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Changes of root lengths and crestal bone height In nail biting patients

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Although the purpose of orthodontic treatment is to increase the function and aesthetics of the jaws as well as to increase stability, there are side effects from the treatment itself such as root resorption and alveolar bone resorption. Such resorption of the apical root is unpredictable and may even proceed into the dentin layer. Once the process has begun, it is irreversible. By evaluating the effects of different oral habits, especially that of nail biting, and their correlation with the root and the periodontal tissues, the appropriate biomechanics for orthodontic treatment can be taken into consideration. The possibility of root resorption and alveolar bone loss during orthodontic treatment can also be considered. Also, any legal problems that might occur may be pondered as well.

Among the male and female patients of the ages 10~15, 63 were chosen as the test group with known nail biting habits at time of examination and within the same age range those without nail biting habits as the control group. The test group was composed of 30 males and 33 females. The control group had 31 males and 32 females.

The result from this study were as follows :

1. Of the 63 patients of both the test and control groups, the male-to-female-ratio was 1:1, and had no statistically significant difference in male and female root resorption.
2. In comparing crown length of the test and control groups, no significant difference existed, but in root length, maxillary and mandibular right and left central incisors and mandibular right lateral incisors had a smaller value. ($p<0.001$)
3. Average crown-to-root ratio of the test group on the periapical view show a noticeably high value for the maxillary and mandibular right and left central incisors and mandibular right and left lateral incisors. ($p<0.01$)
4. In comparing and evaluating the alveolar bone loss measured from the cemento-enamel junction to the alveolar bone crest, mesial surfaces of the maxillary and mandibular right and left central incisors and distal surface of maxillary right central incisor of the test group showed greater loss of crestal bone than the control. ($p<0.05$)

Key words: Nail biting habits, Root resorption, Alveolar bone loss, Crown/root ratio

The purpose of orthodontic treatment is to increase function and aesthetics of the teeth and jaws and to increase stability of the jaws. In reaching these goals, many unwanted side affects may occur. Root resorption and alveolar bone resorption are included. Resorption of the apical root is unpredictable, progresses into the dentin, and occurs irreversibly. Apical root resorption has become a frequent idiopathic problem, and recently has become a legomedical issue.

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Table 1. Average age of the control and experimental group unit : yrs

Group	Average Age
Control	12.21 1.60
Experiment	12.46 1.99

Table 2. Number of male and female patients in each group

Group	Male	Female	Total
Control	31	32	63
Experiment	30	33	63

Although most research on root resorption focuses on the cause and the predictability of root resorption, no primary cause has been clearly proven. Only individual sensitivity, hereditary factors, biomechanics related to systemic, local, and anatomical factors, etc. have been mentioned.

In 1914 Ottolengui[1] was the first directly related case of root resorption to orthodontic treatment, and in 1927, Ketcham[2] proved the change in root form on radiographic film before and after orthodontic treatment..

Also Phillips[3] and Reitan[4] noted many factors influencing root resorption of permanent dentition; physiological tooth movement, pressure from near by impacted teeth, inflammation of root apex or periodontal tissues, tooth implantation or replantation, continuous traumatic occlusion, tumors or cysts, and metabolic disorder[5] or systemic disorder, local function or behavioral problems, orthodontic treatment, idiopathic factors, etc.

On the other hand, Brezniak & Wasserstein[6] classified factors causing root resorption after orthodontic treatment into 4 groups ; biological factor, mechanical factor, biological factor and mechanical factor combined, and other factors.

Habit is one of these biological factors, and in this category, nail biting, tongue thrusting habit associated with open bite, and increased tongue pressure are included.

Odernick et al,[7] studied the relationship between frequency of habit and root resorption during orthodontic treatment of 13-15 year-old Swedish adolescents. According to his studies, among 340 adolescents who answered questionnaires, 45% had nail biting habits, and among 1,025 interviewed adolescents, 14.3% had severe nail biting habits.

Studies by Wechsler,[8] Coleman and McCalley,[9] Massler and Malone,[10] Nilner,[11] Nilner and Lassing,[12] etc. show similar frequencies.

Also in Odernick's[7] studies (252 teeth studied), apical root resorption of patients with nail biting habits after orthodontic treatment was significantly high, and Newman[3] showed that increased tongue pressure increases root resorption. Hwang & Song's[14] study also showed root resorption in patients with nail biting habits.

