ORIGINAL ARTICLE

Cephalometric evaluation of the anterior open bite treatment

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The present study was aimed at evaluating the treatment changes of anterior open bite malocclusion cases treated by means of the Multiloop Edgewise Arch Wire technique, which is considered one of the more effective treatment modalities for anterior open bite malocclusions. The open bite sample was composed of 16 young adults, 4 males and 12 females. The normal occlusion sample, as a controlled sample was composed of 58 young adults who had pleasing facial profiles and normal occlusions with no experience of orthodontic or prosthodontic treatment. The normal sample was subdivided by the cephalometric vertical facial relationships. Forty adults with cephalometric vertical facial relationships within the normal range of Korean standards were classified as Normal Occlusion Group 1. Eighteen adults with an increased vertical facial relationship but with normal occlusion, were classified as Normal Occlusion Group 2. Thirty-nine reference points were digitized on each film, and the computerized cephalometric analysis was obtained with 8 skeletal, 10 dentoalveolar, 17 teeth angulations, and 4 occlusal plane measurements. Treatment changes were determined by the paired *t* test, and the structural differences between the four groups were tabulated by the Student's *t* test. The treatment changes were observed mainly in the dentoalveolar region in the upper and the lower occlusal planes, accompanied by the uprighting of the posterior teeth to the occlusal plane through the distal tipping movement of the entire dentition. After the treatment, there was a tendency for the structural feature of the open bite group to approximate those of the normal occlusion group 2. This ascertains that the treatment changes of open bite malocclusion produced by means of the multiloop edgewise arch wire technique are similar to those found in the natural dentoalveolar compensatory mechanism. (Am J Orthod Dentofacial Orthop 1999;115:29-38)

There are varieties of severe malocclusions that can be treated orthodontically but with a great deal of effort. Anterior open bite, in particular, is one malocclusion thought to be more difficult to treat, and therefore most have to be corrected by means of surgical intervention. To solve these problems, numerous studies[1-11] pertinent to treatment modalities have been introduced with controversies on the effectiveness of treatment. Suggested treatment modalities for anterior open bite are based directly or indirectly on the neuromuscular and morphologic features[12-18] and on the etiologic and the environmental factors.[19-22]

Even though there have been controversies regarding the dentoalveolar characteristics of open bite malocclusions, many authors[17,19,21,23-26] report that upper and lower anterior teeth have already overerupted in skeletal open bite cases. Therefore extruding the overerupted anterior teeth by using anterior vertical elastics to achieve an overbite has been criticized as an invalid approach for stable results.[19,27,28]

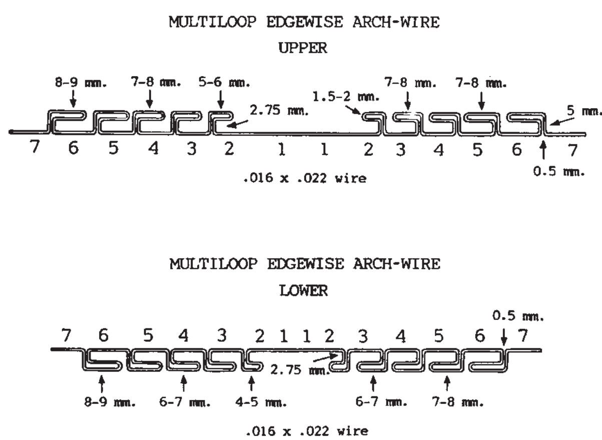

Fig 1. Diagram of the multiloop edgewise arch wire.

Among multiple etiologic factors, the most frequently discussed factor is the overeruption of the upper molars. Clinicians have emphasized the necessity of reducing the vertical dimension of the upper posterior segments, or at least trying to prevent the extrusion during orthodontic treatment.[2,8,9,13,26,29]

