

# Comparison of Soft Tissue Changes between Adolescents and Adults in Class II Malocclusion Treatment

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The purpose of this study was to evaluate the soft tissue changes of class II adolescents and adults in respect to extraction or nonextraction.

The study included 68 patients from Wonkwang Dental Hospital were categorized to adolescent extraction group, adolescent nonextraction group, adult extraction group, adult nonextraction group. Cephalometric tracing of each patient was done to compare pretreatment and posttreatment of each group, to compare the changes between groups. And among the variables that showed significance, correlation analysis and simple linear regression were done.

The results were as follows.

1. In both adolescents and adults after extraction treatment, nasolabial angle significantly increased and in both subjects after non extraction treatment, nasolabial angle significantly decreased.
2. In extraction subjects, there were positive correlation between the amount of treatment changes of vertical-U1 and E line-upper lip, the changes of vertical-L1 and E line-lower lip, the changes of vertical-L1 and vertical-Li.
3. In extraction subjects, simple regression equations of E line-upper lip, E line-lower lip, Li were calculated by regression analysis.

According to the results above, it could be considered that the effect of the extraction or nonextraction treatment was greater than the effect of growth.

Key words: Class II, Adolescent, Adult, Soft tissue change

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## I. INTRODUCTION

Attractive appearance seems to be most peoples' concern whether he or she is young or old. And so, this is also reflected to the goal of orthodontic treatment. Although esthetics used to be one of the goals of orthodontic treatment, it is getting more and more important to patients living in modern society. It is now one of the major reasons why patients seek for orthodontic treatment, and this is why orthodontist's ability to predict the esthetic result is important.

Since the past century, principles and techniques

of orthodontics has been based on Angle paradigm. According to this paradigm, the aim of treatment to achieve perfect occlusion and facial beauty would be automatically attained just as “the ideal form naturally intended”. Because of the Angle paradigm, extraction was considered to be unnecessary in order to achieve perfect occlusion. But, Tweed<sup>1</sup> observed unstable results and relapse in patients treated with non-extraction and suggested that in these cases premolars must be extracted for stable occlusion. According to Baumrind et al.<sup>2</sup> and Paquette et al.,<sup>3</sup> the biggest factor on deciding whether to extract or not was crowding(49%) and the next of all was anterior protrusion(14%), facial enhancement(9%), stability(8%) etc.

During the argument of extraction and nonextraction, another aspect rose about the effect of hard tissue changes on soft tissue changes. Recently, it is proved that the change of hard tissues is not totally reflected to the change of soft tissues. So it is accepted that the factor determinating the limit of orthodontic treatment is actually soft tissues. This shift of Angle paradigm to soft tissue paradigm has emphasized the importance of soft tissues.<sup>4</sup>

Although it could be considered that the initial state would vary between each patient, we can assume that each treatment plan could bring a different result in soft tissue changes. This was also studied by various orthodontists. Bloom,<sup>5</sup> Anderson et al.,<sup>6</sup> Rudee<sup>7</sup> reported that soft tissues were affected by the amount of teeth movement. Ridel<sup>8</sup> suggested that soft tissue profile was related with hard tissues.

But Ricketts<sup>9</sup> reported that the amount of protrusion in upper and lower lips did not decrease as the amount of teeth moved back. Burstone<sup>10</sup> reported that there was no significant relationship between the soft tissue and tooth movement because of individual variation such as lip thickness, length, position.

Growth could also be considered as an another individual variation. It could affect the soft tissue results after treatment - whether extraction or non-extraction is selected. There were some studies

concerned about growth as a factor affecting soft tissue results. Some studies compared the soft changes of adolescents after treatment between extraction and nonextraction in different conditions in each study.<sup>11-16</sup> There were studies trying to see the pure effect of extraction to soft tissue profile excluding the growth factor by investigating only adults<sup>17-19</sup> or trying to compare adolescents and adults. Jin & Moon<sup>20</sup> studied the change of soft tissues after extraction in adolescents and adults with Class I, but this only reported about the difference between pretreatment and posttreatment in each group not comparing the amount of treatment change between each group.

Thus, the aim of this study is to investigate the difference of soft tissue changes after extraction or nonextraction, between adolescent and adult female class II patients.

## II. MATERIAL AND METHODS

### 1. Sample selection

Samples were retrospectively selected from the files of the Department of Orthodontics at Wonkwang Dental Hospital in South Korea. Selected samples were classified into 4 groups; 13 female adolescents were treated with extraction of the first premolar on each quadrant of the dentition. 20 female adolescents were treated with nonextraction. 19 female adults were treated with extraction of the first premolar on each quadrant of the dentition. 16 female adults were treated with nonextraction(Table 1).

### 2. Measurements

The lateral cephalograms were obtained in centric occlusion and were digitized(Fig. 1, Table 2). Tracings and locations of dentoskeletal landmarks were marked and measurements was done by 1 investigator(N.Y.C.) using the V-ceph<sup>®</sup> program (Version 5.3, Cybermed, South Korea). Linear and angular measurements that was used is shown at Fig. 2,3 and Table 3,4.

