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RESEARCH ARTICLE

COMPARISON OF ACCURACY AND EXAMINER RELIABILITY IN EVALUATION OF EXTENT OF PROXIMAL CARIES ON DIGITAL BITEWING AND DIGITAL OPG

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ABSTRACT

Objectives: The purpose of this study was to assess examiner or observer reliability and to correlate the diagnostic accuracy of proximal caries detection by digital bitewing and panoramic radiographic images.

Methods: In this study, digital bitewing and panoramic radiographs of 168 subjects were used. The radiographs were evaluated for the depth of proximal caries by two examiners. Diagnostic accuracy of two modalities was analyzed by means of percentage agreement and discrepancy index. Examiners reliability was assessed using Kappa statistics and Chi Square test.

Results: Digital bitewing radiographs were more efficient in diagnosis of dental caries involving enamel and outer third of dentin. However, digital panoramic radiography had comparable accuracy with bitewing radiographs when lesion involved inner portions of dentin.

Conclusion: Panoramic survey alone was not sufficient for the diagnosis of proximal caries of the entire dentition, but it showed significant diagnostic value in the detection of dentinal carious lesions. Hence, panoramic radiography can be endorsed for detection of proximal carious lesions with moderate to advanced tooth structure loss.

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INTRODUCTION

Radiographs are indispensible in most aspects of oral diagnostics. They are important for diagnosis, treatment planning, patient monitoring during or at conclusion of treatment, and for follow-up treatment outcome. Radiography is useful for the detection of dental caries since the carious lesion causes demineralization of the hard tissues of the tooth (Wenze, 1998). The detection of dental caries on the proximal surfaces of the posterior teeth is a difficult task, since wide contact points hamper direct visual inspection. Various methods can be used to detect such lesions, like visual and visual/tactile inspection, radiography, fiber-optic transillumination (FOTI), electrical conductance (EC), laser fluorescence (LF) (Sahba *et al.,* 2004), cone-beam volumetric imaging (CBVT)(Tsuchida *et al.,* 2007) and cone beam CT system (CBCT) (Haiter *et al.,* 2008). Within the past few years, several digital systems for the acquisition, storage and display of bitewing radiographs have been introduced into clinical practice of dentistry.

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Recent studies have shown that image adjustments, such as contrast enhancement, emboss, color, image inversion and magnification, could improve the accuracy in detecting proximal caries lesions (Akarslan *et al.,* 2008; Analoui, 2001 and Haiter *et al.,* 2009). Panoramic machines have developed with time, both technically and in terms of dose reduction, by using multiple or continuously moving rotation centers, using digital systems and incorporating a selection of special imaging programs. It has been proposed that the image resolution of panoramic radiography has increased with technological improvements and become comparable with intraoral radiography for the diagnosis of dental caries (Akkaya *et al.,* 2006). Studies has been evaluated the efficacy of bitewing, periapical and panoramic images in the diagnosis of approximal carious lesions, (Akarslan *et al.,* 2008; Akkaya *et al.,* 2006; Rushton *et al.,* 2002 and Flint *et al.,* 1998) but to our knowledge a comparison between digital intraoral bitewing and digital panoramic images with regard to caries depth has not been assessed till date. An attempt has been made through the present study to compare the diagnostic accuracy of digital intra oral bitewing radiography and digital panoramic radiography, and inter and intra examiner reliability in detection of extent of proximal caries involving posterior teeth.

