The Saudi Dental Journal (2013) **25**, 153–157

King Saud University

The Saudi Dental Journal

www.ksu.edu.sa
www.sciencedirect.com

ORIGINAL ARTICLE

Non invasive and surgical measurement of length of soft tissue from the tip of interdental papilla to the alveolar crest

Rajashri A. Kolte [*], **Abhay P. Kolte** [1], **Pallavi S. Ghodpage** [2]

Department of Periodontics, VSPM Dental College and Research Centre, Digdoh Hills, Hingna Road, Nagpur 440019, India

Received 23 May 2013; revised 26 September 2013; accepted 13 October 2013
Available online 6 November 2013

KEYWORDS

Interproximal papilla;
Periodontal regeneration;
Radiographic bone length;
Bone probing length;
Actual papilla length

Abstract *Background:* Various methods, including clinical and radiographic techniques, can be used to assess periodontal regeneration in interproximal areas. The goal of the present study was to compare the papilla length relative to the alveolar bone crest measured by clinical, intrasurgical, and radiographic techniques.

Materials and methods: The study sample included 250 interproximal papillae in 68 patients with generalized chronic periodontitis. The papilla length from the alveolar bone crest was measured clinically (as the actual papilla length, APL), intrasurgically (as the bone probing length, BPL), and radiographically (as the radiographic bone length, RBL). Measurements were standardized by using acrylic resin stents, XCP rinn, a paralleling technique, and/or a radiographic grid.

Results: The mean (± standard deviation) for RBL was 4.9 ± 0.8 mm, BPL was 5.1 ± 0.6 mm, and APL was 5.1 ± 0.6 mm. Correlations between RBL and APL and between BPL and APL were 0.918 and 0.943, respectively (both $P < 0.01$).

Conclusions: If the clinical recordings are appropriately standardized, then noninvasive radiographic methods can be used to evaluate the papilla length with good accuracy.

Introduction

The regeneration of a lost attachment apparatus involves the formation of new connective tissue of functionally arranged periodontal ligament fibers and an increase in bone level. One crucial element involved in restoring the periodontal apparatus and teeth is restoring the interdental zone, which includes the contact area, the interproximal embrasure, and the interdental gingiva—or, more precisely, the interdental papilla. The interdental papilla not only acts as a biological barrier in protecting the periodontal structures, but also plays a critical role in aethetics. Therefore, extreme caution must be exercised

* Corresponding author. Tel.: +91 9011071468; fax: +91 07104 232904.
E-mail addresses: drrajashrikolte@gmail.com (R.A. Kolte), drabhaypkolte@gmail.com (A.P. Kolte), pghodpage@gmail.com (P.S. Ghodpage).
[1] Tel.: +91 9011071467.
[2] Tel.: +91 9730755718.

Peer review under responsibility of King Saud University.

ELSEVIER Production and hosting by Elsevier

1013-9052 © 2013 King Saud University. Production and hosting by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.sdentj.2013.10.003

during examination and the performance of periodontal therapeutic procedures, so as to respect and maintain the papilla integrity.

Several surgical and nonsurgical techniques have been developed for reconstructing the interdental papilla. To verify the length and achieve optimal results, different methods of measuring the papilla length have been introduced, including using a clinical photograph index for the interdental papilla contour and applying a bone-sounding technique that relates the papilla to the interdental bone (Grunder, 2000; Jemt, 1997; Olsson et al., 1992). Regarding probing depth assessment, it has been suggested that the probe tip be located at various distances between the soft tissues, rather than at the bottom of the pocket, because probe tip penetration depends on several factors, including tissue inflammation, probing force, and probe diameter, among others. Another nonsurgical technique to assess the actual bone level is to insert a probe until the tip contacts the bone in anesthetized areas. The vertical probing level correlates closely to the bone level (Greenberg et al., 1976).

Most of the above procedures rely on somewhat invasive methods to measure the interdental papilla length, which might cause discomfort to the patient and possibly damage the delicate gingival unit. In contrast, radiographic evaluation is a valuable and noninvasive assessment method that has been widely used in periodontics for many years. Radiographs provide information about hard tissue changes and enable pre- and postoperative comparisons. However, radiographs have multiple sources of errors that can occur at various stages. Despite the known limitations (e.g., variations in projection geometry, exposure, processing errors, and masking of osseous structures by various anatomic structures), radiographs can be a useful noninvasive method for measuring the length of the gingival unit from the crestal bone to the top of the papillae (Chang, 2007).

