The treatment effects of FR III on preadolescent children with Class Ⅲ malocclusion

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English Abstract

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The advantage of using functional appliances in Class III preadolescent children is that they can control or alter the surrounding muscular environment and promote normal growth three dimensionally. The FR-Ⅲ appliance has been known to be effective in redirecting mandibular growth and stimulating forward growth of the maxilla, but there has been some controversy over its true effects. The purpose of this study was to evaluate the skeletal and dental effects produced by the FR III appliance on growing children with Class III malocclusion. 30 preadolescent children with Class III malocclusion (initial mean age of 8.0±1.2 years and mean treatment duration of 1.3±0.6 years) treated by the FR III appliance were compared to 20 matched untreated Class Ⅲ patients (initial mean age of 8.2±1.1 years and mean observation period of 1.5±0.6 years).

The obtained results are as follows;

1. The skeletal treatment effects found were mainly from backward and downward rotation of the mandible.

2. The dental treatment effects found were mainly from linguoversion of the lower incisors.

3. There was little treatment effect on the maxillary complex.

Key Words : FR III appliance, Class III malocclusion, functional modification

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Ⅰ. Introduction

In children with Class Ⅲ malocclusion, it is important to identify whether the etiology is dental, functional, or skeletal. If the problem is skeletal, a proper diagnosis should be made in order to determine whether the cause is an underdeveloped maxilla, an overdeveloped mandible, or a combination of both. In children with an underdeveloped maxilla, maxillary growth can be promoted by means of an orthopedic force with a protraction device.[1,2] However, for patients with an overdeveloped mandible or children showing severe skeletal discrepancies, it is wise to plan for orthognathic surgery after growth is complete.[3]

According to the functional matrix theory of Moss, functional appliances are effective in treating children with mild or pseudo(functional) Class III malocclusion. Andresen's Class III activators are known to show relatively good prognosis in pseudo Class III patients, particularly when used in early mixed dentition cases.[4] In 1966, Frankel modified the activator and designed the Frankel functional regulator (FR). Frankel stated that the main cause of a malocclusion is the improper habitual position and the abnormal activity of the oral and facial muscles, thus emphasizing the importance of guiding the jaws and dentition to develop normally by altering or controlling the muscular environment.[4,5]

In children with an underdeveloped maxilla, the FR III appliance is expected to redirect mandibular growth and stimulate forward growth of the maxilla through the muscle-blocking effects and stretching of the periosteum.[5] There is almost no dispute among the authors who have studied the FR III appliance,[4-12] over the redirection of mandibular growth in a backward and downward direction. However there is some controversy on the skeletal effects of the maxilla. Frankel[5] originally reported that bone apposition at point A increases with the use of the FR III appliance, while McNamara and Huge[6] supported the forward and downward movement of the maxilla. Kohmura et al[7] also reported that significant forward movement of point A and lateral expansion of the upper and lower arches were observed with the use of the FR III appliance. In addition, histologic studies performed by Graber et al[4] on squirrel monkeys suggest that the shields exert an indirect tension on the periosteum overlying the bone, thus enhancing osseous proliferation.

However Ulgen and Firatli[8] reported that the forward displacement of the maxilla is insignificant and most of the improvement is due to the downward backward rotation of the mandible, decrease in SNB, and retrusion of the lower incisors. Loh and Kerr[9], Kerr and TenHave[10], Kerr et al[11] also supports that there is no significant increase in SNA and that the major effects are from the mandible. In addition, Proffit[12] agreed that little true forward movement of the upper jaw is obtained with the use of the FR III appliance and that most of the improvement is from dental change.

As mentioned, there are diverse opinions regarding the treatment effects of FR III. Most studies in the past had their limitations because of the lack of adequate sample size, and instead of using matched untreated Class III children as the control group, mixed malocclusions, Class II patients, and patients treated with different appliances were used as the control. In addition, there are few studies dealing with FR Ⅲ treatment on Korean samples. Therefore the aim of this study was to evaluate the clinical effects of FR Ⅲ on Class Ⅲ preadolescent children by comparing the changes in the maxilla, mandible, and dentition with that of matched untreated Class Ⅲ children.

