Correlation of gingival biotypes with clinical parameters

Sung-Jun Kim · Tae-Il Kim · Yang-Jo Seol · Ki-Young Cho · Young Ku · In-Chul Rhyu · Chong-Pyoung Chung · Soo-Boo Han · Yong-Moo Lee

Department of Periodontology, College of Dentistry, Seoul National University

Ⅰ. Introduction

The current progress of the dental treatment in implant and periodontal plastic surgery has led to a further expectation among many patients to the better esthetic results. Predictability of postoperative success is a major consideration in treatment planning both for periodontal treatment and implant treatment. Therefore a careful understanding and analysis of the surrounding tissue is necessary.

Recently, the dimensions and other characteristics of masticatory gingiva have become the subject of considerable interest in periodontics. For a long time, an "inadequate" zone of keratinized tissue was suggested as a risk factor for the development of gingival recession.[1] That opinion have seriously been questioned by several investigators. Only minimal gingival inflammation has been observed in areas with a very narrow zone of keratinized tissue[2], and the level of attachment can be maintained even in the absence of attached gingiva[3] provided that the patient maintain proper oral hygiene.

Whereas inter-, and intraindividual variation of gingival width has been the subject of numerous investigations, thickness of the gingiva has commanded considerable attention only in recent years. In several other clinical situations, detailed information on the thickness of masticatory mucosa may be highly desirable. For instance, in subjects with thin and vulnerable gingiva, an increased amount of recession is observed following non-surgical periodontal therapy.[4] Moreover, gingival thickness appears to play an important role in wound healing as well as flap management during regenerative and

Corresponding author : Yong-Moo Lee, Department of Periodontology, College of Dentistry, Seoul National University, 28 Yongon-Dong, Chongno-Ku, 110-749, Seoul, Korea

plastic periodontal surgery.

Müller et al[5] investigated the possible influence of gingival thickness and width on bleeding on probing. It was concluded that, apart from supra-gingival plaque, smoking was an independent risk factor for gingival bleeding on probing. Thin and vulnerable gingiva of insufficient width was not more likely to bleed after probing than thicker tissue.

On the other hand, Cardaropoli et al[6] evaluated the role of orthodontic intrusion and alignment in the reduction of gingival recession around maxillary incisors of adult periodontal patients and reported that at the end of orthodontic treatment a predictable reduction of recession both in patients with thin or wide gingiva.

Seibert & Lindhe[7] proposed the term periodontal biotype to designate distinct features("flat-thick" or "scalloped-thin") of the periodontium, including the underlying alveolar bone. Müller et al[8] used the more customary term phenotype to describe features of the marginal periodontium that are influenced by both genetic and environmental factors. Some characteristics of gingival phenotype of the upper front tooth region were found that results clearly indicated evidence for the existence of different gingival phenotypes. It was observed that at least 2 different phenotypes being associated with a wide-short type of crown at the upper anterior segment, one with a "normal" thickness and narrow band of keratinized tissue and one with thick and wide gingiva were observed. It is possible that we distinguish gingiva into groups with different thickness.

Olsson & Lindhe[9] reported that subjects with long, narrow teeth have a comparatively thin periodontium, and may be more susceptible to gingival recession than subjects who belong to a thick periodontal "biotype". They suggested that the form of the upper central incisors may be used to distinguish between different periodontal "biotype". The different gingival biotype showed the different physiologic and pathologic responses and treatment results. From that, determining of gingival biotype can be said useful in diagnosis and treatment planning phase.

Measuring the actual gingival thickness requires additional anesthesia or special equipment like ultrasonic measuring device. Therefore, it is not routine procedure to measure the thickness before treatment. The definite criteria for gingival biotype has not been suggested. Gingival biotype is determined arbitrarily considering some parameters like the shape of crown or gingival scalloping pattern.

The aim of the present study is to confirm our hypothesis that the arbitrary grouping of gingiva into different biotypes has the significant correlation with the gingival thickness and to determine the clinical parameter which represents the gingival thickness.