Because diagnostic methods, such as clinical and radiographic measurements, are the only parameters to assess changes in periodontal tissues, it is essential that these techniques be compared with consideration of their limitations. In our opinion, there has been a distinct lack of comprehensive studies evaluating clinical, intrasurgical, and radiographic methods to determine the interdental papilla length. Therefore, the aim of the present clinical trial was to assess the papilla length from the alveolar bone crest using clinical, intrasurgical, and radiographic approaches.

Materials and methods

Study population

This study included 68 patients (age range: 20–60 years) with generalized chronic periodontitis (moderate to severe) and surgical sites with visibly closed contact areas. All patients were selected for periodontal flap surgery in the anterior maxilla at the Outdoor Patients Department of the Department of Periodontology and Implantology of Vidya Shikshan Prasarak Mandal's Dental College and Research Centre in Nagpur, India. Exclusion criteria included: known systemic conditions; pregnancy; current medication use with drugs that would increase the risk of gingival hyperplasia or alter hemostasis; and artificial crowns, proximal restorations, or abrasions. Patients were subjected to initial therapy, including scaling and root planing, and given instructions in oral hygiene maintenance. The study protocol was approved by the Institutional Ethics Committee. Informed consent was obtained from all subjects.

Table A Mean values and SD for clinical measurements.

	Mean	Std. deviation	Std. error	*f*	*P*
RBL	4.970	0.8340	0.1180		
BPL	5.172	0.6917	0.0978	1.26	0.287
APL	5.176	0.6936	0.0981		
Total	5.106	0.7440	0.0608		

Table B Mean values of probing depth, clinical attachment level, recession, plaque index and gingival index.

	PD	CAL	Rec	PI	GI
Mean	3.616	3.696	1.596	2.600	1.428
Std. deviation	0.51680	0.5617	0.6187	0.4160	0.4949

Interdental papilla measurements

Measurements of 250 interproximal papillae were recorded from the 68 patients. These measurements included the radiographic bone length (RBL), bone probing length (BPL), and actual papilla length (APL), as described below. All measurements were rounded off to the nearest 0.5 mm. Measurements were made by the same examiner (PG), a periodontal specialist who was calibrated before the beginning of the clinical trial in a pilot study.

Radiographic bone length

A radiopaque material (2:1 mixture of endodontic sealer [Harvard Cement, Harvard Dental International, Germany] and barium sulfate) was placed on the papilla tip. A periodontal probe was used to minimize the amount of material used, similar to Lee et al. (2005). In no case did the dimensions of the radiopaque material exceed 1 mm × 1 mm. Pressure on the soft tissues was negligible during placement of the radiopaque material. Intraoral periapical radiographs were taken using XCP rinn (Rinn Corporation, Elgin, IL) and radiovisiography with a paralleling technique. A standard radiographic grid (Pacific Northwest X-Ray Inc., Germany) was applied to the sensor while taking the radiograph. The radiographic image was obtained on a computer screen. RBL was measured with a computer-aided software device as the length from the most coronal portion of the crestal bone to the base of radiopaque material (Figs. A and B).

Bone probing length

An acrylic stent was fabricated on the study model and trimmed flat on the bottom edge. Semi-cylindrical vertical grooves were made in the buccal aspect with burs, for proper guidance and orientation of the periodontal probe. Local anesthesia was administered. A William's graduated periodontal probe was inserted from the papilla tip, until the examiner encountered a strong resistance (Fig. C).

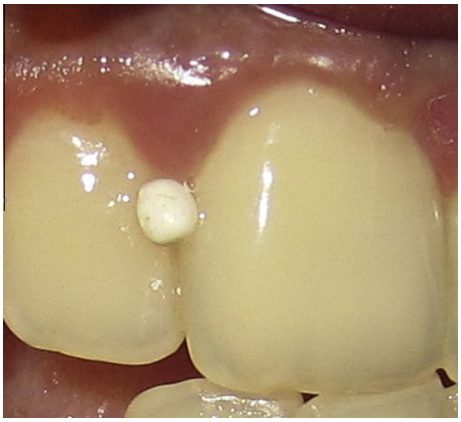


Figure A Placement of the radiopaque material at the tip of the papilla.