Ⅱ. Material and Method

1. Material

Thirty(17 girls, 13 boys) children with Class Ⅲ malocclusion, from the Department of Orthodontics, Yonsei University Dental Hospital, treated with the FR Ⅲ appliance, were selected as the treatment group. Patients at the beginning of treatment were 8.0±1.2 years old (Table 1) and the mean active treatment duration was 1.3±0.6 years.

Table 1. Age distribution and treatment duration of the FR Ⅲ group

	Male (n=13)	Female (n=17)	Total (n=30)
Initial (T1)	8.2±1.2	7.8±1.1	8.0±1.2
End of active treatment (T2)	9.4±1.5	9.1±1.6	9.2±1.5
Duration of treatment (T2-T1)	1.2±0.5	1.3±0.7	1.3±0.6

Unit= Years

The criteria for sample selection were as follows:

(1) Mild or a pseudo (functional) Class Ⅲ malocclusion.

(2) Minimal facial asymmetry (less than 3 mm of denture midline discrepancy).

(3) In the primary or early mixed dentition stage.

(4) No sign of a cleft lip and palate or any other systemic disease.

(5) No appliances used other than the FR Ⅲ.

(6) Good cooperation during the treatment period (The patients wore the appliance for at least 14 hours per day).

The control group consisted of twenty (10 boys, 10 girls) Class Ⅲ preadolescent children of similar age (8.2±1.1 years old at the start of control) and satisfied the criteria above (except for the last two). The observation period of 1.5±0.6 years, was also similar to that of the treatment duration (Table 2).

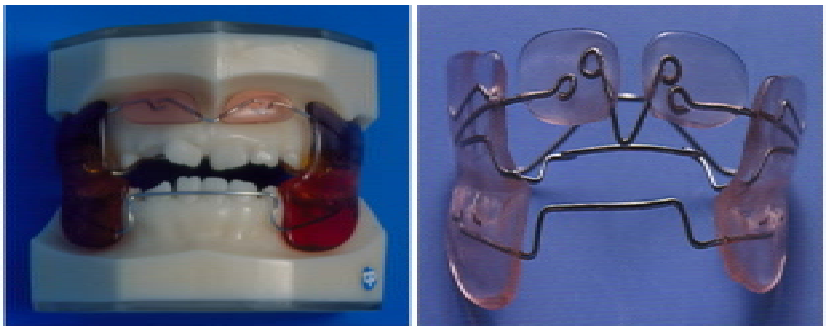
Table 2. Age distribution and observation period of the control group

	Male (n=10)	Female (n=10)	Total (n=20)
Start of control (T1)	8.3±1.2	8.1±0.9	8.2±1.1
End of control (T2)	9.8±1.3	9.6±1.4	9.7±1.3
Observation Period (T2 - T1)	1.5±0.5	1.5±0.8	1.5±0.6

Unit=Years

The FR Ⅲ appliance used in this study is shown in Figure 1. The appliance included passive stabilizing wires on the lingual side of the upper incisors, but protrusion bows or springs for activation were not used. The upper molars were allowed to erupt with no bite block, whereas the lower first molars had wire rests overlying the occlusal surface. Lip pads and buccal shields were fabricated labial or buccal to the upper incisors and molars, all at least 3mm away. For wax bite construction, the mandible was gently guided posteriorly to the centric relation position; the thickness did not exceed 3-4mm in the first molar area.

