ORIGINAL ARTICLE

Correlation of interdental and interradicular bone loss in patients with chronic periodontitis: A clinical and radiographic study

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Abstract

Objective: The aim of this study was to investigate the correlation between interdental and interradicular bone loss and clinical parameters in patients with chronic periodontitis.

Materials and Methods: One hundred-twenty intraoral periapical radiographs of first molars were obtained from patients with chronic periodontitis and were digitalized to record height and width of the bone defect in the interdental and interradicular region (furcation) and bone defect angle in the interdental region in vertical defects. Pocket depth (PD) and clinical attachment loss (CAL) was recorded at three sites. The data was divided into groups according to the pocket depth at each site. One-way ANOVA was used to compare three different pocket depths with respect to CAL, height and width at a particular site. This was followed by Tukeys HSD post hoc tests to know the significant difference between two groups of pocket depths. Lastly Karl Pearsson's co-efficient method was applied to find out the relationship among CAL, height and width for the particular site.

Results: When the pocket depth groups were compared for CAL, height and width of the defect at all three maxillary and mandibular sites, the results were statistically significant. In maxillary molars, a radiographic bone defect height ranging from 3.4–7.1 mm at the mesiobuccal site and 3.6–7.2 mm at the distobuccal site was associated with 1.2–3.5 mm defect height in the interdental region. In mandibular molars, a radiographic bone defect height ranging from 2.9–7.0 mm at the mesiobuccal site and 3.2–6.8 mm at the distobuccal site was associated with 1.2–3.6 mm defect height in the interdental region. The mean bone defect angle was 36.3 ± 16.5 degrees.

Conclusion: Treatment of interdental bone loss can prevent further bone loss in the interradicular region. Radiographic measurements combined with clinical findings can be useful for periodontal risk assessment.

Key words: Alveolar bone loss, chronic periodontitis, dental, furcation defect, radiography

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Introduction

The main goals of the diagnosis of periodontal disease and the subsequent therapy are to eliminate periodontal infection and to reduce the risk for future progression of the disease.[1] To describe the amount of periodontal destruction that has already occurred, the clinician has to rely on data from clinical examinations and radiographs. Determining bone loss using intraoral and panoramic radiographs is essential for accurate diagnosis[2] and appropriate treatment planning.[3,4] Among the methods used to detect alveolar bone dimensions on radiographs are Schei or millimeter rulers[5] and computer analysis of digital images.[6,7]

Radiographic methods provide information about hard tissue changes.[8] Linear measurements between the

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cemento-enamel junction (CEJ) and the alveolar crest (AC) or the bottom of the bony defect (BD) are often used to characterize the amount of bone loss in osseous periodontal defects.[3] The importance of determining the extent of bony lesions has been stated with respect to possible outcomes of different regenerative procedures[9-11] and for correct periodontal risk assessment.[12] With the help of radiographs, periodontal changes can be estimated with high specificity, especially in moderate forms of periodontitis.[13,14]

For both periodontal probing and radiographic analysis, molar furcation areas present particular problems, due to their complex morphology and great challenges to the success of periodontal therapy. It is known that with progression of periodontal destruction and the involvement of furcal areas, the severity of periodontitis increases and treatment is less effective because of limited access for mechanical control. Reduced efficacy of periodontal therapy has been consistently found in multirooted teeth with furcation involvement, regardless of the treatment modality employed.[15] Hence, it is important to treat periodontitis before involvement of furcation areas.

The threshold of alveolar bone loss associated with progression of periodontal destruction and involvement of interradicular areas is not clearly defined in the literature. The aim of this study is to investigate correlation between interdental and interradicular bone loss and clinical parameters in patients with chronic periodontitis.

Materials and Methods

A total of 78 patients (42 females and 36 males) visiting the Department of Periodontics were included in the study. Ethical clearance for the study was obtained from the college ethical clearance committee, HKES SN Institute of Dental Sciences, Gulbarga. Study design was explained to the subjects and informed consents were obtained. The subjects were in between the age group of 30 and 65 years and had chronic periodontitis, grade II buccal furcation involvement with first molars. Chronic periodontitis was diagnosed according to AAP classification.[16] Furcation involvement was assessed using a color coded, calibrated Nabers probe, marked at 3-mm intervals (PQ2N, Hu Friedy, Chicago, IL, USA) according to Glickman's classification.[17] Patients with systemic diseases, lingual furcation involvement and anatomical variations of teeth were excluded from the study.