According to Arat and Iseri,[30] posterior rotation of

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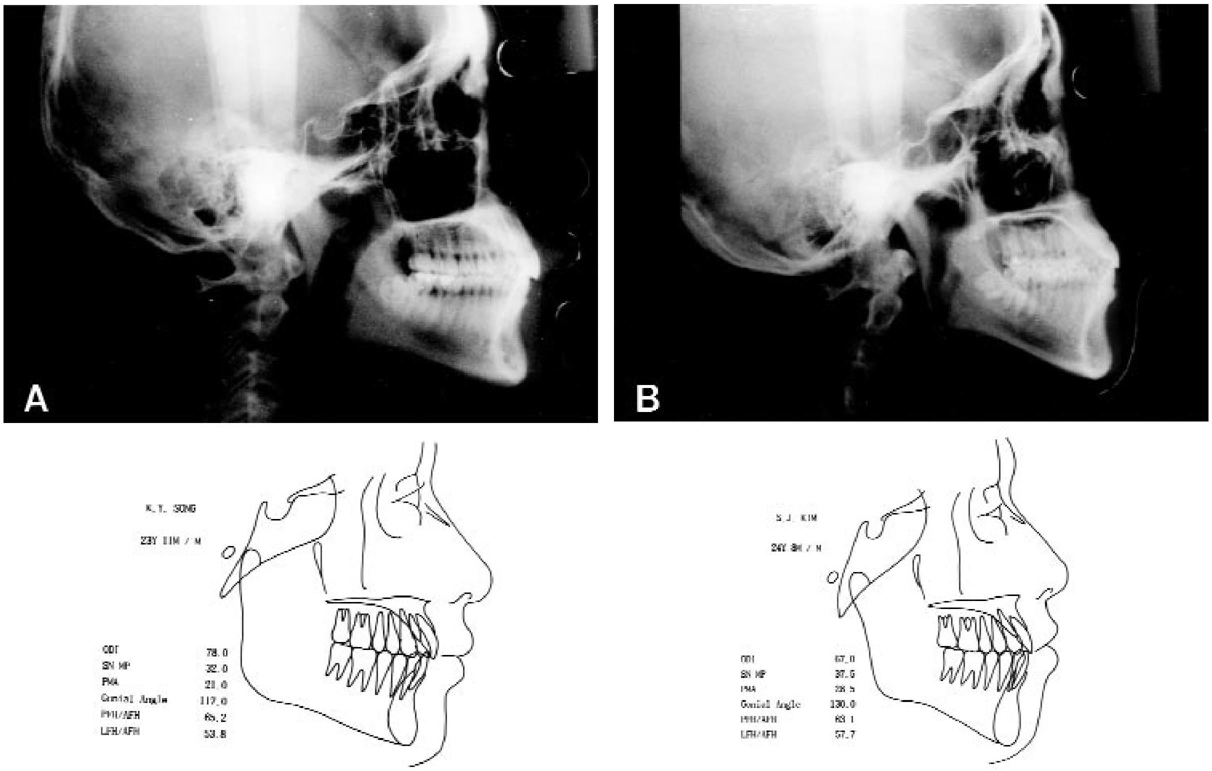

Fig 2. Samples of the normal occlusion group 1 (**A**), and the normal occlusion group 2 (**B**).

the mandible and increase of the lower facial height occur as a result of the extrusion of the posterior teeth, despite the fact that a high pull headgear was used in premolar extraction cases. Similarly, Sato[31] mentioned that the increase of the posterior vertical dimension is due to the mesial tipping of the molars during the premolar extraction treatment. Proffit[32] reported that a high pull headgear can restrict the extrusion of upper molars, but does allow the extrusion of the lower molars. The favorable upper and forward rotation of the mandible can hardly be achieved.

Kim[33] has reported that anterior open bite is characterized by divergent upper and lower occlusal planes and marked mesial inclinations of the dentition in the open bite skeletal pattern. The open bite skeletal pattern is determined by the overbite depth indicator (ODI)[34] and the anteroposterior dysplasia indicator (APDI).[35] The mean value of ODI is 74.5°, and the APDI is 81.4°. Wardlaw,[36] after scrutinizing the cephalometric measurements in the receiver operating characteristic analysis, ascertained that the ODI analysis was found to be the most valuable analytic measurement among all other variables tested.

When the means of ODI and APDI, representing the vertical and the horizontal components, are combined, the sum equals 155.9°, and it is designated as the combination factor (CF).[37] The more the CF falls below 155°, the greater the chance of an open bite. To correct the characteristic features of open bite, Kim[33] created and developed the Multiloop Edgewise Arch Wire (MEAW) (Fig 1) technique and treated the malocclusion with success; a number of reports on treatment of open bite with MEAW therapy have appeared.[38-40]

The purpose of this study is to examine the treatment results of anterior open bite malocclusions treated by means of MEAW technique and to compare the structural changes between the normal group and the open bite group. Appliance manipulation is discussed elsewhere.[33]

MATERIAL

Treatment Group

The treatment group is composed of 16 young adult open bite patients treated by means of the MEAW technique in the Department of Orthodontics, Seoul National University (SNU) Hospital. To eliminate the growth factor, these patients were selected on the basis of wrist x-rays and the height-weight growth curve. In addition, extraction cases were excluded from this study to eliminate any effects that may be caused by the extraction treatment. The 16 patients were 4 males and 12 females with the mean age of 18.1 years at the

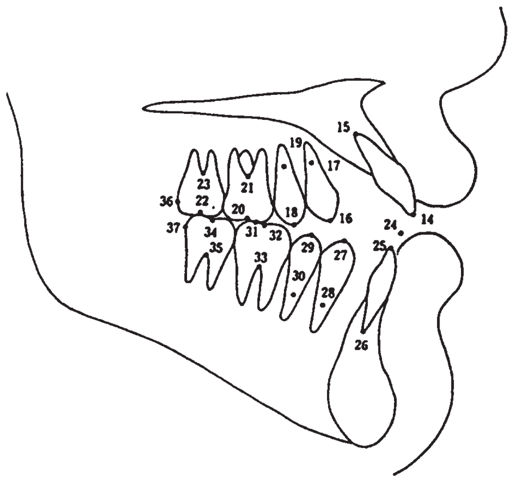

Fig 3. Reference points.