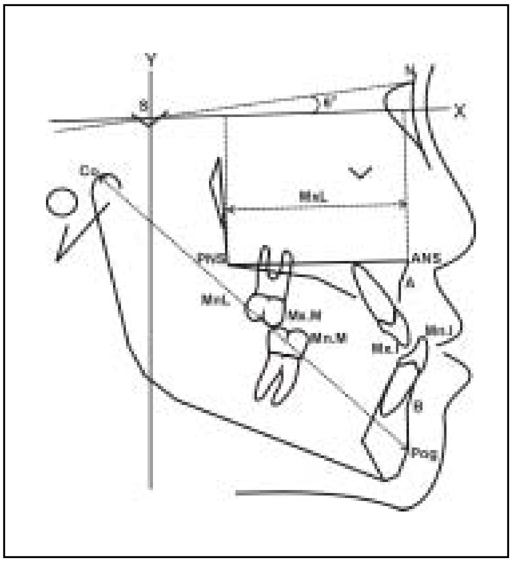
Figure 1. The FR Ⅲ appliance used in this study



2. Method

Cephalograms were taken prior to treatment or at the start of control(T1) and after the end of active treatment with the FR Ⅲ appliance or at the end of control(T2), using the CRANEX 3^{+} Ceph. (Soradex, Finland). All the radiographs were traced by a single observer and the measurements were digitized and calculated with the Yonsei cephalometric analysis program. The landmarks and reference planes used in this study are shown in Figure 2.

Figure 2. Landmarks and reference planes



(1) Landmarks

S (Sella)

N (Nasion)

ANS (Anterior nasal spine)

A (Subspinale)

PNS (Posterior nasal spine)

B (Supramentale)

Pog (Pogonion)

Co (Condylion)

Mx.I (Upper central incisor edge)

Mn.I (Lower central incisor edge)

Mx.M (Upper first molar mesiobuccal cusp tip)

Mn.M (Lower first molar mesiobuccal cusp tip)

(2) Reference planes and measurements

The horizontal reference plane (X-axis) was registered on Sella and defined by Sella-Nasion minus 6°. The vertical reference plane (Y-axis) was perpendicular to the horizontal reference plane passing Sella.[2] Vertical and horizontal linear measurements were assessed from the following landmarks to the X and Y axes: ANS, point A, PNS, point B, incisal edge of the upper incisor (Mx.I), mesial cusp tip of the upper first molar (Mx.M), incisal edge of the lower incisor (Mn.I), mesial cusp tip of the lower first molar (Mn.M). The length of the mandible (MnL) was measured as the distance from pogonion (Pog) to condylion (Co), and the length of the maxilla (MxL) was measured from the perpendicular lines from ANS and PNS projected on the X axis. SNA, SNB, ANB, and Wits appraisal were measured, and the palatal plane (PP) and mandibular plane (MP) angles were determined upon the X axis. In addition, U1 to SN, IMPA, overbite, and overjet were also obtained.

(3) Measurement error

The method error was calculated for all measurements by using Dahlberg’ s formula[13] $\{S^2= (\Sigma d^2)/2n$, s: measurement error, d: measurement difference, n: number of double measurement$\}$ on 10 samples randomly selected from the total observation group. The error ranged between 0.16mm~0.86mm for the linear measurements, and between 0.32^o~0.92^o for the angular measurements.

(4) Statistical Analysis

For statistical analysis the following was evaluated;

① The changes in measurements were analyzed with descriptive statistics (mean and standard deviation).

② Two-sample t-test was performed between male and female patients for all values.

③ Two-sample t-test was performed on T1 between the treatment and control groups.

④ Paired t-test was performed between T1 and T2 (intragroup comparison).

⑤ Two-sample t-test was performed on the cepahlometric changes (T2-T1) between the treatment and control group (intergroup comparison).

