Non-invasive Method to Measure the Length of Soft Tissue from the Top of Papilla to the Crestal Bone

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The Dissertation Thesis submitted to the Department of Dental Science and the Graduate School of Yonsei University in partial fulfillment of the requirements for the degree of Master of Dental Science

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December 2003

감사의 글

미숙한 한편의 논문이 나오기 까지 저를 항상 따뜻한 관심과 지도로 격려해 주시고 이끌어 주신 문익상 교수님께 깊은 감사를 드립니다. 그리고 본 연구에 많은 관심과 도움을 주신 조규성 교수님께도 진심으로 감사드립니다. 아울러 많은 조언과 관심으로 지켜봐 주신 박광호 교수님, 김종관 교수님, 채중규 교수님, 최성호 교수님, 김창성 교수님께도 감사드립니다.

본 연구 내내 많은 도움을 준 치주과 교실원 여러분께 감사의 마음을 전합니다.

석사 과정과 수련 과정 동안 아낌없는 지원을 해주신 부모님과 현주누나, 자형께 아울러 깊은 감사를 드립니다.

2003년 12월

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Abstract

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The aim of the present study was to validate a method of measuring the length of soft tissue from the top of papilla to the crestal bone non-invasively, using radiopaque material and a periapical radiograph.

40 patients with chronic periodontitis were selected, in total 142 interproximal papillae were utilized. The distance between the radiopaque material and most coronal portion of the crestal bone was measured from the periapical radiograph, after digitization (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 between the top of the papilla and crestal bone was measured (actual length, AL). A correlation analysis was performed between AL-RL and AL-BPL using Pearson's correlation coefficients at 0.01 level.

The results were as follows; The correlation between AL-RL and AL-BPL were

0.903 and 0.931, respectively, both of which showed significance at the 0.01 level.

In 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 soft tissue from the top of papilla to the crestal bone.

Key words: interdental papilla; non-invasive length measuring; radiographic length

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I. Introduction

Periodontal tissues form the foundation of proper esthetics and function (Padbury et al., 2003). The current trends in periodontology seem to be shifting their focus from function to esthetics. These trends should be backed up by scientific evidence and long-term clinical results. The concept of biologic width (Gargiulo et al., 1961) has gained significant attention since it was first introduced into the field of periodontology. In conjunction with esthetics, this concept has become a major reference in explaining various phenomena occurring in the esthetic zone, especially in the anterior maxilla. 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 (Takei, 1980), 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 cementoenamel junction (Lindhe

& Karring, 1998). Amongst these different 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, for there are numerous factors underneath the papilla, which may affect its height, width and color. In modern periodontics, various surgical / non-surgical techniques have been developed, in order to achieve optimal results in the regeneration of the interdental papilla. And in order to verify these results, different methods of measuring the length of the papilla have been introduced. Olsson et al. (1992) introduced a method of measuring the length of the papilla with the aid of clinical photographs. Jemt (1997) developed an index for assessing the contour of the proximal papillae. Nemcovsky et al. (2000) used a similar index score in their case report. Grunder (2000) described the stability of the mucosal topography around single implants, using a bone sounding technique, in order to measure the distance from the top of the papilla to the bone crest. Using a similar bone sounding technique, Tarnow et al. (1992) reported the relationship between the interdental papilla and the contact point, and concluded that the distance from the contact point to the crestal bone is significantly related to the length of the papilla. Thus, it is a matter of importance to measure the length from the top of papilla to the crestal bone before treatment, in order to predict the prognosis of papilla regeneration.

Those former mentioned studies (Tarnow et al., 1992; Grunder, 2000) seem to rely on somewhat invasive methods to assess papilla regeneration, such as bone probing. In other cases, the result of regeneration is being adressed using clinical photographs (Olsson et al., 1992; Jemt, 1997; Nemcovsky et al., 2000), which do not allow the length of the crestal bone to the top of the papilla to be measured. Thus, it would be useful, if it were possible to use radiographs to measure the

length of the crestal bone to the top of the papilla non-invasively.

The aim of this 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.