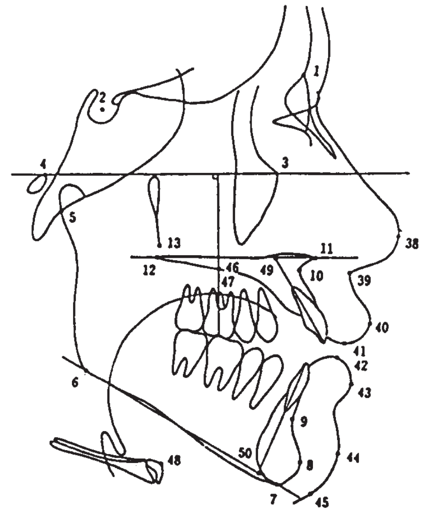

Fig 4. Reference points.

pretreatment stage and 19.8 years at the posttreatment stage. Eight cases were Class I and the other eight were Class II malocclusions. The mean treatment duration was 1.6 years, and the mean duration of MEAW therapy was 6 months.

Normal Occlusion Groups

Fifty-eight students of SNU dental school were selected as the normal group who met the following criteria: (1) clinically pleasing facial profile, (2) esthetically and functionally favorable normal occlusion, and (3) no orthodontic or prosthodontic treatment experience except fewer than three teeth restored for caries.

Because of the considerable variation that existed in the vertical dimensions of the cephalograms, the normal group was subdivided into Normal Occlusion Group 1 (NOG 1) and Normal Occlusion Group 2 (NOG 2). NOG 2 is composed of persons who showed less than 1 standard deviation (SD) from the mean value of the ODI and indicated an increased vertical relationship that was verified by the following five measurements; sella-nasion (SN)-mandibular plane angle, palatomandibular plane angle, gonial angle, and the facial height ratios (posterior facial height/anterior facial height, anterior lower facial height/anterior total facial height). If more than three of the five measurements were more than 1 SD toward a long-face tendency, these individuals were categorized as NOG 2, the group that has a skeletal pattern of an anterior open bite tendency (Fig 2). Eight female and 10 male subjects fell into this group with a mean age of 21.72 years.

The remaining 40 subjects, 20 female and 20 male with a mean age of 20.90 years, were classified as NOG 1 with the normal range of the vertical relationship (Fig 2).

METHODS

The cephalograms were obtained from the Department of Radiology at SNU Hospital. The enlargement factor was found to be 5.6% in all films that ensured the consistency of the image. Thirty-nine reference points were marked on the tracing (Figs 3 and 4). The pretreatment and posttreatment cephalograms were traced and marked concurrently to achieve consistency in the determination of the reference points.

The reference points were digitized into the computer. Eight skeletal, 10 dentoalveolar, 4 occlusal plane, and 17 tooth angular measurements were calculated by a computer program created and used by our department. To reduce the error, all the measurements were tabulated twice at 1 week intervals and the average of the two measurements was recorded. In addition, the intraobserver error by measuring the index of reliability was evaluated.[41] Bisected occlusal plane (BOP)-to-upper second premolar, BOP-to-lower first molar, BOP-to-lower second molar, and the mandibular plane-to-lower second molar showed a reliability of approximately 0.85. All other measurements showed a reliability of better than 0.9. The statistical analysis was tabulated with SAS statistical package.

FINDINGS

Treatment Changes

The means and standard deviations and the results of paired *t* test for the treatment group are listed in Table I. There were no significant changes in the skeletal measurements, except an increase of ODI, which was due to the increase of the AB-to-mandibular plane angle.