Ⅲ. Results

The mean and standard deviation of each measurement in T1, T2, and T2-T1 are given in Tables 3 and 4. There was no statistically significant difference between male and female patients in either treatment or control groups. Thus the data for male and female patients were not subdivided but combined. In the comparison between the treatment and control groups at T1, there was also no statistically significant difference. This verifies that the control group was reasonably selected, satisfying the same criteria as the treatment group. The initial measurements of the treatment group showed a mild skeletal Class Ⅲ pattern with SNA 80.0^{o}, SNB 79.8^{o}, ANB 0.2^{o}, and Wits appraisal -6.4. The average length of the maxilla and mandible were 47.2 and 105.5mm respectively. Moreover, overbite was 1.8mm, and overjet was -2.2mm. The control group also showed a mild skeletal Class Ⅲ pattern at the start of control with SNA 79.9^{o}, SNB 79.8^{o}, ANB 0.1^{o}, and Wits appraisal -6.9. The average length of the maxilla and mandible in the control group were 45.2 and 106.8mm respectively with 0.5mm overbite and -1.5mm overjet.

The statistical significance of the measurement change within each group (intragroup comparison) is also given in Tables 3 and 4. In the comparison within the treatment group, significant change was observed in most variables except for the change in the overbite, palatal plane angle and horizontal change of the lower molars. Meanwhile in the comparison of change within the control group, note that there was lack of significance in the skeletal variables such as SNA, SNB, ANB, and Wits, showing a more compensated skeletal pattern. The significance between the treatment and control groups (intergroup comparison) in T2-T1 are given in Table 5.

Table 3. Changes in the treatment group

	T1	SD	*T2*	SD	*T2-T1*	SD	*Significance*
Horizontal(mm)							
ANS	*69.2*	3.5	*70.6*	3.3	*1.4*	1.2	**
A	*62.8*	3.4	*64.1*	3.4	*1.3*	1.0	**
PNS	*18.6*	2.8	*19.4*	2.7	*0.8*	1.1	*
B	*60.3*	4.8	*59.5*	4.6	*-0.8*	2.0	*
Mx.I	*63.7*	4.5	*67.9*	4.3	*4.2*	2.2	**
Mx.M	*34.8*	3.4	*36.7*	3.6	*1.9*	1.3	**
Mn.I	*66.5*	4.3	*65.3*	3.9	*-1.2*	1.9	**
Mn.M	*38.1*	4.1	*38.3*	3.5	*0.2*	2.0	
Vertical(mm)							
ANS	*46.6*	3.4	*47.9*	3.3	*1.3*	1.5	**
A	*48.1*	4.6	*49.5*	3.1	*1.4*	1.1	**
PNS	*40.5*	1.9	*41.9*	2.4	*1.4*	1.5	**
B	*86.0*	4.1	*89.4*	4.5	*3.4*	2.3	**
Mx.I	*67.8*	3.8	*70.7*	3.9	*2.9*	2.2	**
Mx.M	*59.5*	3.6	*62.6*	3.6	*3.1*	1.5	**
Mn.I	*66.5*	3.8	*68.8*	4.1	*2.3*	1.8	**
Mn.M	*61.7*	3.1	*63.8*	3.5	*2.0*	1.5	**
Angular(°)							
SNA	*80.0*	3.3	*81.1*	3.1	*1.1*	1.1	*
SNB	*79.8*	3.1	*79.0*	2.8	*-0.8*	1.4	*
ANB	*0.2*	2.7	*2.0*	1.9	*1.9*	1.3	**
PP	*2.0*	2.9	*1.8*	3.1	*-0.2*	1.9	
MP	*29.6*	4.5	*30.4*	4.3	*0.8*	1.4	*
U1 to SN	*103.1*	5.0	*107.8*	4.5	*4.7*	5.2	**
IMPA	*89.2*	5.9	*85.8*	6.8	*-3.4*	4.2	**
Others(mm)							
MxL	*47.2*	3.0	*48.7*	2.4	*1.5*	1.2	**
MnL	*105.8*	5.8	*109.3*	4.5	*3.6*	2.9	**
Wits	*-6.4*	2.3	*-4.0*	2.7	*2.4*	2.3	**
Overbite	*1.8*	1.6	*1.5*	1.1	*-0.3*	1.6	
Overjet	*-2.2*	1.4	*1.9*	0.9	*4.1*	2.5	**

