment

	Fränkel	Edgewise
S–N–B °	0.90	0.50
S–N–D °	0.90	0.90
S–L mm	2.20	2.05
S–E mm	0.38	0.18
Go–Gn/S–N °	0.00	0.90
N–B to Pog mm	0.10	0.47
Mand/Occip °	0.70	1.25
U Lip–S line mm	−1.63	−3.19
L Lip–S line mm	−1.42	−2.59
U Lip–E line mm	−2.08	−3.72
L Lip–E line mm	−0.95	−3.08
Co–Gn mm	5.85	5.78
ANS–Me mm	3.08	4.05
Perp Pl–Pog mm	−2.25	0.80
Cond–S mm	1.15	0.10
Mand Length mm	5.95	6.22

Interaction Comparisons were not significant

or anterior positioning of the mandibular incisors.

The S-N-D angle could be changed by the rotation of the mandible in either a hyperdivergent or hypodivergent direction. Hyperdivergent rotation will decrease the S-N-D angle, while hypodivergent rotation will increase it. The S-N-D angle can also be increased by growth of the mandible. The mean increases seen in the S-N-D angle in the Fränkel and Edgewise groups in this study are exactly the same (0.9°), with standard deviations of the underlying angular measurements ranging from 2.03° in the Edgewise group before treatment to 3.82° in the Fränkel group after treatment (Table 1).

Mandibular length was measured in three ways. The measurement S-L represented the effective mandibular length in Steiner's analysis, while McNamara used the distance from Condylion to Gnathion. Wylie used the distance on the mandibular plane between projections of the most posterior point on the head of the condyle and the most anterior point on the chin. The mean values of mandibular length according to Steiner's and McNamara's analyses showed deficient mandibles in both groups at the beginning of treatment; according to Wylie's analysis, they were normal.

The guideline value of S-L according to Steiner's analysis is 51mm. The mean value of S-L at the start of treatment was 48.52mm in the Fränkel group and 49.65mm in the Edgewise group. Mean mandibular length increased 2.20mm in the Fränkel group and 2.05mm in the Edgewise group during the treatment period, which is a statistically insignificant difference.

The mean value of the Condylion to Gnathion dimension according to McNamara's analysis varies according to the age of the patient. The average value for patients of twelve years of age is 113mm. This dimension increased during treatment in both groups, 5.85mm (from 107.37 to 113.22) in the Fränkel group and 5.78mm (from 109.72 to 115.50) in the Edgewise group. Again, the difference in the average increase in the distance from Condylion to Gnathion was not significant.

According to McNamara, the mean annual increase in Condylion-Gnathion due to growth is about 2.75mm. It was found that the changes were greater than might be expected with normal growth in both groups, even though the difference in the changes in the two groups was not statistically significant.

According to Wylie, the mean mandibular length at 11yr 6mo is 101mm for females and 103mm for males. The mean mandibular lengths in Fränkel and Edgewise groups in this study are close to those norms. There was an increase in this measurement in both groups during treatment, 5.95mm (from 102.07 to 108.02) in the Fränkel group and 6.2mm (from 104.75 to 110.97) in the Edgewise group. The difference was not significant.

The measurements of S-E in Steiner's analysis and Co-S in Wylie's both represent the horizontal position of the condyle in relation to Sella (S). Steiner's norm for S-E is 22mm; the pretreatment means in this study are 21.92mm in the Edgewise group and 19.67mm in the Fränkel group. During treatment, the mean value of this measurement increased very little, 0.38mm in the Fränkel group and 0.18mm in the Edgewise group. Similarly, the Co-S measurement in both groups was within the normal range before treatment and showed a mean increase of 1.15mm in the Fränkel group and 0.10mm in the Edgewise group.

The increases in these measurements indicate slight growth at the Condyle and/or anterior repositioning of the mandible during treatment. Interaction com-

parison revealed no significant difference between the Fränkel and Edgewise groups in the changes in the these measurements.

