Non-Invasive Method to Measure the Length of Soft Tissue From the Top of the Papilla to the Crestal Bone

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Background: In order to verify the results of interdental papilla regeneration, various methods of measuring the length of the papilla have been introduced. Invasive methods, such as bone probing under local anesthesia, might cause discomfort to the patients and possibly damage the delicate gingival unit. The purpose of the present study was to validate a method of measuring the length of the interdental papilla non-invasively, using radiopaque material and a periapical radiograph.

Methods: This study involved 142 interproximal papillae in 40 patients with chronic periodontitis. The distance between the radiopaque material and most coronal portion of the crestal bone was measured (radiographic length of papilla, RL). Bone probing at the interdental papilla was performed after local anesthesia (bone probing length, BPL). After flap elevation, the actual length of the papilla was measured (actual length of papilla, AL). A correlation analysis was performed between AL-RL and AL-BPL using Pearson's correlation coefficients.

Results: The correlation between AL-RL and AL-BPL was 0.903 and 0.931, respectively, both of which showed significance at the 0.01 level.

Conclusion: The results of this study suggest that the non-invasive method using a radiopaque material and periapical radiograph could be utilized to measure the length of the interdental papilla. *J Periodontol 2005;76:1311-1314.*

KEY WORDS

Alveolar bone; dental esthetics; dental implants; dental papilla/anatomy and histology; peri-implantitis; radiography, dental.

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One of the crucial elements involved in restoring the periodontal apparatus and teeth is restoring the interdental zone. This zone is composed of the contact area, the interproximal embrasure, and the interdental gingiva,[1] and the shape of the interdental papilla is determined by the contact relationships between the teeth, the width of the approximal tooth surfaces, and the course of the cemento-enamel junction.[2] Among these components, the contact point and adjacent teeth can be restored and repaired with a prosthetic aid. However, it is difficult to restore the proximal defect by regeneration of the interdental papilla because there are numerous factors which may affect its height, width, and color. In modern periodontics, various surgical/non-surgical techniques have been developed to achieve optimal results in the regeneration of the interdental papilla. To verify these results, different methods of measuring the length of the papilla have been introduced. Some authors have introduced a method of measuring the length of the papilla with the aid of clinical photographs;[3] others have developed an index for assessing the contour of the proximal papillae;[4,5] and others measured papilla using a bone sounding technique,[6,7] thus relating papilla with the interdental bone. Those latter studies[6,7] seemed to rely on somewhat invasive methods to measure the length of the interdental papilla, such as bone probing under local anesthesia, which

might cause discomfort to the patients and possibly damage the delicate gingival unit, especially after surgical procedures for regenerating interproximal papilla. However, when using clinical photos or index,[4,5] the relationship of crestal bone and interdental papilla cannot be evaluated, which was found to have significant correlation.[7] Thus, it would be useful to use radiographs to non-invasively measure the length of the gingival unit from the crestal bone to the top of the papilla.

The purpose of the present study was to validate a non-invasive method of measuring the length of papilla from the top of papilla to the crestal bone with radiopaque material.

MATERIALS AND METHODS

Study Population
Forty patients (20 males, 20 females; aged 35 to 55 years) with chronic periodontitis who were scheduled for periodontal surgery were selected for this study. All the patients had undergone initial therapy including oral hygiene instruction and ultrasonic scaling of the entire dentition. Patients who had remaining plaque accumulation were excluded and were re-instructed on proper oral hygiene and examined during another session. Thus, patients included in this study were devoid of supragingival plaque accumulation. The tested sites were confined to the anterior maxillary teeth. Patients with apical involvement, hopeless teeth, or who were taking any medication known to affect the periodontal soft tissues were excluded. In total, 142 interproximal papillae in 40 patients were investigated in this study. After surgery maintenance procedures were begun. The tested sites were free of bleeding on probing following surgery. The study protocol was approved by the Yonsei University Ethics Committee, and informed consent was obtained from all subjects.

Procedures
Experimental group 1. For the measurement of the radiographic length of the papilla (RL), a radiopaque material consisting of a 2:1 mixture of an endodontic sealer[§] and barium sulfate, used as the contrast media for gastrointestinal track,[ǁ] was placed with a probe on the top of the papilla. Care was taken not to place radiopaque material to the apical side, which would make the radiographic length shorter. Only a minimal amount of radiopaque material was needed since the

- (3) Crestal bone
- (2) Radiopaque material marking top of the papilla
- (1) 5 mm ball bearing

