KOREA J. ORTHOD. 2000 : 30(6) : 687-98

Skeletodental changes during treatment and retention in Class II division 1 malocclusion

Sang-Cheol Kim[1] · Sun-Young Kim[2]

The purpose of this study was to evaluate the changes of skeletodental patterns during Class II treatment and its retention period. Forty two patients of Class II malocclusion, which was treated with nonextraction or first premolar-extraction were selected and their lateral cephalograms were examined in this study. Various skeletodental changes in lateral cephalograms of pre-treatment, post-treatment and retention were measured by superimposition in reference to the cranial base for jaws, the palatal plane for maxillary teeth, and mandibular plane for mandibular teeth. The data were analyzed by paired t-test.

In this study, occlusal plane showed the significant anterior downward steepening after active treatment, and remained during retention period. In the nonextraction group, maxillary incisors were retracted and extruded during treatment. Maxillary molars were extruded, and mandibular molars were uprighted, with no mesial movement. In the extraction group, both maxillary and mandibular incisors were retracted and extruded. Maxillary molars were extruded and moved mesially, and mandibular molars were extruded and moved mesially with no mesial tilting. During retention period in both groups, there were tendencies of labial tipping of maxillary incisor, and mesial tipping of maxillary and mandibular molar. But the changes were not significant and most of teeth showed no change in vertical and horizontal direction.

Key words : Class II division 1 malocclusion, skeletodental change

Referring to the possible morphologic variations of Class II division 1 malocclusion that was characterized by increased overbite and overjet, protruded incisor, rotated molar, and mesially inclined tooth axis, Fisk exemplified such cases as maxillary bones and teeth anteriorly situated with relation to the cranium, maxillary teeth anteriorly placed in the maxillary bones, mandible underdeveloped, mandible of normal size but posteriorly placed, as well as mandibular teeth posteriorly placed on adequate base.[1-4]

[1] *Professor, Department of Orthodontics, Wonkwang University.*
[2] *Graduate student, Department of Orthodontics, Wonkwang University.*
(This paper was supported by Wonkwang University in 1999.)

Reprint requests to : Prof. Sang-Cheol Kim
344-2 Shinyong-Dong Ik-San Cheon-Buk 570-711
Department of Orthodontics College of Dentistry Wonkwang University
82-63-850-1960 / sangkim@wonkwang.ac.kr

The treatment of Class II malocclusion can be achieved by inhibition or reorientation of maxilla, distal movement of maxillary dentition, forward growth of mandible, mesial movement of mandibular dentition, or repositioning of condylar fossa by using extraoral force,[5-7] functional appliance,[6,8-11] Herbst appliance,[10,12] Class II elastics,[9,10,12] etc.

West[13] noted that correction of occlusion and facial esthetics could be made possible by extraoral traction and intermaxillary elastics, which resulted from jaw growth and change of maxillary alveolar process and dentition.

Sagittal correction of Class II malocclusion may be achieved primarily by mandibular response, *i.g.* growth in adolescents and by molar movement in adults. Because of the absence of effective growth in adults,

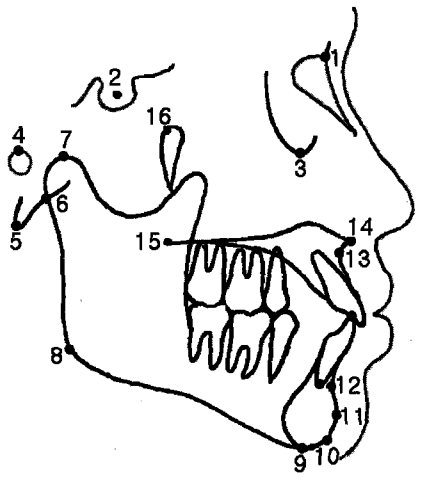


Fig. 1. Cephalometric landmarks.

1. Na	2. S	3. Or	4. Po
5. Ba	6. Ar	7. Co	8. Go
9. Me	10. Gn	11. Pog	12. B
13. A	14. ANS	15. PNS	16. Pt

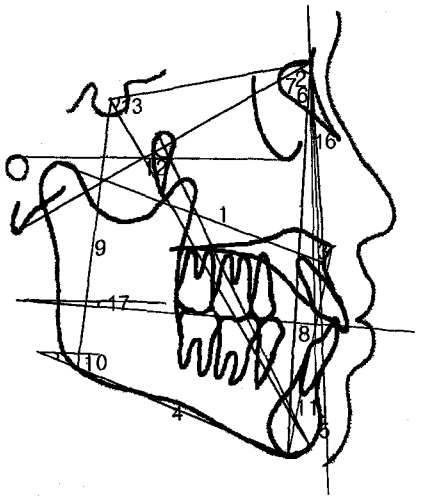


Fig. 2. Skeletal measurements.

1. Condylion-A poin	2. SNA
3. N vertical/ point A	4. Mandibular body length
5. N vertical/Pogonion	6. Facial angle
7. SNB	8. Anterior facial height
9. Posterior facial height	10. FMA
11. Lower facial height	12. Facial axis angle
13. Y axis angle	14. ODI
15. AP 16. ANB	17. OP to FH

the correction must be achieved almost exclusively by tooth movement.[15-18]

In the comparative study of Class II treatment modality in adolescents and adults, Kang and Yang[19] reported that there was significant difference between the two groups in terms of change of anteroposterior position of mandible, vertical dimension and occlusal plane. 63% of total molar correction was achieved by mandibular growth and 37% by tooth movement in adolescents, while 99% was achieved by tooth movement in adults.

Dyer et al[16] reported increased eruption of mandibular molar, intrusion of maxillary molar, overeruption of maxillary incisors, intrusion of mandibular incisors and steepening of occlusal plane when they treated Class II malocclusion by Class II elastics. And the less effective growth makes the treatment the more difficult. It leads the treatment mainly by tooth movement, in most cases. In addition, as the patients become aged, teeth tend to tip more easily and the density of the bone makes it difficult to achieve the amount of dental bodily movement.[17,18]

The purpose of this study was to evaluate the skeletodental changes during treatment and retention in Class II div. 1 malocclusion with fully erupted permanent dentition, which was treated by the conventional comprehensive edgewise appliances, and to try to find the proper treatment modality for Class II div. 1 malocclusion.