Table I. Treatment changes of anterior open bite group

Variables	*Pretreatment*		*Posttreatment*		*t Test*
	Mean	*SD*	*Mean*	*SD*	
Skeletal measurement					
1. SN-MP angle	43.75	4.68	43.44	5.40	NS
2. FH-PP angle	0.66	3.13	0.61	2.96	NS
3. AB-MP angle	60.16	3.78	61.36	4.17	**
4. ODI	60.86	5.28	61.99	5.49	*
5. PP-MP angle	33.31	4.66	33.28	4.78	NS
6. Gonial angle	129.01	6.34	128.45	6.01	NS
7. PTFH/ATFH (%)	59.52	3.87	59.74	4.53	NS
8. ALFH/ATFH (%)	56.87	2.09	57.09	1.81	NS
Dentoalveolar measurements					
9. U1-PP (UADH)	28.56	2.27	30.57	2.27	***
10. U7-PP (UPDH)	21.19	2.12	22.26	2.54	NS
11. L1-MP (LADH)	43.14	2.31	45.92	3.50	***
12. L7-MP (LPDH)	30.31	2.07	29.27	2.45	**
13. Ptm to U7 distal (mm)	4.61	1.79	3.71	2.03	**
14. Ptm to L7 distal (mm)	5.91	2.66	3.98	2.58	***
15. Overbite	-4.63	2.13	0.91	0.66	***
16. Overjet	2.62	1.81	3.24	1.00	NS
17. UADH (long axis)	33.54	2.72	33.71	2.60	NS
18. LADH (long axis)	43.59	2.44	46.66	3.75	***
Occlusal plane measurements					
19. PP-UOP	6.98	3.71	9.89	4.62	**
20. MP-LOP	21.22	3.26	26.20	4.39	***
21. PP-UOP/PP-MP	0.20	0.10	0.29	0.11	**
22. MP-LOP/PP-MP	0.64	0.10	0.79	0.16	***
Tooth axis measurements					
23. Interincisal angle	118.74	9.86	129.44	9.75	**
24. BOP-U4	76.30	4.90	85.02	3.62	***
25. BOP-U5	82.86	3.74	89.78	3.04	***
26. BOP-U6	89.95	6.26	92.64	4.24	NS
27. BOP-U7	98.04	7.81	99.04	6.91	NS
28. BOP-L4	76.82	4.23	85.25	3.36	***
29. BOP-L5	77.99	4.72	87.05	3.39	***
30. BOP-L6	80.59	6.05	88.94	3.74	**
31. BOP-L7	81.01	4.54	92.41	5.89	***
32. PP-U4	93.91	6.46	86.11	5.53	***
33. PP-U5	88.14	7.08	81.58	5.63	***
34. PP-U6	80.21	6.61	78.50	5.88	NS
35. PP-U7	72.16	7.68	72.14	7.09	NS
36. MP-L4	79.31	5.26	69.97	4.00	***
37. MP-L5	78.11	5.71	68.19	4.02	***
38. MP-L6	75.53	7.11	66.30	4.25	***
39. MP-L7	75.09	6.54	62.86	5.14	***

NS, Not significant.
*$P < .05$.
**$P < .01$.
***$P < .001$.

The upper and lower anterior dentoalveolar heights were increased, but the upper anterior dentoalveolar height, measured along the long axis of the tooth, did not change significantly. No significant change was found in the upper posterior dentoalveolar height. The lower posterior dentoalveolar height was significantly decreased.

There were significant changes in the distance of the pterygomaxillary fissure (Ptm)-to-upper second molar and Ptm-to-lower second molar, which indicated the distal movement of the entire dentition. The upper occlusal plane showed downward rotation anteriorly, whereas the lower occlusal plane showed an upward rotation.

The interincisal angle increased significantly. All the posterior teeth were found to be upright to the

Table II. Skeletal measurements

Variables	*NOG 1*	*NOG 2*	*Pretreatment*	*Posttreatment*
SN-MP angle	34.18 ± 5.31	41.68 ± 4.20*	43.75 ± 4.68	43.44 ± 5.40
FH-PP angle	1.00 ± 2.21	0.69 ± 2.83	0.66 ± 3.13	0.61 ± 2.96
AB-MP angle	69.20 ± 3.83	60.56 ± 2.95*	60.16 ± 3.78	61.36 ± 4.17
ODI	70.23 ± 4.81	61.30 ± 4.01*	60.86 ± 5.28	61.99 ± 5.49
PP-MP angle	23.74 ± 3.88	31.74 ± 3.53*	33.31 ± 4.66	33.28 ± 4.78
Gonial angle	121.45 ± 4.16	131.56 ± 4.14*	129.01 ± 6.34	128.45 ± 6.01
PFH/AFH (%)	66.99 ± 4.08	61.02 ± 3.43*	59.52 ± 3.87	59.74 ± 4.53
LFH/TFH (%)	55.27 ± 1.37	56.21 ± 2.21*	56.87 ± 2.09	57.09 ± 1.81

*$P < .05$ (between NOG 1 and NOG 2).
**$P < .05$ (between NOG 2 and pretreatment).
***$P < .05$ (between NOG 2 and posttreatment).

Table III. Dentoalveolar measurements

Variables	*NOG 1*	*NOG 2*	*Pretreatment*	*Posttreatment*
U1-PP (UADH)	29.99 ± 2.76	31.63 ± 2.40*	28.56 ± 2.27**	30.57 ± 2.27
U7-PP (UPDH)	22.45 ± 2.48	22.94 ± 2.36	21.19 ± 2.12**	22.26 ± 2.54
L1-MP (LADH)	45.36 ± 3.67	46.52 ± 3.21	43.14 ± 2.31**	45.92 ± 3.50
L7-MP (LPDH)	33.16 ± 3.54	30.18 ± 2.33*	30.31 ± 2.07	29.27 ± 2.45
Ptm to U7 distal (mm)	5.85 ± 2.52	5.81 ± 2.15	4.61 ± 1.79	3.71 ± 2.03***
Ptm to L7 distal (mm)	5.93 ± 2.72	6.11 ± 2.68	5.91 ± 2.66	3.98 ± 2.58***
Overbite	1.45 ± 0.79	1.39 ± 0.77	–4.63 ± 2.13**	0.91 ± 0.66***
Overjet	3.19 ± 0.79	3.01 ± 0.80	2.62 ± 1.81	3.24 ± 1.00
UADH’ (long axis)	33.70 ± 2.65	35.38 ± 2.51*	33.54 ± 2.72**	33.71 ± 2.60
LADH’ (long axis)	46.22 ± 3.92	47.03 ± 3.29	43.59 ± 2.44**	46.66 ± 3.75