The measurement of N–B to Pogonion indicates the amount of "bony chin button" present in the symphysis of the mandible. Steiner's norm is 4mm. The mean values of 2.25mm in the Fränkel group and 2.35mm in the Edgewise group indicate some chin deficiency in both groups. Increases of 0.10mm in the Fränkel group and 0.47mm in the Edgewise group during treatment again show no statistically significant difference between the two groups.

The Perpendicular Plane to Pogonion measurement in McNamara's analysis relates the bony chin to the perpendicular plane drawn from Nasion through the Frankfort horizontal plane. The mean value (−13.45mm) of this measurement in the Fränkel group indicates a retrusive chin; a mean increase of 2.25mm was observed during treatment. This could be due to growth at Pogonion and/or anterior repositioning of the mandible.

In contrast, the Edgewise group showed an opposite response during treatment, a mean decrease of 0.80mm, which could be due to a downward and backward rotation of the mandible. The difference between these changes in the two groups was also not statistically significant at the .05 level.

Pogonion (chin point) is an important consideration in profile assessment. A prominent chin point will tend to straighten the profile. Conversely, the lack of a chin point can enhance profile convexity. Additionally, the sagittal position of the mandibular incisor can markedly influence the effective chin point. For this reason, the mandibular incisor is related to Pogonion and point B with linear measurements in Steiner's analysis. This was based on on the idea that a harmonious relationship of the mandibular incisors to Pogonion requires that point B be horizontally equidistant, or almost so, from the labial surface of the mandibular incisors and Pogonion.

If a disharmony involving Pogonion exists in a growing child, some growth change may still be expected to occur at Pogonion (Enlow and Harris 1964), so that the chin point may be 1mm to 3mm anterior to the profile line at maturity.

There are several possible explanations for the results related to mandibular growth obtained in this study. The mandibular length, as measured by three different methods, showed no statistically significant differences in average length between the two groups; nor did the anteroposterior position show any significant differences.

Growth

On average, mandibular length increases somewhat more during growth than does maxillary length (Björk 1947). The magnitude of this change may vary from one individual to another.

Age

It is during the pubertal period, approximating the time of transition from the mixed dentition to the permanent dentition stage, that we may gain the greatest advantage from growth in attaining a Class II correction. At this time, there appears to be a general increase in the downward and forward growth of the mandible (Björk 1947).

It was noted by Brodie (1938) that the best results were obtained when growth was most active. Fränkel (1974) suggested that functional appliance treatment should be initiated in the mixed dentition stage. In two cross-sectional studies (Petraitis 1951, and Baird 1952), it was shown that the average female facial pattern undergoes maturation changes sometime between the ages of 11 and 13 years. Similar changes are

observed in the male face a little later. These findings have been substantiated by Barnes (1954) in a serial study of the growth pattern of a group a boys and girls between the ages of 12 years and 15 years.

In this study, the patients were in the age range between 10 and 13 years, indicating that they were undergoing their peak growth. In addition to favorable age, all cases selected had average mandibular plane angles and positive MP/Occ angles, indicating good growth potential. Thus, growth had a substantial influence on the face during orthodontic treatment.

Treatment

In animal studies where the mandible was brought forward by fixed splints, increases in mandibular length resulted. It has been concluded by several investigators that the hyperpropulsion device resulted in growth change at the TMJ and glenoid fossae (Baume 1961, Joho 1968, Charlier and Petrovic 1969, Elgoyhen et al. 1972, and McNamara 1973).

In a study by Fränkel and Reiss (1970), an increase in mandibular dimensions was seen in patients with Class II malocclusion treated with the Fränkel appliance. Variouss mandibular measurements were found to increase in a similar study by Fränkel (1975). The teleradiographic study done by Fränkel (1969) showed that point B was relocated forward by 5mm and Pogonion by 6mm. Another cephalometric study of Class II malocclusion done by Sergl (1976) found an increase in the S-N-B and S-NPog angles. The changes seen in the Fränkel group in the present study were similar to those seen in these prior studies.