In Korea, very few studies on the relationship between oral habits and orthodontic treatment have been performed or on evaluating root resorption, sex before and after orthodontic treatment, type of orthodontic treatment, amount of tooth movement, length of treatment, etc.

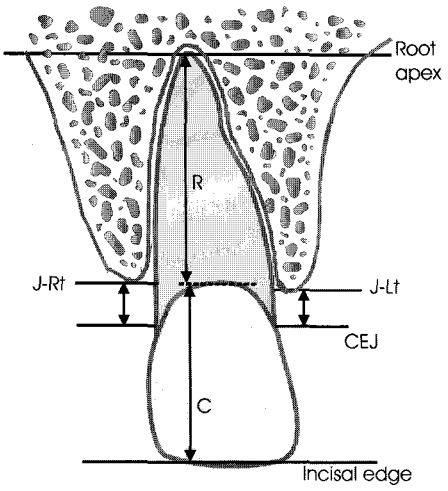
Therefore, the purpose of this study is to protect the patient during orthodontic treatment, to take into consideration the adequate biomechanics, to achieve a proper diagnosis, and document information on this unknown area of study.

MATERIALS AND METHODS

1. Materials

This study was carried out at Yonsei Dental Hospital's Department of Orthodontics from July 1997 to February 1999 using children ages 10-15 who visited with their parents, confirming their nail biting habits and having a typical nail form.[7] Due to biting nails regularly trimming nails is unnecessary and the margin is irregular.

63 patients who stated nail biting during the interview were the test group. Patients without nail biting habits among the same age group were the



C : Vertical length From incisal edge of the crown to deepest of cemento-enamel junction
R : Vertical length from deepest of cemento-enamel junction to root apex
J-Rt : Distance from cemento-enamel junction to right alveolar crest bone
J-Lt : Distance from cemento-enamel junction to left alveolar crest bone

Fig. 1. Measuring points for crown, root length and alveolar bone loss.

control group. The test group consisted of 30 males, 33 females; and the control group 31 males, 32 females. Both groups had no cleft lip, cleft palate or any other cranio-facial disorders, no known systemic disease and no previous orthodontic treatment (Fig. 2).

2. Methods

(1) Radiography

Intraoral periapical views of the maxillary and mandibular incisors were taken and long axis angles of anterior teeth were evaluated by lateral cepahalogram.

Before orthodontic treatment, intraoral periapical views of maxillary and mandibular incisors were taken by the paralleling cone technique (using XCP). The crown and root length of each four incisors of the maxilla and mandible were measured. The vertical length from the lowest portion of the interproximal bone which is located below the mesial and distal surfaces of each tooth, to the mesial and distal cemento-enamel junction of each tooth was measured.

(2) Measurements

1. Incisor length and alveolar crest bone level measuring

The measuring points are indicated in Fig. 1. First, using incisor periapical film, trace the anatomical morphology of the tooth and the alveolar bone. At this time, if the apex formation is not complete, the lowest point is taken as the apex[7]. Connect the mesial-distal incisal edges of incisors and connect the mesial-distal cemento-enamel junctions. Draw a line parallel to the incisor edges tangent to the apex. The crown length is measured vertically from the deepest portion of cemento-enamel junction to the connected incisor edge line. Root length is measured vertically from the deepest portion of the cemento-enamel junction to the apex. The mesial distal alveolar bone height change is measured at each site vertically from the paralleling line through the cemento-enamel junction to the deepest portion of the interproximal alveolar bone.

Since the lateral incisors of the maxilla and mandible overlap with the central incisors and exact measurement points were difficult to indicated, these values were ruled out.

2. Lateral cephalograms were traced to measure maxillary and mandibular long axis angles of anterior teeth. The relationship between these values and root length of each group were analyzed.

A. Maxillary incisor axial angle (Angle between long axis of upper incisors and S-N plane)
B. Mandibular incisor axial angle (Angle between long axis of lower incisors and S-N plane)

* In this study, the nomenclature of teeth are done by the F.D.I Two- Digit System.

Table 3. Comparison of long axis angles of anterior teeth

Group	Control	Experiment
U1 to SN	104.1°	106.2°
IMPA	92.9°	91.8°

(#11 : Maxillary right central incisor, #21 : Maxillary left central incisor, #31 : Mandibular left central incisor, #41 : Mandibular right central incisor, #12 : Maxillary right lateral incisor, #22 : Maxillary left lateral incisor, #32 : Mandibular left lateral incisor, #42 : Mandibular right lateral incisor)

* C : Crown length, R : Root length, J-Rt : Distance from right CEJ to alveolar crest bone, J-Lt : Distance from left CEJ to alveolar crest bone

(3) Statistical Evaluation

Paired t-test was carried out on each category, and comparison and evaluation was done at 95% reliability.