*$P < .05$ (between NOG 1 and NOG 2).
**$P < .05$ (between NOG 2 and pretreatment).
***$P < .05$ (between NOG 2 and posttreatment).

bisected occlusal plane. The changes of the lower first and second molars, however, were not statistically significant ($P > .05$). The upper premolars were upright in relation to the palatal plane, but the lower first and second molars showed no statistical significance ($P > .05$). All of the lower posterior teeth were distally upright in relation to the mandibular plane.

These findings indicate that the MEAW therapy minimally affected the skeletal pattern, correcting the open bite by distal uprighting of the posterior teeth and by changing of the occlusal planes. In addition, the findings indicate that the MEAW therapy not only prevented the extrusion of posterior teeth, but also intruded them, especially lower posterior teeth.

Comparison of the Four Groups

The means and standard deviations of NOG 1, NOG 2, and the treatment group, and the results of the *t* test are listed in Tables II, III, IV, and V.

In the skeletal measurements, all variables showed a significant difference between the NOG 1 and NOG 2, except the Frankfort horizontal (FH)-to-palatal plane angle. There was no significant difference between the NOG 2 and the treatment group. It showed that NOG 2 and the treatment group had the same vertically increased open bite skeletal pattern, but the vertical facial relationship of NOG 1 was within the normal range (Table II).

In the dentoalveolar measurements, the upper anterior dentoalveolar height of NOG 2 was significantly greater than that of NOG 1. The lower posterior dentoalveolar height of NOG 2 was significantly smaller than that of NOG 1. All of the measurements, except the lower posterior dentoalveolar height of the pretreatment group, were significantly smaller than those of the NOG 2. There was no significant difference between the NOG 2 and the posttreatment group (Table III).

The palatal plane-to-upper occlusal plane angle and the mandibular plane-to-lower occlusal plane angle of NOG 1 were significantly smaller than those of NOG 2. The ratio of both angles to the palatal plane-to-mandibular plane angle showed no significant difference. In comparing NOG 2 and the treatment groups, palatal plane-

Table IV Occlusal plane measurements

Variables	*NOG 1*	*NOG 2*	*Pretreatment*	*Posttreatment*
PP-UOP	8.06 ± 2.96	9.84 ± 3.15*	6.98 ± 3.71**	9.89 ± 4.62
MP-LOP	19.37 ± 3.21	26.22 ± 2.91*	21.22 ± 3.26**	26.20 ± 4.39
PP-UOP/PP-MP	0.33 ± 0.10	0.30 ± 0.09	0.20 ± 0.10**	0.29 ± 0.11
MP-LOP/PP-MP	0.82 ± 0.12	0.83 ± 0.13	0.64 ± 0.10**	0.79 ± 0.16

*$P < .05$ (between NOG 1 and NOG 2).
**$P < .05$ (between NOG 2 and pretreatment).
***$P < .05$ (between NOG 2 and posttreatment).

Table V Tooth axis measurements

Variables	*NOG 1*	*NOG 2*	*Pretreatment*	*Posttreatment*
Interincisal angle	121.91 ± 7.51	123.96 ± 6.45	118.74 ± 9.86	129.44 ± 9.75
BOP-U4	80.10 ± 4.17	82.83 ± 3.98*	76.30 ± 4.90**	85.02 ± 3.62
BOP-U5	85.04 ± 3.85	87.56 ± 3.28*	82.86 ± 3.74**	89.78 ± 3.04
BOP-U6	89.59 ± 4.00	90.37 ± 3.79	89.95 ± 6.26	92.64 ± 4.24
BOP-U7	96.67 ± 5.33	95.76 ± 4.62	98.04 ± 7.81	99.04 ± 6.91
BOP-L4	81.13 ± 4.24	83.02 ± 4.38	76.82 ± 4.23**	85.25 ± 3.36
BOP-L5	82.38 ± 3.48	84.16 ± 4.43	77.99 ± 4.72**	87.05 ± 3.39***
BOP-L6	83.58 ± 4.03	84.10 ± 3.98	80.59 ± 6.05**	88.94 ± 3.74***
BOP-L7	81.27 ± 4.82	82.68 ± 4.10	81.01 ± 4.54	92.41 ± 5.89***
PP-U4	93.19 ± 5.03	89.03 ± 4.62*	93.91 ± 6.46**	86.11 ± 5.53
PP-U5	90.23 ± 7.29	84.36 ± 4.27*	88.14 ± 7.08	81.58 ± 5.63
PP-U6	83.67 ± 4.65	81.47 ± 4.36	80.21 ± 6.61	78.50 ± 5.88
PP-U7	76.65 ± 5.34	76.15 ± 4.98	72.16 ± 7.68	72.14 ± 7.09
MP-L4	81.49 ± 4.57	73.01 ± 4.30*	79.31 ± 5.26**	69.97 ± 4.00***
MP-L5	80.24 ± 4.16	71.87 ± 4.24*	78.11 ± 5.71**	68.19 ± 4.02***
MP-L6	79.05 ± 4.70	71.88 ± 3.94*	75.53 ± 7.11	66.30 ± 4.25***
MP-L7	81.35 ± 5.06	73.34 ± 3.47*	75.09 ± 6.54	62.86 ± 5.14***