MATERIALS AND METHODS

1. Materials

Malocclusion cases who had Class II molar relationship and overjet over 3mm and full-erupted maxillary and mandibular second molar were selected. All cases were of males and treated with conventional standard edgewise technique. Total of 42 cases were divided into two groups. One was the nonextraction group of 22 cases, and the other was the first premolar-extraction group of 20 cases. The mean age of nonextraction group was 17.50±3.46 years and the mean age of extraction group was 18.71±3.84 years, in the start of treatment. The pre-treatment and post- treatment

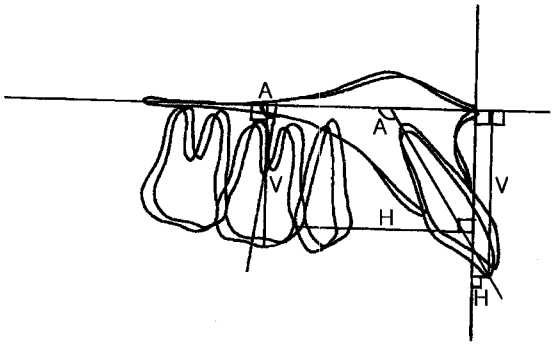


Fig. 3. Maxillary dental measurements.
U1 to PP: angular, vertical, horizontal change
U5 to PP: angular, vertical, horizontal change
U6 to PP: angular, vertical, horizontal change
U7 to PP: angular, vertical, horizontal change

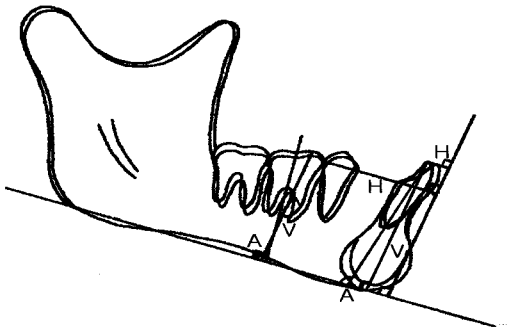


Fig. 4. Mandibular dental measurements.
L1 to MP: angular, vertical, horizontal change
L5 to MP: angular, vertical, horizontal change
L6 to MP: angular, vertical, horizontal change
L7 to MP: angular, vertical, horizontal change

cephalograms were analysed. And cephalograms of 4 extraction cases and 4 nonextraction cases at the retention period were taken and compared with the pre-treatment and post-treatment ones.

2. Methods

Cephalograms at pre-treatment(T_1), post-treatment (T_2) and retention stage(T_3) were taken and traced by one observer. Skeletal changes were examined by superimposition in reference to the cranial base, and dental changes were found by superimposition in reference to the palatal plane or mandibular plane. Following landmarks(Fig. 1) were digitized, and the skeletal measurements(Fig. 2) were measured by 0.01° in angle and 0.01mm in length.

Axial changes and vertical and horizontal movement of teeth were measured in reference to palatal plane for maxillary teeth and mandibular plane for mandibular teeth. Here, tooth axis was considered as the line connecting the bisecting point of the mesiodistal width of crown and embrasure in molar, the line connecting the bisecting point of the mesiodistal width of crown and mesiodistal width of apical 1/3 in premolars and the line connecting the incisal edge and root apex in incisor(Fig. 3, 4).

The mean and the standard deviation of skeletodental variables in the pre-treatment and post-treatment cephalograms were calculated and compared by paired t-test. And, changes of skeletodental pattern in cephalograms at retention stage were evaluated intuitively.

RESULTS

1. Changes in the nonextraction group

1) Skeletal patterns

Most of anteroposterior measurements in maxilla and mandible didn't show significant changes, while Co-A point($p<.01$) and mandibular body length($p<.05$) increased significantly .

The measurements that represent the anteroposterior discrepancy also didn't show significant changes, while the inclination of occlusal plane increased significantly ($p<.001$). The anterior facial height, posterior facial height and lower facial height in vertical dimension increased significantly($p< .01$)(Table 1).

2) Maxillary teeth

As for the angular changes of the tooth axis, the incisor and second premolar showed significant lingual tipping($p< .05$). And, as for the vertical changes, incisor showed significant extrusion($p<.001$) and first and second molar did likewise($p< .05$). As for the horizontal changes, incisor showed significant distal movement ($p< .05$), on the contrary, no molar showed the horizontal movement(Table 2).

During retention, incisors that had tipped lingually

Table 1. Skeletal changes during treatment in Class II nonextraction group

variables	pre-treatment mean±S.D.	post-treatment mean±S.D.	t-test
Condylion-A	89.10± 3.01	89.99±3.17	**
SNA	79.75± 2.86	79.64±3.02	NS
N vertical/A point	-1.96± 2.99	-2.00±3.27	NS
Mn. body length	72.89± 6.02	74.02±6.09	*
N vertical/Pog	-11.95± 6.52	-12.33±7.48	NS
Facial angle	84.34± 3.00	84.19±3.02	NS
SNB	76.32± 3.36	76.09±3.13	NS
APDI	80.53± 4.72	80.94±3.99	NS
ANB	3.42± 1.85	3.42±1.68	NS
OP to FH	9.97±3.29	12.00±3.28	***
Anterior facial height	129.61± 6.34	132.50±6.70	**
Posterior facial height	81.05± 5.42	83.43±5.78	***
FMA	31.32± 6.21	31.61±6.30	NS
Lower facial height	74.32± 5.25	76.19±4.67	**
Facial axis angle	81.90± 4.35	81.95±4.31	NS
Y axis angle	79.81±17.32	80.34±17.82	NS
ODI	70.04± 5.05	70.36±4.67	NS

(N.S. : not significant, * : p<0.05, ** : p<0.01, *** : p< 0.001)

during treatment showed a tendency of slight proclination, and molars that had tipped distally slightly tipped mesially again, as well. But incisors and molars tended to be retained in the vertical and horizontal position. Mean changes of the maxillary teeth during treatment and retention were illustrated(Fig. 5).