Table 1. Comparison between the examiners in digital bitewing radiographs

Score	Bitewing diagnosis		True disease status	Percentage agreement (%)		Discrepancy index (%)		Chi square value	P- Avlue
	Examiner 1	Examiner 2		Examiner 1	Examiner 2	Examiner 1	Examiner 2		
0	7	6	6	85.71	100.00	14.29	0.00	0.037	0.848
E1	27	26	25	92.59	96.15	7.41	3.85	0.009	0.924
E2	12	14	15	75.00	92.86	25.00	7.14	0.083	0.774
D1	10	13	8	80.00	61.54	20.00	38.46	0.161	0.688
D2	27	14	23	85.19	35.71	14.81	64.29	2.229	0.135
D3	29	28	30	96.55	92.86	3.45	7.14	0.009	0.924
P	102	113	107	95.10	94.69	4.90	5.31	0.281	0.596

Table 2. Comparison between the examiners in digital panoramic radiographs

Score	Bitewing diagnosis		True disease status	Percentage agreement (%)		Discrepancy index (%)		Chi square value	P- Avlue
	Examiner 1	Examiner 2		Examiner 1	Examiner 2	Examiner 1	Examiner 2		
0	9	11	6	66.67	54.55	33.33	45.45	0.075	0.784
E1	26	17	25	96.15	52.94	3.85	47.06	1.022	0.312
E2	8	17	15	12.50	88.24	87.50	11.76	1.816	0.178
D1	11	13	8	72.73	61.54	27.27	38.46	0.067	0.796
D2	30	27	23	76.67	85.19	23.33	14.81	0.071	0.791
D3	31	24	30	96.77	75.00	3.23	25.00	0.467	0.495
P	99	105	107	91.92	98.10	8.08	1.90	0.090	0.764

MATERIALS AND METHODS

The study was conducted in the Department of Oral Medicine and Radiology and the study comprised of total 168 experimental subjects, they were in the age group of 20-39 years with a mean age of 29.32 years. Informed consent was taken from the subjects and clinical examination was carried out with aseptic procedure, suspected proximal carious lesions were selected and subjected to digital bitewing and panoramic radiographic examination. Digital bitewing radiographs were performed by intra oral sensor (size 1, schick, Sirona) and intra oral X-ray machine (Gnatus, Brazil; 0.06 seconds, 70 kVP and 7 mA) with the help of XCP sensor holder; paralleling cone technique was performed for all the subjects. Digital panoramic X-ray machine (NewTom Giano, Italy) was used with 65 kVP, 5 mA and 16 seconds parameters were fixed to expose all subjects. Radiographs were evaluated by two different examiners who were not aware of the clinical diagnosis. Examiners were allowed to use different enhancement tools to facilitate visibility such as magnification, brightness, contrast, image inversion and pseudo colour. Using the digital ruler the extent of proximal radiolucency (carious portion) was established and scores were given based on six point scoring system. Values have been observed by two examiners who were unaware of the clinical status of the tooth. Individual scores were compared with "true disease status" (gold standard) based on the result of simultaneous assessment of both digital bitewing and digital panoramic radiographs by two examiners. Total 214 teeth were evaluated by two examiners and scores were given for proximal radiolucency. The criteria considered for evaluating proximal dental caries involving enamel and dentin were proposed by Lussi *et al*. (2006) and Novaes TF et al. (2009) no radiolucency visible radiographically (Score 0), the radiolucency confined to outer half of enamel (Score E1); radiolucency extending into the inner half of enamel (Score E2); radiolucent lesion involving outer (Score D1), middle (Score D2) and inner third of dentin (Score D3), and approximating the pulp (Score P) (Figure 1 & 2). The data was analysed using SPSS software (Version: 11.5.2.1). Intra and inter examiner reliability were evaluated by Kappa and Chi Square test. Diagnostic accuracy of bitewing and panoramic modalities were evaluated by percentage agreement and discrepancy index.

RESULTS

All data were fed into computer and was subjected to statistical analysis. For each tooth we calculated depth of the carious lesion and was scored accordingly. According to different regions of tooth diagnostic accuracy and examiner reliability was calculated. Percentage agreement and discrepancy index for two modalities was calculated comparing the scores of different examiners with true disease status (Table 1 and 2).