II. Materials and Methods

A. Subjects and Sites

40 patients (20 males, 20 females) aged 35 to 55 years with chronic periodontitis who were scheduled for periodontal surgery were selected for this study. The sites were confined to the anterior maxillary teeth. Subjects 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 were investigated in this study.

B. Procedures

1. Experimental group I

For the measurement of the radiographic length of the papilla (RL), a radiopaque material consisting of a 2:1 mixture of an endodontic sealer (Tubli-Seal, Kerr dental, West Collins Orange, CA, USA) and barium sulfate, used as the contrast media for gastrointestinal track, (Solotop suspension 140, TAEJOON Pharm, Seoul, Korea) 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 radiopacity was greatly enhanced by the contrast media. A periapical radiograph (Kodak Insight, film speed F, Rochester, NY, USA) was taken (60 KVp, 10mA, 1.0 sec, Yoshida REX 601, Tokyo, Japan) using parallel techniques with an XCP device, along with a 5 mm metal ball bearing (X-ray Distortion Markers, Salvin Dental Specialties, Charlotte, NC, USA) attached to the teeth, in order to calibrate the length. All films were developed using the

same automatic processor (Periomat, Durr Dental, Bietigheim-Bissingen Germany) following the manufacturer's instructions. (Figure 1)

The films were digitized using a digital scanner (EPSON GT-12000, EPSON, Nagano, Japan) at an input resolution of 400 p.p.i. with 256 grey color (Attaelmanan et al., 2000) and the file format was TIFF. After digitization, all files were transferred to a personal computer (processor, Intel Pentium 2.4 GHz, Santa Clara, CA, USA; operating system, Windows 2000, Redmond, WA, USA) and examined using the same monitor (Flatron LCD, LG, Seoul, Korea), which was set to a resolution of 1024 x 768 pixels. During the computer assisted radiographic measurements, the room was darkened (Attaelmanan et al., 2000; Kim et al., 2002). In order to calculate the length between the crestal bone and the top of papilla, we measured the length between the most coronal portion of the crestal bone to the radiopaque material with the computer aided device (UTHSCSA ImageTool, University of Texas Health Science Center at San Antonio Dental Diagnostic Science, San Antonio, USA).

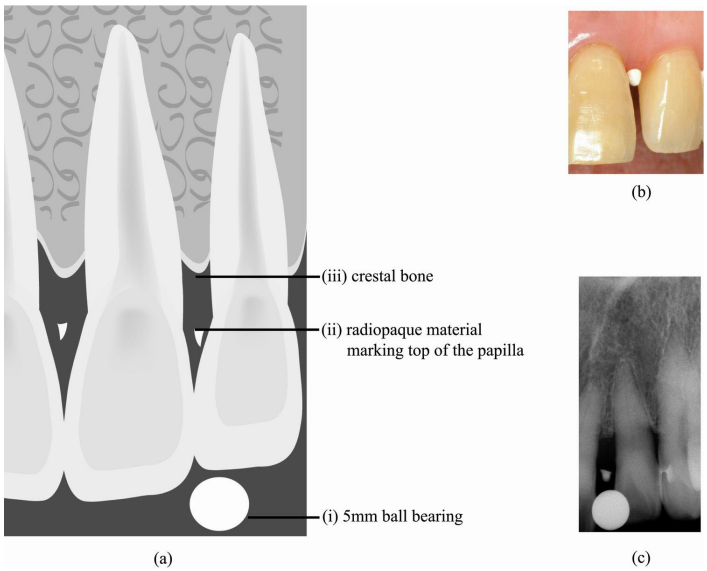

Figure 1. Measuring radiographic length. (a) Radiographic length (RL) is determined by measuring the distance between (ii) and (iii). (b) Clinical photo of applying radiopaque material. (c) Periapical film of (b).