*$P < .05$ (between NOG 1 and NOG 2).
**$P < .05$ (between NOG 2 and pretreatment).
***$P < .05$ (between NOG 2 and posttreatment).

to-upper occlusal plane angle and mandibular plane-to-lower occlusal plane angle of the pretreatment group were significantly smaller initially than those of NOG 2. After treatment, both angles were increased and showed no significant difference to those of NOG 2. The ratio of the two angles to the palatal plane-to-mandibular plane angle was increased during treatment and became similar to those of NOG 2 (Table IV).

The mean interincisal angle was increased to 5.48° greater than that of NOG 2. Despite some variation in the skeletal pattern, the NOG 1 and the NOG 2 were similar in the angle between all posterior teeth and the occlusal plane. After the treatment, all of the posterior teeth were found to be upright in relation to the occlusal plane and they became more upright than those of NOG 2. In general, the angles between the upper posterior teeth and the palatal plane did not show any significant difference between the groups. These angles, however, showed a tendency to become smaller in NOG 2 and in the posttreatment group. The angles between the lower posterior teeth and the mandibular plane of NOG 2 were found to be significantly smaller than those of NOG 1. These angles in the pretreatment group were more obtuse than those of NOG 2, but became acute after treatment.

In other words, the upper and the lower posterior teeth were distally uprighted to the palatal plane and the mandibular plane with treatment (Table V).

DISCUSSION

Treatment Changes

The ODI was increased due to the increase of the AB-to-mandibular plane angle. This change was probably caused by the distal movement of the lower dentition and the B point during the treatment of eight Class III open bite patients. There were no significant changes in other skeletal measurements. In some cases, 10 of 16 cases, the upward and forward rotation of the mandible and the decreasing of the lower face height due to the intrusion of the lower posterior teeth were

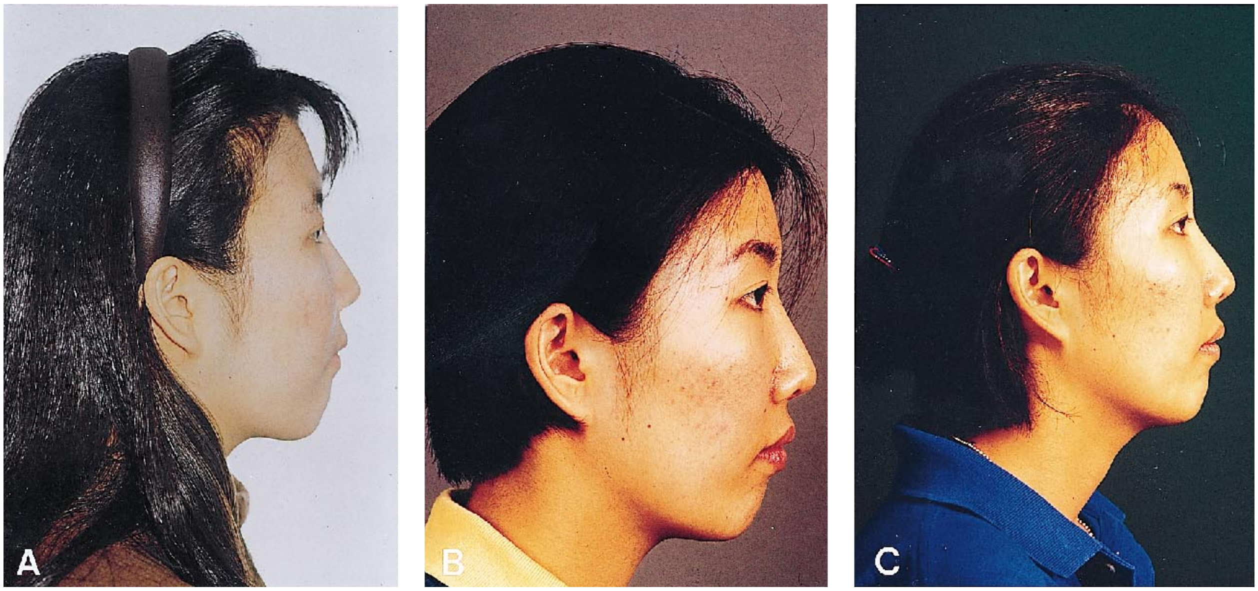

Fig 5. Facial photographs of pretreatment **(A)**, during **(B)**, and after retention **(C)**.

observed, but the treatment effect of the MEAW seemed confined to the dentoalveolar region.

