

# Relationship between Gingival Biotype and Underlying Crestal Bone Morphology

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**Purpose:** The purpose of this study was to assess the relationship between gingival biotype and underlying crestal bone morphology in the maxillary anterior region.

**Materials and Methods:** The maxillary anterior teeth from 40 subjects (20 thin biotype, 20 thick biotype) with ages from 20 to 50 years were included in this study. All subjects had healthy gingiva in the maxillary anterior region and had no history of orthodontic treatment, periodontal treatment, or hyperplastic medication. Using the probe transparency method, the scalloped distance (SCD) between the contact point-bone crest and the midface-bone crest was measured for each maxillary anterior teeth of two groups.

**Result:** The mean SCD was  $3.00 \pm 0.21$  mm in thin biotype and  $2.81 \pm 0.20$  mm in thick biotype. The SCD value in the thin biotype was statistically significantly greater than in the thick biotype ( $t=2.982$ ,  $P<0.01$ ). Comparing the degree of crestal bone scallop in each maxillary anterior teeth in the two groups, all six teeth in the thin biotype showed higher bone scallop than in the thick biotype.

**Conclusion:** A simple procedure using a probe could to determine gingival biotype and to predict the underlying crestal bone morphology was introduced. This may be useful for effective treatment planning.

**Key Words:** Anterior teeth; Crestal bone; Gingival biotype; Maxilla

## Introduction

The shape and characteristics of gingiva are closely related to the aesthetics of the maxillary anterior region. Several approaches were made to explain the morphological characteristics of soft tissues. In

1969, Ochsenbein and Ross<sup>1)</sup> classified gingiva into two types: scalloped-thin and flat-thick. They also determined that flat gingiva was associated with the square teeth and scalloped gingiva with tapered teeth<sup>1)</sup>. Lindhe<sup>2)</sup> introduced the term "periodontal biotype" for the first time and classified it into two

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types: thick-flat and thin-scalloped. Claffey and Shanley<sup>3)</sup> divided gingiva into two biotypes: a thick tissue biotype, where the thickness is more than 2 mm, and a thin tissue biotype where the thickness is less than 1.5 mm. If the thickness is 1.6 to 1.9 mm, it is unclassified.

In particular, because individuals with different gingival biotypes tend to respond differently to injuries stemming from inflammation or periodontal treatment, it is important to understand such characteristics when performing periodontal, prosthetic, aesthetic, and implant treatments<sup>4)</sup>. Weisgold<sup>5)</sup> posited that gingival recession is likely to occur in patients with the thin, scalloped gingival biotype. The resilient thick biotype is prone to pocket formation, but the friable thin biotype is often subject to gingival recession<sup>6)</sup>. Likewise, it has been reported that the thick-flat gingival biotype is closely related to successful results from aesthetic treatment in patients recovering from implants<sup>7)</sup>. Patients with thick gingiva show better prognoses during root coverage, and one of the most important factors that lead to complete root coverage is the thickness of the initial gingiva<sup>8,9)</sup>.

Various methods have been developed to measure the thickness of gingiva and to assess gingival biotype: a direct method, a probe transparency method, and methods involving ultrasonic devices and cone-beam computed tomography (CBCT)<sup>3,4,10-15)</sup>. In the probe transparency method, gingiva are classified as thin if the probe tip is visible through the gingiva when the periodontal probe is applied to the gingival sulcus. This simple, highly reproducible, and non-invasive method has frequently been used to determine gingival biotype<sup>4,13)</sup>.

Since the studies conducted so far did not take into account the shape and location of the underlying alveolar bone, there is a need to assess the relevance of gingiva to the underlying alveolar bone in order to gain a better understanding of the biotype of the periodontal tissue. The purpose of this study is to determine if there is an association between the

amount of scallop in the crest of the alveolar bone and the gingival biotype in the maxillary anterior region, and to examine whether the differences can be utilized in periodontal treatment, implant placement, and/or aesthetic restoration.