Table 1. Initial age and treatment period of samples

		Adolescent		Adult	
		Ext.	Non-ext.	Ext.	Non-ext.
Age (years)	Mean	12.60	12.71	22.42	22.89
	SD	2.02	1.99	4.25	5.06
Treatment Period (years)	Mean	2.80	2.10	2.36	2.15
	SD	0.87	0.65	0.65	0.61

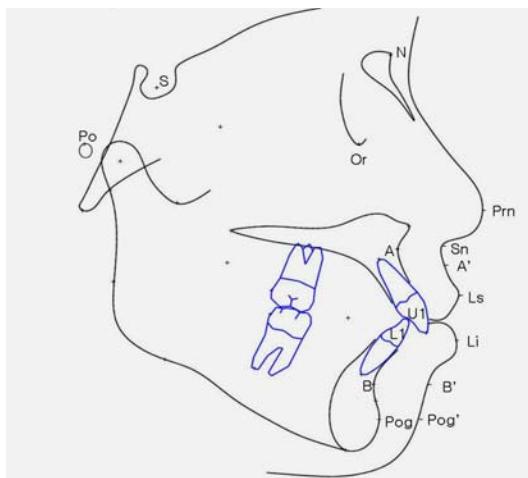


Fig. 1. Cephalometric landmarks.

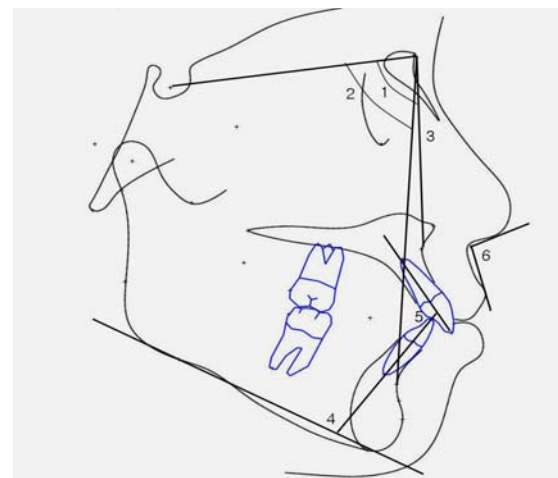


Fig. 2. Angular measurements.

1. SNA, 2. SNB, 3. ANB, 4. IMPA
5. Interincisal angle, 6. Nasolabial angle.

Table 2. Cephalometric landmarks

<p>S : Center of sella turcica                  N : 'V' notch of frontal and nasal bone                  Or: Most inferior point of the orbital contour                  Po: Most anterior point of the symphysis                  A: Deepest point between ANS and the upper incisal alveolus                  B: Deepest point between pogonion and the lower incisal alveolus                  UI: Center of the crown of the upper incisor                  LI: Center of the crown of the lower incisor                  Is: Tip of the crown of the upper incisor                  Pog: Most anterior point of the symphysis                  Prn: Tip of the nose                  Sn: Crossing point of the inferior border of nose and the origin of upper lip                  A': Soft tissue A point                  Ls: Most anterior point of the upper lip                  Li: Most anterior point of the lower lip                  B': Soft tissue B point                  Pog': Most anterior point of the soft tissue symphysis</p>
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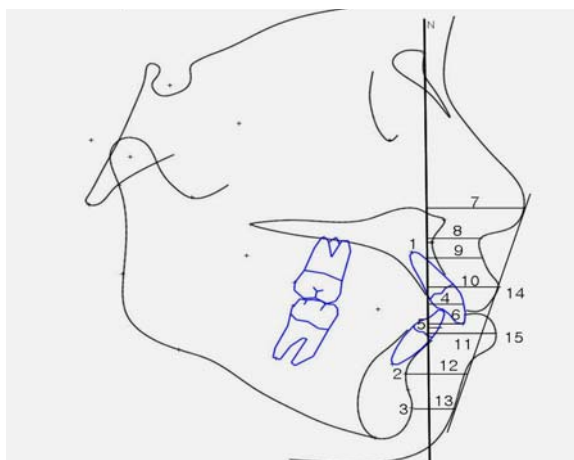


Fig. 3. Linear measurement.

- 1.vertical-A. 2.vertical-B. 3.vertical-Pog
- 4.vertical-U1. 5.vertical-L1. 6.vertical-Is
- 7.vertical-Prn. 8.vertical-Sn. 9.vertical-A'
- 10.vertical-Ls. 11.vertical-Li. 12.vertical-B'
- 13.vertical-Pog'. 14.E-upper lip.
- 15.E-lower lip.

Table 3. Angular measurements

**Skeletal variables**

SNA: SN to NA angle

SNB: SN to NA angle

ANB: NA to NB angle

**Dental variables**

Interincisal angle: Angle between the long axis of maxillary and mandibular incisors

IMPA: Angle between the long axis of mandibular incisor and mandible plane

**Soft tissue variables**

Nasolabial angle: Cl, Sn, UL angle

In order to see intra-examiner errors, fifteen cephalograms were randomly selected and remeasured by the same examiner. The casual error was calculated according to Dahlberg's formula<sup>21)</sup> ( $S^2 = \Sigma d^2 / 2n$ ), where  $S^2$  is the error variance,  $d$  is the

Table 4. Linear measurements

**Skeletal variables**

VRL-A: Linear distance from A point to nasion perpendicular

VRL-B: Linear distance from B point to nasion perpendicular

VRL-Pog: Linear distance from pog to nasion perpendicular

**Dental variables**

U1-Apog: Linear distance from U1 to A-pog plane

L1-Apog: Linear distance from L1 to A-pog plane

U1-FP: Linear distance from U1 to Facial plane

L1-FP: Linear distance from L1 to Facial plane

VRL-U1: Linear distance from U1 to nasion perpendicular

VRL-L1: Linear distance from L1 to nasion perpendicular

VRL-Is: Linear distance from Is to nasion perpendicular

**Soft tissue variables**

UL-E line: Distance from the upper lip to the esthetic plane to Ricketts(line from Pg' to Pr)