RESULTS

1. Comparison of maxillary and mandibular incisor axial angle of each group

Maxillary and mandibular incisor angle on lateral cephalograms were within normal limits, showing no difference between the two groups (Table 3).

2. Comparison of crown length

No noticeable difference between the experiment group and control group average crown lengths (Table 4).

3. Comparison of average root length

Between the two groups, the root length of maxillary and mandibular right and left central incisors and mandibular right lateral incisors was significantly shorter in the experiment group, especially the mandibular right and left central incisors had a low significance of $p<0.001$ (Table 5).

Table 4. Average and standard deviation of crown lengths (unit : mm)

	Control	Experiment	Significance
#11	11.71±0.80	11.87±0.96	ns
#21	11.84±0.84	12.12±1.21	ns
#31	9.47±0.58	9.43±0.88	ns
#41	9.57±0.61	9.44±0.99	ns
#12	10.37±0.95	10.21±1.52	ns
#22	10.34±0.82	10.64±0.87	ns
#32	9.61±0.71	9.80±0.82	ns
#42	9.50±0.68	9.75±0.82	ns

ns ; not significant

Table 5. Average and standard deviation of root length (unit : mm)

	Control	Experiment	Significance
#11	14.37±1.07	13.40±2.06	2)
#21	14.35±1.01	13.60±1.98	1)
#31	12.82±1.01	11.97±1.25	3)
#41	12.98±1.07	11.88±1.42	3)
#12	13.25±1.64	13.03±2.31	
#22	13.36±1.17	13.17±1.59	
#32	13.29±1.06	12.96±1.99	
#42	13.34±1.14	12.79±1.33	1)

3) ; $p<0.001$, 2) ; $p<0.01$, 1) ; $p < 0.05$

4. Comparison of crown-to-root ratio

Excluding the crown-to-root ratio of the maxillary right and left central incisors, the four maxillary and mandibular incisors had larger values than normal ($p<0.01$). Crown-to-root ratio of maxillary and mandibular central incisors of the experiment group were especially high (Table 6, Fig. 2, 3).

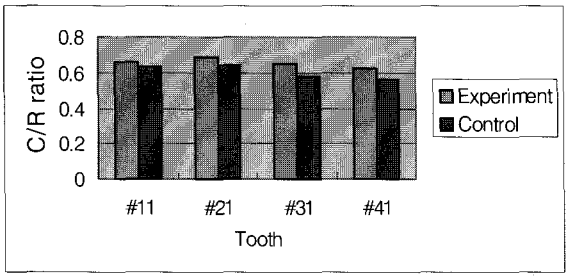


Fig. 2. Crown and root length of central incisors.

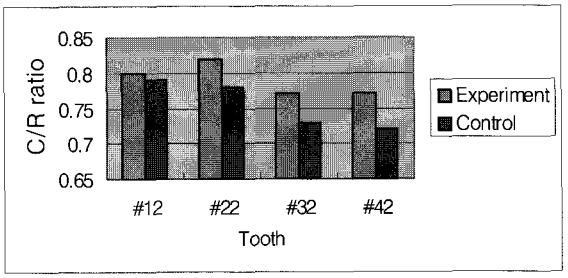


Fig. 3. Crown and root length of lateral incisors.

Table 6. Average and standard deviation of crown-to-root ratio

	Control	Experiment	Significance
#11	0.82±0.72	0.91±0.15	3)
#21	0.83±0.07	0.91±0.14	3)
#31	0.74±0.07	0.80±0.11	2)
#41	0.74±0.06	0.80±0.11	3)
#12	0.79±0.10	0.80±0.18	
#22	0.78±0.08	0.82±0.09	
#32	0.73±0.07	0.77±0.12	1)
#42	0.72±0.08	0.77±0.07	2)

3) ; p<0.001, 2) ; p<0.01, 1) ; p < 0.05

Table 7. Average and standard deviation of alveolar crest level of the maxilla (unit : mm)

