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The effects of maxillary protraction appliance (MPA) depending on vertical facial patterns

Young-Kyu Ryu[a], Kee-Joon Lee[b], Chang-Hun Oh[c]

Preadolescent children with deficient maxillae are suitable candidates for the maxillary protraction appliance(MPA). The theoretical effect of the MPA is protraction or anterior displacement of the maxilla. However, it is known that complex effects such as anterior displacement of the maxillary teeth, downward and backward rotation of the mandible, linguoversion of the mandibular anterior incisors, are known to play a role in improving the Cl Ⅲ malocclusion. There have been much studies with regard to maxillary protraction, but the different effects of MPAs depending on the vertical facial pattern are not known precisely. This study was based on 67 patients (31 males, 36 females) aged from 6 years 6 months to 13 years 3months, who visited the Dept. of Orthodontics at Yonsei Univ., Dental Hospital and diagnosed as skeletal Class Ⅲ with maxillary deficiency. They were divided into 3 groups (low, average, high angle groups) depending on gonial angle and the SNMP (Go-Gn) angle, respectively. Pretreatment and post-treatment lateral cephalograms were used to compare the effects of MPA and the following conclusions were obtained: ① A significantly large amount of backward movement of the B point was observed in patients with a low SNMP angle. Those with a high SNMP angle had significant forward movement at A point. ② The patients with low gonial angle had the least forward movement at the A point, and those with a high angle had more forward movement. ③ In comparing the arcTan of the A point, the high angle group showed more horizontal movement while the low angle group showed more vertical movement. ④ There was no significance between the treatment duration of the SNMP and the Gonial angle groups.

Key words : vertical facial patterns, facemask, maxillary protraction

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A chin cap or maxillary protraction appliance (MPA) may be used to treat Cl Ⅲ preadolescents depending on the disharmony of the jaws.[1-5] The maxillary protraction appliance(MPA) is indicated for Cl Ⅲ children with a deficient maxilla. The hooks attached to the intra-oral appliance is the point of force application. Face masks are applied against the chin and the forehead, thus protracting the nasomaxillary complex through elastics. Since 1944 when Oppenheim[6]

Table 1. The age and gender of the patients at the first dental examination and treatment time distribution (T1−T0)

		Female (n=36)	Male (n=31)	Female and Male
SNMP	Low	4 (11Y 4M)	3 (9Y 5M)	7 (10Y 6M)
	Middle	28 (9Y 9M)	22 (9Y 8M)	50 (9Y 9M)
	High	4 (9Y 5M)	6 (9y 11M)	10 (9Y 9M)
Gonial angle	Low	3 (12Y 3M)	2 (9Y 10M)	5 (11Y 3M)
	Middle	18 (10Y 4M)	12 (9Y 6M)	30 (10Y)
	High	15 (9Y 12M)	17 (9Y 1M)	32 (9Y 6M)

suggested the capability of treating a Cl Ⅲ malocclusion by protracting the maxilla, many animal experiments were carried out. These proved histologically that the protraction force applied to the maxilla expands the suture area against the cranial base, consequently induces bone formation.[7,8] The main purpose of MPA is the forward displacement of the maxilla, but in fact other complex effects play a role in improving the Cl Ⅲ malocclusion and in regaining normal overjet and overbite.

These effects include labioversion of the maxillary anterior teeth, downward and backward rotation of the mandible, and linguoversion of the mandibular anterior incisors. The skeletal and dental change during treatment are the results of both the orthopedic effects and the normal growth. In addition, orthopedic treatment not only have an effect on anterior-posterior disharmony, but also on the vertical facial height.[12] Schudy,[13,14] Bjrk, [15,16] Issacson,[17] Ricketts,[18] Jarabak[19] etc. classified the vertical facial height and according to their classification, the high angle facial type shows a vertical growth pattern, a high gonial and SN-MP(Go-Gn) angle, and an openbite tendency by weak occlusal force. In con-trast, the low angle facial type shows a heavy occlusion making the posterior teeth difficult to extrude, leading to a deep bite tendency.[20,21,22] Therefore it can be predicted that in low angle facial types, upon maxillary protraction, the skeletal Cl Ⅲ relationship is improved by anterior displacement of the maxilla rather than the rotation of the mandible, while in high angle facial types the downward and backward rotation of the mandible is predominant due to the extrusion of the upper posterior teeth and the downward displacement of the maxilla. Thus it is important to minimize the extrusion of the posterior teeth and vertical growth of the maxilla, in high angle patients, in order not to increase the facial height. However, in low angle patients, some extrusion of molars could be allowed by protracting maxilla in a more downward direction.