LL-E line: Distance from the lower lip to the esthetic plane to Ricketts(line from Pg' to Pr)

VRL-Prn: Linear distance from Prn to nasion perpendicular

VRL-Sn: Linear distance from Sn to nasion perpendicular

VRL-Ls: Linear distance from Ls to nasion perpendicular

VRL-Li: Linear distance from Li to nasion perpendicular

VRL-A': Linear distance from soft tissue A to nasion perpendicular

VRL-B': Linear distance from soft tissue B to nasion perpendicular

VRL-Pog': Linear distance from soft tissue Pog to nasion perpendicular

difference between the 2 determinations of the same variable and the systemic error with dependent *t* test, at  $p < 0.05$ .

The range of casual error was 0.35 to 1.36, and no variable had statistically significant systematic errors.

### 3. Statistical analyses

The Shapiro-Wilk test was applied to verify the normal distribution of the variables. Paired *t*-tests were used to compare the pretreatment and posttreatment stages in each group. Independent *t*-tests were used to compare the amount of treatment changes between groups. Correlation analysis was done to see the correlation between dental variables and soft tissue variables in extraction subjects. Based on this result, simple regression analysis was used to see the relationship between vertical-U1 and E line-upper lip, vertical-L1 and E line-lower lip, vertical-L1 and Li. Results were considered statically significant at  $p < 0.05$ .

## III. RESULTS

### 1. Comparisons between pretreatment and posttreatment

Table 5 to 8 shows the result of the comparison between pretreatment and posttreatment. In the adolescent extraction group, SNB, ANB, vertical-U1, vertical-L1, vertical-Is, U1 to Apog, L1 to Apog, U1 to FP, L1 to FP, IMPA, interincisal angle, nasolabial angle, E line-upper lip, E line-lower lip, vertical-Prn, vertical-Li, vertical-Pog' were statistically different between pretreatment and posttreatment.

In the adolescent nonextraction group, SNB, ANB, IMPA, nasolabial angle, vertical-Prn, vertical-Sn were statistically different between pretreatment and posttreatment.

In the adult extraction group, vertical-U1, vertical-L1, vertical-Is, U1 to Apog, L1 to Apog, U1 to FP, L1 to FP, IMPA, interincisal angle, nasolabial angle, E line-upper lip, E line-lower lip, vertical-Li

were statistically different between pretreatment and posttreatment.

In the adult nonextraction group, nasolabial angle was the only statistically different variable.

### 2. Comparisons between extraction and nonextraction groups

*Adolescent subjects.* Table 9 shows the result of the comparison of the amount of treatment changes(T1-T2) between the extraction group and the nonextraction group. The changes of vertical-U1, vertical-L1, U1 to Apog, L1 to Apog, U1 to FP, L1 to FP, IMPA, interincisal angle, nasolabial angle, E line-upper lip, E line-lower lip, vertical-Sn, vertical-Ls were statistically significant.

*Adult subjects.* Table 10 shows the result of the comparison of the amount of treatment changes(T1-T2) between the extraction group and the nonextraction group. The changes of vertical-U1, vertical-L1, vertical-Is, U1 to Apog, L1 to Apog, U1 to FP, L1 to FP, IMPA, interincisal angle, nasolabial angle, E line-upper lip, E line-lower lip, vertical-Li were statistically significant.

### 3. Comparisons between adolescent groups and adult groups

*Extraction subjects.* Table 11 shows the result of the comparison of the amount of treatment changes(T1-T2) between the adolescent group and the adult group. The changes of SNB, nasolabial angle, E line-upper lip, vertical-Prn, vertical-Pog' were statistically significant.

*Nonextraction subjects.* Table XI also shows the result of the comparison of the amount of treatment changes(T1-T2) between the adolescent group and the adult group. The changes of SNB, ANB, vertical-Prn, vertical-Pog' were statistically significant.

### 4. Correlation analysis

In extraction subjects, there were positive correlation between the amount of treatment changes

Table 5. Comparison between pretreatment and posttreatment in adolescent extraction group