	Control	Experiment	Significance
#12 - Rt	1.50±0.51	1.73±1.30	
#12 - Lt	1.35±1.00	1.34±0.90	
#11 - Rt	1.34 ±0.58	1.78±0.55	3)
#11 - Lt	1.61±0.63	1.96±1.05	1)
#21 - Rt	1.43±0.58	1.83±0.97	1)
#21 - Lt	1.52±0.56	1.56±0.68	
#22 - Rt	1.15±0.59	1.23±0.78	
#22 - Lt	1.63±0.59	1.59±1.05	

3) ; p<0.001, 2) ; p<0.01, 1) ; p < 0.05

5. Comparison of changes in Alveolar bone height

In measuring the length from the cemento-enamel junction to the apex of the alveolar bone level, experiment group with nail biting habits had lower bone level toward the medial line at the mesial surface of the tooth on maxillary left central incisors (p<0.01), maxillary right central incisors (p<0.05), and mandibular right and left central incisors (p<0.05). Also, bone level was low (p<0.01) in the distal surface of maxillary right central incisor (Table 7, 8).

In the experiment group and the control group, there was crestal bone height difference in J-Rt of maxillary teeth.

Table 8. Average and standard deviation of alveolar crest level of the mandible (unit : mm)

	Control	Experiment	Significance
#32 - Rt	1.55±0.83	1.70±0.78	
#32 - Lt	1.54±0.66	1.61±0.74	
#31 - Rt	1.65±0.71	2.07±1.01	1)
#31 - Lt	1.52±0.77	1.77±0.90	
#41 - Rt	1.80±0.72	1.91±0.96	
#41 - Lt	1.75±0.74	2.16±1.03	1)
#42 - Rt	1.73±0.67	2.00±0.94	
#42 - Lt	1.38±0.69	1.70±0.92	

3) ; p<0.001, 2) ; p<0.01, 1) ; p < 0.05

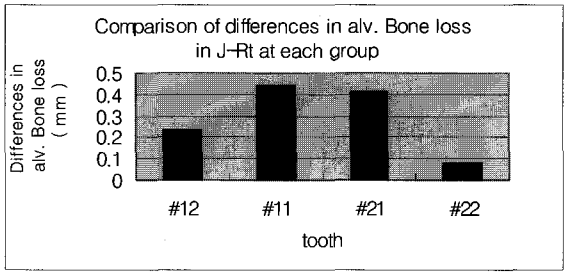
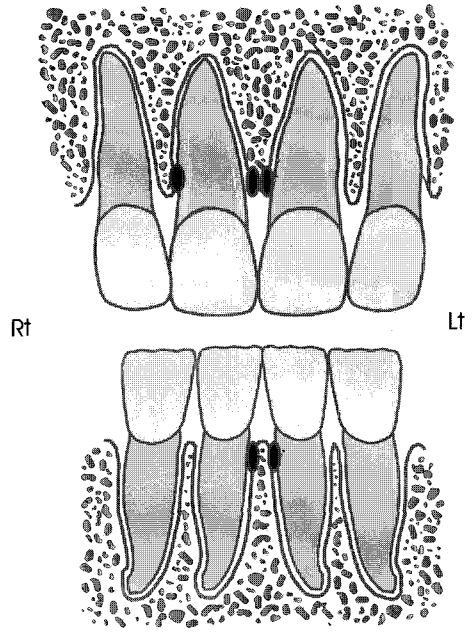


Fig. 4. Difference in average alveolar bone crest difference in J-Rt of maxillary incisors of each group.



: Crestal bone loss of maxillary and mandibular central incisor mesial is shown, and distal of maxillary right central incisor also had bone loss.(In the experiment group, severe bone loss is marked by black circle)

Fig. 5. Parts of importance in alveolar bone height.

DISCUSSION

Root resorption and alveolar bone resorption is one of the biggest side effects of orthodontic treatment. Especially in permanent dentition, if root resorption was already in process before the treatment, the frequency of resorption may increase. If idiopathic root resorption before treatment exists, modification of orthodontic treatment has no decreasing effect on resorption.[6] Massler & Malone,[16] Phillips,[17] Newman, [13] Malmgren et al,[18] reported more teeth being involved than the control group.