3) Mandibular teeth

As for the angular changes of the tooth axis, the second premolar($p<.05$), first molar($p<.05$) and second molar($p<.001$) showed significant distal tipping. And, as for the vertical changes, the first molar and second molar showed significant extrusion($p<.05$). As for the horizontal changes, no teeth showed horizontal movement(Table 3).

During retention, incisor didn't show typical patterns, while molar that had tipped distally showed a tendency of slight mesial tipping, especially in second molar. But incisors and molars tended to be retained in the vertical and horizontal position.

Table 2. Maxillary dental changes during treatment in Class II nonextraction group

	pre-treatment mean±S.D.	post-treatment mean±S.D.	t-test
Angular change			
U1 to pp	120.77±5.04	115.99±5.49	*
U5 to pp	86.80±3.62	82.73±5.45	*
U6 to pp	76.47±5.45	75.55±5.51	NS
U7 to pp	68.83±5.52	69.23±5.58	NS
Vertical change			
U1 to pp	31.52±2.84	32.63±2.73	***
U5 to pp	27.63±2.34	27.80±1.81	NS
U6 to pp	25.25±2.66	25.90±1.79	*
U7 to pp	21.91±2.58	23.16±2.17	*
Horizontal change			
U1 to pp	-4.5±3.00	-3.09±2.59	*
U5 to pp	19.52±3.10	19.13±2.11	NS
U6 to pp	26.57±2.98	25.45±5.51	NS
U7 to pp	37.52±2.93	37.84±2.21	NS

(N.S. : not significant, * : p<0.05, ** : p<0.01, *** : p< 0.001)

Table 3. Mandibular dental changes during treatment in Class II nonextraction group

	pre-treatment mean±S.D.	post-treatment mean±S.D.	t-test
Angular change			
L1 to mp	98.54±4.60	98.55±6.63	NS
L5 to mp	80.52±6.19	76.96±4.04	*
L6 to mp	78.64±3.99	75.58±4.33	*
L7 to mp	83.84±6.03	74.70±6.82	***
Vertical change			
L1 to mp	45.97±2.82	46.71±3.55	NS
L5 to mp	37.81±2.21	37.99±7.97	NS
L6 to mp	35.41±2.18	36.96±2.18	*
L7 to mp	32.27±2.20	33.15±2.10	*
Horizontal change			
L1 to mp	3.42±2.24	3.52±2.47	NS
L5 to mp	18.35±2.50	19.04±1.83	NS
L6 to mp	26.34±2.00	26.70±1.97	NS
L7 to mp	38.37±2.42	38.66±3.51	NS

(N.S. : not significant, * : p<0.05, ** : p<0.01, *** : p< 0.001)

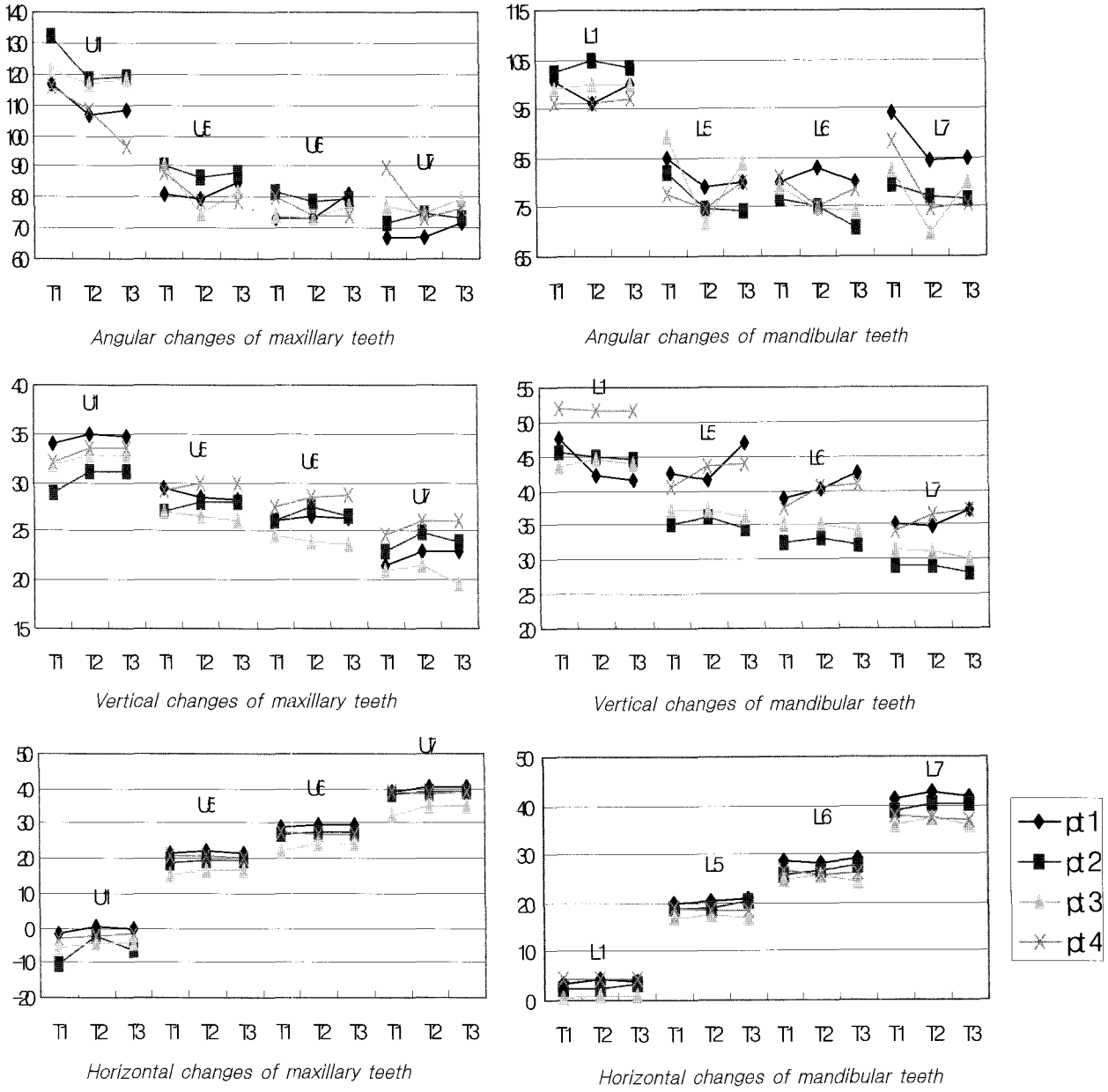


Fig. 5. Dental changes of nonextraction group.