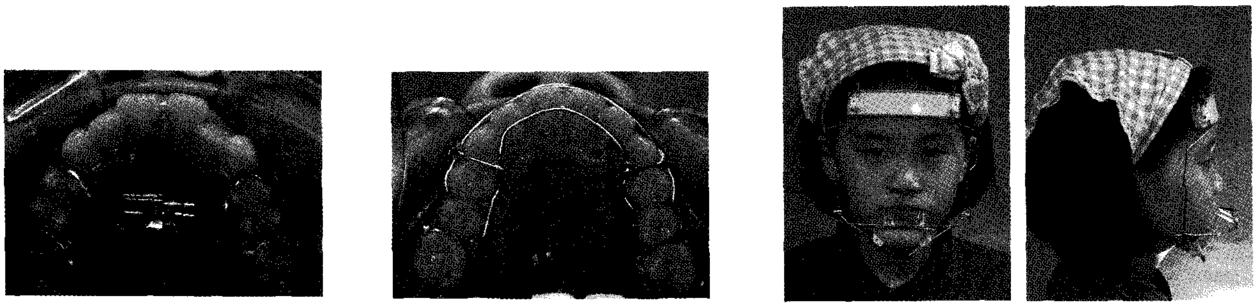
The objective of this study was to compare the results from using the MPA on Cl Ⅲ preadolescents with different facial heights, and to aid the use of this appliance in practice.

MATERIALS AND METHODS

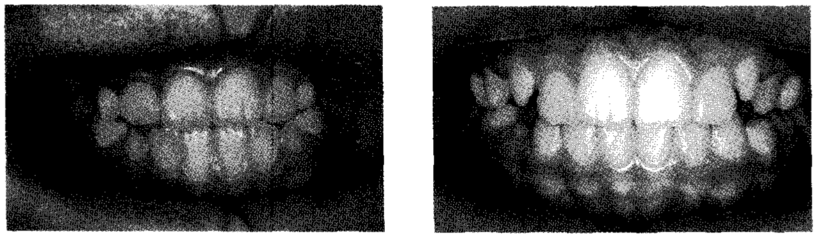
A. Subjects

67 patients (31 males, 36 females) were selected as subjects for this study, who visited the Orthodontic Department of Yonsei Univ., Dental Hospital from 1998 to 2000, with a chief complaint of anterior crossbite. These patients had a slight to moderate skeletal Cl Ⅲ pattern with a deficient maxilla compared to the korean standard,[4] with anterior crossbite and Cl Ⅲ molar relationship. The initial age of the children ranged from 6 years 6 months to 13 years 3 months (Table 1).

Lateral cephalograms were taken in maximum intercuspation. The samples were subdivided according to their vertical facial type using different parameters. Compared to the Korean norm of the SNMP angle, they were divided into the low angle group (under 30°), average angle group (30~41°), and high angle group (above 41°). Alternatively, using the gonial angle, the



a. b. c.



d. e.

Fig. 1. Appliances used in this study.
a. Intraoral anchorage – RPE
b. Intraoral anchorage
– Labiolingual appliance
c. Extraoral anchorage
– Delaire's face mask
d. Before Tx.
e. After Tx.

samples were divided again into the low angle group (below 116°), average angle group (116~128°), and high angle group (above 128°) according to Korean norm.[23-25]

B. Methods

Maxillary protraction appliance and Intraoral appliances

Protraction hooks were soldered to the premolar area of intraoral fixed appliance and 300–400g per side forces was applied in a 20° downward direction to the occlusal plane. Depending on the necessity of maxillary expansion, a RPE or labiolingual appliance was inserted as the intraoral fixed appliance (fig 1a, b). For the extraoral protraction appliance, Delaire's facemask was used for each patient (fig 1c). The patients were instructed to wear the appliance for at least 14 hours.