The lower anterior teeth were extruded lingually, and the alveolar bone showed definitive remodeling followed by the movement of the teeth. This finding is in agreement with the experimental study by Lee et al[42] on monkeys. It showed that marked tooth movement and considerable cellular activities took place in the monkey with the use of MEAW therapy; the control monkey without MEAW therapy showed insignificant tooth movement and cellular activity. Proffit[43] pointed out that when an anterior open bite can be treated by elongating the incisors, it is better for both esthetics and stability to elongate the lower incisors, not the upper incisors.

As mentioned earlier, some clinicians emphasize a careful control of the posterior teeth in the treatment of open bites and recommend a high-pull headgear or a posterior bite-block.[8,9,44] According to the study on the force system of MEAW by the finite element analysis,[45] MEAW with second order tip-back activations on the posterior segments exerts an uprighting force on the posterior teeth and an extrusive force on the anterior teeth with anterior vertical elastics. In another study using photoelastic analysis,[46] it was found that MEAW with the activations has an intrusive effect on the incisors and the second molars without elastics, but the intrusive forces on the incisors are counteracted by the anterior vertical elastics. The consequence is the extrusion of incisors. The molars, on the other hand, receive greater intrusive force and a stronger uprighting effect from the anterior vertical elastic force.

From this study, it was evident that there was no significant change in the upper posterior dentoalveolar height, but the lower posterior dentoalveolar height was significantly decreased. A sample case treated with MEAW therapy is shown in Figs 5, 6, 7, and 8.

Comparison of the four groups

NOG 2 and the treatment groups showed an increased vertical dimension of the face, but NOG 1 showed the normal range of the vertical facial relationship. Despite the fact that NOG 2 had a similar open bite skeletal pattern with the treatment group, NOG 2 had normal occlusion. Björk and Skieller[47] pointed out that the eruption path of the teeth should be changed to compensate for the positional changes of the jaws during growth and development. If this process is absent or incomplete, a dysplasia of the occlusion and a space problem may appear. Because there is a large variation in the amount and the direction of growth and because a perfect harmony of the growth cannot always be achieved in the jaws, Solow[48] referred to the need for the dentoalveolar compensatory mechanism. The eruption of teeth and the change in the position to compensate the interarch variation, therefore, can produce the normal occlusal relationship between the dental arches. This discussion suggests that the NOG 2, which has the open bite tendency skeletal pattern, can possess a normal occlusal relationship by an adequate dentoalveolar compensation. The treatment group, which had a similar skeletal pattern to NOG 2, however, could not possess a normal occlusal relationship because of an inadequate dentoalveolar compensation.

Fig 6. Intraoral photographs of pretreatment (**A**), during (**B** and **C**), postorthodontic treatment (**D**), and after retention (**E**).

In evaluating the dentoalveolar region, NOG 2 was significantly greater than NOG 1 in the upper and lower anterior dentoalveolar heights. This difference is probably due to the dentoalveolar compensation in NOG 2. The pretreatment group showed smaller upper and lower anterior dentoalveolar heights than those of NOG 2 but showed no difference after treatment. That probably means that there was an inadequate den-