## Materials and Methods

### 1. Study Design and Patient Selection

The study protocol was approved by the Institutional Review Board of Ajou University Medical Center (approval no. MED-OBS-13-360). Prior to inclusion, all patients read and signed a written consent form.

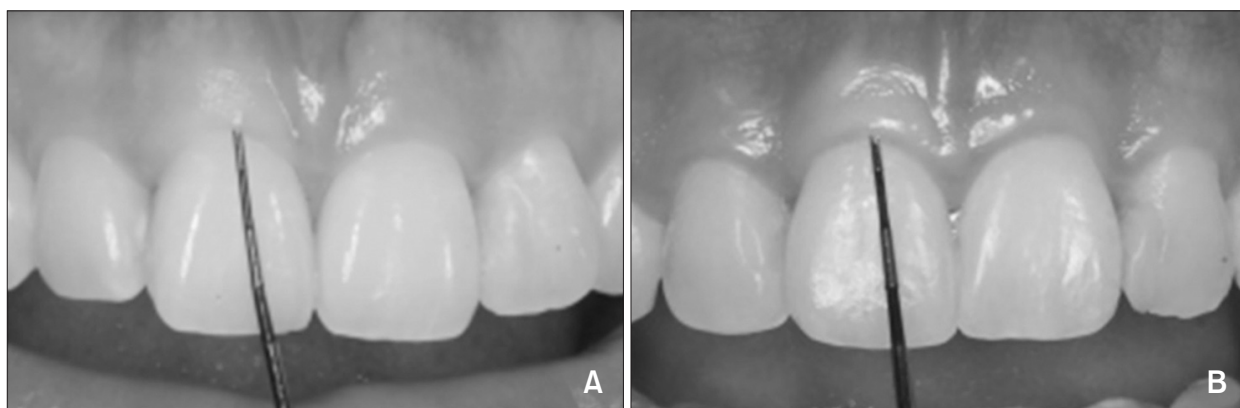
The subjects of this study consisted of healthy patients aged 20 to 50 years who did not show gingival inflammation in the maxillary anterior region (upper left and right central incisor, lateral incisor, and canine). They were selected from the patients who visited Ajou University Dental Hospital in 2013 for regular dental check-ups. The experiment was conducted in a total of 40 subjects (20 with thin gingiva and 20 with thick gingiva).

The following inclusion criteria were applied:

- 1) Patients had neither gingival recession nor interproximal papilla loss;
- 2) Patients did not take drugs associated with gingival enlargement;
- 3) Patients had a periodontal pocket less than 4 mm depth;
- 4) Patients did not have a fixed restoration;
- 5) Patients did not receive orthodontic treatment at the time of the study;
- 6) Patients had no exposed dentin via severe rotation or wear in the maxillary anterior region.

The following exclusion criteria were applied:

- 1) Patients had a periodontal pocket greater than 4 mm;
- 2) Patients had gingival inflammation or gingival enlargement resulting from periodontal diseases;
- 3) Patients had a history of dental injury.



**Fig. 1.** Photographs of patients with the thin biotype (A) and the thick biotype (B). (A) The probe tip is visible in the thin gingival biotype. (B) The probe tip is invisible in the thick gingival biotype.

## 2. Clinical Measurements

Patients' biotypes were divided into thick and thin using the probe transparency method. The thin biotype was assigned if the periodontal probe was visible through the gingival tissue, and thick if not (Fig. 1)<sup>4</sup>.

