ORIGINAL ARTICLE

Invasive versus non-invasive method of assessment of distance between the tip of papilla to the crest of interdental bone

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ABSTRACT

Statement of Problem: Anatomic and histologic make up of interdental region is crucial in maintaining the integrity and health of interdental papilla during surgical and restorative procedures. The effect of vertical and horizontal distance between the teeth on the incidence of interproximal papilla has been widely explored and is considered as a contentious issue. Though several non-surgical methods have been developed to assess bone level, the accuracy and reliability of these methods were questioned. **Purpose and Aim:** To compare the reliability of the non-invasive method using radiographs with invasive method to measure the length of papilla from the tip of papilla to crest of interdental bone. **Materials and Methods:** In the present study, non-invasive method using radiograph was compared to invasive method to measure length of papilla from the tip of papilla to crest of interdental bone. Radiographic length, bone probing length, and actual papilla length was measured in 20 chronic periodontitis patients, and the results were statistically analyzed. **Results and Conclusion:** A statistically significant correlation was observed in invasive versus non-invasive method of assessment of distance between the tip of papilla to the crest of interdental bone, indicating the importance of standardization of radiographic aids.

Key words
Actual papilla length, bone probing length, interproximal papilla, radiographic length

INTRODUCTION

Interdental papilla is that part of gingiva, which occupies the space between two adjacent teeth. Morphologically, the papilla had been described first by Cohen in 1959. Before this time, interdental papilla was considered as a gingival trait, having a pyramidal shape and functioning for deflection of interproximal food debris. It not only act as biological barrier in protecting the periodontal structures, but also plays a critical role in esthetics. Hence, it is very important to respect papillary integrity during all dental procedures.[1]

The shape of interdental papilla is determined by the contact relationship between the teeth, the width of approximal tooth surfaces, and the course of cemento-enamel junction. The most important factor that influences the presence of papilla is availability of underlying osseous support. From the anatomical point of view, the presence or absence of interproximal papilla depends upon the distance between contact point and crest of the bone. When the distance ≤5 mm, the papilla is almost present; however, when this distance is ≥6 mm, the papilla is absent (Tarnow DP 1992).[2]

Several non-surgical methods have been developed to assess bone level, but the accuracy and reliability of these methods were questioned. Therefore, invasive methods were developed to accurately relate papilla to interdental bone. However, the invasive methods might cause discomfort to the patients and possibly damage the delicate gingival unit, especially after surgical procedures for regenerating interproximal papilla.[3,4]

Radiographs are one of the valuable diagnostic methods in dentistry. They provide information about hard tissue changes, and they can be stored and re-assessed at any time for comparison between pre-treatment and post-treatment parameters. Radiographic, assessments, however, are also subject to multiple sources of error. These include variations in projection geometry, exposure

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and processing errors as well as masking of osseous structures by various anatomic structures. Despite the known limitations, radiograph can be a useful non-invasive method to measures the length of gingival unit from the crestal bone to the top of the papillae.[5,6] The present study was undertaken to compare the reliability of the non-invasive method using radiographs with invasive method to measure the length of papilla from the tip of papilla to crest of interdental bone.

MATERIALS AND METHODS

Twenty patients with generalized chronic periodontitis, having surgical sites with visible closed contact areas, were selected for periodontal flap surgery in maxilla from Outdoor Patients Department, Department of Periodontology and Implantology, B.R.S Dental College, Panchkula. Medically compromised patients, systemically compromised patients e.g., pregnancy or history of taking medication known to increase the risk of gingival hyperplasia, patient with poor oral hygiene, surgical sites having proximal caries, restorations, crowns, or abrasions were excluded.

Study design

After completion of phase I therapy, following parameters were recorded on the day of surgery.

- Radiographic bone length (RBL),
- Bone probing length (BPL),
- Actual papilla length (APL).

(A total of 102 papillae were analyzed)

Radiographic length was recorded by taking intra-oral periapical radiographs using XCP rinn and radiographic grid and after applying radiopaque material (Cavit G) apical to contact point at the tip of papilla [Figure 1]. Thus, the base of radiopaque material represented the tip of papilla. The second parameter that is the bone probing length was recorded by placing acrylic stent and giving local anesthesia. William's periodontal probe was inserted until the tip contacts the bone. The acrylic stent was fabricated on the stone model and trimmed flat on the bottom edge [Figures 2 and 3]. Hemi-cylindrical vertical grooves were made in the buccal aspect with burs for the proper guidance and orientation of periodontal probe. William's periodontal probe with rubber stopper was adjusted to the base of the acrylic stent that is tip of papilla, and then measurement was made with digital vernier caliper (MY CAL Absolute).