One hundred-twenty intraoral periapical (IOPA) radiographs of first molars were obtained from 78 subjects by paralleling technique (long-cone technique/right-angle technique) using commercially available film holder, XCP (Extension Cone Paralleling) kit, Dentsply® (Dentsply Limited, Addlestone, U.K) (RINN). Intraoral dental films size two (E speed, Eastman Kodak Co., Rochester, NY, USA) were exposed to an X-ray source (Heliodent 70, 70 kV, 7 mA, Siemens, Bensheim, Germany) for 0.5 sec. Radiographs were developed under standardized conditions (Periomat, Durr Dental GmbH, Bietigheim-Bissingen, Germany) to reduce the differences in brightness and contrast to a minimum.

Each IOPA radiograph was scanned to make it accessible to digital analysis. This was done by using a scanner with a resolution of 600 dots per inch.

Prior to measuring the radiographs, the examiner was trained to identify the landmarks correctly, viewing 10 radiographs several times. Digital measurement of linear distances was performed using a computer program (Dental Eye Inc. Certified Microsoft Partner software, Sundbyberg, Sweden) on a 17-inch screen. All radiographs were evaluated under 9.5-fold magnification.

Radiographic assessment included the following measurements:

- Height of defect (H):
    - CEJ-AC: Cemento-enamel junction line to alveolar crest (in horizontal bone loss)
    - CEJ-BD: Cemento-enamel junction line to apical extension of the bony defect (BD) (in angular bone loss)
    - Fx-BL: furcation fornix to interradicular bone level.

Definition of landmarks: BD was defined as the most coronal point where the periodontal ligament space showed a continuous width. If no periodontal ligament space was identified, the point where the projection of the AC crossed the root surface was taken as the landmark.[18] If both structures could be identified at one defect, the point defined by the periodontal ligament was used as BD. If several bony contours could be identified, the apical-most that crossed the root was defined as the BD. [Figure 1]

- Width of defect (W).

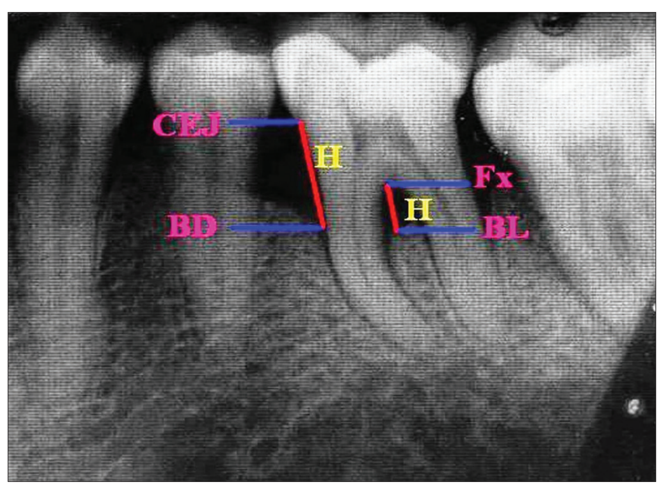

Figure 1: Height of defect

- Auxiliary line (AUX1) was drawn parallel to the long axis of the tooth.
- Auxiliary line (AUX2) was drawn perpendicular to the AUX1 through the most coronal extension of the lateral wall of the infrabony defect.

Bone defect width

Measured from the lateral margin of the infrabony defect to the point where AUX2 crosses the root surface.

Furcation width

The distance between the mesial and distal root on the level of the AC within the furcation. [Figure 2]

Bone defect angle

The angle between line drawn from CEJ to BD and another line drawn from BD to the lateral margin of the infrabony defect is the Bone defect angle (BDA). This was measured at sites with vertical bone loss/defects. [Figure 3]

Pocket depth (PD) and clinical attachment loss (CAL) was recorded at three sites on the buccal aspect (Mesiobuccal, midbuccal and distobuccal) of the teeth to the nearest 0.5 mm using UNC-15 probe (Hu Friedy, Chicago, IL, USA).

Statistical analysis

The data collected was divided into three groups depending upon the pocket depth:

- 4 mm
- 5–6 mm
- ≥ 7 mm.