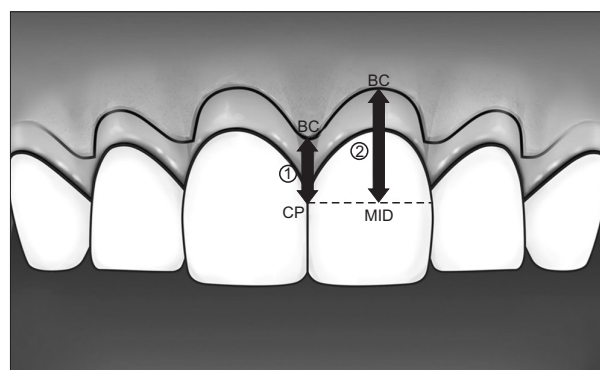
- ① Contact point (CP)~bone crest (BC)=distance between the mesial CP and the alveolar BC.
- ② Mid-face (MID)~BC=distance between the extension of CP of radical center or centrifugation in the mid-face location of teeth and the alveolar crest.

The difference of the distance in ① and ② was calculated as the scalloped distance (SCD) (Fig. 2).

A #10 endodontic file was inserted into the buccal gingival sulcus under topical anesthesia, advanced to the crest of the alveolar bone, and then fixed to a rubber stopper. The distance on the file was measured up to 1/10 mm with a caliper. The distance between ① and ② (SCD) given each biotype was calculated for the underlying bony scallop. The above measurements were performed in all six teeth by the periodontal clinical examiner.

## 3. Statistical Analysis

The statistical analysis was performed using the PASW Statistics software (version 18.0; IBM Co., Armonk, NY, USA). The SCD measurements of all subjects were used to calculate the mean and



**Fig. 2.** Measurements of the amount of bone scallop. The distance between the mesial contact point (CP) and the alveolar bone crest (BC) (CP~BC, ①) and the distance between the extension of contact points and the alveolar crest (MID~BC, ②) were measured. The difference in distance between ① and ② was calculated and is defined as the scalloped distance.

standard deviation values of each tooth. To verify the differences between groups, an independent t-test was used. The cutoff for statistical significance was set at  $P < 0.05$ .

## Result

There were no drop-out cases, and no reported adverse events related to the measurement. The result from the analysis of the difference between the thin and thick biotype group are shown in Table 1.

Regarding the difference in bone scallop for each maxillary anterior tooth between the two groups, the mean SCD for each of the six teeth examined in

**Table 1.** The mean results of SCD in the thin and thick biotype groups (mm)

Biotype	Tooth number						Total teeth
	#13	#12	#11	#21	#22	#23	
SCD							
Thin (n=20)	3.12±0.22	2.81±0.22	3.06±0.24	3.06±0.22	2.80±0.24	3.14±0.21	3.00±0.21
Thick (n=20)	2.94±0.21	2.60±0.19	2.85±0.22	2.88±0.25	2.59±0.19	2.97±0.22	2.81±0.20
t	2.506	3.256	2.851	2.360	2.957	2.512	2.982
P-value	0.017*	0.002*	0.007*	0.024*	0.005*	0.016*	0.005*

SCD: scalloped distance.

Values are presented as mean±standard deviation.

\*Significantly different between thin and thick biotype (P<0.05).

the thin biotype group was statistically significantly greater than for each of the teeth in the thick biotype group. The SCD values were measured in the following order: canine, central incisor, and lateral incisor teeth. The six teeth in the thin biotype group showed more bone scallop than did the teeth in the thick biotype group. In the thin biotype group, mean SCD was 3.00±0.21 mm, whereas in the thick biotype group, the mean SCD was 2.81±0.20 mm. The SCD value of the thin biotype group was significantly higher than that of thick biotype group (t=2.982, P<0.01).

## Discussion

This study aimed to analyze the difference in the amount of scallop of the underlying alveolar bone depending on gingival biotype. In this study, the gingival biotype was divided into thin and thick, as has been done in several previous studies<sup>1,2)</sup>.