Similar changes are also seen in the Edgewise group in this study, which explains the lack of significance in the statistical interaction comparison. These results are in agreement with the findings of Hedges (1948), Stoner (1956), Blueher (1959), and Weislander and Tandlakare (1963).

Vertical Changes

The measurements in this category are focused on lower facial height as indicated by the Anterior Nasal Spine to Menton dimension, the Mandibular/Occipital angle, Occlusal plane/Go-Gn and /S-N, and Go-Gn/S-N angles. The differences between mean values for vertical changes in Fränkel and Edgewise groups did not reach the level of statistical significance for any of these measurements.

The criteria for selection of patients for this study stipulated that deep overbite skeletal patterns be chosen. Increased facial height is an obviously desirable treatment objective in such cases. Both groups showed an improvement in lower facial height, with the Edgewise group showing a 4.05mm mean increase and the Fränkel group 3.08mm. This difference is not statistically significant.

This indicates that lower anterior facial height was increasing in both groups in a similar fashion. Comparing these increases to the mean annual increase of 1mm per year reported by McNamara for the growing child from 9yr to 14yr indicates that treatment could have been a factor in the changes found in this study.

Fränkel appliance treatment has been advocated for patients with short lower anterior facial height, leading to more bite opening and desired facial esthetics. The increase in this measurement with the Fränkel appliance could be due to alveolar growth and/or eruption of the posterior teeth.

In the Edgewise technique the increase could be due to these same factors. This was seen in Poulton's (1959) study of headgear therapy. Klein (1957), Weislander and Tandlakare (1963), and Jakobsson (1967) are also in agreement with

regard to this increase in lower facial height with Edgewise treatment.

The increase in lower facial height could be due to extrusion of maxillary molars by cervical traction, leading to hyperdivergent rotation of the mandible. Many orthodontists assume that any observed difference in facial height has occurred through downward and backward rotation of the mandible. This would lead to an increase in the mandibular plane angle, and this assumption was not substantiated in the current findings; little or no change in mandibular plane angle was observed. This is consistent with findings that use of cervical headgear is associated not only with increases in total facial height but also with significant increases in ramus height relative to controls or activator therapy (Baumrind et al. 1978).

The Mand/Occip angle of Margolis (1947) was used mainly to qualify the growth pattern of the mandible and to select the cases with good mandibular growth pattern. Margolis stated that the mandibular plane usually touches or falls below the occiput, so a plus Mand/Occip angle is an indicator of good growth potential of the mandible. The cases selected in this study had plus Mand/Occip angles prior to treatment. This angle increased in both groups during the treatment period, 0.70° (from 0.62° to 1.32°) in the Fränkel group, and 1.25° (from 2.12° to 3.37°) in the Edgewise group, a statistically insignificant difference.

The angle between the mandibular plane (Go-Gn) and the cranial base line S-N showed variable changes in this study, not statistically significant for intergroup, over time and interaction comparisons. The most obvious explanation is that no real differences existed between the Fränkel and Edgewise groups, but it is also possible that the angular changes may have been too small to be detected by the methods of measurement and recording that were used.

The mean Go-Gn to S-N angle was unchanged in the Fränkel group during the treatment period, while there was a small increase of 0.90° in the Edgewise group.

A change in this angle reflects a change in the mandibular plane due to rotation of the mandible during treatment, as could be caused by change in the vertical position of the posterior teeth. In most cases, this angle should be maintained or decreased during treatment. The most important single factor accounting for increases in the mandibular plane angle is the extrusion of the upper first molar with the use of cervical traction. This effect was most noticeable in the Edgewise group as reflected by the increase in that angle, although the difference from the Fränkel group was not statistically significant between the two groups and for over time comparison.

This indicates that the Fränkel and Edgewise groups behaved similarly. One factor presumed by the authors is an increase in ramus height in both groups, which will maintain the mandibular plane orientation relatively unchanged in spite of an increase in anterior lower facial height.