Mean changes of the mandibular teeth during treatment and retention were illustrated(Fig. 5).

2. Changes in extraction group

1) Skeletal patterns

Most of anteroposterior measurements in maxilla and mandible didn't show significant changes, while Condylion-A point($p<.01$) and mandibular body length ($p<.001$) increased significantly and SNB decreased significantly($p<.05$).

The measurements that represent the anteroposterior discrepancy didn't show significant changes, while the inclination of occlusal plane increased significantly ($p<.001$). The anterior facial height, posterior facial height($p<.001$) and lower facial height($p<.05$) in verti-

Table 4. Skeletal changes during treatment in Class II extraction group

variables	pre-treatment mean±S.D.	post-treatment mean±S.D.	t-test
Condylion-A	88.17±4.33	89.16±4.60	*
SNA	80.53±3.96	80.19±3.38	NS
N vertical/A point	-2.52±2.83	-3.05±2.52	NS
Mn. body length	73.00±6.48	75.04±6.36	***
N vertical/Pog	-11.46±4.72	-11.73±5.92	NS
Facial angle	84.58±2.01	84.66±2.49	NS
SNB	77.67±3.48	77.18±3.48	*
APDI	80.29±3.28	79.80±4.15	NS
ANB	3.28±1.75	3.43±1.78	NS
OP to FH	9.81±2.87	12.53±3.10	***
Anterior facial height	131.04±6.48	134.58±7.56	***
Posterior facial height	82.25±6.47	84.71±6.96	***
FMA	31.67±4.32	31.56±4.91	NS
Lower facial height	75.12±5.28	76.97±4.86	*
Facial axis angle	80.60±3.41	80.97±3.84	NS
Y axis angle	72.84±3.51	73.09±3.86	NS
ODI	68.41±5.73	69.51±5.29	*

(N.S. : not significant, * : p<0.05, ** : p<0.01, *** : p< 0.001)

cal dimension increased significantly and ODI($p<.05$) increased significantly(Table 4).

2) Maxillary teeth

As for the angular changes of the tooth axis, the incisor showed significant lingual tipping($p< .001$) and the second molar showed mesial tipping($p< .05$). And, as for the vertical changes, incisor ($p< .05$), first molar ($p< .05$) and second molar($p< .001$) showed significant extrusion. As for the horizontal changes, incisor showed significant distal movement($p< .05$), and the second premolar, first molar, second molar mesial movement did($p< .001$)(Table 5).

During retention, incisors that had tipped lingually in treatment had a tendency of slight proclination, while molars that had tipped distally were retained in their position. Incisors which had been extruded during treatment were retained in their position, and molars had a tendency to be retained in their position or to intrude slightly. Horizontally both incisors and molars

Table 5. Maxillary dental changes during treatment in Class II extraction group

	pre-treatment mean±S.D.	post-treatment mean±S.D.	t-test
Angular change			
U1 to pp	119.88±6.62	111.05±7.53	***
U5 to pp	85.75±5.30	85.43±5.68	NS
U6 to pp	76.15±5.59	76.86±5.25	NS
U7 to pp	65.45±7.00	71.33±7.65	*
Vertical change			
U1 to pp	31.20±3.18	32.94±3.26	*
U5 to pp	28.63±3.56	28.42±2.50	NS
U6 to pp	25.35±2.39	26.35±2.07	*
U7 to pp	21.22±2.92	23.24±2.05	***
Horizontal change			
U1 to pp	-3.68±3.29	-1.39±2.24	*
U5 to pp	18.77±2.26	16.16±2.49	***
U6 to pp	26.52±2.52	24.15±2.55	***
U7 to pp	37.58±2.68	35.86±2.86	***

(N.S. : not significant, * : p<0.05, ** : p<0.01, *** : p< 0.001)

Table 6. Mandibular dental changes during treatment in Class II extraction group

	pre-treatment mean±S.D.	post-treatment mean±S.D.	t-test
Angular change			
L1 to mp	96.23±6.71	92.38±6.76	*
L5 to mp	78.70±5.86	77.35±5.71	NS
L6 to mp	75.45±5.16	72.52±4.13	*
L7 to mp	78.02±6.71	70.25±4.25	***
Vertical change			
L1 to mp	46.35±2.95	45.82±2.96	NS
L5 to mp	38.63±2.52	40.93±2.73	***
L6 to mp	35.95±2.28	37.92±2.89	***
L7 to mp	32.40±2.45	33.98±2.64	***
Horizontal change			
L1 to mp	5.45±3.70	7.55±3.08	*
L5 to mp	18.83±2.97	17.80±2.66	NS
L6 to mp	26.73±3.09	25.45±2.73	*
L7 to mp	39.38±3.40	37.65±2.91	*

(N.S. : not significant, * : p<0.05, ** : p<0.01, *** : p< 0.001)