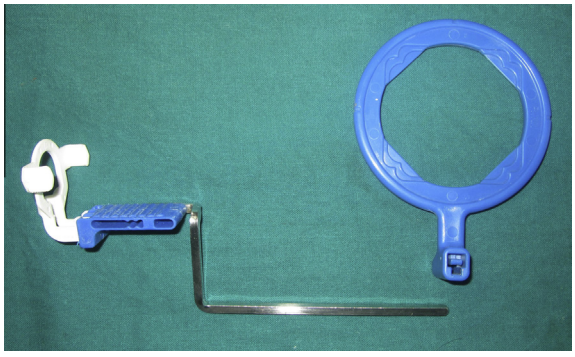


Figure B XCP rinn.

Figure C Bone probing length.

Actual papilla length

Under adequate local anesthesia, a full-thickness mucoperiosteal flap was reflected. The papilla was split in the interdental area at the central portion of the buccolingual dimension. The APL was measured with a William's graduated periodontal probe, which was oriented using the grooves on the stent. The probe was placed parallel to the flap, with its tip in contact with the bone, and the APL was measured from the alveolar bone crest to the papilla tip (Fig. D).

Statistical analysis

Statistical analysis was performed using the SPSS version 11.5 software package. Correlations between RBL and APL and between BPL and APL were analyzed by analysis of variance (ANOVA).

Results

The mean (± standard deviation) for RBL was 4.9 ± 0.8 mm, BPL was 5.1 ± 0.6 mm, and APL was 5.1 ± 0.6 mm (Graph A). Correlations between RBL and APL and between BPL and APL were 0.918 and 0.943, respectively (both $P < 0.01$; Graph B) (see Tables A and B).

Discussion

Patient's desire and clinicians aim to achieve a harmonious relationship of the interproximal papillae and a healthy gingiva with the natural dentition. Various methods have been advocated to evaluate the length from the alveolar crest to the tip of the interdental papilla. The present study aimed to assess the papilla length by three different methods, and to compare these measurements in terms of their accuracy.

In most clinical situations of restoring the periodontal apparatus, the maxillary anterior sextant is distinctly visible and has high aesthetic relevance. To ensure similar anatomical locations and defect morphologies throughout the study, the maxillary anterior area was selected for the clinical trial. Further studies can be undertaken to compare maxillary and mandibular soft tissue measurements. A custom-made stent was used to standardize the measurements. If the site and direction of probing are not consistent, then it will be difficult to evaluate and compare the attachment levels (Hassell et al., 1972). The same problem may occur in the evaluation of regenerative therapy. Therefore, a consistent reference and orientation for probing are needed. Although the cementoenamel junction (CEJ) has been suggested as a reference point, the presence of subgingival calculus or subgingival location of the CEJ may frustrate its use (Ramfjord, 1959). Alternatively, an onlay-type stent can be used to guide the probe to an exact location with a proper orientation.

The probing depth is defined as the distance from the gingival margin to the base of periodontal pocket. The difference

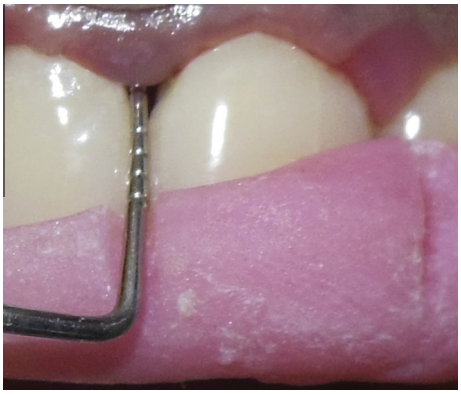
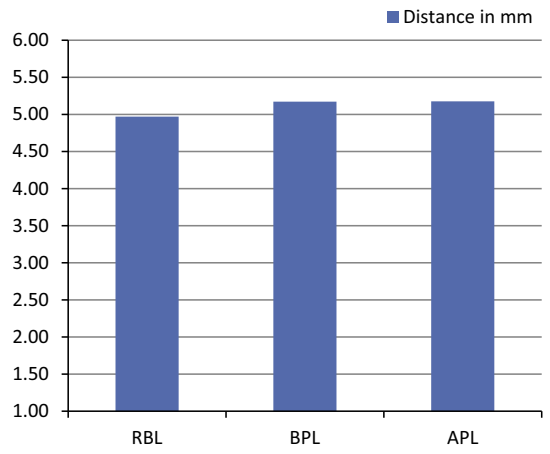
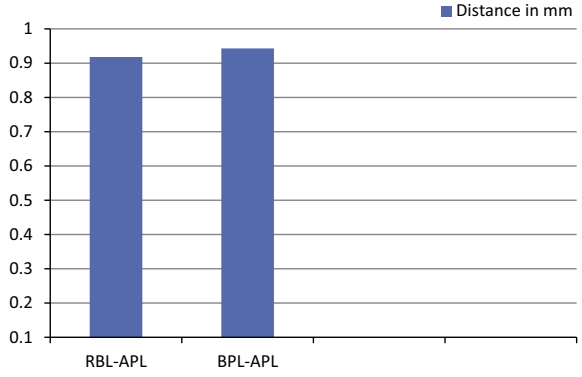