A

B

C
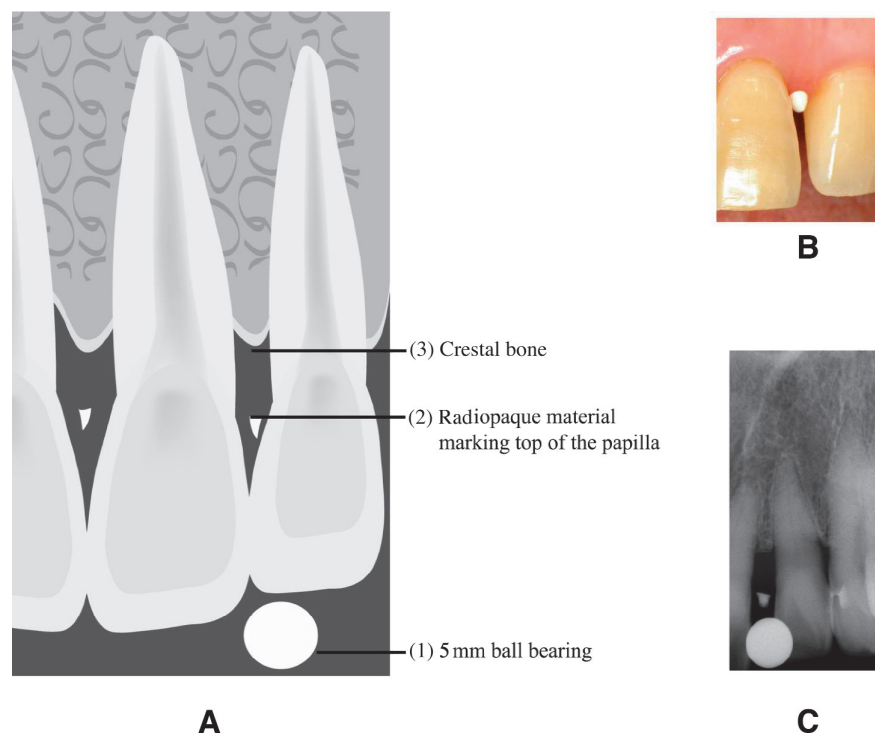
Figure 1.
*Measuring radiographic length. **A)** Radiographic length (RL) is determined by measuring the distance between points 2 and 3. **B)** Clinical photo applying radiopaque material. **C)** Periapical film of B.*

radiopacity was greatly enhanced by the contrast media. A periapical radiograph[¶] was taken (60 KVp, 10mA, 1.0 second[#]) using parallel cone techniques with a XCP device, along with a 5 mm metal ball bearing[**] attached to the teeth, in order to calibrate the length. All films were developed using the same automatic processor[††] following the manufacturer's instructions (Fig. 1).

The films were digitized using a digital scanner[‡‡] at an input resolution of 400 ppi with 256 gray color[8] and the file format was TIFF. After digitization, all files were transferred to a personal computer[§§] and examined using the same monitor,[ǁǁ] which was set to a resolution of $1,024 \times 768$ pixels. During the computer-assisted radiographic measurements, the room was darkened.[8,9] In order to calculate the length between the crestal bone and the top of papilla, the

Table 1.

Mean Value ± SD for Clinical Measurements (mm) and Correlation Between Measurements and Actual Alveolar Bone Level (N = 142)

RL	BPL	AL	γ (RL:AL)	γ (BPL:AL)
5.7 ± 1.5	5.6 ± 1.5	5.8 ± 1.8	0.903*	0.931*

* Correlation is significant at the $P = 0.01$ level (2-tailed), Pearson's correlation.

length between the most coronal portion of the crestal bone to the radiopaque material was measured with the computer-aided device.[¶¶]

Experimental group 2. Probes[##] calibrated at 1, 2, 3, 5, 7, and 10 mm were used to measure the length of the papilla (BPL: bone probing length). After local anesthesia, the deepest depth at which the probe met strong resistance from the top of the papilla to the bone was recorded.[10]

Control group. For the measurement of the actual papilla length (AL: actual length), an intracrevicular incision was made. After flap elevation, the actual length of the papilla was measured with the same probe that was used for the bone probing length.

All of the measurements were rounded off to the nearest 0.5 mm.[10]

Statistics

The correlation between RL and AL, and BPL and AL were analyzed with Pearson's correlation coefficients.[***]

RESULTS

The mean value of the radiographic length of the papilla (RL) was 5.7 ± 1.5 mm, the mean bone probing depth (BPL) was 5.6 ± 1.5 mm, and the mean actual length of the papilla (AL) was 5.8 ± 1.8 mm. The correlations between RL-AL and BPL-AL were 0.903 and 0.931, respectively, both of which showed statistical significance at the 0.01 level (Table 1).

DISCUSSION

The main purpose of this study was to validate the proposed method, designed to record the relationship between the papilla and the interdental bone. Radiography is a valuable diagnosis method in dentistry. It is non-invasive and usually requires minimal patient cooperation.[11] However, due to its inherent property of penetrating soft tissue, its diagnostic importance in measuring the length of the interdental papilla has been somewhat reduced. Some authors proposed the use of underexposing radiography to reveal soft tissue changes around dental implants.[12] Although the results obtained using this technique

were found to have a high correlation with the actual soft tissue changes, it is not always easy to use in every clinical situation because underexposed radiography may not contain enough information for the clinician. A more useful method would be to detect both soft tissue and hard tissue in a single radiographic image. This was made possible by using contrast media on the soft tissue side.

Bone probing has been confirmed as a valid method of reporting the papilla length.[6,7] However, it is a rather invasive method since administering the local anesthesia is likely to cause the patient some discomfort and pain, thus making the clinician hesitant to use bone probing in daily practice.

The method proposed in this study might be able to be applied to implant dentistry. It would be convenient to apply this method to implant dentistry since there are many reference points for calibration, such as the thread pitch distance, fixture diameter, and length. Esthetic implant therapy has become a major topic in implant dentistry, of which the regeneration of the interproximal papilla is an important component. It would be possible for us to predict the outcome of regeneration of papilla, whether it is adjacent to the natural teeth or between the dental implants.

By using radiopaque material, it would be possible to non-invasively measure the papilla length in relation to the crestal bone, and possible to more accurately predict the prognosis of the regenerated papilla. The clinical data concerning the papilla length could be improved if it were possible to monitor the tissue length in relation to the crestal bone.

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