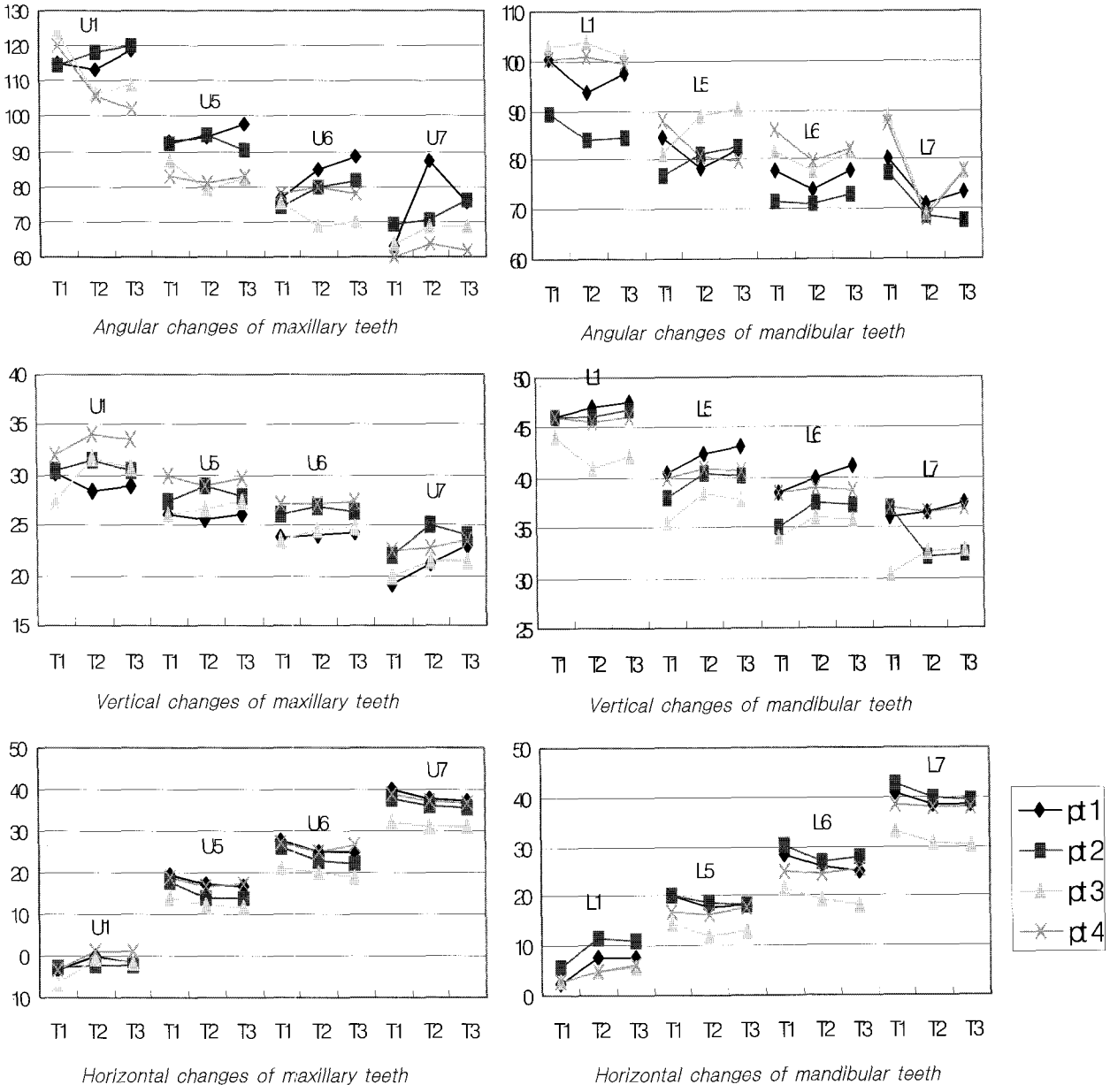


Fig. 6. Dental changes of extraction group.

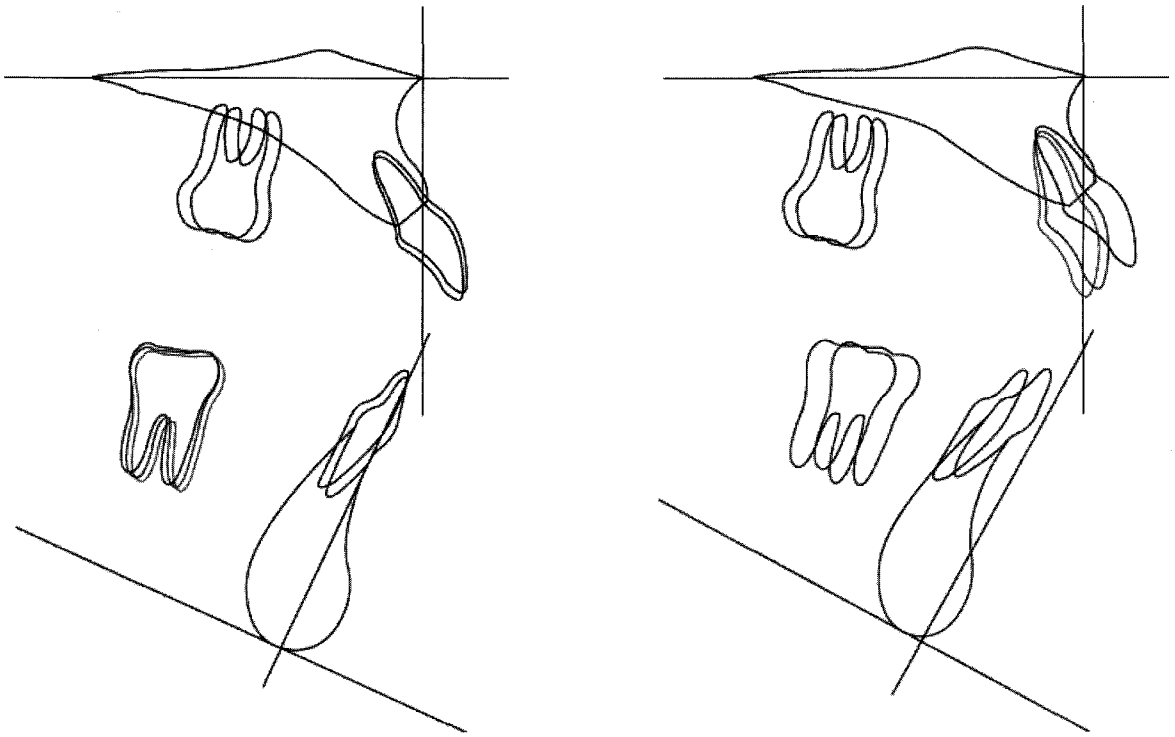
were retained in their position.