One-way ANOVA was used to compare three different pocket depths with respect to CAL, height and width at a particular site. This was followed by Tukeys HSD post hoc tests to know the significant difference between two groups of pocket depths, i.e., 4 mm and 5–6 mm, 4 mm and ≥ 7 mm, and 5–6 mm and ≥ 7 mm. Lastly, Karl Pearsson's co-efficient method was applied to find out relationship among CAL, height and width for the particular site.

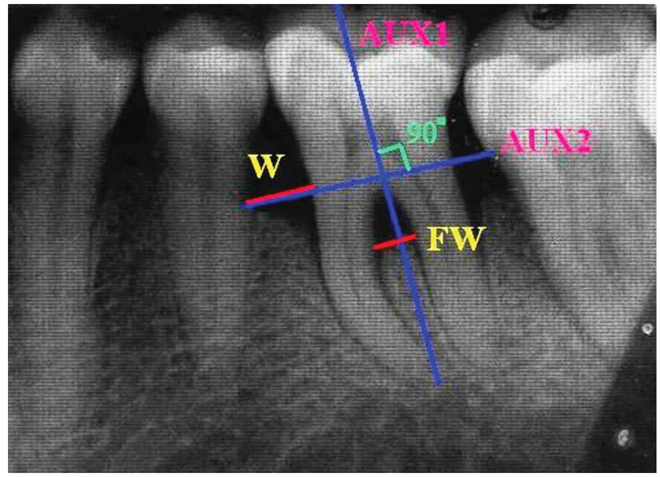

Figure 2: Width of defect

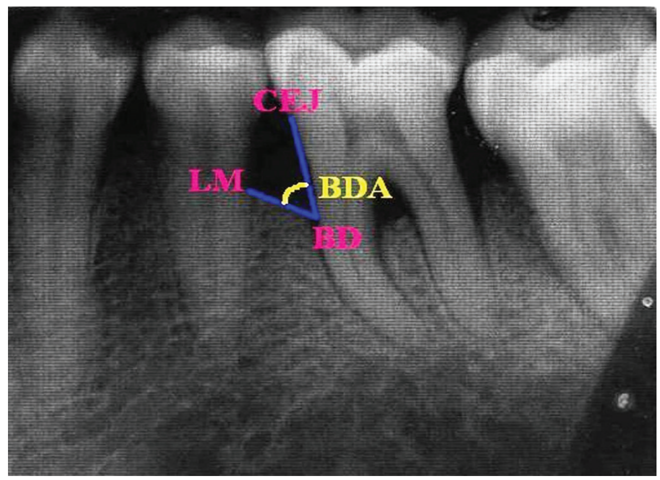

Figure 3: Bone defect angle

Results

A total of 120 IOPA radiographs of first molars were analyzed out of which 47 were maxillary and 73 were mandibular. The group according to pocket depth at each site was compared to CAL and radiographic parameters, i.e., height and width of defect at the same site. Comparison of groups of pocket depth 4 mm, 5-6 mm and ≥ 7 mm in maxillary mesiobuccal, distobuccal and midbuccal (Furcation) site is given in Tables 1–3 respectively. When the pocket depth groups were compared for CAL, height and width of the defect at all three maxillary sites, the results were statistically significant.

On comparing Tables 1–3, it is seen that 4-mm pocket depth at maxillary mesiobuccal and distobuccal sites was associated with 1.2-mm height and 1.3-mm width of the bone defect at the midbuccal site, i.e., at furcation area. Pocket depth of 5–6 mm at maxillary mesiobuccal and distobuccal sites was associated with 1.9-mm height and 2.0-mm width of the bone defect at furcation area. Pocket depth of ≥ 7 mm at maxillary mesiobuccal and distobuccal sites showed a radiographic defect height of 3.5 mm and width of 3.4 mm in the molar furcation.

Comparison of groups of pocket depth 4 mm, 5–6 mm and ≥ 7 mm in mandibular mesiobuccal, distobuccal and midbuccal (furcation) sites is given in Tables 4–6, respectively. When the pocket depth groups were compared for CAL, height and width of the defect at all three mandibular sites, the results were statistically significant.