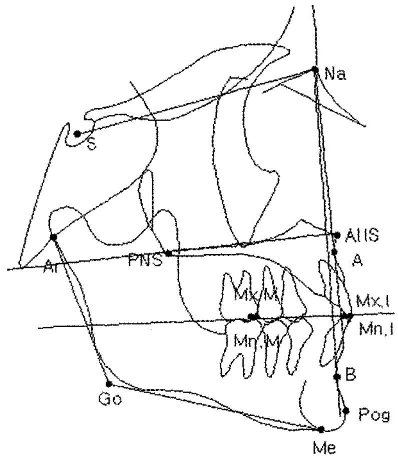


Fig. 2. The landmarks for the measurements
S, Na, A, B, Pog, Me, ANS, PNS, Ar, Go,
MxI ; incisal edge of the maxillary incisor
MnI ; incisal edge of the mandibular incisor
MxM ; mesial cusp tip of the maxillary first molar
MnM ; mesial cusp tip of the mandibular first molar

Analysis of the lateral cephalograms

Lateral cephalograms were taken after the patient gained 2 mm of positive overjet on the anterior teeth. This took approximately 6–7 months (Table 5). Then X-rays were traced and digitized by a single person, and after one month 20 X-rays were randomly selected from the samples and were retraced and redigitized to examine the reproducibility. The correlation coefficient between the two measurements ranged 0.8964–0.9927.[26]

The landmarks for the measurements are marked on fig 2. The SN line was used as the reference plane for

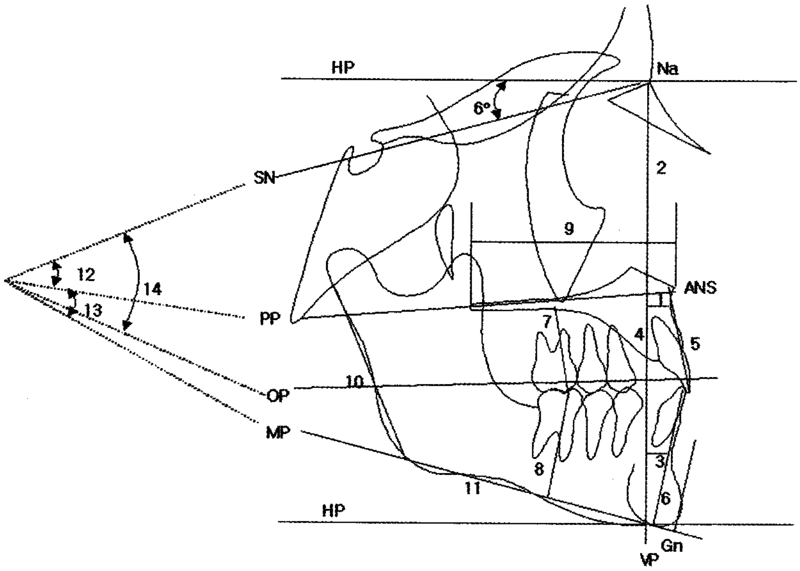


Fig. 3. Measurements
1.VP-A (mm)
2. HP-A (mm)
3. VP-B (mm)
4. HP-B (mm)
5. U1-PP (mm)
6. L1-MP (mm)
7. U6-PP (mm)
8. L6-MP (mm)
9. PNS-ANS (mm)
10. Ar-Go (mm)
11. Go-Pog (mm)
12. SN-PP (°)
13. PP-MP (°)
14. SN-OP (°)

angular measurements. SN line rotated 6° clockwise around the Nasion(Na), was used as the horizontal reference plane (SN-6°), and a perpendicular line to the horizontal reference plane at Na was designated as the vertical reference plane. To examine the skeletal changes, SNA, SNB, ANB, Wits, facial convexity (N-A-Pg), and the Posterior/Anterior facial height ratio were measured before and after treatment. To examine the vertical, horizontal changes in the basal bone, the distance of the A, B point from the vertical/horizontal reference plane was measured. To examine the vertical change of the teeth in relation to the basal bone, the distance of the MxI, MxM from the palatal plane in fig 3 and the mandibular plane were measured. The length of the maxilla was measured as the distance between PNS and ANS. The size of the mandible was assessed by measuring the length of the ramus (Ar-Go) and the length of the body (Go-Pg).

The angle between the SN and palatal plane, SN and occlusal plane, and the angle between the palatal and mandibular plane were also measured to evaluate the skeletal rotation (Fig 3). SummaSketch ®III digitizer was used to transfer the values to a computer, and the measurements were evaluated through an IBM-compatible analyzing program.

<u>Statistics</u>

A. Evaluation of the influential factors

In order to control the factors that may have an influence on treatment effects, such as gender, age, and palatal expansion, Fisher's exact test was conducted to obtain a distribution chart for each group according to the type of vertical facial height. The age was initially classified using Merwin's method,[34] which regards 8 years of age as the standard for early mixed dentition and 12 years as the standard for late mixed dentition. Subsequently, a Fisher's exact test was carried out. Additionally, considering age to be a continuous variable, Pearson correlation analysis was performed to estimate the changes after treatment.