2. Experimental group II

Probes calibrated at 1, 2, 3, 5, 7 and 10 mm (Williams PW, Hufriedy, USA) were used to measure the length of the papilla with the probe (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 (Baek et al., 1994, Kim et al., 2000). (Figure 2)

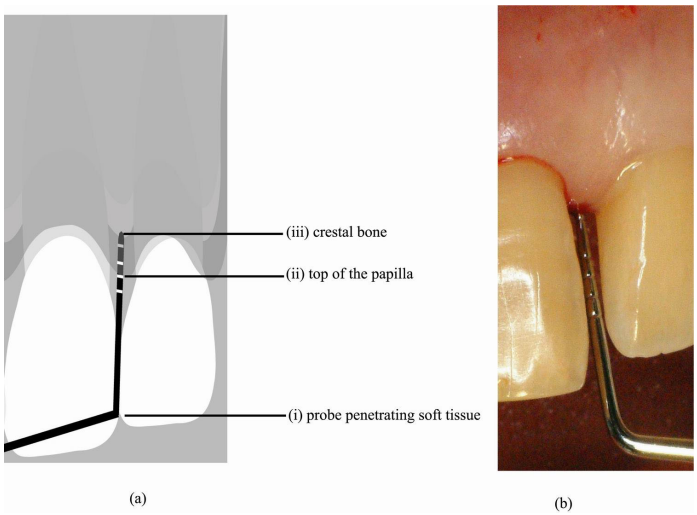

Figure 2. Measuring bone probing length. (a) Bone probing length (BPL) is determined by measuring the distance between (ii) and (iii). (b) Clinical photo of bone probing.

3. 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 as was used for the bone probing length. (Figure 3)

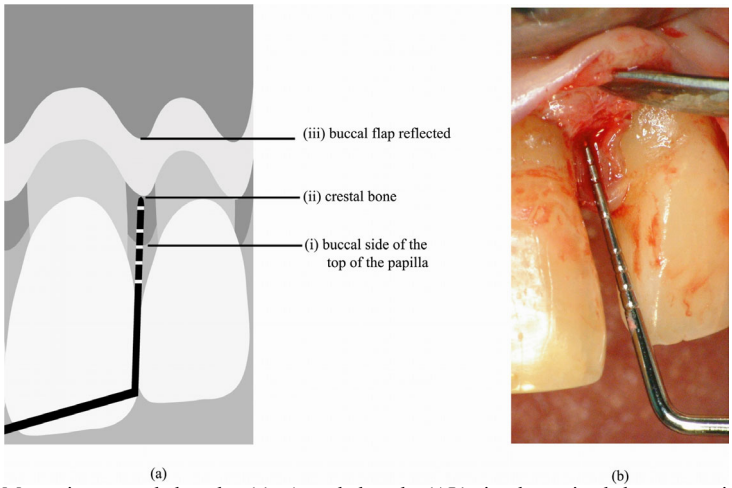

Figure 3. Measuring actual length. (a) Actual length (AL) is determined by measuring the distance between (i) and (ii). (b) Clinical photo of measuring after buccal flap reflection.

All of the measurements were rounded off to the nearest 0.5mm. (Kim et al., 2002)

C. Statistics

The correlation between RL and AL, and BPL and AL were analyzed with Pearson's correlation coefficients (SPSS for Windows release 10.0.1, SPSS Inc., Chicago, IL, USA)

III. Results

The mean value of the radiographic length of the papilla (RL) was 5.68±1.47 mm. The mean bone probing length (BPL) was 5.57±1.45 mm, and the mean actual length of the papilla (AL) was 5.80±1.84 mm.

The correlation between RL-AL and BPL-AL were 0.903 and 0.931, respectively, both of which showed statistical significance at the p=0.01 level.

Table 1. Mean value and standard deviation for each clinical measurement (mm) and the correlation between the clinical measurements and the actual alveolar bone level (n=142)

	RL	BPL	AL	ϒ (RL:AL)	ϒ (BP:AL)
n=142	5.68±1.47	5.57±1.45	5.80±1.84	0.903*	0.931*

RL=radiographic length of papilla, BPL= bone probing length of papilla
AL = actual length of papilla, ϒ= Pearson's correlation value
* = Correlation is significant at the p=0.01 level (2-tailed).