＊P ＜ 0.05, ＊＊P ＜ 0.01

T1: initial, T2: end of active treatment

Table 4. Changes in the control group

	T1	SD	*T2*	SD	*T2-T1*	SD	*Significance*
Horizontal(mm)							
ANS	*64.2*	3.2	*65.2*	3.5	*1.0*	1.1	*
A	*61.7*	3.5	*62.6*	3.8	*0.9*	2.1	*
PNS	*19.1*	3.1	*19.6*	3.2	*0.5*	2.5	
B	*58.7*	6.3	*60.3*	6.2	*1.7*	3.5	**
Mx.I	*64.6*	4.6	*67.4*	5.5	*2.9*	3.3	**
Mx.M	*34.8*	3.2	*36.4*	4.3	*1.6*	3.1	**
Mn.I	*65.8*	4.3	*68.2*	5.1	*2.4*	3.0	**
Mn.M	*37.3*	4.2	*39.7*	4.6	*2.4*	4.1	**
Vertical(mm)							
ANS	*43.8*	3.5	*45.0*	3.8	*1.2*	1.4	**
A	*49.4*	4.6	*51.1*	2.7	*1.7*	2.2	**
PNS	*41.9*	3.0	*43.4*	3.2	*1.6*	1.8	**
B	*91.8*	7.2	*94.7*	5.5	*2.9*	3.2	**
Mx.I	*70.9*	5.5	*73.7*	5.3	*2.8*	2.4	**
Mx.M	*63.1*	4.2	*65.9*	4.8	*2.8*	2.3	**
Mn.I	*69.9*	6.0	*72.7*	5.3	*2.8*	3.3	**
Mn.M	*64.1*	4.5	*66.9*	4.5	*2.9*	1.6	**
Angular(°)							
SNA	*79.9*	3.2	*80.0*	2.8	*0.1*	1.9	
SNB	*79.8*	3.3	*80.3*	3.0	*0.5*	1.9	
ANB	*0.1*	1.5	*-0.3*	1.7	*-0.4*	1.2	
PP	*3.3*	2.5	*3.2*	2.1	*-0.1*	1.8	
MP	*33.1*	4.3	*32.5*	5.0	*-0.5*	3.4	
U1 to SN	*105.2*	7.5	*108.7*	8.0	*3.4*	6.2	**
IMPA	*88.6*	4.6	*86.8*	4.7	*-1.8*	3.5	**
Others(mm)							
MxL	*45.2*	3.0	*46.8*	3.4	*1.6*	2.7	**
MnL	*106.8*	5.1	*111.4*	5.9	*4.6*	3.7	**
Wits	*-6.9*	2.1	*-7.3*	2.2	*-0.3*	2.6	
Overbite	*0.5*	1.6	*0.7*	1.5	*0.2*	1.4	
Overjet	*-1.5*	1.7	*-0.9*	3.0	*0.6*	2.2	