Ⅱ. Material and Methods

1. Subjects

The study population was 211 volunteers (127 males, 84 females), 22-43 years of age

(mean age 24.7), who were dental students of Seoul National University. The measurement was performed on maxillary central incisors and the mean values were used. In conjunction with the intra- and extra-oral examination, clinical photographs and intra-oral dental radiographs for maxillary anterior incisors were taken.

2. Clinical measurements

Width of keratinized gingiva(KG)

The distance was measured mid- buccally, to the nearest mm, from the mucogingival junction to the gingival margin. If the mucogingival junction was not readily perceivable, the "wrinkle technique"(Mazeland[10] 1980) was utilized.

Gingival thickness(GTH)

The endodontic files(K-file,#15,Mani, Japan) were employed to measure thickness of masticatory mucosa under local anesthethia. The measurements were performed at the midbuccal 1/2 level of keratinized gingival zone which was determined to measure KG to the nearest 0.1 mm.

Probing depth(PD)

Measurements were made using periodontal probes and determined to the nearest mm.

Bleeding on probing(BOP)

The measurement was performed with the criteria by Ainamo and Bay[11].

Palque index(PI)

The measurement was performed with the criteria by Löe and Silness[12].

Gingival index(GI)

The measurement was performed with the criteria by Silness and Löe[13].

Gingival recession(GR)

The distance was measured between the gingival margin and cementoenamel junction.

Cervical convexity(CC)

The convexity was determined by measuring the undercut of 0.5mm at the mid-buccal level of crown surface.

Body mass index(BMI)

The body mass index was calculated by the ratio of a square of body weight(kg) to height(m).

Percent body fat(BF)

The subcutaneous fat thickness of face skin was measured to nearest 5mm.

Somatotype(ST)

The somatotype was categorized using the mesomorphy rating from the Heath-Carter[14] anthropometric somatotype to endomorph, mesomorph and ectomorph.

Facial types(FT)

The facial type was categorized to brachycephalic, mesocephalic and dolichocephalic[15].

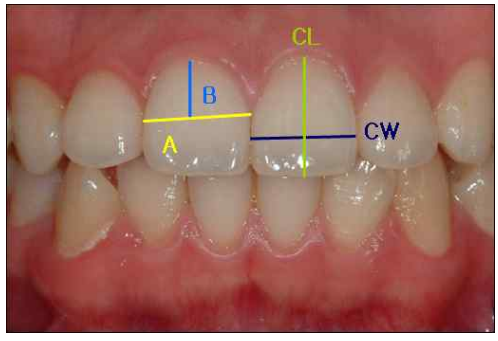

Figure 1. Measured distances of clinical photographs. A=distance between the tops of mesial and distal papillae, B=distance between the most apical portion of buccal gingival margin and the line that connect the tops of both papillae, CL= length of crown, CW=width of crown.

Dentition(DEN)

The dentition was determined by crowding /rotation/crossbite/deepbite of the maxillary dental arch.

3. Clinical photographs

Ratio of width/length of crown(CW/CL)

The distance of crown width was measured between the mesial and distal contact points. The distance of crown length was measured between the gingival margin, or if discernible, the cementoenamel junction and the incisal edge(CW/CL in Figure 1).

Gingival curvature(GC)

The curvature of gingival margin was defined the ratio of the distance between the tops of mesial and distal papillae and the distance between the most apical portion of buccal gingival margin and the line that connect the tops of both sides of papillae (A/B in Figure 1).

Gingival biotype (BIO)

The biotype was determined into thick or thin by one examiner.

4. Radiographs

Width of Tooth/length of tooth(TW/TL)

The ratio of the distance between proximal contact points of the tooth and the distance between incisal edge and apex was

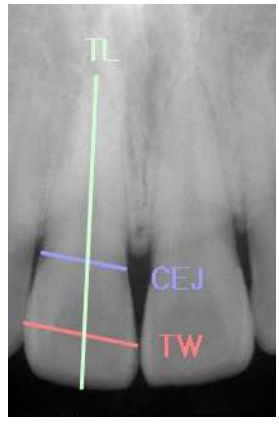

Figure 2. Measured distances of radiographs.
TL=length of tooth, TW=width of tooth, CEJ=the distance between the mesio and distal surfaces of the CEJ level.

calculated(TW/TL in Figure 2).