Soft Tissue Changes

An acceptable appearance of the soft tissue profile is a major objective of orthodontic treatment today, in addition to creating a functional occlusion. Changes occur in the soft tissue profile and skeletal base with age, with or without orthodontic intervention. The skeletal base is the foundation over which the soft tissue is draped.

The parts of the soft tissue profile do not necessarily change in concert with the growth of the skeletal profile; nor is the soft tissue covering of adipose tissue, connective tissue and muscle distributed

in a uniform manner. Numerous investigators have set about to analyze the soft tissue profile and evaluate facial esthetics.

Steiner's S line is drawn from the middle of the S curve formed by the lower border of the nose and the upper lip to the soft tissue counterpart of Pogonion. In Steiner's ideal profile the lips fall on this line. Lips positioned anteriorly would be full, and lips positioned posteriorly would be flat. His analysis took the size of the nose and chin and their harmony with the lips into account (Steiner 1953 and 1959).

Ricketts based his facial analysis on his esthetic line or plane (1968). This is a line drawn from the tip of the nose to the chin, which his adult criteria indicate should contain the upper lip with the lower lip slightly ahead of the upper.

The soft-tissue comparison in this study used the above two analyses. At the beginning of treatment, the upper lip was 1.80mm ahead of the S line in the Fränkel group and 1.92mm ahead in the Edgewise group, indicating that the lips were protrusive according to Steiner's analysis. Both lips were retracted during the treatment. Mean retraction of the upper lip was 1.63mm (from 1.80 to 0.17) in the Fränkel group, and 3.19mm (from +1.92 to −1.27) in the Edgewise group. Mean retraction of the lower lip in the Fränkel group was 1.42mm (from 2.22 to 0.80), and in the Edgewise group it was 2.59mm (from 0.97 to −1.62). Statistical analysis of the relative difference between the Fränkel and Edgewise groups in the retraction of the upper and lower lips in relation to S line indicated that it was not significant.

Retraction of lips in relation to the E line of Ricketts was also observed during the treatment, and statistical analysis again indicated no significant difference between the Fränkel and Edgewise groups.

Since the lips are closely related to underlying structures, it can reasonably be assumed that lip contour can be modified by dentoalveolar changes. Because the incisal third of the maxillary incisor is covered by the lower lip, retraction of the maxillary and mandibular teeth could affect both the upper and lower lips. In studies by Branoff (1971),Hershey (1972) and Wisth (1972) it was shown that the position and morphology of the upper and lower lips are dependent on tooth position.

However, there are differences in the findings on the amount of change in position of the upper lip relative to the corresponding changes in the incisor position. Ricketts (1960) found that the upper lip follows the maxillary teeth in the ratio of 1:3, as did Wisth (1972). The ratio for retraction of maxillary teeth and the lower lip was 1:2.2. A more recent study by Waldman (1982), reports an average 1mm retraction of the upper lip with an average maxillary incisor retraction of 3.8mm in the horizontal plane.

This variation in lip retraction could be related to the extraction of teeth. The studies of Ricketts and Wisth were based on cases treated with the extraction of bicuspid teeth in the traditional Edgewise treatment. In the current study, the cases in the Fränkel group were treated as nonextraction cases in Phase I of the treatment. Eleven out of twenty patients in the Edgewise group were treated as nonextraction cases, while the remaining nine patients were treated with four first bicuspid extractions.

The studies of Stoner and Lindquist (1956), Buchin (1957), and Schudy (1968) showed that soft tissue changes were the result of bodily retraction of the anterior teeth and an increase in vertical height of the anterior face. Bloom (1961) and Rudee (1964) also obtained a high correlation between upper and lower incisor move-

ments and lip position. Ricketts firmly believes in the dependence of the soft tissues on the hard tissue framework. The changes seen in lip retraction in this study are in agreement with those findings.

In order to correlate the skeletal profile with the soft tissue profile in Class II malocclusion, one must have an idea of what happens to the skeletal bases and soft tissue in the "normal" facial pattern with growth and with orthodontic treatment. According to WYLIE (1947) a "normal" facial pattern is a nonexistent entity. He envisions dentofacial abnormalities as being combinations of facial parts which may not be abnormal in themselves, but when taken together, fit poorly with each other.