On comparing Table 4, Table 5 and Table 6, it is seen that 4-mm pocket depth at mandibular mesiobuccal and distobuccal site was associated with 1.2-mm height and 1.2-mm width of the defect at the midbuccal sites, i.e.,

Table 1: Comparison of 4 mm, 5–6 mm and ≥ 7 mm pocket depth groups at maxillary mesiobuccal site with respect to clinical attachment loss and radiographic parameters by ANOVA and Tukeys HSD post hoc tests procedure

Pocket depth	CAL (in mm)		Height (in mm)		Width (in mm)	
	Mean	SD	Mean	SD	Mean	SD
4 mm	4.4	0.6	3.4	0.7	2.6	0.6
5–6 mm	5.7	0.6	5.0	0.7	3.3	0.8
≥ 7 mm	8.1	0.9	7.1	0.9	3.7	0.6
Total	5.9	1.6	5.1	1.6	3.2	0.8
F-value	194.8		163.2		17.6	
P-value	0.0000*		0.0000*		0.0000*	
Pair-wise comparison between pocket depth groups						
4 mm to 5–6 mm	0.0001*		0.0001*		0.0005*	
4 mm to ≥ 7 mm	0.0001*		0.0001*		0.0001*	
5–6 mm to ≥ 7 mm	0.0001*		0.0001*		0.0700*	

Table 2: Comparison of 4 mm, 5–6 mm and ≥ 7 mm pocket depth groups in maxillary distobuccal site with respect to clinical attachment loss and radiographic parameters by ANOVA and Tukeys HSD post hoc tests procedure

Pocket depth	CAL (in mm)		Height (in mm)		Width (in mm)	
	Mean	SD	Mean	SD	Mean	SD
4 mm	4.3	0.6	3.6	0.6	2.6	0.6
5-6 mm	5.7	0.7	4.8	0.8	3.2	0.8
≥ 7 mm	8.1	1.0	7.2	1.0	3.7	0.5
Total	6.1	1.8	5.3	1.7	3.2	0.7
F-value	201.2		163.1		21.2	
P-value	0.0000*		0.0000*		0.0000*	
Pair-wise comparison of pocket depth groups						
4 mm to 5–6 mm	0.0001*		0.0001*		0.0015*	
4 mm to ≥ 7 mm	0.0001*		0.0001*		0.0001*	
5–6 mm to ≥ 7 mm	0.0001*		0.0001*		0.0242*	

Table 3: Comparison of 4 mm, 5–6 mm and ≥ 7 mm pocket depths in maxillary midbuccal site (furcation/interradicular area) with respect to clinical attachment level and radiographic parameters by ANOVA and Tukeys HSD post hoc tests procedure

Pocket depth	CAL (in mm)		Height (in mm)		Width (in mm)	
	Mean	SD	Mean	SD	Mean	SD
4 mm	4.5	0.7	1.2	0.3	1.3	0.4
5–6 mm	5.7	0.6	1.9	0.4	2.0	0.5
≥ 7 mm	7.9	0.9	3.5	0.9	3.4	0.7
Total	6.0	1.5	2.2	1.1	2.2	1.0
F-value	162.4		108.2		100.2	
P-value	0.0000*		0.0000-*		0.0000*	
Pair-wise comparison of pocket depth groups						
4 mm to 5–6 mm	0.0001*		0.0001*		0.0001*	
4 mm to ≥ 7 mm	0.0001*		0.0001*		0.0001*	
5–6 mm to ≥ 7 mm	0.0001*		0.0001*		0.0001*	

at furcation area. Pocket depth of 5–6 mm at mandibular mesiobuccal and distobuccal sites was associated with 2.1-mm height and 2.1-mm width of the defect at furcation area. Pocket depth of ≥ 7 mm at mandibular mesiobuccal and distobuccal sites showed a radiographic defect height of 3.6 mm and width of 3.5 mm in the molar furcation.

Table 4: Comparison of 4 mm, 5–6 mm and ≥ 7 mm pocket depths in mandibular mesiobuccal site with respect to clinical attachment level and radiographic parameters by ANOVA and Tukeys HSD post hoc tests procedure

Pocket depth	CAL (in mm)		Height (in mm)		Width (in mm)	
	Mean	SD	Mean	SD	Mean	SD
4 mm	4.1	0.4	2.9	0.6	2.4	0.5
5–6 mm	5.7	0.8	4.3	0.5	3.1	0.6
≥7 mm	8.1	1.0	7.0	1.0	3.8	0.7
Total	6.0	1.8	4.8	1.9	3.1	0.8
F-value	295.8		323.3		49.9	
P-value	0.0000*		0.0000*		0.0000*	
Pair-wise comparison of pocket depth groups						
4 mm to 5–6 mm	0.0000*		0.0000*		0.0000*	
4–mm to ≥ 7 mm	0.0000*		0.0000*		0.0000*	
5–6 mm to ≥ 7 mm	0.0000*		0.0000*		0.0000*	