The third parameter that is actual papilla length was measured after reflecting full thickness flap and, acrylic stent was again placed. William's periodontal probe was placed, and rubber stop was adjusted to the base of acrylic stent. After recording the described parameters, debridement was done, and flap was sutured. The results were statistically analyzed.

OBSERVATIONS AND RESULTS

Paired sample *t*-test was applied to compare the two methods. The mean difference between radiographic bone length and actual papilla length (RBL-APL) was 0.7321, the mean difference between radiographic bone length and bone probing length (RBL-BPL) was 0.4494, and the mean difference of the bone probing length and actual papilla length (BPL-APL) was 0.2827. The above differences were within 1 mm range. Significant association was seen in all the three methods $P<0.00$. To further evaluate the correlation between radiographic bone length, bone probing length, and actual papilla length, Pearson's correlation coefficient was applied.

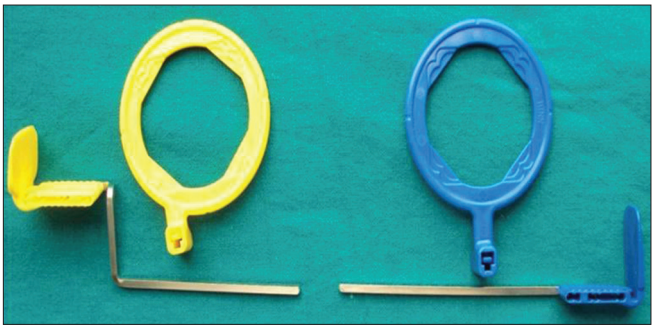

Figure 1: Rinn XCP holders for accurate parallelism of intra-oral radiographs

Figure 2: Acrylic stent place in patient mouth

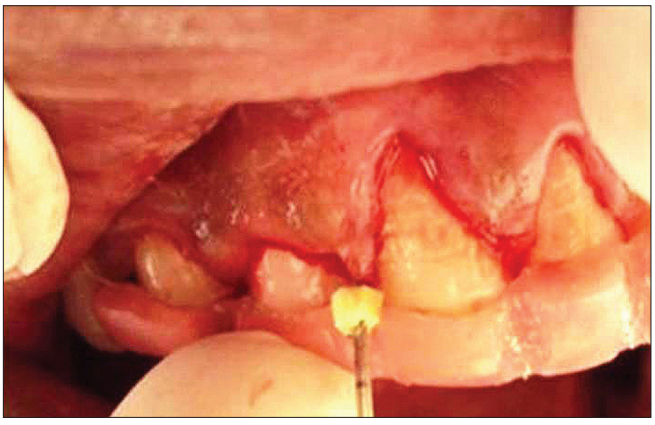

Figure 3: Measurement of actual papilla length

Highest Pearson's correlation coefficients were seen in APL-BPL followed by RBL-BPL and RBL-APL, but all the three pairs correlated significantly [Table 1].

Regression analysis of actual papilla length and radiographic bone length was done. Regression coefficient=0.717 showed significant correlation $P<0.001$ of actual papilla length and radiographic bone length [Figure 4]. In addition, actual papilla length can be calculated from given radiographic bone length using regression analysis equation. Actual papilla length represented by Y axis and radiographic bone length represented by X axis.

$$\text{APL(Y axis)} = \text{constant} + \text{coefficient} \times \text{RBL(X axis)},$$
$$\text{APL} = 2.146 + 0.714 \times \text{RBL}$$

Regression analysis of actual papilla length and bone probing length was done, regression coefficient R=0.934 showed significant correlation $P<0.001$ of actual papilla length and bone probing length.

In addition, actual papilla length can be calculated from given bone probing length using regression analysis equation. Actual papilla length represented by Y axis and bone probing length represented by X axis.

$$\text{APL(Y axis)} = \text{constant} + \text{coefficient} \times \text{BPL(X axis)},$$
$$\text{APL} = 0.699 + 0.932 \times \text{BPL}$$

Although, regression coefficient of APL-BPL is 0.934 is higher than regression coefficient of APL-RBL, which is 0.717, correlation of both radiographic bone length and bone probing length with actual papilla length was statistically significant [Figure 5].

