

## Skeletal and dental changes induced by frankel (FR-2) appliance

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### Abstract:

Frankel appliance is one of the functional appliances used to treat Class II skeletal cases. The aim of this study was to evaluate the skeletal and dental changes induced by Frankel (FR-2) appliance. Pre and post treatment cephalometric and dental cast records of eight treated cases were analyzed. The results showed little skeletal and marked dental corrections.

Maxillary incisor retraction and mandibular incisor proclination were significant. The increase in mandibular plane angle was very small.

The maxillary inter molar distance and mandibular inter canine and inter molar distances were increased significantly during treatment.

### Keywords:

Skeletal changes, Frankel appliance, cephalometric changes, dental arch changes.

### Introduction:

The choice of treatment used to correct skeletal class II cases is a matter of controversy between orthodontists. The use of functional appliances is one of those choices. These appliances were developed in Europe, they were used in an attempt to stimulate mandibular growth and improve muscular balance with the dentition<sup>(1,2)</sup>. Frankel functional regulator (FR-2) is one of those functional appliances.

Experimental animal studies on this appliance showed stimulated condylar growth<sup>(3-5)</sup>. Some researchers suggested similar results in human beings<sup>(6-8)</sup>. Also shielding muscular influence on the dentition in buccal region with stretching of the periosteum was claimed to cause alveolar bone deposition and widening of the dental arches<sup>(9-11)</sup>. The labial pads inhibit the effect of mentalis muscle and orbicularis oris on the

dentition, this with widening of the dental arches reduce the amount of crowding in the developing dentition<sup>(12,13)</sup>, yet other investigators disagreed with those findings denying mandibular growth more than the expected normal growth<sup>(14,15)</sup>. Some researchers even blamed Frankel appliance for mandibular joint resorption<sup>(16)</sup>.

Other researchers concluded that the class II correction was due to a restraining effect on the maxilla and retroclination of maxillary anterior teeth with proclination of mandibular anterior teeth<sup>(15)</sup>.

With those contradicted informations in mind the idea of this research emerged.

The purposes of this study are:

- 1- To examine if there are skeletal changes as a result of the use of Frankel (FR-2) functional regulator.
- 2- To examine if there are any dental changes caused by Frankel appliance treatment.

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## Materials and methods:

The sample consisted of eight patients treated with Frankel appliance, the criteria used were as described by Hamilton, et al<sup>(17)</sup> which were:

- 1- Skeletal CI II malocclusion ( $ANB > 4.5^\circ$ ) and full step dental Class II.
- 2- Mandibular plane to Frankfort horizontal plane angle of  $25^\circ$  or less.
- 3- Considerable skeletal growth potential remaining as expected from patient age (patient pretreatment age range is 8-9.5 years).
- 4- Average treatment time is (2) years, and the patients age range at the end of treatment is 10-11.5 years.

The following records were taken for each patient:-

- 1- Standardized pre and post treatment cephalograms.
- 2- Pre and post treatment study models.

For the construction bite of the appliance the guidelines suggested by Bishara<sup>(18)</sup>, and McNamara and Hugu<sup>(19)</sup> are used: if the patient's mandible could be protruded to an edge to edge relationship with out exceeding 5 mm advancement then the construction bite was fabricated at this position; if not the mandible was advanced 5 mm for 6

months then advanced again until an edge to edge relation is reached. The patients were given instructions for appliance wear according to McNamara and Hugu<sup>(19)</sup>, and Owen<sup>(20)</sup>, these are: 5 hours each day for the first week and add 1 hour each day until 24 hours is reached removing the appliance during eating and sports. The patients were instructed to read aloud for 30 minutes each day until normal speech was achieved.

It is very important to mention that the rather hard criteria for both sample selection and appliance instructions mentioned above led to a small sample size selection, we started with 20 patients, but only eight patients have been followed up successfully for about two years, whereas those who discontinued the appliance or failed to achieve the instructions perfectly have been excluded [war conditions played a major role].

The pre and post treatment cephalograms were traced and the following land marks identified:

\*Points: S, N, A, B, Po, Or, Go, Me (Fig 1).

\*Planes: SN, Frankfort horizontal, mandibular palne, (Fig. 1).