B. Comparison of the difference in the different vertical facial patterns

The difference between the values before and after treatment was calculated. A paired t test was carried out to determine if there were any significant change after treatment. ANOVA was used to ascertain the difference between each group and multiple comparison analyses were performed on the groups that showed statistical significance.

Table 2. The correlation between the influencing factors; Fisher's exact test (2-tail)

	P value	
	SNMP	gonial Angle
Female/Male	0.713	0.564
LaLi/RPE	0.421	0.306
Age	0.615	0.295

Table 3. The mean difference of all samples and their significance (Paired t-test)

Measurement	Mean (Pre-Tx)	Δ	S.D	Prob
SNA (°)	79.32	1.72	1.32	0.0001***
SNB (°)	81.27	-1.24	1.29	0.0001***
ANB (°)	-1.90	3.32	1.46	0.0001***
Wits (mm)	-9.11	5.19	2.19	0.0001***
Post./Ant. (%)	64.27	-0.99	7.12	0.2601
Facial Convexity (°)	-4.06	6.79	3.32	0.0001***
SN-PP (°)	9.06	-1.13	1.84	0.0001***
PP-MP (°)	26.76	2.74	2.29	0.0001***
SN-OP (°)	17.96	-1.80	2.23	0.0001***
VP-A (mm)	3.48	1.77	1.72	0.0001***
HP-A (mm)	57.41	0.97	1.43	0.0001***
VP-B (mm)	-2.81	-2.61	2.41	0.0001***
HP-B (mm)	98.07	3.68	2.43	0.0001***
U1-NF (mm)	27.07	0.60	1.49	0.0015***
L1-MP (mm)	39.71	1.13	0.90	0.0001***
U6NF (mm)	20.01	2.29	1.28	0.0001***
L6-MP (mm)	30.00	1.04	1.19	0.0001***
PNS-ANS (mm)	47.98	0.30	5.35	0.6476
Ar-Go (mm)	44.87	-0.20	2.29	0.4704
Go-Pog (mm)	75.48	0.89	1.67	0.0001***

***P < .001.

RESULTS

(1) Evaluation of the influential factors

The p values of the groups according to gender, age and palatal expansion, ranged from 0.295 to 0.713, showing no significance (Table 2).

This implies that the subgroups by each of these parameters are evenly distributed in each of the SN-MP/gonial angle groups, thus eliminating the possible influence on the treatment effects by these parameters.

There was no significant correlation between the treatment changes and the age at the beginning of treatment, except for the PNS-ANS. This means that age had little influence on the treatment effects in these subjects.

Table 4. The effect and significance of Maxillary protraction appliance in various SNMP (Paired t-test)

Measurements	Low SNMP (n=7)			Average SNMP (n=50)			High SNMP (n=10)			ANOVA
(T1-T0)	mean	S.D	Prob	mean	S.D	Prob	mean	S.D	Prob	
SNA (°)	1.46	0.91	0.0017**	1.76	1.46	0.0001***	1.72	0.81	0.0001***	0.8555
SNB (°)	-2.11	1.77	0.0195*	-1.24	1.23	0.0001***	-0.65	0.99	0.0675	0.0690
ANB (°)	3.54	1.62	0.0012**	3.40	1.52	0.0001***	2.77	0.92	0.0001***	0.4229
Wits (mm)	5.17	2.26	0.0009***	5.22	2.22	0.0001***	5.05	2.18	0.0001***	0.9762
Post./Ant. (%)	-2.20	0.98	0.0010**	-1.02	1.62	0.0001***	0.04	18.83	0.9948	0.8182
facial convexity (°)	7.42	3.53	0.0014**	7.09	3.19	0.0001***	4.84	3.49	0.0017**	0.1275
SN-PP (°)	0.07	1.90	0.9244	-1.29	1.88	0.0001***	-1.20	1.33	0.0193*	0.1851
PP-MP (°)	2.60	2.35	0.0262*	2.92	2.30	0.0001***	1.89	2.21	0.0243*	0.4277
SN-OP (°)	-0.51	1.58	0.4209	-1.77	1.94	0.0001***	-2.83	3.43	0.0283*	0.1061
VP-A (mm)	0.26	1.21	0.5954	1.90	1.82	0.0001***	2.17	0.86	0.0001***	0.0419*
HP-A (mm)	0.57	0.88	0.1362	1.09	1.48	0.0001***	0.65	1.51	0.2066	0.5041
VP-B (mm)	-4.77	2.76	0.0038**	-2.57	2.29	0.0001***	-1.29	1.85	0.0546	0.0112*
HP-B (mm)	3.44	1.64	0.0014**	3.93	2.51	0.0001***	2.60	2.38	0.0072**	0.2804
U1-NF (mm)	-0.60	1.45	0.3154	0.78	1.47	0.0005***	0.54	1.33	0.2318	0.0686
L1-MP (mm)	0.89	0.75	0.0204*	1.16	0.94	0.0001***	1.13	0.84	0.0022**	0.7573
U6-NF (mm)	2.04	1.30	0.0059**	2.31	1.30	0.0001***	2.31	1.31	0.0003***	0.8729
L6-MP (mm)	0.67	0.44	0.0070**	1.14	1.29	0.0001***	0.84	1.04	0.0313*	0.5367
PNS-ANS (mm)	0.83	2.19	0.3548	0.08	6.09	0.9227	1.01	1.94	0.1337	0.8534
Ar-Go (mm)	-1.21	2.70	0.2791	-0.16	2.28	0.6177	0.30	2.04	0.6523	0.3994
Go-Pog (mm)	0.51	1.47	0.3918	0.97	1.77	0.000***	0.80	1.27	0.0778	0.7881