* $P < 0.05$, ** $P < 0.01$

T1: start of control, T2: end of control

Table 5. Comparison of the changes between the treatment and control groups

	Treatment group (n=30)			Control group (n=20)			
	T1	T2	*T2-T1*	T1	T2	*T2-T1*	*Significanc*
Horizontal(mm)							
ANS	69.2	70.6	*1.4*	64.2	65.2	*1.0*	
A	62.8	64.1	*1.3*	61.7	62.6	*0.9*	
PNS	18.6	19.4	*0.8*	19.1	19.6	*0.5*	
B	60.3	59.5	*-0.8*	58.7	60.3	*1.7*	**
Mx.I	63.7	67.9	*4.2*	64.6	67.4	*2.9*	
Mx.M	34.8	36.7	*1.9*	34.8	36.4	*1.6*	
Mn.I	66.5	65.3	*-1.2*	65.8	68.2	*2.4*	**
Mn.M	38.1	38.3	*0.2*	37.3	39.7	*2.4*	*
Vertical(mm)							
ANS	46.6	47.9	*1.3*	43.8	45.0	*1.2*	
A	48.1	49.5	*1.4*	49.4	51.1	*1.7*	
PNS	40.5	41.9	*1.4*	41.9	43.4	*1.6*	
B	86.0	89.4	*3.4*	91.8	94.7	*2.9*	
Mx.I	67.8	70.7	*2.9*	70.9	73.7	*2.8*	
Mx.M	59.5	62.6	*3.1*	63.1	65.9	*2.8*	
Mn.I	66.5	68.8	*2.3*	69.9	72.7	*2.8*	
Mn.M	61.7	63.8	*2.0*	64.1	66.9	*2.9*	
Angular(°)							
SNA	80.0	81.1	*1.1*	79.9	80.0	*0.1*	
SNB	79.8	79.0	*-0.8*	79.8	80.3	*0.5*	*
ANB	0.2	2.0	*1.9*	0.1	-0.3	*-0.4*	**
PP	2.0	1.8	*-0.2*	3.3	3.2	*-0.1*	
MP	29.6	30.4	*0.8*	33.1	32.5	*-0.5*	*
U1 to SN	103.1	107.8	*4.7*	105.2	108.7	*3.4*	
IMPA	89.2	85.8	*-3.4*	88.6	86.8	*-1.8*	*
Others(mm)							
MxL	47.2	48.7	*1.5*	45.2	46.8	*1.6*	
MnL	105.8	109.3	*3.6*	106.8	111.4	*4.6*	
Wits	-6.4	-4.0	*2.4*	-6.9	-7.3	*-0.3*	**
Overbite	1.8	1.5	*-0.3*	0.5	0.7	*0.2*	
Overjet	-2.2	1.9	*4.1*	-1.5	-0.9	*0.6*	**

$*$ $P < 0.05$, $**$ $P < 0.01$

T1: initial/start of control, T2: end of active treatment/end of control

IV. Discussion

1. Skeletal change

The FR III appliance has been known to restrict forces of associated soft tissues on the maxillary complex while transmitting these forces through the appliance to the mandible. This is accomplished mainly through the lip pad, which eliminates the restrictive pressure of the upper lip on the underdeveloped maxilla, exert tension on the tissue and periosteal attachments for stimulation of bone growth, and control mandibular growth to a backward and downward direction by delivering upper lip pressure to the lower labial wire.[4] This redirection of the mandible has been widely accepted among various authors, but there has been some dispute over the growth stimulation effects on the maxilla.

The skeletal effects on the maxilla obtained in this study showed a statistically significant forward (point A: 1.3mm, $p<0.01$) and downward (point A: 1.4mm, $p<0.01$) displacement when compared within the treatment group (Table 3). Meanwhile, significant forward (point A: 0.9mm, $p<0.05$) and downward (point A: 1.7mm, $p<0.01$) displacement of the maxilla was also observed within the control group (Table 4). Thus, in the comparison between the treatment and control groups, the treatment change was not statistically significant (Table 5). The lack of significance in the mean change of the SNA angle also suggest the lack of treatment effect on the maxillary complex, which is in agreement with recent studies.[8-12]

As for the skeletal effects on the mandible, statistically significant backward (point B: -0.8mm, $p<0.05$) and downward (point B: 3.4mm, $p<0.01$) displacement was observed within the treatment group. In the control group, the change in mandible showed significant forward (point B: 1.7mm, $p<0.01$) and downward (point B: 2.9mm, $p<0.01$) displacement. There was a statistically significant difference between the treatment and control groups for the horizontal change while lack of significance existed in the vertical change (Table 5). The increase in the mandibular plane angle and decrease in SNB also support this redirection of the mandible, which was in agreement with previous studies.[4-12] Although mandibular growth is not inhibited, the change in position and posture of the mandible is indeed advantageous in most children with mild skeletal Class III malocclusions.[11] Subsequent change in ANB (treatment group: 1.9, control group: -0.3) and Wits (treatment group: 2.4, control group: -0.3) obtained after treatment was also statistically significant compared to the control.