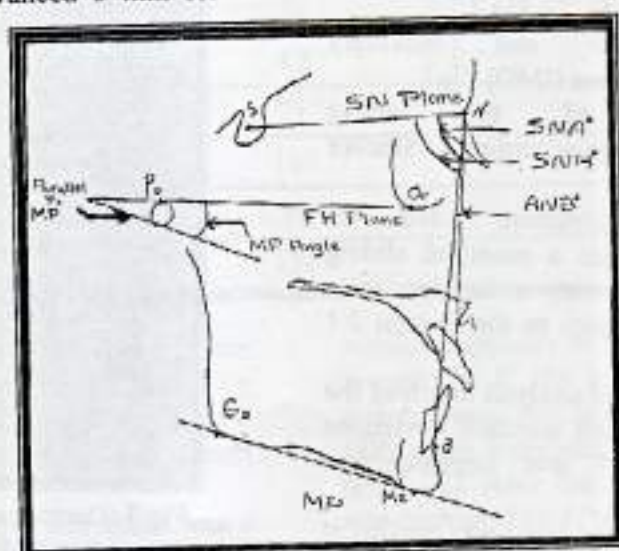
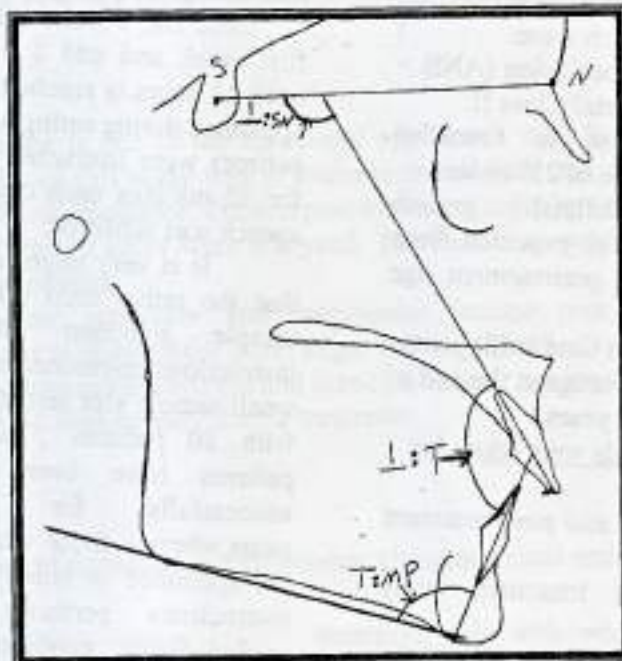


Fig 1: Cephalometric landmarks.



\*Angles: SNA, SNB, ANB, mandibular plane to Frankfort plane angle (MPA), maxillary incisor to SN angle (UI: SN), mandibular incisor to mandibular

plane angle (L1 : MP) and maxillary incisor to mandibular incisor angle (UI : L1) (Fig.1 and 2).



**Fig 2:** I:SN= Maxillary incisor to SN plane angle.  
L:MP= Mandibular incisor to mandibular plane angle.  
I:L = Maxillary incisor to mandibular incisor angle.

On the pre and post treatment dental casts the following measurements were made:-

- 1- Mandibular and maxillary inter canine distance (ICD) Fig 3.
- 2- Mandibular and maxillary intermolar distance (IMD) Fig3.

Both of the above measurements are according to Sinclair and Little.<sup>(21)</sup>

The instrument used for measurement was a modified sliding caliper gauge with a vernier scale permitting readings to the nearest 0.1 mm.

Statistical analysis involved the use of means and standard deviations for all dental and cephalometric parameters.

The paired t-test was applied at  $P < 0.05$  significance level to test the presence or absence of any significant

difference between the mean values of pre and post treatment measurements.



**Fig 3:** Dental cast measurements.  
1,4=inter canine distance  
2,3=inter molar distance

## Results:

As shown in table (1), the sample had a low SNB angle, mandibular palne angle (MPA), and

inter incisal angle;while the ANB angle, and ( U1 : SN) angle are high when compared with skeletal class I values of these parameters.

**Table (1): Pretreatment Cephalometric Measurements.**

Measurement	Mean	SD
SNA <sup>o</sup>	80.5	3.3
SNB <sup>o</sup>	75	3.3
ANB <sup>o</sup>	5.5	2
MPA <sup>o</sup>	20	5.1
U1 :SN <sup>o</sup>	107	9.5
L1 :Mp <sup>o</sup>	95	5
U1 : L1 <sup>o</sup>	125	8

The analysis of the cephalometric measurements of post treatment X-rays revealed little significant effect on the antero-posterior growth pattern of the sample (Tables 2 and 3) , there is slight increase in SNB angle and slight

decrease in ANB angle in the post treatment results ( $P < 0.05$ ),while the SNA angle remained unchanged. So, after treatment the sample still have SNB value and ANB value of skeletal Class II pattern.

**Table (2): Post Treatment Cephalometric Measurements.**

Measurement	Mean	SD
SNA <sup>o</sup>	80.5	3.5
SNB <sup>o</sup>	76	2.8
ANB <sup>o</sup>	4.5	2.3
MPA <sup>o</sup>	21	5.5
U1 :SN <sup>o</sup>	102	8.8
L1 :Mp <sup>o</sup>	98	5.3
U1 : L1 <sup>o</sup>	129	8.7

Tables 1 and 2 show that the mandibular plane angle increased by one degree (20<sup>o</sup> to 21<sup>o</sup>) ( $P < 0.05$ ) but it is still low when compared with Class I values.

