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Original Article

Dentistry Section

Comparison of Diagnostic Accuracy of Conventional Intraoral Periapical and Direct Digital Radiographs in Detecting Interdental Bone Loss

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ABSTRACT

Background: Periodontitis is an inflammatory disease of the supporting tissues of the teeth caused by specific microorganisms, resulting in destruction of the periodontal ligament and alveolar bone. Progressive loss of alveolar bone is the salient feature of periodontal disease. Accurate detection of periodontal disease with the use of radiographs helps in diagnosis, treatment and prognosis.

Aims: The present study aims to compare the efficacy of conventional intraoral periapical (IOPA) and direct digital radiographs (RVG) in detecting interdental alveolar bone loss using intrasurgical (IS) measurements as the gold standard.

Materials and Methods: Thirty patients elected to undergo periodontal flap surgery with periodontitis computing to 60 interdental alveolar defects on mandibular first molars were considered. IOPA and RVG were captured using standardized techniques. Bone loss measurements in IOPA and RVG were compared to the IS measurements.

Statistical Analysis: Statistical analysis was carried out using student t test and ANOVA with the help of SPSS software and p-value <0.05 was considered as significant.

Results: Both IOPA and RVG underestimated the bone loss measurements when compared to IS measurements which was statistically significant (p<0.0001). Bone loss measurements in RVG were closer to IS measurements than IOPA.

Conclusion: Both the radiographic techniques IOPA and RVG underestimated bone loss by 1.5–2.5 mm. RVG was superior to IOPA for the detection of interdental bone loss due to reduced time and radiation exposure to obtain the same diagnostic information.

Keywords: Direct digital radiography, Interdental bone loss, Periapical radiograph, Periodontal disease, Surgical measurements

INTRODUCTION

Bone loss at the crest of the alveolar bone and interdental osseous defects are a frequent sequel of periodontal disease. Diagnosing their presence and establishing their morphology before surgical access requires a careful clinical examination combined with diagnostic quality radiographs. Radiographs are valuable adjunct to the clinical examination, as they provide essential information about the morphology of residual bone covered by soft tissues. Radiographs contribute greatly towards assessment of alveolar bone destruction, in determining the prognosis, to formulate a comprehensive treatment plan and to ascertain the outcome of various therapies [1]. Radiographs like intraoral periapical (IOPA), bitewing and panoramic views are used in periodontal diagnosis and treatment. Radiovisiography (RVG) is one of the digital imaging techniques that have become widely accepted as an alternative to film based radiography because of superior image quality, reduced time and radiation exposure. Studies both in vitro and in vivo have compared the accuracy of conventional D, E and F speed films versus direct digital images in detection of alveolar bone loss [2-4]. Contradictory views exist regarding the accuracy of digital and conventional radiographs. Some authors have either under estimated [5,6], or overestimated [7,8], the amount of bone loss as seen through the radiographs. In this light, the present study was designed to compare the diagnostic accuracy of IOPA and RVG in detection of interdental bone loss taking intra surgical (IS) measurements as the gold standard.

MATERIALS AND METHODS

Thirty patients diagnosed with moderate to severe chronic periodontitis electing to undergo periodontal flap surgery were recruited for the study by purposive sampling technique. We enrolled subjects who voluntarily signed an informed consent after obtaining institutional ethical committee clearance. Patients were informed about the objectives of the study and explained about the benefits and risks involved. Patients with any systemic diseases like uncontrolled diabetes, hypertension and local factors such as supernumerary teeth adjacent to mandibular first molars, three rooted mandibular first molars and patients undergoing orthodontic treatment were excluded from the study. The study was conducted during the period from December 2011 to August 2012.

Sixty interdental sites (30 mesial and 30 distal) from 30 mandibular first molars (right or left) were considered for the study. After phase I therapy of periodontal treatment, an occlusal stent was prepared for each patient on mandibular cast with clear acrylic. The stent at the level of occlusal plane incorporated a steel ball (3.3 mm diameter) on buccal surface and a steel wire on lingual surface. The steel ball was used to determine the magnification factor as explained by G Li et al., [9]. The steel ball and the wire were used as reference points for bone loss measurements in IOPA, RVG and IS.