Width of the crown/width of CEJ(CW/CEJ)

The ratio of the distance between proximal contact points of the crown and the distance between the mesial and distal surfaces of the CEJ level was calculated(TW/CEJ in Figure 2).

5. Data analysis

The data for each of the examined parameters were averaged and divided into the groups of thin gingiva(THIN) and thick gingiva(THICK) and mean values for subjects in group THIN and THICK were compared by means of a Student t-test. The asso- ciation between the groupings with mea- sured data and arbitrary determination of biotype by the examiner was tested by means of a chi-squared test. Values of $p<0.01$ were considered statistically significant. The SPSS software(version 10.0, SPSS, Chicago, IL, USA) was used for all calculations.

Ⅲ. Results

The mean value of gingival thickness was 1.3 mm and the distribution is presented in Figure 1. The subjects were divided into two groups of THIN and THICK. In grouping, the subjects with the thickness near mean value were excluded. The subjects whose gingival thickness below 1.2mm were divided into the group THIN and above 1.4mm into the group THICK. The mean values between 2 groups are significantly different($p<0.01$).

The frequency of subjects determined as "thin" biotype among group THIN was 21 out of 58 and the result from chi-square test was not statistically significant. In the case of group THICK, 55 subjects out of 72 were determined as "thick" biotype and there was no statistical significance.

The individual mean values for parameters in all subjects are presented in Table 1.

The results of the Student-t test with clinical parameters are presented in Table 2. The differences between groups are statistically significant in KG, CC, CW/CL and GC. ($p<0.01$) The other parameters showed no significant differences. The correlation of age, gender, periodontal and orthodontic treatment history with gingival thickness is presented in Table 3. The differences for those variables between groups were not statistically significant.

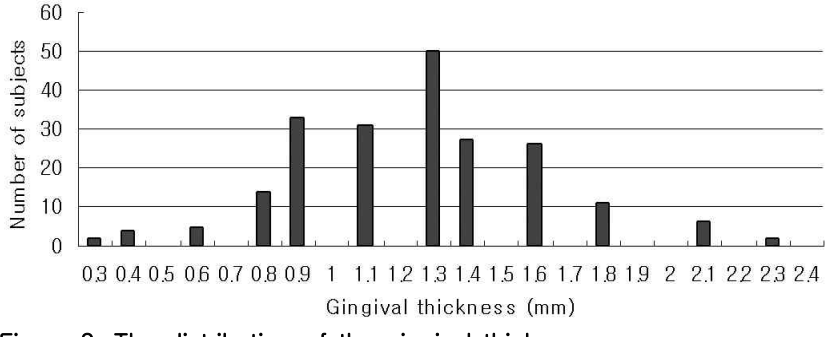

Figure 3. The distribution of the gingival thickness

Table 1. Mean values and standard deviation for parameters in all subjects (n=211)

Variables	mean	SD
GTH	1.3	0.36
PD	2.2	0.70
BOP	0.8	0.79
PI	0.5	0.61
GI	0.6	0.71
KG	5.4	1.3
GR	0	0.40
CC	43	
CW/CL	0.8	0.09
GC	1.9	0.32
TW/TL	0.4	0.04
CW/CEJ	1.4	0.14

GTH:gingival thickness, PD:probing depth, BOP:bleeding on probing, PI:plaque index, GI:gingival index, KG:width of keratinized gingiva, GR:gingival recession, CC:cervical convexity(% presence), CW/CL:ratio of length of crown and width of crown, GC: gingival curvature, TW/TL:ratio of width of tooth and length of tooth, CW/CEJ:ratio of width of the crown and width of CEJ