Table3 show that there was a highly significant retraction of

maxillary incisors with ( U1:SN) angle lowered by 5<sup>o</sup> ( $P < 0.01$ ), while lower incisors were proclined by 3<sup>o</sup> as ( L1: MP) angle increased from 95<sup>o</sup> to 98<sup>o</sup> ( $P < 0.05$ ). Also the interincisal angle was increased by 4<sup>o</sup> from 125<sup>o</sup> to 129<sup>o</sup> ( $P < 0.05$ ).



**Table (3):** Paired t-test between pre and post treatment cephalometric values.

Variable	t-value	Significance
SNA <sup>o</sup>	0.01	NS
SNB <sup>o</sup>	2.17	S
ANB <sup>o</sup>	2.93	S
MPA <sup>o</sup>	2.57	S
U1 :SN <sup>o</sup>	3.33	HS
L1:Mp <sup>o</sup>	2.85	S
U1 :L1 <sup>o</sup>	3.79	S

The dental arch changes were studied from measurements of the pre

and post treatment dental casts (Tables 4 and 5).

**Table (4):** Pretreatment Dental Cast Measurements .

Measurement	Mean (mm)	SD
Maxillary ICD	31	2.8
Mandibular ICD	25	2.5
Maxillary IMD	44	2.5
Mandibular IMD	40.5	2.4

ICD= Intercanine distance  
IMD= Inter molar distance

**Table (5):** Post Treatment Dental cast measurements.

Measurement	Mean (mm)	SD
Maxillary ICD	32	3.4
Mandibular ICD	26.5	2.4
Maxillary IMD	47.5	3.3
Mandibular IMD	42	2.6

ICD= Intercanine distance  
IMD= Inter molar distance

#### The inter canine distance (ICD) :

50% of the sample showed an increase in maxillary intercanine distance , but this increase was not significant (Table 6), while the mandibular inter canine distance increase which was (1.5) mm and was present in five patients was a significant increase ( $P < 0.05$ ).

#### Inter-molar distance (IMD):

The increase in intermolar distance in the maxillary arch was present in seven patients, this increase was 3.5 mm which was highly significant ( $P < 0.001$ ).

In the mandibular arch the increase in the inter molar distance was 1.5 mm, this increase was present in six patients and was significant at ( $P < 0.05$ ) (Table 6).

**Table (6):** Paired t-test between pre and post treatment dental cast measurements.

Variable	t-value	Significance
Maxillary ICD	0.99	NS
Mandibular ICD	2.44	S
Maxillary IMD	4.75	HS
Mandibular IMD	2.99	S

## Discussion:

The results of this study showed little skeletal changes, the main results were due to dental changes and minimal skeletal class II correction was achieved.

The restraining effect on the maxillary growth was not observed as it was suggested by other researchers<sup>(15,22,25)</sup>. Many authors suggested that mandibular growth was stimulated during Frankel therapy<sup>(8,13,22)</sup>, but our sample did not show this growth to be clinically significant. The sample showed considerable dental Class II correction as shown by other researchers<sup>(16, 23)</sup>.

In comparison with other researchers who showed marked clinical increase in MPA after treatment with Frankel appliance<sup>(15)</sup>, this study showed slight increase of MPA (one degree); while in both studies there was significant maxillary incisor retraction and proclination of lower incisors due to the tipping effects gained from the labial bow, lingual wire, and lip pads.

Accordingly, an important clinical note must be considered before treatment, if the upper incisors were originally retroclined and lower incisors were proclined, FR-II appliance will have a bad effect on the dentition.

The increase in IMD was significant in the maxilla and mandible. This finding was

demonstrated by many researchers<sup>(7,9,11,22)</sup>, and it can be attributed to the periosteal stretching effect of the buccal acrylic shields.

The increase in maxillary inter canine width was not significant, which may be attributed to the presence of the maxillary labial bow; while the significant increase in mandibular ICD can be explained by the forward positioning of the mandible in combination with the action of the lingual wire and lip pads.

Hamilton, Sinclair, and Hamilton<sup>(17)</sup> attributed the lack of marked skeletal changes to the age range of their patients which was 8-9.5 years rather than the 7.5-8.5 years as recommended by Frankel<sup>(13)</sup>. In our study this factor may have also caused the lack of marked skeletal changes, also the time recommended for appliance wear may not be adhered to by our patients especially during school hours (as some of them asked if they could leave the appliance during school hours). Furthermore, the sample size may have played a role in not displaying clear skeletal changes as seen by Frankel<sup>(13)</sup>.

## Conclusion:

When evaluating the role of Frankel appliance one should keep in mind that this appliance, just like the other functional appliances, can improve the skeletal jaw discrepancy



to a certain limit, even though the main changes are dental in nature.

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