Radiographs were exposed using Gendex Oralix AC (Gendex Corporation, Cusano Milanino, Milano, Italy) machine operating at 65 kVp and 7.5 mA. The exposure time was adjusted to make the dentin density of both IOPA and RVG as 1.0. Accordingly, the exposure time was set to 0.5 sec for IOPA and 0.06 sec for RVG. Constant source to object and object to film distance was maintained for all the radiographs [Table/Fig-1]. IOPA were captured with No. two size, Ektaspeed films (Eastman, Kodak, Rochester, NY, USA) using paralleling technique with the help of Rinn XCP (Rinn Corporation, Elgin, Ill, USA) as per the criteria given by Jorgenson T et al., [10], after placing the occlusal stent. RVG images were captured with

charged couple device (CCD) sensor VisualiX (Gendex Corporation, Des Plaines, Ill, USA) provided by the manufacturer by paralleling technique and saved. IOPA films were processed in automatic film processor Veloprex Sprint (Medivance instruments Ltd, Harlesden, London, UK) with freshly prepared developer and fixer solutions. VixWin image processing software (Gendex Dental Systems, Des Plaines, Ill, USA) provided with the Visualix system was used to process the RVG images.

Bone loss measurements from the reference points on mesial and distal sides, at the crest of existing bone (MC, DC) and base (MB , DB) were recorded by single Oral and Maxillofacial radiologist. The bone loss in IOPA were measured using a caliper after blocking the light around the periphery of the film by an opaque paper [Table/Fig-2] and in RVG with VixWin software [Table/Fig-3].

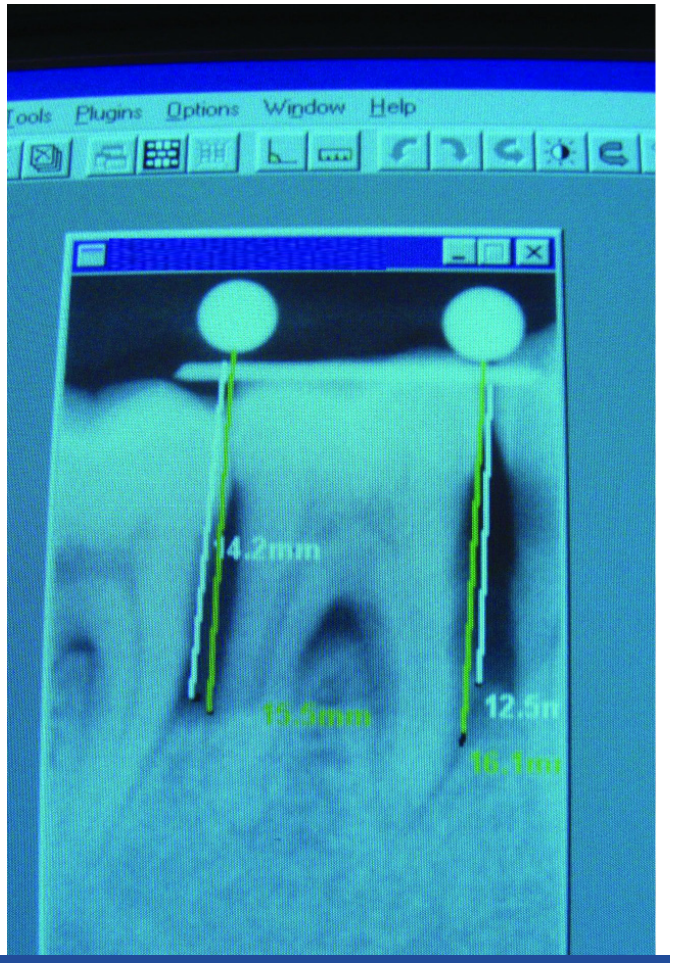
[Table/Fig-1]: Patient positioned for radiographic procedure

[Table/Fig-2]: Bone loss measurements in IOPA using caliper

Surgical measurements MC, MB, DC and DB were recorded to the nearest millimeter with UNC 15 probe (University of North Carolina SKU:PCNC 15, Hu-Friedy, Chicago, IL) during periodontal flap surgery and compared with radiographic measurements [Table/Fig-4].

STATISTICAL ANALYSIS

The raw data was entered in Microsoft excel sheet and analysis performed with Statistical Package for the Social Sciences (SPSS) software version 19 (Armonk, New York: IBM. Corporation). Unpaired student t-test and one-way ANOVA test were used to see the significant differences, where p-value <0.05 was considered significant.