Mean changes of the maxillary teeth during treatment and retention were illustrated(Fig. 6).

3) Mandibular teeth

As for the angular changes of the tooth axis, the incisor($p<.05$) showed significant lingual tipping, but the first molar($p< .05$) and the second molar($p< .001$) showed distal tipping. As for the vertical changes, the second premolar, first molar and second molar showed significant extrusion($p< .001$). As for the horizontal changes, the incisor showed significant distal movements($p< .05$), and the first molar and second molar did mesial movements($p< .05$)(Table 6).

During retention, incisors that had tipped lingually during treatment had a tendency of slight proclination,



Non-extraction case *Extraction case*

Fig. 7. Dental changes during treatment and retention of class II malocclusion.

while first and second molar that had tipped distally during treatment had a tendency to slightly tip mesially. As for the vertical changes, molar that had been quite extruded during treatment had a tendency to be retained in its position. As for the horizontal changes, both retracted incisors and protracted molars had a tendency to be retained in their position.

Mean changes of the mandibular teeth during treatment and retention were illustrated(Fig. 6).

DISCUSSION

Skeletal Class II division 1 malocclusion may be resulted from the mandibular deficiency, maxillary excess, or combination and clinically characterized by increased overbite and overjet, protruded incisor, rotated molar, and mesially inclined tooth axis.[1-4,20]

The correction of Class II malocclusion can be achieved by extraoral force, functional appliance, Herbst appliance and Class II elastics etc. Jakobson[6] and Gianelly et al[9] indicated that extraoral traction produced maxillary orthopedics which could represent either restriction of the growth of the maxilla and/or distal movement of the maxillary complex. Also, Remmer et al[10] indicated that functional appliances altered a Class II relationship through transmission of muscular force to the dentition and alveolus by positioning the mandible anterior to its usual position, and that fixed appliances required intermaxillary elastics and/or extraoral traction. West[13] noted that correction of occlusion and facial esthetics could be made possible by extraoral traction and intermaxillary elastics, which resulted from jaw growth and change of maxillary alveolar process and dentition. Bishara et al[2] also described that the success of treatment depends as much on the skill of the orthodontist as on a favorable pattern of facial growth, so, lack of sufficient and/or favorable growth, during treatment, will make it difficult to correct the skeletal malrelationship or improve the profile.

Dyer et al[16] who studied the mandibular response to treatment of Class II malocclusion reported that the adults showed no significant increases in mandibular length and showed a decreases in facial angle. In the same manner, Remmer et al[10] reported that mandible had little forward movement in the fixed therapy, comparing with activator therapy.

The result of this study showed no significant changes in the measurements that described the anteroposterior position of mandible, but showed significant increases only in the mandibular body length. The observed changes may be due to mandibular response following treatment because we selected the patients who remain growth potential and all of their second molars were erupted. This result coincides with the results of study of Adenwalla and Kronman[11] reporting the increase in the SNB, SND and mandibular length of patient who remains to grow potentially. It may be resulted from the slight growth of the condyle and the anterior repositioning of the mandible.

Class II elastic force is usually employed to be compensated for the absence of substantive growth in adults. Therefore, the main sagittal correction in adults may be resulted from steepening of occlusal plane. Dyer et al[16]and Harris et al[15] also reported that the adult showed the steeper occlusal plane than the adolescents. Class II elastics produce not only anteroposterior and transverse effects but also a vertical force. This force elongates the mandibular molars and the maxillary incisors, rotating the occlusal plane up posteriorly and down anteriorly. If amount of extrusion of maxillary molars was larger than the growth of ramus vertically, the mandible itself will be rotated downward. Class II elastics are therefore contraindicated in nongrowing patients who cannot tolerate some downward and backward rotation of the mandible.[21] Condylar growth and vertical development of the alveolar process during childhood allow tooth movement to be partly extrusive. In the adult, extrusion of teeth in the posterior segment will lead to an opening of the bite through backward rotation of the mandible, resulting in increased facial height and overjet. Therefore, major difference in treatment of the adults is the demand for vertical control of the molars. Nelson et al[12] and Greekmore et al[22] also reported that class II elastics have increased the vertical height. Also, Harris and Dyer[16], Adenwalla and Kronman[11] reported the significant increases in the facial height. Similarly, Nelson et al[23] reported the increase of the mandibular plane angle and lower facial height. Schudy[14] suggested that Class II elastics are disastrous when the angle SNM(SN-MP) is above 45° and the OM(OP-MP) angle is above 25°. Under these circumstances the pull of the elastics causes an elevation of the mandibular molars. This causes point B and pogonion to go downward and backward resulting in opening the bite and an increase rather than a decrease of the ANB angle. In similar to previous study, the result of this study showed significant increase in anterior, posterior facial height and lower facial height in both group, and did rather than significant decrease in SNB in extraction group.

Tooth movement can be an important factor in the correction of adult Class II malocclusion. In this study, the changes of dental patterns in adult Class II treatment was evaluated by superimposing pretreatment, post-treatment and retention cephalogram in reference to palatal plane for the maxilla and madibular plane for the mandible, respectively. In the maxilla, palatal plane was established by superimposing on the lingual cortical plate of the lower border of the palate in according to "best fit method"[24] and then vertical line was drawn on the ANS. The angular, vertical and horizontal changes for upper teeth was measured. In the mandible, mandibular plane was established by superimposing on the internal cortical structure, microstructure of mandibular canal that was a stable structure, in according to "mandibular structural method "[24-26], and then vertical line was drawn on the Pm. In the same manner, the angular, vertical and horizontal changes for lower teeth was measured. Here, tooth axis was determined from the line connecting the bisecting point of mesiodistal width of the crown and the bisecting point of mesiodistal width of the apical 1/3. This is due to severe morphologic variation in the apical 1/3.[27,28]

Klein noted that distal bodily movement of the upper first molar was occurred by cervical traction. While,

Harvold and Vargervik[29] stated that a class II molar relationship may be corrected by inhibiting the downward migration of the maxillary teeth while permitting eruption of the mandibular teeth. McNamara et al[8] reported that dentoalveolar adaptations due to treatment included a decrease in the normal forward movement of the upper molar and an increase in the normal vertical movement of the lower molar. Also, Dyer et al[16] reported that upper molar was intruded and upper incisor was retracted, extruded and uprighted followed by steepening of the occlusal plane. They also reported that lower incisor was intruded and lower molar was extruded followed by vertical displacements of the mandible.