DISCUSSION

The existence of interdental papillae and healthy gingiva in harmony with the natural dentition is one of the important esthetic aspects that need to be considered for dental treatment and diagnosis. A variety of measuring methods have been advocated to accurately determine the level of alveolar crest from the tip of the interdental papilla.[7] Though surgical measurement of the bone and transgingival probing has been confirmed as a valid method of reporting papilla length (Tarnow DP 1992)2, it is rather a invasive method since administrating of local anesthesia is likely to cause the patient some discomfort, pain, and complication, thus making the clinician hesitate to use it in daily practice.

Radiograph is the valuable method in diagnosis. It is non-invasive and usually requires minimum patient co-operation. 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; however, it is not always easy to use it in every clinical situation, because underexposed radiography may not contain enough information for the clinician. Radiographs are also associated with lot of inherent errors, which make them less reliable for assessing bone level. Through the development of new devices and technologies like XCP rinn and radiographic grid, these short comings can be reduced.[8-10]

In our study, for the measurement of the radiographic

Table 1: Correlation between radiographic bone length, bone probing length and actual papilla length

	Paired samples correlations			
	Mean differences	*N*	Correlation	Significance
Pair 1	RBL-APL	102	0.784	<0.001
Pair 2	RBL-BPL	102	0.795	<0.001
Pair 3	BPL-APL	102	0.970	<0.001

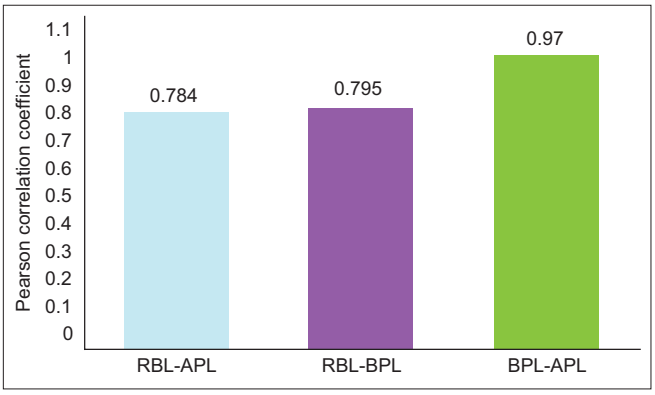

Figure 4: Graphic representation of correlation between radiographic bone length, bone probing length, and actual papilla length. RBL: Radiographic bone length, BPL: Bone probing length, APL: Actual papilla length

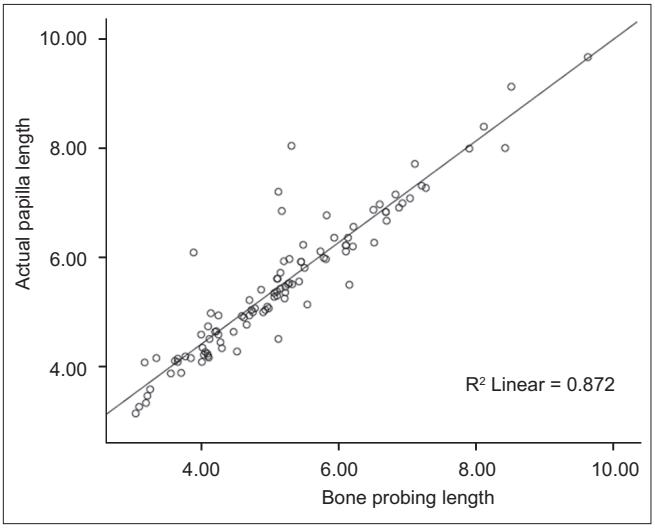

Figure 5: Scatter diagram representing regression analysis of actual papilla length with bone probing length

length of the papilla, contrast media, a soft radiopaque restorative material Cavit G was used, which contains barium sulfate as an opacifier. Li Ching Chang (2007)[11] also used Cavit G as a radiopaque material in a study to find the association between embrasure morphology and central papilla recession. Lee *et al.* (2005)[6] in a study that measured the length of soft tissue from the tip of the papilla to the crestal bone by non-invasive method and used a mixture of an endodontic sealer and barium sulfate in a ratio of 2:1 as a radiopaque material. The distance between the radiopaque material and most coronal portion of the crestal bone (radiographic length of papilla, RL) was measured, following which they performed bone probing at the interdental papilla after local anesthesia (bone probing length, BPL). In contrast to our study, they measured the actual length of the papilla by flap elevation (actual length of papilla, AL). They observed correlation between AL-RL and AL-BPL that was 0.903 and 0.931, respectively, both of which showed significance at the 0.01 level. However, the study results of our study were in agreement with the study conducted by Lee *et al.*, as they also suggested that the non-invasive method using a radiopaque material and periapical radiograph could be utilized to measure the length of the interdental papilla. Therefore, radiopaque material acts as a good reference point to measure the alveolar crest from the tip of interdental papilla. XCP rinns were used to standardize the radiographs. It helps to position the film properly in the patient's mouth and parallel to the teeth and project the periapical areas onto the film. With the help of XCP rinns, we can get the repeated radiographs of similar size of a particular area. A similar device was made by Rosling *et al.* (1975)[12] for identical radiographs. Li Ching Chang (2008)[11] also used XCP rinns for the paralleling technique.