Table 5: Comparison of 4 mm, 5-6 mm and ≥ 7 mm pocket depths in mandibular distobuccal site with respect to clinical attachment loss and radiographic parameters by ANOVA and Tukeys HSD post hoc tests procedure

Pocket depth	CAL (in mm)		Height (in mm)		Width (in mm)	
	Mean	SD	Mean	SD	Mean	SD
4 mm	4.3	0.6	3.2	0.3	2.6	0.6
5–6 mm	5.7	0.7	4.7	0.7	3.3	0.6
≥ 7 mm	8.1	0.9	6.8	0.9	3.8	0.6
Total	5.9	1.7	4.8	1.6	3.2	0.8
F-value	236.5		286.1		35.1	
P-value	0.0000*		0.0000-*		0.0000*	
Pair-wise comparison of pocket depth groups						
4 mm to 5–6 mm	0.0000*		0.0000*		0.0000*	
4 mm to ≥ 7 mm	0.0000*		0.0000*		0.0000*	
5–6 mm to ≥ 7 mm	0.0000*		0.0000*		0.0000*	

Table 6: Comparison of 4 mm, 5–6 mm and ≥7 mm pocket depths in mandibular midbuccal site with respect to clinical attachment loss and radiographic parameters by ANOVA and Tukeys HSD post hoc tests procedure

Pocket depth	CAL (in mm)		Height (in mm)		Width (in mm)	
	Mean	SD	Mean	SD	Mean	SD
4 mm	4.3	0.6	1.2	0.3	1.2	0.3
5–6 mm	5.7	0.6	2.1	0.4	2.1	0.5
≥ 7 mm	7.9	1.0	3.6	0.9	3.5	0.8
Total	5.8	1.6	2.2	1.1	2.2	1.0
F-value	231.4		153.2		161.1	
P-value	0.0000*		0.0000*		0.0000*	
Pair-wise comparison of pocket depth groups						
4 mm to 5–6 mm	0.0000*		0.0000*		0.0000*	
4 mm to ≥ 7 mm	0.0000*		0.0000*		0.0000*	
5–6 mm to ≥ 7 mm	0.0000*		0.0000*		0.0000*	

Twenty-eight IOPA radiographs showed vertical defects, so BDA measurements were recorded at mesiobuccal and distobuccal sites of these maxillary and mandibular first molars, respectively. The mean BDA was 36.3 ± 16.5 degrees.

Discussion

In periodontal therapy, clinical and radiographic measurements are commonly used to assess treatment outcomes.[8] Studies of intraoral radiographs in assessing linear distances between a reference point such as the CEJ and alveolar bone crest or the apical border of a vertical defect and the cemento-enamel junction are common. Either direct measurements have been made from enlarged intraoral radiographs[19-21] or computer digitized images[22,23] have been studied. In principle, there should be no differences in outcomes when measurements are made from enlarged images or from digitized images.[8] The computer software program used in the present study allowed measurements with an accuracy of 0.1 mm.

IOPA radiographs can be easily obtained and can be used for diagnosis and to predict the prognosis. When OPG (Orthopantomogram) and IOPA radiograph measurements were compared with open surgery measurements in a study done by Akesson L *et al*.,[13] OPG showed underestimation of bone loss ranging from 13–32%. OPG readings were less accurate as compared with IOPA radiographs. Thus, IOPA radiographs were preferred in this study.