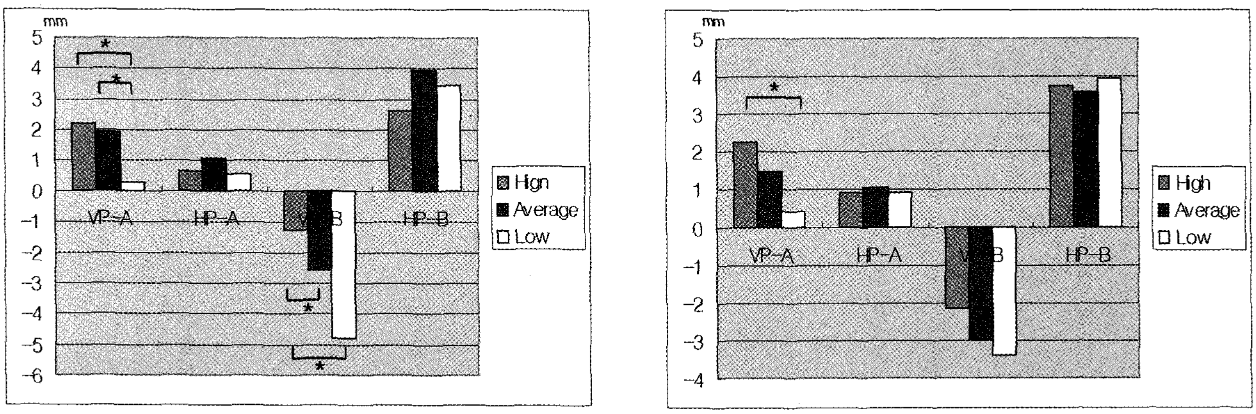
* $P < .05$, ** $P < .01$, *** $P < .001$.

(2) Comparison of values before and after treatment in all groups

Each value showed significant change after treatment except for the PNS-ANS and Ar-Go. Forward and downward movement of A point, a backward and downward movement of the B point, and increase in the ANB and facial convexity were observed. The upper and lower anterior and posterior teeth all extruded and among them, the upper posterior teeth showed 2.29 mm of vertical change, which was the greatest. The palatal and occlusal plane was rotated both forward and upward (counterclockwise). An increase in the angle between the palatal and mandibular plane (PP-MP) was noted (Table 4).