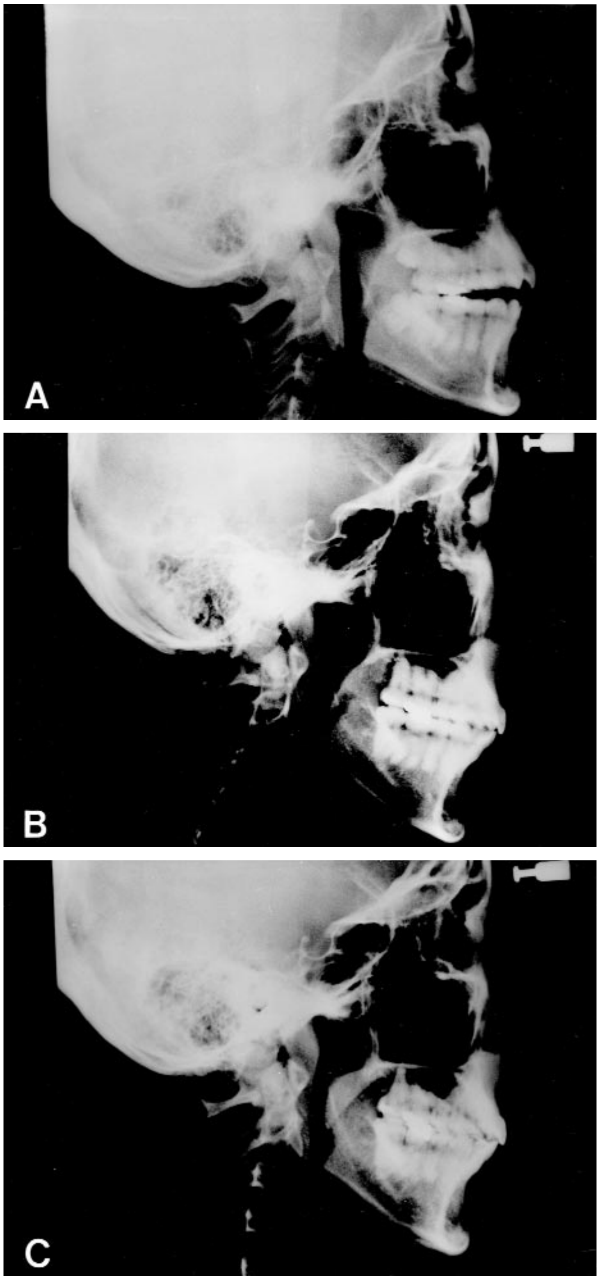

Fig 7. Cephalograms of pretreatment (**A**), during (**B**), and after retention (**C**).

toalveolar compensation in the pretreatment group relative to the vertically increased jaw relationship and that a proper dentoalveolar height was achieved after treatment.

The palatal plane-to-upper occlusal plane angle and the mandibular plane-to-lower occlusal plane angle were greater in NOG 2 than in NOG 1. Both angles were smaller in the pretreatment group but showed no difference after treatment. Nielsen[49] defined the maxillary zone as the palatal plane-to-upper occlusal plane angle, normally 10° ± 3°. The mandibular zone is defined as the mandibular plane-to-lower occlusal plane angle, normally 20° ± 4°. He also reported that in the case of an increase in the vertical jaw relationship, an increase in the maxillary zone and the mandibular zone means a favorable dentoalveolar compensation.

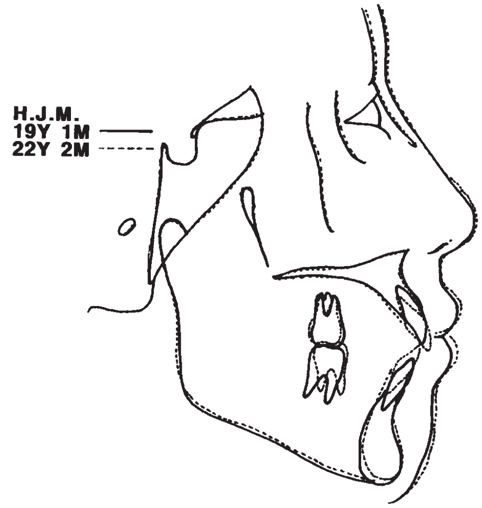

Fig 8. Superimposition of preorthodontic and postorthodontic treatment.

In the pretreatment group, the angulations of the posterior teeth to the occlusal plane were smaller than those of NOG 2. Kim[33] noted the typical mesial inclination of the posterior teeth in open bite was in agreement with aforementioned findings. And the fact that those of NOG 2 tended to be larger than those of NOG 1 concurs with the findings of Björk,[47] who reported that there is a tendency of the distal inclination of the posterior teeth in the backward rotation pattern with an adequate dentoalveolar compensation. Those of the pretreatment group were increased during treatment and became similar to those of NOG 2, or more upright to the occlusal plane than those of NOG 2.

In summary, even though the vertical relationship of the face is increased because of growth, the normal occlusal relationship can be achieved by the adequate dentoalveolar compensatory mechanism, but in the case of inadequate or negative dentoalveolar compensation, open bite is likely to be present. If the skeletal dysplasia is too severe to be solved by orthodontic treatment alone, combined treatment with surgery should be done to restore the function and the esthetics of the orofacial complex. In many cases, however, orthodontic alteration of the dentition pertinent to the given skeletal pattern with the proper diagnosis and treatment planning can bring satisfactory results.

The treatment changes with the MEAW therapy occurred mainly in the dentoalveolar region and showed a considerable similarity to the natural dentoalveolar compensatory mechanism. In other words, the MEAW technique allows orthodontists to produce the natural dentoalveolar compensation orthodontically. The morphologic features of the posttreatment group appeared to be like those of NOG 2, which had normal occlusion because of the natural dentoalveolar compensation despite its open bite skeletal pattern.

Even if an open bite is corrected by the orthodontic dentoalveolar compensation suitable for the skeletal pattern, relapse may still occur from the persisting etiologic factors that originally prohibited the natural dentoalveolar compensation. The etiologic factors should be determined at the time of initial diagnosis and should be controlled during treatment and retention.

CONCLUSION

The conclusions of this study are as follows:

1. The treatment changes mainly occurred in the dentoalveolar region.
2. The treatment changes are alteration of occlusal planes accompanied by uprighting of the posterior teeth.
3. The treatment changes are similar to natural dentoalveolar compensation.

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