Various methods have been used to measure the thickness of soft tissue. Transgingival probing method, which is a direct invasive measurement involving a periodontal probe, may be influenced by the diameter, angulation, and pressure of the periodontal probe and may cause the distortion of the tissue on probing; it is, however, simple and relatively inexpensive<sup>3,10)</sup>. The ultrasonic method is also simple; however, the area available for study is limited by the large diameter of

the probe and the results may be influenced by humidity<sup>11,12,16,17)</sup>. Recently, many studies using radiographic measurements with CBCT have been reported. CBCT is non-invasive, comparable to clinical measurements, and allows for quantitative measurement of the thickness of soft tissue, but it is expensive and the radiation dosage is more than what is ideal<sup>14,15,18)</sup>. The probe transparency method, which was used in the present study to determine gingival biotype, is simple, less expensive, non-invasive and highly reproducible, compared to the transgingival probing method<sup>4,13)</sup>.

The average amount of scallop of the alveolar bone in the maxillary anterior region in this study was as follows: mean SCD in the thin biotype was 3.00±0.21 mm, and in the thick biotype 2.81±0.20 mm, which is a statistically significant difference (t=2.982, P<0.01). When comparing each tooth, each of the six teeth showed a significantly higher amount of scalloping in thin patients with the thin biotype. In this study, the value of SCD depending on gingival biotype was similar to the value of the distance from the height of the interdental bone to the buccal alveolar crest as measured at the dry skull by Becker et al.<sup>19)</sup>, who divided experimental subjects into three groups: flat, scalloped, and pronounced scalloped, defined as 2.1, 2.8, and 4.1 mm, respectively, which was significantly different between groups. Similarly, the present study showed a significant difference in SCD value

between the thin and thick biotype groups.

In a comparative study on the dimensions of the periodontal tissue surrounding single implant inserted in the maxillary anterior region, there was a significant difference in the value of bone-sounding depth between the two groups measured<sup>13)</sup>. The dimensions of peri-implant mucosa in patients with the thick biotype were notably greater than in those with the thin biotype. Therefore, considering the biotype seems to be necessary before doing implant surgery in the maxillary anterior region. In patients with the thin biotype, the teeth have a triangular shape and the point of contact is located near the incisal edge, whereas in patients with the thick biotype, the teeth are bulging and rectangular and the point of contact is more apically located<sup>20,21)</sup>. Furthermore, Chow et al.<sup>22)</sup> has recently reported that the thickness of the gingiva is closely related to the height of soft tissue in the interproximal region.

In the present study, it is suggested that gingival biotype is closely related to the shape of the underlying alveolar bone, identifying a relationship among gingival biotype, tooth shape, and gingival architecture. In other words, in cases of thin gingival biotype, the crest of the underlying alveolar bone was more scalloped, as was the height of the supracrestal gingiva. The dentoalveolar complex responds differently to surgical procedures according to gingival biotype. Gingival recession and bone loss occur more often in patients with the thin biotype than in those with the thick biotype after aesthetic crown lengthening, tooth extraction, periodontal operations, and implant placement. Achieving optimal gingival aesthetics is a challenging procedure<sup>20)</sup>. In particular, the surgeon's understanding of the gingival biotype and the dentoalveolar complex, especially in the maxillary anterior region which is aesthetically more demanding than other regions, will have a great impact on the aesthetic results of treatment. Simply applying a periodontal probe to the gingival sulcus can determine the gingival biotype and help to

establish an effective treatment plans by predicting the morphology of the underlying alveolar bone. Although the difference in the morphology of the alveolar bone depending on biotype should be considered when making a diagnosis and forming a treatment plan as suggested in the present study, direct bone sounding for each tooth would be the most accurate method.

In this study, the shape of the underlying alveolar bone depending on gingival biotype was examined without taking into account gender and age. These variables should be considered in future studies. In addition, further studies must be done to look for more objective ways of evaluating and classifying gingival biotype and additional studies with larger sample sizes are required.

## Conclusion

Within the limit of this study, the morphology of the alveolar bone can be predicted by evaluating the gingival biotype. Therefore, successful outcomes of aesthetic treatments can be obtained by establishing treatment plans based on such assessments.

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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