Many radiographic images are used to study root resorption. Among these are anterior periapical views, and lateral cephalograms and panoramic views. Levender and Malmgren[19] used periapical view, Harris & Beck[20,21] used lateral cephalogram to measure incisors, and panoramic view to measure molars, Hendrix et al,[22] Kaley and Phillips.[23] used panoramic view to evaluate root resorption of molars. Kjaer[24] and Hwang & Song[14] took periapical views by paralleling cone technique to properly evaluate incisors and used panorama to evaluate the existence and degree of root resorption of molars. In the anterior periapical view, the following errors may occur: first-improper reference points, second - a projection error during the radiographic imaging procedure. In order to minimize errors, the XCPs for the paralleling cone technique were from Yonsei Dental Hospital Department of Radiology. Measurements were made by one person in order to eliminate differences on view of reference points on radiographs. Periapical view with great errors were excluded. Baumrind et al[26] stated that cephalograms' measurements had 4 times more errors than measurements done on intraoral periapical films. Intraoral periapical film is an important recording device in comparing root resorption before and after orthodontic treatment.

Becks,[5] Newman,[13] Goldie and King[27] tried to analyze several hormones quantatively in relation to male and female root resorption differences. The studies showed different results on relationship between gender and root resorption frequency and severity. Rudolph[28] and Massler & Perrault[29] discovered iatrogenic root resorption to be more frequent in women than men, but Becks,[5] Phillips,[17] Linge and Linge,[30,31] McFadden et al[32] reported no gender differences. Hwang & Song's[14] study states the necessity of a study group of a more equal male to female ratio. Most patients seeking orthodontic treatment are female, especially in adults. The

number of females are 2.5 times greater than the number of males. This study is more accurate since the male to female ratio is approximately 1:1 and as a result, there is no difference in male or female prevalence (Table 2). In Hwang & Song's[14] study, patients with recent oral habits or in elderly patients, had severe root resorption. Of the 5 oral habits of mouth breathing, nail biting, lip biting, thumb or finger sucking and tongue thrusting, the most frequent and severe root resorption was caused by nail biting and tongue thrusting.

Rudolph,[28] Stenvik & Mjor,[33] and Linge & Linge[30] reported relevance between root resorption and the age at which treatment was received. Their conclusion was the greater the age, the greater the resorption. When the patient is younger than 11 years of age, root resorption occurs less. On this basis, these authors recommended early treatment. But Phillips[17] and McFadden et al[32] reported no relationship between age and root resorption. In our study, no great difference in root length before and after treatment among age groups existed.

Axial angles of all maxillary and mandibular incisors of both the experiment and control group were within normal range. Hwang & Song's[14] study shows when axial angles are large, each incisor show root resorption. Therefore, in relation to these results, root resorption due to nail biting in this study group is of no relation to previous root resorption due to axial angulation (Table 3).

The main and effective method in observing root resorption on radiographic photos is using a crown-to-root ratio.[13] This is because crown length remains almost constant while root length and alveolar bone height decrease due to many internal and external factors. On periapical view, 4 maxillary incisors and the right and left mandibular lateral incisors of the experiment group show significant differences in crown-to-root ratio (Table 6). This seems to be the result of biting nails with central incisors, the size differences between maxillary and mandibular incisors, and mandibular central and lateral incisors occluding with maxillary central incisors making all 4 mandibular incisors susceptible to root resorption. Mandibular incisors show an especaiially high value since in order to bite with the incisors the mandible is protruded more than C.O., occluding with maxillary incisors exerting more force. No significant changes in crown length were shown (Table 4). Comparing the relationship between root length and nail biting habits with the experiment group and control group may not seem very significant, but in comparing the values, those of maxillary and mandibular right and left central incisors and mandibular right lateral incisor were shorter in patients with nail biting habits (Table 5). In relation to the crown-to-root ratio, crown length almost remains the same while the root becomes shorter. Normally, patients with short roots before treatment tend to show more root resorption after treatment.[13,32,34,35]

In evaluating alveolar bone loss amounts, the form of the cemento-enamel junction to the alveolar crest bone, the amount of bone loss in mesial surfaces of maxillary right and left central incisors as well as mandibular right and left central incisors, and distal surfaces of mandibular right central incisor of the experiment group were significant (Table 7, 8). In the early stages of root resorption with less than 3mm of bone loss, crestal bone loss seems to be more important than root resorption.[25,36,37] This study also shows quite a bit of bone loss at the mesial surface of the central incisors of the experiment group with nail biting habits (Fig. 4, 5). This also corresponds to the crown-to-root ratio of the central incisor area. To minimize calculation errors in anterior periapical radiographs, digitalized imaging - such as C.T. which has minimal image distortion should be used. All measurements should be computerized. Also, in evaluating patients with such habits, child psychological factors, frequency, duration, severity of the habit, oral hygiene, etc., should be taken into consideration.