Figure D Actual length of papilla.



Graph A Graphic representation of radiographic bone length, bone probing length and actual papilla length.



Graph B Graphic representation of correlation between radiographic bone length, bone probing length, and actual papilla length.

between the surgically measured bone level (SBL) and the probing depth is the distance from the base of the pocket to the bone. Many studies have shown that the probe often reaches the apical end of the junctional epithelium or even the connective tissue. Thus, the probing depth actually corresponds to the coronal-most location of the intact connective tissue attachment along the root surface (Listgarten et al., 1976; Sivertson and Burgett, 1976). The difference between the SBL and probing depth may be the distance from the apical extent of the junctional epithelium to the bone or the coronal-most location of the intact connective tissue attachment, rather than the length of the dentogingival junction.

Biopsy studies revealed that the mean distance from the apical end of the junctional epithelium to the bone was 1.07 mm, similar to the difference of 1.08 mm found by Gargiulo et al. (1961) and Kim et al. (2000). A previous study by Suomi et al. (1968) demonstrated that the difference between the probing depth and SBL was 1.84 mm when a stent was not used. In the present study, the measurement was 1.56 mm. Variations between the measurements in our study and those by Kim et al. could be attributed to varying degrees of inflammation present within the tissue. In the study by Garguilo et al. the measurements were recorded histologically.

We determined the bone levels (i.e., RBL, BPL, and APL) using the methods described in a previous clinical trial (Kim et al., 2000), in which a custom-made acrylic resin stent was used for proper probe orientation during the measurements. Kim et al. (2000) found minimal difference between the values of BPL and APL, and proposed the transgingival probing method as a reliable approach for measuring the papilla length. In the present study, an acrylic stent with semi-cylindrical grooves was fabricated on the study cast to determine a specific path of probe insertion during measurements of APL and BPL. The results of our study were in accordance with the findings of several previous studies (Gargiulo et al., 1961; Kim et al., 2000; Suomi et al., 1968). We also found a strong correlation between BPL and APL.

Probing methods may cause discomfort for patients and some possible damage to the regenerated tissues. It is difficult to employ such invasive procedures for periodontal diagnosis. Therefore, many studies have sought a nonsurgical method for assessing the bone level with acceptable accuracy and reliability. Radiography is a valuable and noninvasive diagnostic tool that requires minimal patient cooperation. However, radiography has an inherent property of penetrating the soft tissues; hence, its diagnostic importance in terms of measuring the soft tissue length is somewhat reduced. Some authors have suggested underexposing radiographs for this purpose, but this approach may hamper the diagnostic value for hard tissues. Radiographs are also associated with inherent errors that make them less reliable for assessing the bone level. However, these errors can be minimized by using devices such as XCP rinn and grids.

Lee et al. (2005) measured the soft tissue length from the papilla tip to the crestal bone by a noninvasive method, using a mixture of endodontic sealer and barium sulfate. As in this study, the RPL was measured and compared to the BPL and APL was measured with a William's graduated probe. The correlations between APL and RBL and between APL and BPL were 0.903 and 0.931, respectively (both $P < 0.01$). The strong correlation between APL and RBL suggested that the radiographic method can be used for measuring the papilla length. Wahi et al. (2013) found a similarly significant correlation between invasive and noninvasive methods of assessing the distance between the papilla tip and the alveolar bone crest.