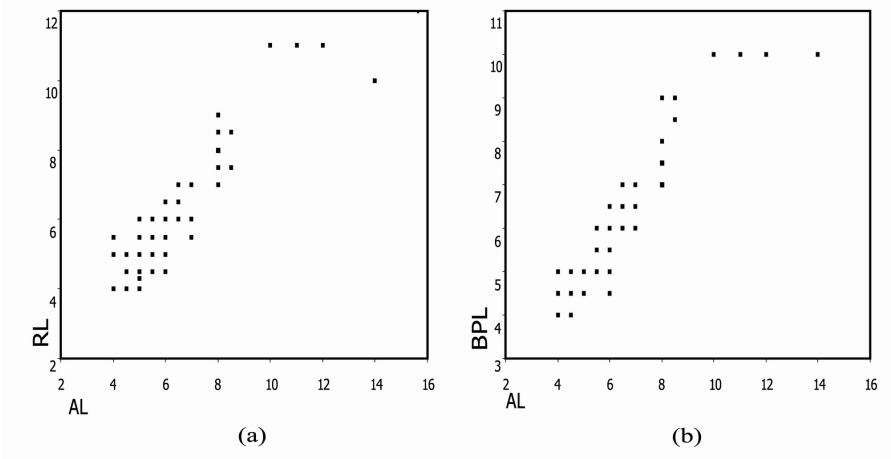

Figure 4. Scattergram showing the correlation between (a) RL -AL and (b) BPL-AL

IV. Discussion

The main purpose of this study was to validate the proposed method, which was designed to record the relationship between the papilla and the interdental bone. Radiography is a valuable method of making diagnosis in dentistry. It is non-invasive and usually requires minimal patient cooperation (Van der Stelt et al., 1985). 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. Fourmousis et al. (1994) proposed the use of underexposing radiography, in order to reveal soft tissue changes around dental implants. 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. It would be a more useful method, if it were possible to detect both soft tissue and hard tissue in a single radiographic image. This was eventually made possible by using contrast media on the soft tissue side.

Kim et al. (2000) obtained results using bone probing which had a high correlation with the actual bone level (Υ=0.92), which is in accordance with the results of this study (Υ=0.93).

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

The method proposed in the 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 interdental 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 measure the papilla length, in relation to the crestal bone, non-invasively. It would be possible to predict the prognosis of the regenerated papilla more accurately. The power of 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.

V. Conclusion

The aim of this 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.

The results obtained after comparing the distance between the radiopaque material and most coronal portion of the crestal bone (radiographic length of papilla, RL), bone probing at the interdental papilla (bone probing length, BPL) and the actual length between the top of the papilla and crestal bone (actual length, AL) were as follows; The correlation between AL-RL and AL-BPL were 0.903 and 0.931, respectively, both of which showed significance at the p=0.01 level.

In 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 soft tissue from the top of papilla to the crestal bone.

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국문요약

치간골정-치간유두 정상간 연조직 길이의 비침습적 측정 방법

<지도교수 **문익상**>

연세대학교 대학원 치의학과

이동원

본 연구는 치간골정과 치간유두 정상간의 길이를 비침습적 방법으로 측정 시 방사선 불투과성 물질과 방사선 사진을 사용한 방법의 유용성을 검증하기 위해 시행하였다.

만성 치주염 환자 40명을 대상으로 시행하였으며, 총 142개의 치간유두를 검사하였다. 실험군은 2개로 나누었으며 이는 다음과 같다. 즉, 방사선 사진상에서 방사선 불투과성 물질과 치간골정 사이의 길이를 측정하였다 (radiographic length, RL). 국소 마취 후 치주 탐침기를 이용하여 골탐침을 치간유두 정상에서 시행하였다 (bone probing length, BPL). 대조군은 협측 치주판막 거상 후 치간골정과 치간유두 정상간의 길이를 동일한 치주 탐침기를 이용하여 측정한 길이를 사용하였다 (actual length of papilla, AL). 각 실험군과 대조군의 상관도를 (AL-RL, AL-BPL) Pearson's correlation coefficients를 사용하여 조사하였다.

AL-RL 과 AL-BPL 의 상관 계수는 각각 0.903과 0.931로 p value 0.01(양쪽)

수준에서 유의성있는 상관계수를 보였다.

이상의 연구에서 볼 때, 본 연구에서 사용한 방사선 불투과성 물질과 방사선 사진을 이용한 방법은 치간골정과 치간유두 정상간의 길이를 측정하는 도구로 사용될 수 있으리라 사료된다.

핵심되는 말 : 치간유두, 치간골정, 골탐침