[Table/Fig-3]: Bone loss measurements in RVG

[Table/Fig-4]: Bone loss measurements surgically using UNC 15 probe

RESULTS

In our study, the patients were in the age group of 28-57 years with a mean age of 43.0±7.9 SD. We divided all the 30 subjects into four groups according to their age [Table/Fig-5].

Group	Age	Male		Female		Total	
		n	Percentage	n	Percentage	n	Percentage
1	<30	2	9.5%	2	22.2%	4	13.3%
2	31-40	6	28.6%	1	11.1%	7	23.3%
3	41-50	11	52.4%	4	44.4%	15	50.0%
4	51-60	2	9.5%	2	22.2%	4	13.3%
Total		21	100.0%	9	100.0%	30	100.0%

[Table/Fig-5]: Age and gender distribution

Two measurements at the crest and base of the existing interdental bone were computed for IOPA, RVG and IS separately on mesial and distal surface of mandibular first molar. We also compared the measurements for different parameters such as gender, sites and sides.

The total mean value of IOPA measurement of combined male and female patients was 9.20 ± 2.41 SD, RVG was 9.90 ± 2.52 SD and IS was 11.44 ± 2.43 SD. The comparison between them by non-parametric one-way analysis of variance (ANOVA) showed statistically significant difference between IOPA and IS, RVG and IS (p<0.0001). The differences between IOPA and RVG was not significant (p>0.05), even though there was slightly higher measurements seen in RVG.

Gender wise comparison [Table/Fig-6] was not statistically significant in all the three techniques denoting both the sexes had similar bone loss measurements, even though it was slightly more in males. Both males and females had statistically significant differences between IOPA and IS, RVG and IS. The differences were not significant between IOPA and RVG.

Sex		TECHNIQUE			ANOVA	
		IOPA	RVG	IS	f-value	p-value
MALES		9.24±2.58	10.01±2.67	11.59±2.56	17.827	<0.001*
FEMALES		9.11±1.97	9.64±2.16	11.08±2.13	8.585	0.0004*
Un paired student t test	t-value	0.2582	0.7304	1.041		
	p-value	0.7967	0.4666	0.2999		

[Table/Fig-6]: Comparison of gender wise measurements
*Extremely Significant

Site wise comparison [Table/Fig-7] between mesial and distal was not significant in all the three techniques, denoting that both mesial and distal sites had similar bone loss measurements even though it was slightly more on distal site. In both mesial and distal sites, statistically significant differences observed between IOPA and IS, RVG and IS. The differences were not significant between IOPA and RVG.

SITE		TECHNIQUE			ANOVA	
		IOPA	RVG	IS	f-value	p-value
MESIAL		9.04±2.50	9.53±2.70	11.12±2.48	10.754	<0.0001*
DISTAL		9.36±2.32	10.27±2.29	11.76±2.37	16.231	<0.0001*
Unpaired student t test	t-value	0.7234	1.606	1.447		
	p-value	0.470	0.1110	0.1507		

[Table/Fig-7]: Comparison of site wise measurements
*Extremely Significant

Comparison between right and left mandibular first permanent molar [Table/Fig-8] was very significant in RVG and significant in IS measurements but was not significant in IOPA, denoting that right molar had higher levels of bone loss compared to left molar. In both right and left sides, an extremely significant difference observed between IOPA and IS, RVG and IS. The differences were not significant between IOPA and RVG.

TOOTH/SIDE		TECHNIQUE			ANOVA	
		IOPA	RVG	IS	f-value	p-value
46 (Right)		9.65±2.66	10.51±2.74	11.99±2.61	13.334	<0.0001*
36 (Left)		8.81±2.01	9.33±2.05	10.92±2.17	17.929	<0.0001*
Unpaired student t-test	t-value	1.904	2.72	2.532		
	p-value	0.0594	0.0075§	0.0126†		

[Table/Fig-8]: Comparison between right and left sides
†Significant
§Very Significant
*Extremely Significant

All individual variables i.e. MC, MB, DC and DB in males and only DB in females had significant differences between IOPA and IS but not between IOPA and RVG [Table/Fig-9].