Table 3. Comparison within examiner 1 in digital bitewing and panoramic radiographs

Score	Bitewing	Panoramic	True disease status	Chi square value	P-Value
0	7	9	6	0.108	0.743
E1	27	26	25	0.009	0.924
E2	12	8	15	0.483	0.487
D1	10	11	8	0.021	0.886
D2	27	30	23	0.071	0.791
D3	29	31	30	0.033	0.855
P	102	99	107	0.023	0.879

Table 4. Comparison within examiner 2 in digital bitewing and panoramic radiographs

Score	Bitewing	Panoramic	True disease status	Chi square value	P-Value
0	6	11	6	0.627	0.428
E1	26	17	25	1.022	0.312
E2	14	17	15	0.143	0.705
D1	13	13	8	0.00	1.00
D2	14	27	23	2.229	0.135
D3	28	24	30	0.165	0.685
P	113	105	107	0.145	0.703

Based on percentage agreement and discrepancy index, diagnostic accuracy of bitewing was superior to panoramic radiographs when the lesion involved outer and inner halves of enamel, and outer third of dentin. Percentage agreement in these regions ranged from 75.0% to 100% on bitewing radiographs. When the radiolucency was in middle third of dentin, accuracy of panoramic radiographs was better than bitewing views with higher percentage accuracy and lower discrepancy index. Teeth in which the radiolucency of dental caries involved inner third of dentin or encroached pulp, the

accuracy of two modalities was comparable as reflected by comparable percentage accuracy values. We assessed agreement between the examiners in two ways. First we assessed overall agreement between the examiners and substantial agreement was observed as reflected by the kappa value of 0.689. Then we computed Chi square value to compare difference between the examiners in different regions of the tooth with using digital bitewing and panoramic radiographs. Table 1 and 2 show the comparison of two examiners on digital bitewing and digital panoramic radiographs. No statistical significant difference existed in the performance of two examiners ($P > 0.05$) regardless of the modality used and the lesion depth. Similar results were obtained when the examiners were compared with their own scores using bitewing and panoramic radiography (Table 3 and 4).