Table 2. Mean values and standard deviation for parameters in groups THIN and THICK and Student t-test results(* p<0.01)

Parameters	group THIN		group THICK		p-value
	mean	SD	mean	SD	
GTH	0.9	0.2	1.7	0.2	<0.01
PD	2.1	0.6	2.2	0.71	0.7
BOP	1.4	0.5	1.3	0.5	0.72
PI	1.2	0.4	1.2	0.4	0.33
GI	1.3	0.5	1.4	0.6	0.99
KG	4.9	1.4	5.8	1.1	<0.01
GR	0.4	1.2	0.3	1.5	0.58
CC	34		56		<0.01
BMI	22.2	7.9	25.0	9.0	0.06
BF	0.3	0.4	0.4	0.5	0.08
ST	0.3	0.5	0.5	0.6	0.06
FT	0.4	0.6	0.7	0.7	0.02
DEN	22		17		0.13
CW/CL	0.8	0.1	0.9	0.1	<0.01
GC	1.9	0.3	2.0	0.3	<0.01
TW/TL	0.4	0	0.4	0	0.41
CW/CEJ	1.4	0.1	1.4	0.1	0.65

GTH:gingival thickness, PD:probing depth, BOP:bleeding on probing, PI:plaque index, GI: gingival index, KG:width of keratinized gingiva, GR:gingival recession, CC:cervical convexity(% presence), BMI:body mass index, BF:percent body fat, ST:somatotype, FT:facial type, DEN: dentition, CW/CL:ratio of length of crown and width of crown, GC: gingival curvature, TW/ TL:ratio of width of tooth and length of tooth, CW/CEJ:ratio of width of the crown and width of CEJ

Table 3. Variables in groups THIN and THICK

Variables	p-value
age	0.10
gender	0.04
periodontal treatment history	0.13
orthodontic treatment history	0.82

Ⅳ. Discussion

The most challenging procedure in clinical dentistry is the restoration of gingival harmony and dental esthetics in the anterior area, where the dentogingival interface is clearly visible. Therefore understanding of structure and physiology of the gingival tissue in relation to teeth, osseointegrated implants, and restorations is necessary to achieve a healthy, harmonious, and maintainable interface between the restoration and the surrounding soft tissue[16].

In the present investigation, attempts were made to confirm the reliability of arbitrary determining of the gingival biotype and to find clinical parameters that represent the thickness of masticatory gingiva. However, the results failed to show significant relationship between arbitrary determining of groups and actual gingival thickness.

The distribution of gingival thickness of subjects follows normal distribution as shown in Figure 3.

Weisgold et al[17] suggested that there were two basic human periodontal forms. The more prevalent, the thick, flat type occurred in over 85% of the patient population. The other, the thin, scalloped type occurred in less than 15% of cases. Findings from the present study are different. Weisgold et al classified the periodontium with the "rise and fall" of underlying bony crest using dry skulls, whereas the distribution of the thickness of the gingival soft tissue was used to characterize the periodontium in this study.

Weisgold et al described that the teeth found in the thick, flat periodontium were usually characterized by being more bulbous and having a more square form. Contact areas are located more apically and facio-lingually. The cervical convexity on the facial surface is reasonably prominent. Since the contact areas begin more apically, a central incisor viewed from the facial surface appears to be square. The interproximal papillae filling the space between the teeth terminate at the contact areas- hence a "flat" periodontium. In comparing the crown and root forms of each type, it is obvious that the mesiodistal inter-root bone is greater in the thin, scalloped type than in the thick, flat type of periodontium.

The arbitrary determining of gingival biotype from the curvature of gingiva and shape of crown had no significant relation with the actual gingival thickness. Thirty seven subjects were grouped into THIN group(58 subjects) had thick gingiva(Figure 4), 17 subjects who were classified as THICK group(72 subjects) had thin gingiva(Figure 5). The gingival thickness could not be determined from the outer appearance of gingiva.