In addition, there was no statistically significant difference in the length of the maxilla (MxL) and mandible (MnL), even though the change in the control group was slightly greater. There was also no particular significance in the comparison of the vertical changes between the treatment and control groups.

2. Dental change

Even though the mean horizontal change in the upper incisor tip (Mx.I) and U1 to SN showed a significant labioversion of the upper incisors when compared within the treatment group, the change was not significant in comparison to the control. Meanwhile, the mean horizontal change in the lower incisor tip (Mn.I) and the mean change in IMPA both indicate that the linguoversion of the lower incisors was statistically significant. Thus there was a significant change in overjet, with a mean increase of 4.1mm. Note that more overjet change was obtained in less time compared to other studies.[8-11] Although the overbite change was insignificant compared to the control, the mean decrease of 0.3mm maybe due to the backward downward rotation of the mandible, in agreement with the findings of Ulgen and Firatli.[8]

The horizontal position of the lower molar (Mn.M) was maintained with little change. This is possibly due to the occlusal rests effectively inhibiting the forward displacement of the lower molars. A forward and downward eruption of the upper molars (Mx.M) was observed but the amount was not statistically significant compared to the control. This tooth movement, along with the linguoversion of the lower incisors helps in the improvement of the Class III molar relationship and development of a normal overjet and overbite.

It is important to emphasize that the homogeneity between the treatment and control groups, as to type of malocclusion, skeletal and dental characteristics at the first observation, age range, sex distribution, and observation period allowed a fairly accurate comparison of the changes found for all cephalometric variables.

Frankel[5,6], who believed that the faulty postural performance pattern may play an important causative role in the development of skeletal deformities, encouraged the full time wear of the appliance because he believed that the term " functional" is related to the continuously repetitive and frequent activity. Since most patients in this study did not wear the appliance all day, and because the active treatment duration was fairly short, this may explain why it was difficult to observe significant bone deposition in the maxilla. Thus, the results obtained maybe interpreted as the initial effects of FR Ⅲ. Future investigation related to long term observation with full time wear of the appliance is necessary to verify the effects of FR Ⅲ, especially related to the maxilla. And to evaluate the arch expansion effects of the buccal shield, the change in arch width should be measured from models in another study.

Nevertheless excellent results were obtained in most samples from the treatment group. It should be emphasized that this was possible because the sample did not contain patients with severe skeletal Class Ⅲ malocclusions. Only preadolescent children with mild or pseudo Class Ⅲ malocclusion were selected in this study. In preadolescent children with severe skeletal Class Ⅲ malocclusion, the treatment modality would of course be maxillary protraction with the facemask and rapid palatal expansion appliance. However, in mild or pseudo Class Ⅲ children, the FR Ⅲ appliance maybe encouraged as the treatment of choice to begin with. Because the appliance is relatively inconspicuous, wearing the appliance actually improves the appearance of the patient with an underdeveloped maxilla by filling out the upper lip region. Short treatment duration is another advantage since most crossbite is corrected within a few months, and most of all, the FR Ⅲ appliance can be used in fairly young children.[4]

In summary, the treatment effects of FR Ⅲ from this study can be considered to be both from skeletal and dentoalveolar change. The skeletal effects of the FR Ⅲ appliance were mainly obtained by the backward downward rotation of the mandible with little forward growth stimulation on the maxilla, while the dentoalveolar effects were mostly due to the linguoversion of the lower incisors.

Ⅴ. Conclusions

Thirty preadolescent children who attended the Yonsei University Dental Hospital, Department of Orthodontics, diagnosed as mild or pseudo (functional) Class Ⅲ and treated with the FR Ⅲ appliance, were selected and the cephalograms taken before and after active treatment were compared to that of a matched untreated Class Ⅲ sample.