Variable	unit	Pretreatment(T1)		Posttreatment(T2)		T value
		Mean	SD	Mean	SD	
<b>Skeletal variables</b>						
SNA	°	79.89	2.53	79.27	2.63	2.124
SNB	°	75.35	3.23	75.74	3.21	-2.384*
ANB	°	4.25	1.35	3.50	1.25	2.341*
Vertical-A	mm	-1.88	2.02	-2.18	2.16	1.071
Vertical-B	mm	-11.37	4.17	-10.45	3.97	-1.498
Vertical-Pog	mm	-11.93	5.72	-10.47	4.59	-1.561
<b>Dental variables</b>						
Vertical-U1	mm	5.76	3.59	2.80	2.46	3.799**
Vertical-L1	mm	0.88	4.07	-1.94	2.89	3.173**
Vertical-Is	mm	4.87	4.69	1.61	2.52	2.569*
U1 to Apog	mm	13.42	1.29	7.69	1.34	14.276***
L1 to Apog	mm	8.05	1.35	4.36	1.39	10.019***
U1 to FP	mm	15.15	3.30	9.68	1.82	8.008***
L1 to FP	mm	10.69	2.59	6.61	1.83	8.363***
IMPA	°	100.34	6.98	94.00	8.95	5.409***
Interincisal angle	°	109.66	9.45	125.13	8.42	-7.906***
<b>Soft tissue variables</b>						
Nasolabial angle	°	96.99	9.63	102.76	9.70	-6.658***
E line-Upper lip	mm	3.60	1.87	0.60	1.28	6.692***
E line-Lower lip	mm	5.72	2.90	2.04	2.12	6.362***
Vertical-Prn	mm	25.45	3.50	27.47	2.26	-3.110**
Vertical-Sn	mm	12.52	2.73	12.48	2.92	0.114
Vertical-Ls	mm	18.85	3.05	17.69	3.05	2.187
Vertical-Li	mm	15.59	4.43	13.77	3.15	2.340*
Vertical-A'	mm	13.37	3.33	12.80	2.73	1.096
Vertical-B'	mm	3.00	5.29	3.27	4.28	-0.306
Vertical-Pog'	mm	0.58	6.25	3.14	4.63	-2.406*

\* $p < 0.05$  ; \*\* $p < 0.01$  ; \*\*\* $p < 0.001$ .

Table 6. Comparison between pretreatment and posttreatment in adolescent non extraction group

Variable	unit	Pretreatment(T1)		Posttreatment(T2)		T value
		Mean	SD	Mean	SD	
<b>Skeletal variables</b>						
SNA	°	78.89	3.46	78.53	3.46	1.124
SNB	°	73.33	3.78	73.83	3.50	-2.446*
ANB	°	5.16	0.79	4.26	1.16	3.429**
Vertical-A	mm	-2.38	1.89	-2.25	2.21	-0.336
Vertical-B	mm	-12.22	3.62	-11.85	4.45	-0.539
Vertical-Pog	mm	-13.54	4.26	-13.02	5.22	-0.646
<b>Dental variables</b>						
Vertical-U1	mm	4.04	2.33	4.04	2.67	-0.007
Vertical-L1	mm	-2.51	3.99	-1.31	3.79	-1.777
Vertical-Is	mm	2.99	3.00	2.64	3.04	0.540
U1 to Apog	mm	8.93	1.43	8.89	2.28	0.153
L1 to Apog	mm	5.44	1.32	5.79	1.49	-1.600
U1 to FP	mm	13.11	2.74	12.39	2.87	1.795
L1 to FP	mm	7.97	2.88	8.28	2.69	-1.237
IMPA	°	95.29	3.86	97.25	4.64	-2.258*
Interincisal angle	°	121.74	8.80	118.70	7.57	1.305
<b>Soft tissue variables</b>						
Nasolabial angle	°	99.52	7.13	95.01	8.59	2.543*
E line-Upper lip	mm	2.14	1.83	1.97	1.89	1.118
E line-Lower lip	mm	3.94	2.94	3.50	2.75	1.298
Vertical-Prn	mm	25.24	3.07	26.71	2.96	-2.946**
Vertical-Sn	mm	11.28	2.36	12.30	1.67	-2.509*
Vertical-Ls	mm	17.17	3.04	17.62	3.42	-0.930
Vertical-Li	mm	14.04	3.51	14.15	3.66	-0.128
Vertical-A'	mm	12.56	2.14	12.79	2.17	-0.555
Vertical-B'	mm	2.92	5.08	2.62	4.78	0.350
Vertical-Pog'	mm	1.14	6.84	1.53	6.75	-0.414

\* $p < 0.05$  ; \*\* $p < 0.01$  ; \*\*\* $p < 0.001$ .

Table 7. Comparison between pretreatment and posttreatment in adult extraction group

Variable	unit	Pretreatment(T1)		Posttreatment(T2)		T value
		Mean	SD	Mean	SD	
<b>Skeletal variables</b>						
SNA	°	80.64	4.19	80.18	4.21	2.807
SNB	°	75.92	4.45	76.59	4.06	-1.126
ANB	°	4.32	1.55	4.03	1.52	1.489
Vertical-A	mm	-1.00	3.19	-0.37	3.09	-1.005
Vertical-B	mm	-10.09	5.96	-9.24	4.62	-0.987
Vertical-Pog	mm	-11.19	6.58	-9.66	5.15	-1.452
<b>Dental variables</b>						
Vertical-U1	mm	6.79	4.34	3.25	4.05	4.748***
Vertical-L1	mm	1.31	5.13	-1.84	4.43	3.290**
Vertical-Is	mm	6.45	4.51	1.39	4.23	5.486***
U1 to Apog	mm	12.86	1.38	6.16	2.09	13.167***
L1 to Apog	mm	8.67	1.18	2.81	1.76	16.353***
U1 to FP	mm	14.69	3.71	8.50	2.76	8.023***
L1 to FP	mm	10.36	3.07	4.95	2.80	6.248***
IMPA	°	97.49	5.94	88.59	7.07	4.946***
Interincisal angle	°	113.11	8.73	133.78	12.34	-4.996***
<b>Soft tissue variables</b>						
Nasolabial angle	°	99.92	7.25	103.56	7.84	-2.694*
E line-Upper lip	mm	0.95	1.79	-0.63	1.60	4.058**
E line-Lower lip	mm	3.57	2.73	-0.12	2.47	7.722***
Vertical-Prn	mm	27.26	3.28	27.51	3.82	-0.495
Vertical-Sn	mm	12.52	2.97	12.75	2.79	-0.397
Vertical-Ls	mm	17.73	4.66	16.65	3.85	1.578
Vertical-Li	mm	15.06	5.12	12.33	4.22	3.266**
Vertical-A'	mm	13.26	3.56	12.79	3.36	0.808
Vertical-B'	mm	4.10	5.68	4.15	4.58	-0.048
Vertical-Pog'	mm	2.49	7.01	3.50	5.52	-1.212

\* $p < 0.05$  ; \*\* $p < 0.01$  ; \*\*\* $p < 0.001$ .