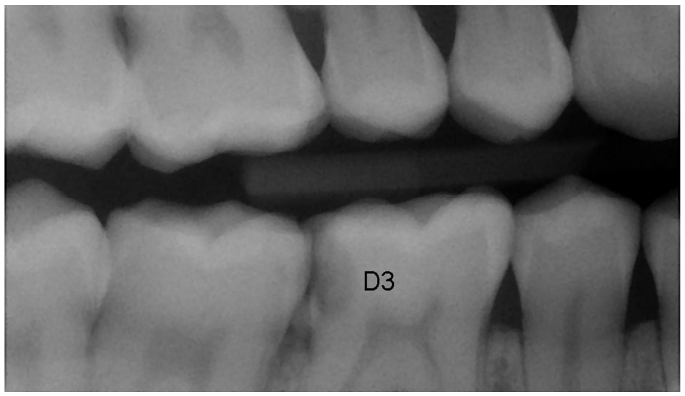

Figure 1. Digital Bitewing Radiograph showing scoring

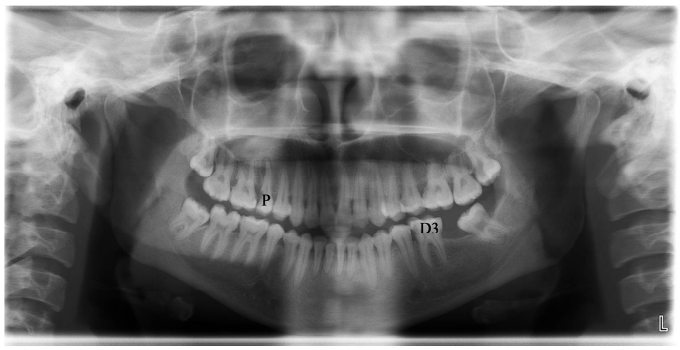

Figure 2. Panoramic Radiograph showing scoring

DISCUSSION

The criteria for defining a carious lesion have shown variations between the studies. For example, Steward and Bieser (1968) established diagnostic criteria for their study; a carious lesion was defined as a radiographically detectable lesion which should be restored. We accepted the criteria for defining a carious lesion established which includes a carious lesion with any amount of decalcification present of the proximal surface of the tooth. This definition includes incipient, moderate and profound carious lesions (Galal *et al.,* 1985). Early detection of small carious lesions has become an important goal in dentistry. Including or excluding incipient lesions in the diagnostic criteria does not affect the sensitivity and specificity (Akkaya *et al.,* 2006). The use of a sensor holder with a beam-aiming device reduces the number of overlapping contact point and improves image quality, thus minimizing interpretation errors (Wenzel, 2002). In the present study, the digital bitewing image showed a wider opening between maxillary and mandibular teeth. We observed this wider opening on most digital bitewing images and speculate that it may be related to the USB cord's being present between the upper and lower teeth (Khocht *et al.,* 2003). The true disease status should be assessed based on the histological examination in studies in which the comparison of different methods for caries detection is analyzed. However, in clinical studies, the style of the clinical setting does not make it possible for histological evaluation. The consensus diagnosis obtained from examiners could be used for the comparison of different radiographic methods (Akarslan *et al.,* 2008; Akkaya *et al.,* 2006 and Flint *et al.,* 1998). We therefore used the consensus of the two examiners for the determination of the true disease status of the examined teeth. The difference between the examiners, though statistically insignificant could be attributed to individual differences in visual perception due to physiological differences, conformity, tolerance of ambiguity, differences in cognitive style, prejudice, mood, and education, training and experience of the examiner (Chandler, 2008; Vaarkamp *et al.,* 2000). In our study diagnostic accuracy of digital bitewing was superior to digital panoramic images in detection of carious lesions confined to outer and inner half of enamel, and outer third of dentin. These findings were consistent with previous literature (Akarslan *et al.,* 2008; Akkaya *et al.,* 2006; Rushton *et al.,* 2002 and Flint *et al.,* 1998) which concluded that intra oral radiography was more sensitive than panoramic radiography for detection of proximal dental caries. However, rotational panoramic radiography exhibits marked overlapping of the tooth crowns frequently, resulting in difficulties in the assessment of proximal carious lesions (Akarslan *et al.,* 2008). The diagnostic accuracy of panoramic was comparable to bitewing in detection of caries involving inner part of dentin.

Few studies revealed that no significant difference exists between intra oral radiography and panoramic radiography in detection of dentinal caries affecting posterior teeth (Stewart and Bieser, 1968). Others have reported that as the depth of carious lesion increased, it could be well detected on the digital panoramic (Akarslan *et al.,* 2008). Intra and inter examiner reliability in assessing the depth of carious lesion showed no difference exists since high technology in the field of digital radiography improves the visibility (Akarslan *et al.,* 2008; Akkaya *et al.,* 2006 and Flint *et al.,* 1998). In the present study, there was low frequency of proximal carious lesions in certain categories and both the examiners were oral radiologists. Also, interpretations were of bitewing and panoramic images were done on same day. We think that readings made by general practitioners or other specialist in dentistry instead of oral radiologists and with time gap between interpretations of images may affect the results. Further studies are needed to investigate this probability with larger sample size, uniform distribution of carious lesions in different zones, utilizing other modes of detection of proximal caries in posterior teeth and using histopathology as gold standard. In conclusion, the use of panoramic radiography was not sufficient for the detection of small lesions involving enamel and outer third of dentin. Accuracy of digital panoramic was comparable to bitewing radiographs when dental caries involved inner parts of dentin. Hence, panoramic radiography can be endorsed for detection of proximal carious lesions with moderate to advanced tooth structure loss. This method when used to assess clinical findings is preferable because of patient convenience, lower radiation dose, reduced time and large area of coverage.

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