Radiopaque material can be used as a good reference point to measure the alveolar crest from the tip of interdental papilla. In the present study, a radiopaque material (endodontic sealer and barium sulfate mixture) was used to mark the papilla tip. Chang (2007) used a similar radiopaque material to find the association between the embrasure morphology and central papilla recession. XCP rinn aids in positioning the film in the patient's mouth, such that the film is accurately placed relative to the periapical areas and parallel to the teeth. In this study, XCP rinn was used to standardize the radiographs. Rosling et al. (1975) used a similar device to determine or avoid elongation or shortening of the radiograph. A grid was placed in front of the radiographic film, and measurements were performed using a computer-aided software to minimize human error.

We observed a significant association among RBL, BPL, and APL. Hence, radiographs can reliably and accurately serve as substitutes for bone probing or surgical reentry in the fields of periodontics and implantology. The mean values of APL, BPL, and RBL did not show statistically significant differences between the groups. Considering that similar and accurate

measurements were obtained with all three methods, the choice of method can be left to the operator.

Limitations

This study has some limitations. First, the clinical trial was confined to the anterior maxillary interdental papilla; the mandibular interdental papillae were not considered. The results may differ according to the clinical site within the oral cavity. Second, we did not account for any potential volumetric changes in the soft tissue after the administration of local anesthesia.

Conclusion

Transgingival probing has been considered as one of the most reliable methods for measuring accurate bone levels. However, probing methods are invasive and may cause patient discomfort. If standardized measures were to be properly adopted, we propose that radiographic techniques could be established as alternative, noninvasive, and reliable methods of determining the interproximal papilla length relative to the alveolar bone crest.

Conflict of interest

The authors hereby declare that there is no conflict of interest.

References

Chang, L.C., 2007. The association between embrasure morphology and central papilla recession. J. Clin. Periodontol. 34, 432–436.

Gargiulo, A.W., Wentz, F.M., Orban, B., 1961. Dimensions and relations of the dentogingival junction in humans. J. Periodontol. 32, 261–266.

Greenberg, J., Laster, L., Listgarten, M.A., 1976. Transgingival probing as a potential estimator of alveolar bone level. J. Periodontol. 47, 514–517.

Grunder, N., 2000. Stability of the mucosal topography around single tooth implants and adjacent teeth: 1 year results. Int. J. Periodontics Restorative Dent. 20, 11–17.

Hassell, T.M., Germann, M.A., Saxer, U.P., 1972. Periodontal probing: inter-investigator discrepancies and correlations between probing force and recorded depth. Helv. Odontol. Acta 17, 38–42.

Jemt, T., 1997. Regeneration of gingival papillae after single implant treatment. Int. J. Periodontics Restorative Dent. 17, 327–333.

Kim, H.Y., Yi, S.W., Choi, S.H., 2000. Bone probing measurement as a reliable evaluation of the bone level in periodontal defects. J. Periodontol. 71, 29–735.

Lee, D.W., Kim, C.K., Park, K.H., 2005. Non-invasive method to measure the length of soft tissue from the top of the papilla to the crestal bone. J. Periodontol. 76, 1311–1314.

Listgarten, M.A., Mao, R., Robinson, P.J., 1976. Periodontal probing and the relationship of the probe tip to periodontal tissues. J. Periodontol. 47, 511–513.

Olsson, M., Lindhe, J., Marinello, C.P., 1992. On the relationship between crown form and clinical features of the gingival in adolescents. J. Clin. Periodontol. 20, 570–577.

Ramfjord, S.P., 1959. Indices for prevalence and incidence of periodontal disease. J. Periodontol. 30, 51–59.

Rosling, B., Hollender, L., Nyman, S., 1975. A radiographic method for assessing changes in alveolar bone height following periodontal therapy. J. Clin. Periodontal. 2, 211–217.

Sivertson, J.F., Burgett, F.G., 1976. Probing of pockets related to the attachment level. J. Periodontol. 47, 281–286.

Suomi, J.D., Plumbo, J., Barbano, J.P., 1968. A comparative study of radiograph and pocket measurements in periodontal disease evaluation. J. Periodontol. 39, 311–315.

Wahi, S., Chhina, K., Chhabra, V., Bhatnagar, R., 2013. Invasive versus non invasive method of assessment of distance between the tip of papilla to the crest of interdental bone. Eur. J. Dent. 2, 37–41.