Table 8. Comparison between pretreatment and posttreatment in adult non extraction group

Variable	unit	Pretreatment(T1)		Posttreatment(T2)		T value
		Mean	SD	Mean	SD	
<b>Skeletal variables</b>						
SNA	°	82.58	3.70	82.30	3.64	1.360
SNB	°	77.29	3.46	76.70	3.02	2.276
ANB	°	5.29	1.19	5.59	1.45	-1.497
Vertical-A	mm	0.76	3.00	0.61	3.42	0.400
Vertical-B	mm	-9.41	3.66	-10.02	4.10	1.047
Vertical-Pog	mm	-11.11	5.06	-12.44	5.32	1.849
<b>Dental variables</b>						
Vertical-U1	mm	7.77	2.87	7.01	3.07	1.870
Vertical-L1	mm	2.15	3.89	1.87	3.31	0.468
Vertical-Is	mm	7.05	3.19	6.25	2.71	1.374
U1 to Apog	mm	10.00	0.826	9.92	0.79	0.251
L1 to Apog	mm	6,09	1.34	6.52	1.66	-1.082
U1 to FP	mm	15.32	2.33	14.66	2.53	1.899
L1 to FP	mm	12.04	2.95	11.20	3.09	1.467
IMPA	°	101.40	7.80	103.21	8.70	-1.868
Interincisal angle	°	109.65	7.62	115.01	8.78	-2.163
<b>Soft tissue variables</b>						
Nasolabial angle	°	99.96	6.65	96.22	5.95	2.358*
E line-Upper lip	mm	2.67	1.96	2.79	2.13	-0.714
E line-Lower lip	mm	4.24	2.45	4.07	2.42	0.467
Vertical-Prn	mm	29.42	3.24	29.73	4.25	-0.653
Vertical-Sn	mm	14.40	2.88	13.65	4.86	0.764
Vertical-Ls	mm	20.26	4.03	19.39	4.00	1.177
Vertical-Li	mm	15.86	4.16	16.00	4.33	-0.250
Vertical-A'	mm	15.69	2.76	15.16	3.67	0.906
Vertical-B'	mm	5.88	5.37	5.39	5.73	0.697
Vertical-Pog'	mm	4.53	7.37	1.87	6.95	2.114

\* $p < 0.05$  ; \*\* $p < 0.01$  ; \*\*\* $p < 0.001$ .

Table 9. Comparison of the amount of treatment changes between adolescent extraction group and adolescent non extraction group

Variable	unit	adolescent extraction group (N=13)		adolescent non extraction group (N=20)		T value
		Mean	SD	Mean	SD	
<b>Skeletal variables</b>						
SNA	°	0.61	1.04	0.35	1.41	0.606
SNB	°	-0.49	0.52	-0.50	0.92	0.053
ANB	°	0.74	1.14	0.59	1.52	0.321
Vertical-A	mm	0.29	0.98	-0.13	1.78	0.883
Vertical-B	mm	-0.91	2.19	-0.37	3.09	-0.586
Vertical-Pog	mm	-1.46	3.37	-0.51	3.58	-0.766
<b>Dental variables</b>						
Vertical-U1	mm	2.96	2.81	0.56	2.55	2.479*
Vertical-L1	mm	2.82	3.20	-1.20	3.01	3.602**
Vertical-Is	mm	3.26	4.58	0.34	2.87	2.048
U1 to Apog	mm	5.65	1.61	0.04	1.37	10.348***
L1 to Apog	mm	3.69	1.32	0.00	1.29	7.884***
U1 to FP	mm	5.46	2.46	0.71	1.78	6.008***
L1 to FP	mm	4.07	1.75	-0.30	1.11	8.007***
IMPA	°	6.33	4.22	-1.96	3.88	5.689***
Interincisal angle	°	-15.46	7.05	-3.04	8.47	-4.559***
<b>Soft tissue variables</b>						
Nasolabial angle	°	-5.38	2.26	0.53	8.38	-2.473*
E line-Upper lip	mm	3.00	1.61	0.17	0.69	6.930***
E line-Lower lip	mm	3.68	2.08	0.44	1.51	4.830***
Vertical-Prn	mm	-2.01	2.33	-1.69	2.05	-0.397
Vertical-Sn	mm	0.03	1.14	-1.01	1.81	2.047*
Vertical-Ls	mm	1.15	1.90	-0.45	2.17	2.239*
Vertical-Li	mm	1.82	2.81	-0.10	3.81	1.674
Vertical-A'	mm	0.56	1.86	-0.22	1.80	1.205
Vertical-B'	mm	-0.27	3.23	0.29	3.78	-0.463
Vertical-Pog'	mm	-2.56	3.83	-1.79	3.84	-0.558

\* $p < 0.05$  ; \*\* $p < 0.01$  ; \*\*\* $p < 0.001$ .