(3) Comparison between the groups according to SN-MP angle

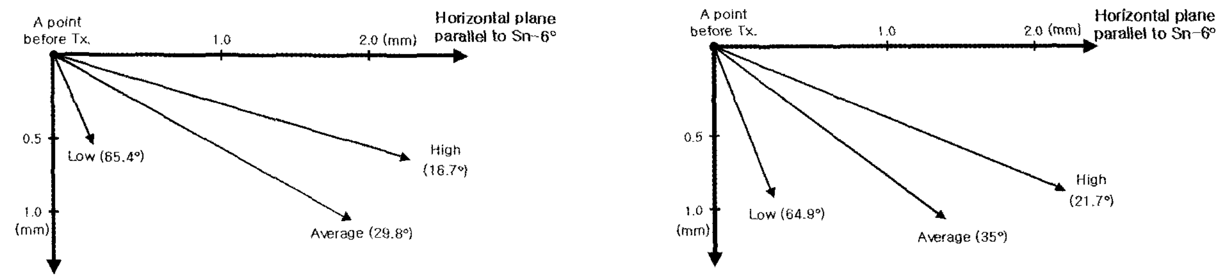
Only the horizontal movement of point A and B showed a significant difference (Table 5). The forward movement of the A point was greatest in the high angle group. In the low angle group, the backward movement of the B point was the most significant. A multiple comparison analysis was carried out with the categories showing significant difference, and the forward movement of the A point showed a significant difference between high and low, and between average and low angle group. The backward movement of the B point showed a significant difference between high and average, and between high and low angle group (Fig 4).



a. SNMP group

b. gonial angle group

Fig. 4. Positional change of A point and B point in each group
Through multiple comparison analysis, VP−A and VP−B in the SNMP group and VP−A in the gonial angle group showed a significant value in detailed sections.



a. SNMP group

b. gonial angle group

Fig. 5. ArcTan of the horizontal and vertical movement of the A point

(4) Comparison of the groups according to gonial angle

Only the horizontal movement of the A point showed a significant difference. The forward movement of the A point was in the following order; low<average<high. The backward movement of the B point was in the order; high<average<low. This result is similar to those from the SN−MP grouping (Fig 4).

(5) Comparison of treatment duration. (Table 7).

DISCUSSION

Treatment effects are clearly the summation of both the normal growth and the orthopedic effect. In this study, the A point moved 1.7 mm forward, and SNA was increased by 1.72°. According to Shanker et al.,[9] 1.77 mm forward movement of the A point was achieved in the treated group, whereas the untreated control showed 1.2 mm increase. Previous studies have shown that the difference in the various values before and after treatment is much greater than that of non−

Table 5. The effect and significance of MPA in various gonial angle.

Measurements (T1-T0)	Low Gonial angle (n=5)			Average Gonial angle (n=30)			High Gonial angle (n=32)			ANOVA
	mean	S.D	Prob	mean	S.D	Prob	mean	S.D	Prob	
SNA (°)	1.60	0.87	0.0069**	1.47	1.29	0.0001***	1.98	1.39	0.0001***	0.3082
SNB (°)	-0.88	0.96	0.1105	-1.57	1.35	0.0001***	-1.00	1.23	0.0001***	0.1733
ANB (°)	2.88	00.94	0.0024**	3.34	1.47	0.0001***	3.38	1.53	0.0001***	0.7797
Wits (mm)	4.20	1.04	0.0008***	5.54	2.12	0.0001***	5.01	2.35	0.0001***	0.3726
Post./Ant (%).	-1.14	1.88	0.2457	-1.17	1.56	0.0003***	-0.79	10.25	0.6657	0.9774
facial convexity (°)	5.88	1.59	0.0012**	6.88	3.30	0.0001***	6.85	3.58	0.0001***	0.8209
SN-PP (°)	0.32	1.36	0.6255	-1.22	1.93	0.0016**	-1.28	1.76	0.0003***	0.1839
PP-MP (°)	1.34	1.99	0.2072	2.95	2.13	0.0001***	2.75	2.45	0.0001***	0.3496
OP-HP (°)	-0.56	1.71	0.5035	-2.20	2.60	0.0001***	-1.61	1.85	0.0001***	0.2578
VP-A (mm)	0.42	1.37	0.5302	1.49	1.64	0.0001***	2.23	1.71	0.0001***	0.0429*
HP-A (mm)	0.90	0.81	0.0677	1.07	1.08	0.0001***	0.89	1.78	0.0080**	0.8866
VP-B (mm)	-3.36	3.04	0.0688	-2.97	2.55	0.0001***	-2.15	2.16	0.0001***	0.3185
HP-B (mm)	3.92	0.71	0.0003***	3.58	2.34	0.0001***	3.73	2.71	0.0001***	0.9470
U1-NF (mm)	-0.08	1.69	0.9209	0.29	1.38	0.2640	1.00	1.50	0.0007***	0.0936
L1-MP (mm)	0.76	0.77	0.0919	1.10	0.95	0.0001***	1.21	0.88	0.0001***	0.5683
U6-NF (mm)	2.50	1.41	0.0166*	2.13	1.12	0.0001***	2.39	1.41	0.0001***	0.6687
L6-MP (mm)	0.48	0.29	0.0220*	0.86	1.16	0.0003***	1.31	1.27	0.0001***	0.1841
PNS-ANS (mm)	1.40	2.52	0.2817	-0.97	7.56	0.4894	1.32	1.94	0.0006***	0.2201
Ar-Go (mm)	0.84	1.61	0.3090	-0.67	2.42	0.1428	0.07	2.20	0.8611	0.2599
Go-Pog (mm)	0.14	1.44	0.8387	0.81	1.56	0.0084**	1.13	1.76	0.0010**	0.2635