The obtained results are as follows;

1. The skeletal treatment effects found were mainly from backward and downward rotation of the mandible.
2. The dental treatment effects found were mainly from linguoversion of the lower incisors.
3. There was little treatment effect on the maxillary complex.

References

1. Baik HS. Clinical results of maxillary protraction in Korean children. Am J Orthod Dentofacial Orthop 1995;108:583-592.
2. Sung SJ, Baik HS. Assessment of skeletal and dental changes by maxillary protraction. Am J Orthod Dentofacial Orthop 1998;114:492-502
3. Proffit, WR, White RP. Surgical-orthodontic treatment. Mosby, St Louis 1991
4. Graber TM, Rakosi T, Petrovic AG. Dentofacial orthopedics with functional appliances. Mosby, St Louis 1997
5. Frankel R. Maxillary retrusion in Class III and treatment with the function corrector III. Trans Eur Orthod Soc 1970;249-259
6. McNamara JA Jr, Huge SA. Functional regulator (FR-3) of Frankel. Am J Orthod 1985;88:409-424
7. Kohmura T, Tokuda N, Hara S. Effects of therapy using the function regulator(FR III) on the cases with the reversed occlusion. Japan. J. Orthod 1986;45:693-711.
8. Ulgen M, Firatli S. The effect of the Frankel's function regulator on the Class III malocclusion. Am J Orthod Dentofacial Orthop 1994;105:561-567.
9. Loh MK, Kerr WJ. The function regulator III: effects and indications for use. Br J Orthod 1985;12(3):153-157
10. Kerr WJS, TenHave TR. A comparison of three appliance systems in the treatment of Class III malocclusion. Eur J Orthod 1988;10:203-214.
11. Kerr WJS, Ten Have TR. McNamara JA Jr. A comparison of skeletal and dental changes produced by functional regulators (FR-2 and FR-3). Eur J Orthod 1989;11:235-242.
12. Proffit WR. Contemporary Orthodontics. Mosby, St. Louis 2000
13. Dahlberg G. Statistical methods for medical and biological students. Interscience Publications. New York 1940

국문요약

성장기 Ⅲ급 부정교합 아동에서 FR-Ⅲ 장치의 치료효과

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지성훈

성장기 Ⅲ급 부정교합 아동에서 악기능 장치는 주위 근조직 환경을 변화시키거나 조절하여 악골 및 치아가 3 차원적으로 정상적인 발육을 할 수 있도록 유도하는 효과가 있다. FR-Ⅲ 장치는 하악의 성장 방향을 재조정하고 상악의 전방 성장을 촉진하는 것으로 알려져 왔는데 그 진정한 효과에 대해서는 다소 상반된 견해들이 있다. 본 연구의 목적은 성장기 Ⅲ급 부정교합 아동에서 FR–Ⅲ를 이용한 치료시 상하악골 및 치열의 변화등을 구체적으로 알아 보고자 하는 것이었다. 연세대학교 치과대학병원 교정과에 내원한 성장기 아동 중 경미한 골격성 혹은 가성 III 급 부정교합으로 진단되어 FR–Ⅲ 악기능 장치로 치료받은 30 명의 아동 (치료전 평균연령: 8.0±1.2 세, 평균 치료기간: 1.3±0.6 년)과 어떤 치료도 받지 않은 20 명의 Ⅲ급 부정교합 아동 (초진시 평균연령 8.2±1.1 세, 평균 관찰기간: 1.5±0.6 년)을 비교하여 다음과 같은 결과를 얻었다.

1. 주된 골격성 효과는 하악의 후하방 회전으로부터 얻어졌다.

2. 주된 치성 효과는 하악 전치의 설측경사로부터 얻어졌다.

3. 상악에대한 치료 효과는 적었다.

핵심되는 말: FR-III 장치, III급 부정교합, 악기능 효과