Table 10. Comparison of the amount of treatment changes between adult extraction group and adult non extraction group

Variable	unit	adult extraction group (N=19)		adult non extraction group (N=16)		T value
		Mean	SD	Mean	SD	
<b>Skeletal variables</b>						
SNA	°	0.34	0.95	0.28	0.83	0.183
SNB	°	-0.17	0.61	0.46	0.90	-2.387
ANB	°	0.29	0.82	-0.17	0.64	1.891
Vertical-A	mm	-0.22	3.29	0.15	1.58	-0.429
Vertical-B	mm	-0.52	4.28	0.61	2.33	-0.992
Vertical-Pog	mm	-1.07	5.25	1.32	2.87	-1.713
<b>Dental variables</b>						
Vertical-U1	mm	3.76	4.10	0.76	1.63	2.747**
Vertical-L1	mm	3.34	4.70	0.27	2.37	2.364*
Vertical-Is	mm	5.20	4.77	0.80	2.33	3.363**
U1 to Apog	mm	6.49	2.24	0.07	1.23	10.214***
L1 to Apog	mm	5.03	1.35	-0.42	1.55	10.952***
U1 to FP	mm	5.95	3.46	0.66	1.40	5.710***
L1 to FP	mm	5.15	3.81	0.83	2.28	4.129***
IMPA	°	8.33	7.81	-1.80	3.86	4.981***
Interincisal angle	°	-19.85	17.61	-6.90	8.64	-2.677**
<b>Soft tissue variables</b>						
Nasolabial angle	°	-7.47	3.95	3.73	6.34	-6.381***
E line-Upper lip	mm	1.60	1.66	-0.11	0.65	3.887***
E line-Lower lip	mm	3.62	2.04	0.16	1.43	5.847***
Vertical-Prn	mm	0.12	2.61	0.09	1.61	0.050
Vertical-Sn	mm	0.27	3.12	0.75	3.94	-0.391
Vertical-Ls	mm	1.44	3.88	0.87	2.96	0.495
Vertical-Li	mm	3.17	4.53	-0.13	2.21	2.806**
Vertical-A'	mm	0.85	3.16	0.53	2.34	0.348
Vertical-B'	mm	0.48	5.27	0.49	2.82	-0.004
Vertical-Pog'	mm	-0.34	5.46	1.91	3.08	-1.532

\* $p < 0.05$  ; \*\* $p < 0.01$  ; \*\*\* $p < 0.001$ .

Table 11. Comparison of the amount of treatment changes between adolescent extraction group and adult extraction group, adolescent-non extraction group and adult non extraction group

Variable	unit	adolescent extraction group (N=13) & adult extraction group (N=19)	adolescent non extraction group (N=20) & adult non extraction group (N=16)
		T value	
<b>Skeletal variables</b>			
SNA	°	0.757	0.185
SNB	°	-2.660**	-3.160**
ANB	°	1.023	2.042*
Vertical-A	mm	0.552	-0.520
Vertical-B	mm	-0.336	-1.087
Vertical-Pog	mm	-0.252	-1.716
<b>Dental variables</b>			
Vertical-U1	mm	-0.660	-0.269
Vertical-L1	mm	-0.376	-1.643
Vertical-Is	mm	-1.159	-0.522
U1 to Apog	mm	-1.237	-0.070
L1 to Apog	mm	-1.873	0.154
U1 to FP	mm	-0.460	0.095
L1 to FP	mm	-1.079	-1.974
IMPA	°	-0.933	-0.123
Interincisal angle	°	0.848	1.342
<b>Soft tissue variables</b>			
Nasolabial angle	°	1.938*	0.325
E line-Upper lip	mm	2.826**	1.289
E line-Lower lip	mm	0.295	0.556
Vertical-Prn	mm	-2.427*	-2.921**
Vertical-Sn	mm	-0.266	-1.659
Vertical-Ls	mm	-0.280	-1.494
Vertical-Li	mm	-1.034	0.028
Vertical-A'	mm	-0.325	-1.061
Vertical-B'	mm	-0.506	-0.178
Vertical-Pog'	mm	-1.907*	-3.206**

\* $p < 0.05$  ; \*\* $p < 0.01$  ; \*\*\* $p < 0.001$ .

Table 12. Correlation between vertical-U1 and soft tissue variables of adolescent extraction group and adult extraction group

		E line-upper lip	Nasolabial angle
Vertical-U1	adolescent extraction group	0.561*	-0.279
	adult extraction group	0.506*	0.091

Table 13. Correlation between vertical-L1 and soft tissue variables of adolescent extraction group and adult extraction group

		E line-lower lip	vertical-Li
Vertical-L1	adolescent extraction group	0.621*	0.689**
	adult extraction group	0.461*	0.850**

Table 14. Simple regression analysis on the relation between the amount of treatment change of vertical-U1 and E line-upper lip in adolescent extraction group and adult extraction group

	R <sup>2</sup>	Adjusted R <sup>2</sup>	F value	p	Equation
adolescent extraction group	0.314	0.252	5.043	0.046	$\Delta E_u = 1.262(\Delta U_1) + 0.620$
adult extraction group	0.256	0.213	5.861	0.027	$\Delta E_u = 1.085(\Delta U_1) + 0.161$

Table 15. Simple regression analysis on the relation between the amount of treatment change of vertical-L1 and E line-lower lip in adolescent extraction group and adult extraction group

	R <sup>2</sup>	Adjusted R <sup>2</sup>	F value	p	Equation
adolescent extraction group	0.386	0.330	6.910	0.023	$\Delta E_L = 2.493(\Delta L_1) + 0.366$
adult extraction group	0.213	0.166	4.592	0.047	$\Delta E_L = 2.610(\Delta L_1) + 0.231$

of vertical-U1 and E line-upper lip, vertical-L1 and E line-lower lip, vertical-L1 and vertical-Li (Table 12, 13).