In treating the orthodontic patient, these oral habits should be considered from the first examination and identified. By using radiographic pictures, idiopathic problems such as alveolar bone loss and root resorption can be avoided. Also, the patient should be

informed about the consequences of the oral habit so that any side affects can minimized.

Alveolar bone loss is an important factor in choosing biomechanics. When the patient's oral habit is taken into consideration during treatment, it is possible to take more care during treatment as not to cause root resorption and alveolar bone loss. One can also prepare for any legal problems.[25]

CONCLUSION

The purpose of this study is to evaluate the degree of root resorption and alveolar bone loss related to nail biting habits. The subjects were chosen among male and female patients who visited Yonsei Dental Hospital Department of Orthodontics for treatment in 1997. The age of the group was 10~15. The experiment group was comprised of 63 patients with nail biting habits at the time of the initial examination. The control group consisted of the same age group without nail biting habits. 30 were male and 33 were female in the experiment group. 31 were male and 32 were female in the control group.

The results from this study are as follows :

1. The experiment and control group was comprised of 63 patients with 1:1 male to female ratio. No significant difference in root resorption between the two groups was noticed.
2. In comparing crown length, no significant difference between the experiment and control group existed, but root length in the experiment group of maxillary and mandibular right and left central incisors and mandibular right lateral incisor had a relatively shorter value ($p<0.001$).
3. In comparing the average crown to root ratio on periapical radiographs, maxillary and mandibular right and left central incisors and mandibular right and left lateral incisors had significantly large numbers ($p<0.01$).
4. In comparing alveolar bone loss, by measuring the length from the cemento-enamel junction to the alveolar crest bone, the mesial surfaces of maxillary and mandibular left and right central incisors and distal surfaces of maxillary right central incisor of the experiment group had greater crestal bone loss than the control group.

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국문초록

손톱 깨물기 습관을 가진 아동의 전치부 치근길이와 치조골 높이 변화에 관한 연구

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교정치료의 목표는 치아와 악골의 기능성과 심미성을 높이며 안정성을 도모하는데 있지만 치료 과정 중에 치근흡수와 치조골 흡수와 같은 여러 가지 후유증이 발생할 수 있다. 이러한 치근첨의 흡수는 예측이 불가능하고, 상아질 부위까지 파급될 수 있으며, 발생 후 비가역적이다. 여러 가지 구강악습관중 손톱 깨물기 버릇의 치근과 치주조직에 대한 영향을 평가하여 교정 치료시 적절한 생역학을 고려하고, 교정치료동안 잠재적으로 치근흡수와 치조골 상실의 가능성에 대처하며, 사전에 법적인 문제에 신중을 기할 수 있을 것이다.

연구대상은 10~15세의 남녀 환자를 문진을 통해서 파악된 손톱깨물기 버릇을 가진 63명을 실험군으로 하였고, 같은 연령대의 손톱 깨물기 버릇이 없는 군을 대조군으로 설정하였다. 이들은 실험군에서 각각 남자30명, 여자 33명이었고, 대조군에서는 남자 31명, 여자 32명이었으며 다음과 같은 연구 결과를 얻었다.

1. 실험군과 대조군은 각각 63명을 대상으로 하였으며 남.여 비율은 1:1이었고, 치근흡수에 있어서 통계학적으로 남.여간의 유의성 차이는 보이지 않았다.
2. 치관의 길이를 비교할 때 실험군과 대조군에서 유의성 있는 차이를 보이지 않았으나, 치근의 길이는 실험군에서 상 하악 양측 중절치와 하악 우측 측절치에서 상대적으로 더 짧은 값을 보였다($p<0.001$).
3. 실험군의 치근단 방사선 사진상에서 치관 대 치근 평균 길이의 비에서 상.하악 양측 중절치와 하악 양측 측절치에서 유의성 있는 큰 값을 보였다 ($p< 0.01$).
4. Cemento-Enamel Junction에서 alveolar crest bone까지의 거리 측정에 의한 치조골 상실량의 비교 평가한 경우 실험군에서 상 하악 좌 우측 중절치의 근심면과 상악 우측 중절치의 원심면에서 대조군보다 유의성 있게 crestal bone의 상실을 보였다 ($p<0.05$).

주요 단어 : 손톱깨물기습관, 치근흡수, 치조골 상실, Crown/root ratio