The most common shortcoming associated with radiographs is dimensional changes that are elongation and shortening of the image that makes difficult for the examiner for the accurate measurement of the bone level from the fix reference point. To overcome this, radiographic grid was placed in front of radiographic film in the XCP rinn before exposure. It divides the radiographs like a graph in a millimeter marking, thus reducing the problem of dimensional changes associated with the radiographs.

For the accurate measurement of the actual papilla length and bone probing length, acrylic stent was fabricated on the stone model for the fix reference point. Accuracy of probing in the evaluation of attachment level might suffer if the site and the direction of probing were not consistent (Hessell *et al.* 1972). Ramfjord (1959) suggested cemento-enamel junction as a reference point, but the presence of subgingival calculus or the subgingival location of the CEJ may make it difficult to use. Clark (1987) and Badersten (1984) reported that stent could enhance the reliability of attachment level assessment. In the study, mean value of the actual papilla length that is distance of the crest of alveolar bone from the tip of papilla was 5.45±1.26 mm, the mean value of transgingival/bone probing was 5. 17±1.28 mm, and mean value of radiographic bone length was 4.76±1.29 mm. On comparing the three groups, difference in mean value between radiographic bone length and actual papilla length (RBL-APL) was 0.73±0.84 mm, the difference of mean value between radiographic bone length and bone probing length (RBL-BPL) was 0.44±0.82 mm, and the difference of mean value between bone probing length and actual probing length (BPL-APL) was 0.28±0.31 mm. The difference between the three groups was found to be within the range of 1 mm. These results are in accordance with studies done by Lee *et al.* (2005),[6] Kim *et al.* (2000).[9]

To further evaluate the correlation, Pearson's correlation coefficient was applied. Pearson's correlation coefficient was highest for actual papilla length and bone probing length. A high degree of correlation was seen between all the three groups, which was statistically highly significant (P<0.001). Study by Lee *et al.* (2005)[6] also found that the correlation between radiographic bone length to actual papilla length was 0.903, and correlation between bone probing length to actual papilla length is 0.931, both of which shows statistical significance at the 0.01 level, and confirmed radiography was a valid tool in diagnosis of alveolar crest level in periodontics.

Similar results were reported by Ursell MJ *et al.* (1989)[4] who compared transgingival probing with surgical estimation of bone found that there relation was statistically significant of r=0.975. Kim *et al.* (2000)[5] also found a strong correlation (x^2=0.92) between bone probing length and actual papilla length. Regression analysis of actual papilla length, bone probing length, and radiographic bone length showed that regression coefficient of actual papilla length and bone probing length (APL-BPL) R=0.934 is higher than regression coefficient of actual papilla length and radiographic bone length (APL-RBL) R=0.717, but both correlate significantly to actual papilla length. These results are in accordance with studies done by Kim *et al.* (2000),[5] Zybutz *et al.* (2000).[13]

The results of our study showed that significant association is present between radiographic bone length, bone probing length, and actual papilla lengths. Hence, radiographs can reliably and accurately serve as substitute for bone probing or surgical re-entry in the field of periodontics and implantology.

In addition, regression analysis can be used to calculate actual papilla length from constant and coefficient of given radiographic bone length and bone probing length. This is of great value, especially in regenerative periodontics and implants dentistry, where changes in bone level can be calculated from radiographs avoiding invasive procedure such as surgical re-entry.

SUMMARY AND CONCLUSION

Although the actual papilla length and bone probing are the most accurate method to measure the bone level, these methods are invasive, as local anesthesia is administered prior to these methods and required patient's co-operation. When these two methods are compared to radiographic measurement of bone length, it was seen that correlation exist that is statistically significant. Thus, by standardization of radiographs by using XCP rinns, contrast media, and radiographs grid etc., radiographs can be used effectively in the periodontal diagnosis with greater degree of accuracy.

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