### 5. Simple regression prediction

Based on the result of correlation analysis, regression of E line-upper lip, E line-lower lip, Li was done.

*E line-upper lip* In the extraction group, simple regression was used to predict E line-upper lip change. The percentage of explainable variance in E

line-upper lip was 25% in the adolescent group, 21% in the adult group (Table 14).

*E line-lower lip* In the extraction group, simple regression was used to predict E line-lower lip change. The percentage of explainable variance in E line-lower lip response was 33% in the adolescent group, 16% in the adult group (Table 15).

*Li* In the extraction group, simple regression was used to predict Li change. The percentage of explainable variance in Li response was 42% in the adolescent group, 70% in the adult group (Table 16).

Table 16. Simple regression analysis on the relation between the amount of treatment change of vertical-L1 and Li in adolescent extraction group and adult extraction group

	R <sup>2</sup>	Adjusted R <sup>2</sup>	F value	p	Equation
adolescent extraction group	0.475	0.427	9.955	0.009	$\Delta Li = 0.119(\Delta L1) + 0.604$
adult extraction group	0.722	0.706	44.146	0.000	$\Delta Li = 0.143(\Delta L1) + 0.933$

#### IV. DISCUSSION

Orthodontic treatment is a procedure establishing desirable dental and skeletal relationship through teeth movement and growth management. One of the important factors determining final facial esthetics is the soft tissue. And because of this, the soft tissue paradigm which main concept is to establish a treatment plan based on the final facial appearance will be useful for esthetic outcomes.

In order to predict these esthetic outcomes and the influence of the treatment plan that results these outcomes, the relationship between hard tissues and soft tissues must be considered. Especially, lip structure seems to have an influence on lip response to incisor retraction. In an attempt to determine the effects of incisor retraction on the profile, several studies have been conducted to quantify and predict the relationship between incisor retraction and lip retraction.<sup>5-7,15)</sup>

Several investigators have commented on the effect of maxillary incisor retraction on lip posture. Ricketts<sup>22)</sup> suggested that for every 3 mm of incisor retraction there is 1 mm of lip thickening. Bloom<sup>5)</sup> reported that since the correlation between hard tissue changes and soft tissue changes are high, it is possible to use regression analysis. Lai et al.<sup>23)</sup> found no correlation of lip retraction to changes in incisor position with treatment. Oliver<sup>24)</sup> reported that no significant correlation could be established between incisor retraction and lip movement in subjects with thick lips, whereas a high correlation was observed in those with thin lips and significant lip strain. The increase in lip thickness could have been a result of growth during that period,<sup>25)</sup> since it is difficult to separate the effects of growth and

treatment in growing patients.

In this study, we sought to assess the soft tissue differences between first premolar extraction and nonextraction of adolescent and adult patients after treatment.

Except for some variables, most treatment changes(T2-T1) of dental and soft tissue variables between adolescents and adults were similar comparing extraction subjects and nonextraction subjects each.

In extraction subjects, because of the different treatment plan, including 4 first premolar extraction, there were more significant changes than nonextraction subjects. Especially changes in dental variables were dramatic. This will be probably because of the different condition at pretreatment stage between the extraction and nonextraction group(Table 5, 7).

The type of soft tissue variable that was statistically significant were a little different between the adolescent extraction group and the adult extraction group. E line-upper lip and E line- lower lip, nasolabial angle, vertical-Li were significant in both groups but the amount of treatment change of vertical-Pm and vertical-Pog' were only significant in the adolescent extraction group. This is speculated as an effect of the growth of nose and chin. It was reported by Anderson et al.,<sup>6)</sup> Angelle,<sup>26)</sup> and Koch et al.<sup>27)</sup> that nose and chin growth exceed the lip changes observed in adolescents undergoing active treatment.

Measurement of the lips relative to Ricketts' E line focuses attention on the relationship of nose, lips and chin.<sup>28)</sup> In the extraction group, the upper and the lower lips moves back relative to the E line. For the nonextraction group, the backwards change of the lip

region was less pronounced. The cephalometric findings indicate that the upper and lower lips were more protrusive relative to the esthetic plane.

Changes in profile seems to be related to variables such as pretreatment lip strain, variations in lip structure and thickness, and amount of incisor retraction. Individual growth changes and unpredictable aspects of treatment response might play large roles in the variability of treatment results for the soft tissue profile.<sup>13)</sup>

In nonextraction subjects, the number of variables that changed significantly were more in the adolescent group than in the adult group. By SNB and vertical-Prn, it could be suspected that growth has affected the results. The nonextraction procedure affected the nasolabial angle to decrease resulting a more acute angle in both groups. Similarly, only vertical-Prn was significant in the adolescent group (Table 6, 7).