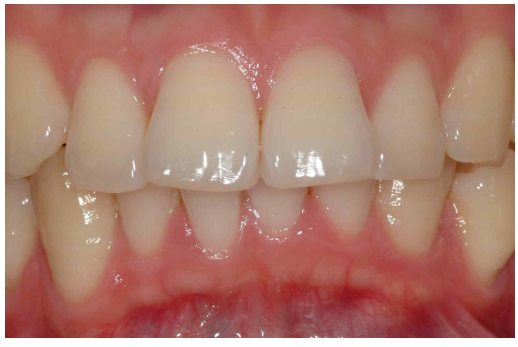

Figure 4. Individual with thick gingiva looking thin.

Figure 5. Individual with thin gingiva looking thick.

Data in this study agree with the previous studies(Table 2). Width of keratinized gingiva, cervical convexity of crown, the ratio of width/length of crown and curvature of gingival margin were significantly different between 2 groups. However, the other parameters have no significant relationship with the gingival thickness.

Subjects with periodontal diseases were excluded from the study. All subjects in the present study were dental students with good oral hygiene. Periodontal epidemiologic indices showed that subjects had healthy gingiva and no significant differences between THIN and THICK groups.

Olsson and Lindhe[18] reported that the thickness of the free gingiva in central incisors was significantly related to the width of the keratinized gingiva, the buccolingual width of the crown and the presence of an interproximal gingival groove. Their study demonstrated that individuals with a long-narrow form of the central incisors displayed, compared to individuals with a short-wide crown form (i)thin free gingiva, (ii)narrow zone of keratinized gingiva, (iii) shallow probing depths, and (iv)a pronounced "scalloped" contour of the gingival margin, expressed as the height of the distal papilla and the "gingival angle".

In a different study by Olsson and Lindhe[9], the observations reported tend to confirm the hypothesis that subjects with long, narrow teeth have a comparatively thin periodontium, and may be susceptible to gingival recession than subjects who belong to a thick periodontal "biotype". The length(CL) and width(CW) of the crowns were determined and the CW/CL ratio was calculated for each tooth to divide the subjects into two groups. Their findings agreed with the results from the present study.

Müller et al[19] categorized the gingival phenotypes into 3 clusters. Based on thickness and width of facial gingiva as well as crown form, different phenotypes could be identified. The clusters were characterized by 2 clusters of different gingival width with thin gingiva and a slender tooth form and a cluster with relatively thick and wide gingiva and a quadrant tooth shape. Mean thickness of masticatory mucosa as well as gingival width and crown form differed significantly among clusters. It was concluded that perio-

dontal phenotypes did actually exist and palatal mucosa might be rather thin in subjects with a thin and narrow gingiva and a slender shape of upper front teeth. In addition, masticatory mucosa was found to be thinner in women. In the present study, the difference with gender was slight but not statistically significant.

It would be clinically useful that to obtain a information on gingival thickness during initial examination. The most important indication for measuring the thickness of soft tissue is clearly periodontal plastic surgery. The hard palate usually serves as a donor site for either full-thickness epithelialized graft or connective tissue graft for plastic surgery in the oral cavity. And palatal mucosa is thin in individuals with thin periodontal phenotype.[19]

Kois[20] suggested diagnostic keys to more accurately predict the peri-implant esthetic outcome before removing a failing tooth. Those keys included relative tooth position, form of the periodontium, periodontal biotype, tooth shape, and position of the osseous crest. The periodontal biotype was considered the risk factor for recession after implant management protocols. Subject in the present study were young and showed little recession.