Sex		Mesial Crest (MC)	Mesial Base (MB)	Distal Crest (DC)	Distal Base (DB)
Male	p-value	0.012†	0.0312†	0.0139†	0.0010§
Female	p-value	0.05	0.368	0.0829	0.0014§

[Table/Fig-9]: Individual variable and significance
§Very significant
†Significant

No statistical differences observed in all the individual variables when compared between the genders. Out of 60 sites, we found 25 interdental defects with lingual plate missing and 18 with buccal plate missing, nine with horizontal bone loss, four vertical defects and four osseous craters when observed IS. Comparison of total measurements on mesial (MC+MB) as well as distal (DC+DB) were extremely significant between IOPA and IS (p <0.001), significant between RVG and IS (p <0.01) and non-significant between IOPA and RVG (p>0.05).

DISCUSSION

Periodontitis involves progressive loss of alveolar bone around the teeth, if left untreated leads to subsequent loss of teeth. It is characterized by periods of activity in which the periodontal supporting structures are destroyed by the action of chemical mediators of inflammation [11]. The goal of dental radiology is to make an accurate diagnosis using the most effective imaging modality with the lowest radiation possible.

Our study consisted of 21 males and nine females, with a mean age of 43 years which correlates with studies done by Eickholz and Khocht et al., [12,13]. The mean measurements in IOPA were 2.24 ± 1.14mm less than IS measurements, which correlates with Akesson et al., where they underestimated surgically assessed interproximal bone loss by 2.3±2.0 mm [14]. Our results are also in accordance with previous studies [6,12,15].

The mean measurements in RVG were 1.55 ± 0.93 mm less than IS measurements, which showed bone loss measurements in RVG were closer to gold standard IS measurements. This was in accordance with Eickholz P and Albandar et al., study [12,16], where both conventional and direct digital radiographs showed underestimation of bone loss when compared with actual IS bone loss measurements. The results are contradictory to results of Chandrashekaraiah D and Talaiepour AR et al., studies who overestimated the interproximal bone loss measurements in RVG [1,8]. These differences may be due to the different reference points and sites considered. Talaiepour AR et al., used occlusal plane and Chandrashekaraiah D et al., used cementoenamel junction, and we have used base of the steel ball and stainless steel wire as reference point for measurements. The previous studies have considered different locations at maxilla and mandible, whereas we have only considered mesial and distal side of mandibular first molar to minimize the radiographic distortion.

The bone loss measurements in our study were more in males when compared to females though it was not statistically significant. The results are in accordance with studies done by Beck JD and Boromthanarat S who did not find any significant difference between males and females [17,18]. Contradictory views exists regarding the prevalence of periodontitis in gender, Mumghamba EG and Gopalkrishnan studies showed male predominance [19,20], where as Vandana et al., study showed females predominance [21]. In our study, periodontitis was more in male patients that may be because of higher prevalence of deleterious oral habits like tobacco chewing and smoking. In addition, males have poorer oral hygiene than females as evidenced by higher levels of plaque and calculus

[22]. Females are more aware and considerate about maintenance of their oral hygiene and regular professional dental care.

In our study, the mean bone loss measurements on distal sites were more than the mesial sites of mandibular first molar, even though it was not statistically significant which may be due to tooth characteristics that facilities the retention of plaque and impair plaque removal and difficulty in access for self-cleansing techniques and instrumentation on the distal sites. Our results correlate with the studies conducted by Talaiepour AR et al., and Fukuda et al., where they found more bone loss in distal site [8,23].

Comparison of left and right first mandibular molars showed more bone loss on right side when compared to left side with significant differences in RVG and IS but no statistical significant difference were observed in IOPA which may be due to right-handed persons clean thoroughly on their left sides and 90% of the people are right handed. Until now as per our knowledge, no studies have compared bone loss between right and left side first molar. Further studies with larger samples and different teeth are required to substantiate the findings.

In our study, we found that digital images were superior to conventional intraoral radiographs for the detection of bone loss that also may be due to variation in measuring scales used, as digital radiographs impart a constant addition of millimeters to measures [13].

LIMITATIONS

The sample size in our study was less, was conducted only on mandibular first molars, and we considered only interdental bone loss measurements. This study can be expanded in the future with larger sample size and in all quadrants of the oral cavity. We recommend further studies with more sample size and in all quadrants to substantiate the results.

CONCLUSION

IOPA and RVG are useful in detecting the interdental bone loss and both underestimated interdental bone loss by 1.5-2.5 mm. RVG was superior to IOPA for the detection of interdental bone loss due to reduced time and radiation exposure to obtain the same diagnostic information.

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