When the amount of treatment changes (T2-T1) of each group was compared, the result was somewhat different. The comparison between the adolescent extraction group and the adolescent nonextraction group, the adult extraction group and the adult nonextraction group both showed similar results because of the application of different treatment plans. When the adolescent extraction group and the adolescent nonextraction group were compared, naturally, the changes of most dental variables were significant. Nasolabial angle was more acute and upper lower lip was more pronounced to the E line in the nonextraction group. This result was similar in comparing the adult extraction group and the adult nonextraction group (Table 9, 10).

When the adolescent group and the adult group were compared in nonextraction subjects and extraction subjects each, we could see that growth was reflected to the result (Table 11). Significant difference of SNB in comparison between the adolescent extraction group and the adult extraction group shows mandible growth and difference of vertical-Prn shows nose growth in the adolescent extraction group. This is also seen in comparison of the adolescent nonextraction group and the adult

nonextraction group which also shows significant changes of SNB, vertical-Prn, vertical-Pog'. The difference of these two comparison is that nasolabial angle and E line-upper lip was significant in comparison between the adolescent extraction group and the adult extraction group, showing that, as mentioned before, there were more treatment changes in the adult extraction group than in the adolescent extraction group. This could be understood by the study of Nanda et al.,<sup>25)</sup> who stated that the nasolabial angle slightly decreased from 7 to 18 years in both sexes. Subtelny<sup>29)</sup> also found that, as the nose grew, the lower border had a tendency to tip forward and downward slightly, thereby decreasing the nasolabial angle.

By correlation analysis, the variable most related with the amount of treatment change of anterior teeth retraction was Li and the correlation coefficient was bigger in the adult extraction group, showing different pattern with E line-upper lip, E line-lower lip (Table 12, 13).

Upper and lower lip changes were predicted using simple regression analysis in the adolescent extraction group and the adult extraction group. Although the significant level was below 0.05, the explainable variance was somewhat low. This low percentage of explainable variance could be explained by the small sample size. Among three variables, E line-upper lip, E line-lower lip, Li, the explainable variance of Li was the highest, followed by E line-lower lip, E line-upper lip (Table 14, 15, 16).

According to the results in this study, age could be a factor to consider when choosing treatment plans - extraction or nonextraction. In adults, since there is no growth potential of the soft tissue, extraction must be carefully considered. Because of the demand for esthetic results, extraction is more frequently selected in adult patients than in adolescent patients. This tendency might sometimes lead to unsatisfying results since the thickness of lips decrease after the age of 16 according to Mamandras.<sup>30)</sup>

Taking into account the flexible and mobile lip texture, a rather large variability in lip position can

be expected on lateral cephalograms even when patients are instructed to keep their lips relaxed and their teeth in occlusion.<sup>31)</sup> And so, the could explain the reason for variant results for vertical-Ls, vertical-Li.

Further study must be conducted with more samples considering other possible influencing factors such as sex, lip thickness, vertical position changes of the incisor, retraction of the upper dentition, etc between adolescents and adults. These factors can have a great effect on the results of treatment.

## V. CONCLUSION

The purpose of this study was to evaluate the soft tissue changes of class II adolescents and adults in respect to extraction or nonextraction.

The study included 68 patients from Wonkwang Dental Hospital were categorized to adolescent extraction group, adolescent nonextraction group, adult extraction group, adult nonextraction group. Cephalometric tracing of each patient was done to compare pretreatment and posttreatment of each group, to compare the changes between groups. And among the variables that showed significancy, correlation analysis and simple linear regression were done.

The results were as follows.

1. In both adolescents and adults after extraction treatment, nasolabial angle significantly increased and in both subjects after non extraction treatment, nasolabial angle significantly decreased.
2. In extraction subjects, there were positive correlation between the amount of treatment changes of vertical-U1 and E line-upper lip, the changes of vertical-L1 and E line-lower lip, the changes of vertical-L1 and vertical-Li.
3. In extraction subjects, simple regression equations of E line-upper lip, E line-lower lip, Li were calculated by regression analysis.

According to the results above, it could be

considered that the effect of the extraction or nonextraction treatment was greater than the effect of growth.

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국문초록

## 청소년 및 성인 환자에서 II급 부정교합 치료시 연조직 변화에 관한 비교

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본 연구의 목적은 II급 청소년, 성인 환자에서 발치와 비발치 후 연조직 변화를 비교하기 위한 것이었다.

원광대학교 치과병원 교정과에 내원한 환자 68명을 각각 청소년발치군, 청소년비발치군, 성인발치군, 성인비발치군으로 분류하여 치료 전후의 측모 두부방사선사진을 계측하였다. 각 군의 치료 전후를 비교하고 각 군 간의 변화량을 비교하였으며, 그 중 통계적으로 유의한 변수들의 상관성과 회귀분석을 하여 다음과 같은 결과를 얻었다.

청소년과 성인의 발치군에서 비순각은 유의하게 증가하였고 비발치군에서는 유의하게 감소하였다. 발치군에서는 vertical-U1과 E line-upper lip의 변화량 간에, vertical-U1과 E line-lower lip의 변화량 간에, vertical-L1과 vertical-Li의 변화량 간에 양의 상관관계를 보였다. 또한 발치군에서 회귀분석을 통해 E line-upper lip, E line-lower lip, Li에 대한 단순 회귀방정식이 도출되었다.

주요어: II급, 청소년, 성인, 연조직 변화

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