The BDA is an important factor to be considered, especially in vertical defects. Cortellini and Tonetti[24] tried to determine cut-off values that could help clinicians select the ideal cases for regeneration. Using the 25th and 75th percentiles, they defined the radiographic angle of 25 or less as narrow, while 37 or more was considered wide. When comparing wide with narrow intrabony defects, a significant difference (P<0.0001) was observed, in that narrow defects gained 1.5 mm more CAL than wide defects. They concluded that the radiographic defect angle could be used by a clinician as a useful pre-surgical parameter to determine the potential of CAL gain in intrabony defects treated with GTR (Guided Tissue Regeneration). Filip Klien *et al*.[25] stated that in narrow defects <26° BDA, the bony fill was more pronounced. They concluded that narrow and deep defects respond radiographically, and to some extent clinically, more favorably to GTR therapy than wide and shallow defects. Eickholz *et al*.[9] concluded that defects with <37° angulation respond well to regenerative procedures. Tsitoura *et al*.[26] stated that narrower defects <22° healed better than defects with >36° angulation. Cut-off values were quite similar in all studies seems to indicate that these "universal" cut-offs may be applicable in practice.[26] In our study, 28 radiographs showed vertical bone defects and mean BDA was 36.32° ± 16.56°. Accordingly, this BDA measurement would have responded well to regenerative therapy.

The height[27]and width[24] of the defect seem to influence the outcome of the treatment. We have compared the clinical probing depth measurements with radiographic defect height and width. In the maxillary radiographs, the mesiobuccal and distobuccal pocket depth of 4 mm, 5–6 mm and ≥ 7 mm was associated with defect height of 1.2 mm, 1.9 mm and 3.5 mm, respectively, in the furcation area. The width of defect in the furcation area was 1.3 mm, 2.0 mm and 3.4 mm, respectively. In the mandibular radiographs, the mesiobuccal and distobuccal pocket depth of 4 mm, 5–6 mm and ≥ 7 mm was associated with defect height of 1.2 mm, 2.1 mm and 3.6 mm and a width of 1.2 mm, 2.1 mm and 3.5 mm, respectively, in the furcation area. The results of this study demonstrate that the recorded mean values of height of interradicular bone loss in mandibular molars are nearly the same as in maxillary molars. This clearly shows that increased pocket depth causes increased amount of bone loss, which can be recorded as height and width of the defect on the radiographs.

In the maxillary molars, a radiographic bone defect height ranging from 3.4 mm to 7.1 mm at the mesiobuccal site and from 3.6 mm to 7.2 mm at distobuccal site was associated with 1.2–3.5 mm defect height in the interdental region. In the mandibular molars, a radiographic bone defect height ranging from 2.9 mm to 7.0 mm at the mesiobuccal site and from 3.2 mm to 6.8 mm at the distobuccal site was associated with 1.2–3.6 mm defect height in the interdental region. Our results differ from the study done by Popova C *et al*.,[28] wherein mesial and distal interdental bone loss in mandibular molars higher than 4 mm (range 4.48 mm to 5.24 mm), was associated with interradicular bone loss with values higher than 1 mm (range 1.64 mm to 1.83 mm). In their study, they did not take into consideration the depth of pockets. In our study, periodontal pockets were divided on the basis of mild (4 mm), moderate (5–6 mm) and severe (≥ 7 mm) pockets and were compared. When the pocket depth groups were compared for CAL, height and width of the defect at all three mandibular and maxillary sites, the results were statistically significant.

Interradicular bone loss associated with the progression of bone destruction in multirooted teeth of patients with chronic periodontitis demonstrates some correlation to the loss of bone in the interdental area. This correlation suggests that treatment of interdental bone destruction with different modalities can prevent further bone loss in the interradicular area according to the root trunk length and furcation anatomy. This correlation can be useful to determine the risk of involvement of the furcation area during progression of the periodontal disease.

According to report given by AAP[29] on the clinical reality of today's use of radiographs, it is striking that the simplest radiographic measurements are not included in periodontal charting.[29] The changes in clinical probing depth may be due to shrinkage of tissues or increase in resistance to the probing force. Combining and superimposing readings of probing and radiographs, can provide valuable information about periodontal hard and soft tissues[2] and assist in arriving at a periodontal diagnosis and in developing a comprehensive treatment plan.

Some of the limitations of the study were, as each radiograph carries with it some exposure to ionizing radiation, panoramic radiographs provide a large quantity of information with a single exposure that reduces the level of ionizing radiation significantly compared to the multiple IOPAs used here. Root trunk length was not recorded.

Conclusion

The aim of this study was to investigate the correlation between interdental and interradicular bone loss and clinical parameters in patients with chronic periodontitis. Interdental defect height and the BDA are associated with the defect height and width in the furcation. So we conclude that treatment of interdental bone loss at early stage may prevent the progression of disease and involvement of the furcation areas, which are difficult to treat.

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