It must be emphasized that changes in basic soft tissue position occur primarily as a part of growth, and there is little that an orthodontist can do to influence them. It is true that the lips themselves will fall back in relation to other soft tissues with growth; however, in so doing the lips have been found to maintain the same approximate relationship to each other, much as the skeletal points A and B maintain a proportionate relationship with age. Thus, while the lips may change in relation to the profile, there is little change that can be hoped for in one lip as it relates to the other lip without orthodontic treatment.

The successfully treated orthodontic case is one in which optimal esthetic and functional relationships are achieved. Despite this, current concepts of a favorable facial appearance have not been clearly formulated. An "ideal" facial and esthetic result can have many interpretations. Some clinicians feel that although the use of headgears in treatment of Class II[1] malocclusion helps to solve the occlusal problem, it may result in undesirable facial changes. As seen from the current study, the soft tissue changes resulting from treatment with the Fränkel and Edgewise techniques were not significantly different.

A recent increase in the use of functional appliances is obvious. The effect that these appliances have in the treatment of Class II malocclusion with deficient mandibles is the subject of continuing debate. The results of the current study show no demonstrable difference in the average effect seen with conventional Edgewise therapy and after treatment with the Fränkel appliance.

Isolated cases have demonstrated that Fränkel appliances can elicit a favorable response. In some instances, changes occur with the use of these appliances which are different from what one would expect with normal growth. This can be misleading, since such cases are generally selected from a larger sample, and exceptional changes can be found in most large groups of treated or untreated individuals. It would be interesting to randomly select a sufficient number of consecutively treated functional appliance cases and rigorously analyze the cephalographs (WATSON 1981).

WATSON (1981) indicated that there is a need for functional appliances as an adjunct to the orthodontic armamentarium, similar to the many ramifications of fixed appliances. However, he suggested caution in their use.

In the treatment of Class II cases, two basic philosophies may be described (Graber and Swain 1975). The first attempts to move teeth, keeping the existing relationship of the mandible to the maxilla. The other basic philosophy applies the facial orthopedic concept to attempt to effect extensive changes in the denture base relationships with tooth movement a minor factor.

If the orthodontist can adequately determine whether the problem is one of

maxillary protrusion, mandibular retrusion or a combination of the two, or skeletal bases that relate the maxilla and mandible well to the cranial base, mechanotherapy can be selected to create optimal functional and esthetic results. In Coben's words, "the treatment philosophies employed in correction of Class II malocclusions is governed by one's concept of the Class II problem, the possibilities of tooth movement and the relationship of growth to treatment" (Coben 1966).

In closing, it might be of interest to note that two recent articles (CREEKMORE AND RADNEY 1983, AND ROBERTSON 1983) addressed the same issues investigated in this study. The present findings are essentially in agreement with those, with some minor differences related to variations in sample selection and analyses used.

— Summary —

• Comparison of the performance of the Fränkel and Edgewise appliance treatment in effecting changes in mandibular length during treatment, using the analysis of variance for mixed factorial designs at the 0.05 confidence level, revealed no significant difference between the two techniques.

• The vertical changes observed during treatment resulted in an increase in the lower facial height which tended to differ between the two treatments, although this was below the level of statistical significance. In the Edgewise treatment, the increase in lower facial height was greater than that seen in the Fränkel treatment.

• Soft tissue analysis of the cephalographs using the Ricketts and Steiner soft tissue lines did not reveal any significant difference in the effect of the two treatments on the upper and lower lips.

• Significant values for intergroup comparison were reported for four measurements: S-E, upper lip to Steiner's soft tissue line, perpendicular plane to Pogonion (McNamara's analysis), and mandibular length (Wylie's analysis).

• A statistically significant difference was observed for time effects comparisons in all measurements except S-E, Go-Gn to Sn, N-B to pogonion, and perpendicular plane to pogonion.

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