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

Table 6. Comparison of the treatment duration with MPA among each group

	Measurements			Low Gonial angle (n=5)		
	mean	S.D	Prob	mean	S.D	Prob
치료기간(M)	5.4	5.9	7.0	5.0	5.8	6.4
S.D	2.6	2.7	2.9	1.6	2.6	3.0
Prob		NS			NS	

NS : No Significance

treated Cl III malocclusion patients or normal controls. Since this was not the main objective of this study, it did not include a comparison between the normal control and treated test group, but only demonstrated the different treatment effects depending on the various vertical facial patterns.

Of the 67 subjects, 7 and 10 patients were categorized as being in the low and high angle SN-MP group, respectively, whereas 5 and 30 patients were categorized as being in the low and high gonial angle group (Table 1). Most korean patients with a Cl III malocclusion tend to have an overdeveloped/excessive mandible rather than a deficient maxilla. Excessive vertical as well as horizontal mandibular growth is another characteristic of korean Cl III patients, which is why there was a preponderance for the average angle and the high angle group, many patients with severe horizontal and vertical disharmony are recommend to receive the orthognathic surgery after growth is ended. Therefore, it was necessary to control the factors that may influence the effect of the treatment in smaller groups. In previous studies, gender,[10,28] palatal expansion,[11,28,29] age10,30 etc. were considered to be the influential factors. Generally gender itself did not influence the effect of treatment, but some studies show different treatment effects between males and females of similar age. This is probably because males and females show different developmental rates at the same chronological age. In this study, after preliminary statistical research, there were no results that showed a significant difference between the genders. Consequently, the influence of gender was excluded as a result of the Fisher' s exact test.

Kim et al[28] reported that there was no significant difference in the results between the cases that underwent maxillary expansion and those that did not, except for the angle of the maxillary incisor. However, many other reports show that maxillary expansion before protraction actually accelerates the protraction effect.[11,29] In this study, the distribution of the expansion/non-expansion samples was examined by a Fisher's Exact test (Table 2). The p values obtained were 0.421(SN-MP grouping) and 0.306(gonial angle grouping), which indicated no significance.

In this study, two parameters (SN-MP, gonial angle) were used to classify the vertical facial patterns. These parameters have often been used in many studies to classify the vertical facial patterns and to establish the criteria for predicting growth. Some believe that a low SN-MP and gonial angle is related to deep bite, while a high angle suggest an open bite. Furthermore, low angle patients could have a more horizontal and vertical growth pattern, and the opposite for high angle patients.

We expected the low angle group to show little backward and downward rotation of the mandible and the high angle group to show much mandibular rotation. However, the low angle group showed little forward and downward movement of the A point and large amount of backward and downward rotation of the mandible (Table 4 and 5). In the high angle group, the A point showed a great deal of forward movement and the mandible showed less positional change. As shown in figure 4, the parameter that exhibited the most significance in the facial patterns was the horizontal movement rather than vertical movement in the SNMP grouping. The different amount of forward movement of the A point (low<average<high) and the backward movement of the B point (high<average<low) according to the facial patterns were quite notable. Only the forward movement of the A point between the low and high angle groups showed a significant difference in the gonial angle classification. There was no significant difference between groups related to the vertical displacement of in the upper and lower teeth, the rotation of the palatal plane along with other parameters. Therefore, in the low angle group, the mandible showed a backward and downward rotation and in the high angle group, the maxilla showed a great deal of forward displacement, thus improving the overjet and the Cl III relationship. Although a long-term effect of growth was not followed up, the results suggest that the high angle group does not exhibit more extrusion in the posterior teeth and backward movement of the maxilla than the low angle group.