Sanavi et al[21] also explained the different characteristics of gingival types. In the thick flat type there normal rise and fall of the gingiva and bone was present, but there is not a great disparity between the direct facial and that found interproximally. The gingiva is thick or dense and is fibrotic in nature. Usually this type of periodontium has, quantitatively and qualitatively, adequate amounts of attached masticatory mucosa. When irritated by tooth preparation, impression procedures, extraction, or other clinical techniques, this periodontium usually reacts with inflammation, followed by migration of the junctional epithelium apically, with resultant periodontal pocket formation or redundant tissue. The thin scalloped type of periodontium, on the other hand, is distinguished by a pronounced disparity between the height on the direct facial and that found interproximally. The underlying bone is usually thin on the facial with dehiscences and fenestrations commonly found. Usually there is less attached masticatory mucosa, from both quantitative and qualitative perspectives. Excessive irritation of this type of periodontium usually leads to recession both facially and interproximally.

Pontoriero et al[22] demonstrated that after surgical crown lengthening, the marginal periodontal tissue showed a tendency to grow in a coronal direction from the level defined at surgery. That pattern of coronal displacement of the gingival margin was more pronounced in patients with "thick" tissue biotype and appeared to be influenced by individual variations in the healing response not related to age or gender.

Kan et al[23] clinically evaluated the dimensions of the peri-implant mucosa and examined the influence of the peri-implant biotype. The mean facial dimension of peri-implant mucosa was slightly greater than the average dimension of the dentogingival complex. Greater peri-implant mucosal dimensions were noted in the presence of thick peri-implant biotype as compared to a thin

biotype.

The present data failed to support the hypothesis that subjects could be divided into 2 different groups of the gingival thickness by determining arbitrarily the gingival biotype from clinical parameters without measuring the actual thickness. The accurate ways to measure thickness of facial gingiva and other parts of the masticatory mucosa are to use a probe or injection needle traumatically, or different ultrasonic devices atraumatically. Ultrasonic devices have been reported to give reliable measurements.[16]

Ⅴ. Conclusion

Determining of the gingival biotype is clinically useful. Different biotypes have different characteristics that may influence results of therapy. The determining of biotype of each individualis not clearly defined and performed arbitrarily in most of cases. In the present study, we confirmed that the arbitrary determining of biotype does not represent the actual gingival thickness. The clinical parameters that were shown to be related to gingival thickness are width of keratinized gingiva, cervical convexity, ratio of width and length of crown and curvature of gingival margin.

Ⅵ. References

1. Ochsenbein C. Newer concepts of mucogingival surgery. *J Periodontol* 1960;31: 175-185.
2. Miyasato M, Crigger M, Egelberg J. Gingival condition in areas of minimal and appreciable width of keratinized gingiva. *J Clin Periodontol* 1977;4: 200-209.
3. Wennstrom JL. Lack of association between width of attached gingiva and development of gingival recession. A 5-year longitudinal study. *J Clin Periodontol* 1998;14:181-184.
4. Claffey N, Shanley D. Relationship of gingival thickness and bleeding to loss of probing attachment n shallow sites following nonsurgical periodontal therapy. *J Clin Periodontol* 1986;13:654-657.
5. Müller HP, Heinecke A. The influence of gingival dimensions on bleeding upon probing in young adults with plaque-induced gingivitis. *Clin Oral Invest* 2002 ;6:69-74.
6. Re S, Cardaropoli RS, Abundo R, Corrente G. Reduction of gingival recession following orthodontic intrusion in periodontally compromised patients. *Orthod Craniofacial Res* 2004;7:35-39.
7. Müller HP, Eger T. Gingival phenotypes in young male adults. *J Clin Periodontol* 1997;24:65-71.
8. Olsson M, Lindhe J. Periodontal characteristics in individuals with varying form of the upper central incisors. *J Clin Periodontol* 1991;18:78-82.
9. Mazeland GR. Longitudinal aspects of gingival width. *J Periodontal Res* 1980; 15:429-433.
10. Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. *Int Dent J* 1975;25:229
11. Silness P, Löe H. Periodontal disease in pregnancy. *Acta Odontol Scand* 1964; 22:121