Results of Pancherz' study on the treatment of Class II malocclusion with Herbst appliance revealed that average 6.7mm of molar correction was mainly a result of a 2.2mm increase in mandibular length, a 2.8mm distal movement of the maxillary molars, and a 1.0mm mesial movement of the mandibular molars, while average 5.2mm of overjet correction was mainly a result of a 2.2mm increase in mandibular length, a 1.8mm mesial movement of the mandibular incisors.[30] Nelson et al[12], who compared subjects treated with Class II elastics with subjects treated with Herbst appliance, reported that the skeletal part of the overjet reduction was 4% in the Begg group compared with 51% in the Herbst group, and skeletal part of the molar correction was 10% in the Begg group compared with 66% in the Herbst group. Also, Nelson et al[22] reported that overjet reduction and molar correction was obtained through fixed appliance and the changes were mostly dental.

The study of Harris et al[15] showed the distal movement of the maxillary incisors and uprighting of the mandibular incisors. In this study, the maxillary incisor of both group showed significant extrusion and distal traction. Dermaut and Beerden[31] reported that the effects of Class II elastics on a dry skull revealed the vertical displacement of the first molar. In this study, maxillary molar of nonextraction group showed extrusion with no horizontal movement, and mandibular molars showed significant extrusion and distal tipping with no horizontal movements. Therefore, the result of this study didn't show distal movements of the upper molar or mesial movements of the lower molar in Class II treatment. In the extraction group, maxillary incisor showed more significant extrusion, distal traction and lingual inclination than that in the nonextraction groups. Maxillary molar showed the significant mesial movement. The anchorage loss of the maxillary molar can be compensated with mandibular growth and mesial movement of the mandibular molars by orthodontic forces in adolescents, while molar correction can be achieved by mesial movement of the mandibular molar in no help of growth in adults. So, adults may be required the proper mechanism to prevent the anchor loss.

Consequently, Class II relationships may be corrected by steepening of the occlusal plane resulting from extrusion of the maxillary incisors and the mandibular molars in both nonextraction group and extraction group.

In assessing the dental changes during retention periods, Harris et al[15] reported that posttreatment changes in the bony and dental structures of the adults were minimal. In this study, most of dental changes appeared to be stable during retention, while incisor tipped lingually showed a tendency to tip labially, and molar uprighted showed a tendency to tip mesially.

Representative dental changes of incisor and molar in treatment and retention could be graphically illustrated in extraction case and nonextraction case, respectively (Fig. 7).

We suppose to demand a further study about how treatment objectives are achieved in adults, and how stable the results remain after the active phase.

CONCLUSIONS

The purpose of this study was to examine the changes of skeletodental patterns in treatment and retention of Class II div.1 malocclusion, and to evaluate the proper treatment modality. Pre-treatment and post-treatment cephalograms of nonextraction group(22 cases) and first premolar-extraction group(20 cases) were examined. Retention cephalograms could be obtained from 4 cases of the nonextraction group and 4

cases of the extaction group. All the cases who had been treated and retained by standard edgewise technique was evaluated for the changes of the skeletal pattern by superimposing the cephalograms in reference to the cranial base, and for the changes of the dental pattern by superimposing the cephalograms in reference to the palatal plane for maxilla, or mandibular plane for mandible. Following results were obtained.

1. Both nonextraction group and extraction group showed the significant increase in vertical dimension, such as anterior facial height, posterior facial height and lower facial height, and the significant steepening of occlusal plane, after active treatment.
2. In nonextraction group, maxillary incisors were retracted and extruded in tretment, and then were slightly proclined in retention. Maxillary molars were extruded, and mandibular molars were uprighted, with no mesial movement, in treatment. And in retention, both maxillary and mandibular molars were slightly tipped mesially.
3. In extraction group, both maxillary and mandibular incisors were retracted and extruded, in treatment, and then were slightly proclined in retention. Maxillary molars were extruded and moved mesially in treatment, and mandibular molars were extruded and moved mesially with no mesial tilting, in treatment, and then were slightly tipped mesially in retention.