The mean displacement angle of the A point upon the horizontal plane can be derived from the arcTan of the horizontal and vertical movement of the A point. According to figure 5, in the SN-MP classification, the high angle group showed 16.7°, the average angle group 29.8°, and the low angle group 65.4°. However, in the gonial angle classification, the high angle group showed 21.7°, the average angle 35°, and the low angle group 64.9°, which suggested that there was more horizontal movement in the groups with long facial patterns. Since short facial patterns showed little forward and downward movement, it can be said that the forward and downward growth promotion was insignificant, rather than that the low angle subjects showed more vertical growth.

According to Issacson,[17] the high angle group has a higher tendency for extrusion of the molars, a weaker masticatory force a great lower facial height, and openbite compared to the low angle group. Mller[20] and Ingervall[21] explained that the different rates of dentoalveolar development and the different growth direction of the two groups were caused by the different masticatory force. In Ueda's study,[33] in the low angle group the masseter muscle, which is a powerful closing muscle, was highly active but the digastic muscle, the opening muscle, also showed high activity. Therefore the difference in the growth pattern cannot be explained by only the masticatory muscle activity.

According to this study, favorable results may be achieved by protracting the maxilla 20~30° downward in all general preadolescent Cl III patients. However, this does not deny the necessity of a modified PHG. Since protraction of the maxilla causes forward and upward rotation of the palatal plane, leading to the backward downward rotation of the mandible, as seen in Table 4, cares should be definitely taken to prevent the downward displacement of the maxilla in the long face patients as much as possible. In addition, the long-term effect of growth cannot be disregarded, and because this differs between facial patterns, the appliance must be modified and followed up to prevent the facial patterns from worsening. Consequently, a further study is necessary to screen long-term changes in the facial patterns after active treatment with PHG depending on the vertical facial patterns.

CONCLUSIONS

A maxillary protraction appliance was used to treat preadolescent children with skeletal Cl III malocclusion. In order to compare the treatment effects depending on the vertical facial height, the skeletal Cl III preadolescents were divided according to the SN-MP and the gonial angles.

By analyzing the data achieved from these groups, the following results were obtained :

① In the SNMP grouping, more backward and downward rotation of the B point was observed in patients with a low angle SNMP, while those with a high angle SNMP showed significant forward movement of the A point.

② In the gonial angle grouping, patients with a high angle exhibited more significant forward movement of the A point than the low angle group.

③ In the comparison of the arcTan upon the A point, the displacement angle of the A point was more horizontal in the long-faced group, while the short-faced group showed a more vertical direction..

④ There were no significant differences between the duration of treatment and dental change between the SNMP and Gonial angle subgroups.

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국문초록

수직적 안모 형태에 따른 상악골 전방 견인 장치의 효과 비교

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성장기 아동에서 상악골 열성장을 보이는 제III급 부정교합은 상악골 전방 견인 장치의 적응증이 된다. 상악골 전방 견인장치의 바람직한 효과는 상악골의 전방 이동이지만, 실제로는 상악 치아의 전방 이동, 하악골의 후하방 회전, 하악 전치의 설측 이동 등의 복합적인 결과로 III급 관계가 개선된다고 알려져 있다. 그러나 수직적 안모 유형별로는 상악골 전방 견인 장치의 효과에 대한 차이는 잘 알려진 바가 없다. 본 연구는 1998년-2000년 사이에 연세대학교 치과병원 교정과에 내원한 환자들 중 초진시 나이는 6세 6개월에서 13세 3개월 사이의 상악골 열성장을 동반한 제 III급 부정교합으로 진단된 67명(남 36, 여 31)을 대상으로, 안모유형별로 SNMP군과 Gonial angle군에서 low, average, high로 세부군을 나누어 치료전 측모 두부방사선 규격사진을 통해 상악골 전방견인 장치의 효과를 비교하여 다음과 같은 결과를 얻었다. ① SNMP군의 low angle에서 B point의 후방이동량이 많았으며, High angle에서는 A point의 전방이동량이 컸다. ② Gonial angle군의 low angle에서 A point의 전방이동양이 가장 적었으며, high angle에서는 A point의 전방이동량이 상대적으로 많았다. ③ A point에 대한 arcTan를 구한 결과 A point의 이동 각도는 장안모 군에서 더 수평적인 이동 양상을 보였고, 단안모 군에서는 수직적 이동양상이 강했다. ④ SNMP군과 Gonial angle의 세부군에서 치료기간별 유의성은 없었다.

주요 단어 : 수직적 안모 유형, 상악골 전방견인