12. Löe H., Silness J. Periodontal disease in pregnancy. *Acta Odontol Scand* 1963;21:533
13. Graber TM. Orthodontics-principles and practice. Philadelphia: W.B. Saunders. 3rd edition. 1972:209-210.
14. Müller H-P, Eger T. Masticatory mucosa and periodontal phenotype: A review. *Int J Periodontics Restorative Dent* 2002;22:172-183.
15. Weisgold AS, Arnoux J-P,Lu J. Single-tooth anterior implant: A world of caution, Part I. *J Esthetic Dent* 1997;9:225-233.
16. Olsson M, Lindhe J, Marinello CP. On the relationship between crown form and clinical features of the gingiva in adolescents. *J Clin Periodontol* 1993;20:570-577.
17. Müller HP, Heinecke A, Schaller N, Eger T. Masticatory mucosa in subjects with different periodontal phenotypes. *J Clin Periodontol* 2000;27:621-626
18. Kois J. Predictable single tooth peri-implant esthetics: Five diagnostic keys. *Compendium* 2001;22:199-206.
19. Sanavi F, Weisgold AS, Rose LF. Biologic width and its relation to periodontal biotypes. *J Esthetic Dent* 1998;10:157-163.
20. Pontoriero R, Carnevale G. Surgical crown lengthening: A 12-month clinical wound healing study. *J Periodontol* 2001;72:841-848.
21. Kan J, Rungcharassaeng K, Umezu K, Kois JC. Dimensions of peri-implant mucosa: An evaluation of maxillary anterior single implants in humans. *J Periodontol* 2003;74:557-562.

-국문 초록-

치은두께와 임상검사지수들과의 상관관계

김성준 · 김태일 · 설양조 · 조기영 · 구 영 · 류인철 · 정종평 · 한수부 · 이용무

서울대학교 치과대학 치주과학교실

1. 목적

이 연구의 목적은 기존의 평가기준에 따라 관찰자에 의해 주관적으로 판단된 치은형과 실제 치은두께와의 상관관계를 규명하고 임상검사 시에 측정할 수 있는 변수들과 치은두께의 연관성을 평가하는 것이다.

2. 방법

211명의 치과대학생(22-43세, 평균 24.7세)을 연구대상으로 하여 상악중절치부위에서 국소마취하에 근관치료용 파일을 치은에 삽입하여 두께를 측정하고 임상검사를 통해 치주낭깊이, 치태지수, 치은지수, 치은퇴축, 체형 및 비만도, 피부형, 치경부의 형태, 관측자가 임의로 판단한 치은형을 기록하였다. 임상사진으로 치관의 폭경과 길이의 비율, 치은외형의 만곡정도를 조사하고 평행촬영법을 이용한 방사선사진으로 치아의 장평비율 및 치아의 치관 폭경과 치경부 폭경의 비율을 조사하였다. 전체 대상을 치은의 두께를 기준으로 평균두께보다 얇은 군과 두꺼운 군의 두 개의 군으로 분류하여 임상검사 시에 측정한 변수들이 각 군 간에 유의할 만한 차이를 보이는지와 임의로 판단한 치은형이 실제 치은두께와 연관이 있는지를 알아보았다. 통계처리는 Student t-test를 이용하였다.

3. 결과

치주낭 깊이, 치은지수, 체형 및 비만도, 피부형, 치아의 형태, 치경부의 형태, 치아의 장평비율의 경우 실제 측정하여 얻은 치은의 두께와의 상관관계는 통계적으로 유의성이 없었다. 치은의 형태는 치은의 두께와 상관성은 보이고 있으나 통계적으로 유의하지 않았다. 관측자가 임의로 평가한 치은형과 실제 측정치도 유의할만한 일치를 보이지 않고 있다.

4. 결론

치은의 형태는 치은의 두께를 예상하는데 약간의 도움이 될 수 있으나 실제 치은의 두께는 임상적으로 간단히 측정할 수 있는 검사지수들과 직접적인 상관관계를 보이지 않았다. 따라서 치료결과의 예측에 있어서 치은형을 분류하여 예상하는 것은 큰 도움이 되지 않는다고 할 수 있다.

주요어 : 치은두께, 치은형, 치아형태