REFERENCES

1. Fisk GV, Culbert MR, Grainger RM. The morphology and physiology of distocclusion. Am J Orthod 1953 : 35 : 3-12.
2. Bishara SE, Zaher AR, Cummins DM, Jakobson JR. Effects of orthodontic treatment on the growth of individuals with Class II, division 1 malocclusion. Angle orthod 1994 : 64 : 221-30.
3. Duk-Jin Mo, Kyu-Rhim Chung. The study of craniofacial skeletal characteristics in Class II division 1 malocclusion. Kor J Orthod 1998 : 18 : 141-53.
4. Yoo-Kyung Kim, Hee-Moon Kyung, Oh-Won Kwon, Jae -Hyun Sung. Roentgenographic cephalometric study of Angle Class II, division 1 malocclusion in Korean children. Kor J Orthod 1989 : 19 : 67-77.
5. Klein PL. An evaluation of cervical traction on the maxilla and the upper first permanent molar. Angle Orthod 1957 : 27 : 61-8.
6. Jakobsson SO. Cephalometric evaluation of treatment effect on Class II, division 1 malocclusions. Angle Orthod 1967 : 53 : 446-57.
7. Baumrind S, Molthen R, West EE, Miller DM. Distal displacement of the maxilla and the upper first molar. Am J Orthod 1979 : 75 : 630-40.
8. McNamara JA, Bookstein FL, Shaughnessy TG. Skeletal and dental changes following functional regulator therapy on Class II patients. Am J Orthod 1985 : 88 : 91-110.
9. Gianelly AA, Arena SA, Bernstein L. A comparison of Class II treatment changes noted with the light wire, edgewise, and Fränkel appliances. Am J Orthod 1984 : 86 : 269-76.
10. Remmer KR, Mamandras AH, Hunter WS. Cephalometric changes associated with treatment using the activator, the Fränkel appliance, and the fixed appliance. Am J Orthod 1985 : 88 : 363-72.
11. Adenwalla ST. Kronman JH. Class II, division 1 treatment with Fränkel and edgewise appliances. Angle Orthod 1985 : 55 : 281 -98.
12. Nelson B, Hansen K. Hägg U. Class II correction in patients treated with Class II elastics and with fixed functional appliances : A comparative study. Am J Orthod Dentofac Orthop 2000 : 118 : 142-9.
13. West EE. Analyses of early Class II, division 1 treatment. Am J Orthod 1957 : 43 : 769-77.
14. Schudy FF. Cant of the occlusal plane and axial inclinations of teeth. Angle Orthod 1963 : 33 : 69-82.
15. Harris EF, Vaden JL, Dunn KL, Behtents RG. Effects of patient age on postorthodontic stability in Class II, division 1 malocclusions. Am J Orthod Dentofac Orthop 1994 : 105 : 25-34.
16. Dyer GS, Harris EF, Vaden JL. Age effects on orthodontic treatment : Adolescents contrasted with adults. Am J Orthod Dentofac Orthop 1991 : 100 : 523-30.
17. Harris EF, Dyer GS, Vaden JL. Age effects on orthodontic treatment : Skeletodental assessments from the Johnston analysis. Am J Orthod Dentofac Orthod 1991 : 100 : 531-6.
18. Barrer HG. The adult orthodontic patient. Am J Orthod 1977 : 72 : 617-40.
19. Bo-Seon Kang, Won-Sik Yang. A comparative analysis of Class II division 1 treatments : adolescents contrasted with adults. Kor J Orthod 1995 : 25 : 247-61.
20. Young-Chel Park, Hyeon-Shik Hwang, Kwang-Chul Choy. Biomechanics in clinical orthodontics. Seoul : Narae Publishings, 1997 : 143-55.
21. Proffit WR. Contemporary orthodontics, 3rd edition, St Louis : CV Mosby, 2000 : 565-6.
22. Greekmore TD. Inhibition or stimulation of the vertical growth of the facial complex, its significance to treatment. Angle Orthod 1967 : 37 : 285-97.
23. Nelson B, Hansen K, Hägg U. Overjet reduction and molar correction in fixed appliance treatment of Class II, division 1 malocclusions : sagittal and vertical components. Am J Orthod Dentofac Orthop 1999 : 115 : 13-23.
24. Cook AH, Sellke TA, BeGole EA. The variability and reliability of two maxillary and mandibular superimposition techniques. Part II. Am J Orthod Dentofac Orthop 1994 : 106 : 463-71.
25. Youn-Sic Chun, Chung-Ju Hwang. Logic for the use of stable structural superimposition method and introduction of its application. Kor J Orthod 1997 : 27 : 669-82.
26. Dibbets JM. A method for structural mandibular superimpositioning. Am J Orthod Dentofac Orthop 1990 : 97 : 66-73.
27. Byung-Taik Choi, Won-Sik Yang. A roentgenocephalometric study on mesiodistal axial inclination of posterior teeth. Kor J Orthod 1984 : 14 : 151-9.
28. Sang-Beom Jeon, Jin-Beom Kim, Woo-Sung Shon. A cephalometric study on mesiodistal axial inclination of posterior teeth in open bite and deep bite. Kor J Orthod 1993 : 23 : 391-403.
29. Harvold EP. and Vargervik K. Morphogenic response to activator treatment. Am J Orthod 1971 : 60 : 478-90.

30. Pancherz H. The mechanism of Class II correction in Herbst appliance treatment : A cephalometric investigation. Am J Orthod 1982 : 82 : 104-13.

31. Dermaut LR. and Beerden L. The effects of Class II elastic force on a dry skull measured by holographic interferometry. Am J Orthod 1981 : 80 : 296-304.

국문초록

II급 부정교합의 치료와 유지시 골격치성요소의 변화

원광대학교 치과대학 교정학교실

김 상 철·김 선 영

일반적이고 포괄적인 Edgewise 방법으로 치료하고 유지시킨 II급 부정교합의 골격 및 치성요소의 변화를 치료 전, 후 및 유지시의 측모두부방사선사진을 비교하여 알아봄으로써 성인 II급 부정교합의 치료 양식을 살펴보고자 하였다. 비발치로 치료한 II급 부정교합자 22명과 상하악 제1소구치 발치로 치료한 20명을 대상으로 치료 전, 후의 측모두부방사선사진을 비교하였으며, 발치치료군 4명과 비발치치료군 4명의 유지시 측모두부방사선사진을 채득하여 유지시의 변화를 살펴보았다. 두개저 및 상,하악 기저골에 기준으로 서로 중첩시켜 골격양상의 변화 및 치아의 경사도와 수직적, 수평적 변화양상을 관찰하여 평가한 결과 다음과 같은 결론을 얻었다.

1. 발치군과 비발치군 모두에서 전, 후방 안면고경과 하안면고경 등의 수직고경이 유의하게 증가하였으며, 교합평면의 유의한 경사를 보였다.
2. 비발치군에서 상악 중절치는 치료에 따른 후방견인과 정출을 보였으나 유지기간 동안 약간 순측경사 되었다. 상악 구치부는 수직적인 정출을, 하악 구치부는 원심경사를 보였으나, 근심이동은 보이지 않았다. 유지 기간 동안 상하악 구치는 약간의 근심경사를 보였다.
3. 발치군에서 상하악 중절치 모두 치료에 따른 후방견인과 정출을 보였으나 유지기간 동안 약간 순측경사되었다. 상악 구치부는 수직적인 정출과 동시에 유의한 근심이동을 보였으며, 하악 구치부는 원심경사와 수직적인 정출 및 근심이동을 보였으나 유지기간 동안 약간의 근심경사만을 보였다.

주요 단어 : II급 1류 부정교합, 골격치성 요소의 변화