Original Study

A COMPARISON OF THE DIAGNOSTIC ACCURACY OF DIGITAL BITEWING AND DIGITAL PANIROMIC RADIOGRAPHIES IN THE DETECTION OF PROXIMAL CARIES

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ABSTRACT

Background: Conventional radiography is used in the diagnosis of problems such as tooth caries and root canal therapy. Although the diagnostic accuracy of conventional radiography is acceptable in the evaluation of anatomical and pathological structures, it seems that the use of digital radiography can give us more information.

Aim: The aim of this study is to compare the diagnostic accuracy of digital bitewing radiography and digital panoramic imaging in the detection of proximal caries.

Materials and Method: This study is of a descriptive-analytical nature and evaluated the digital bitewing and digital panoramic radiographs of 1000 proximal surfaces of the posterior teeth of the patients referring to a private office in the city of Qazvin in Iran. The radiographs were separately shown to two observers, who were asked to decide on the presence or absence of proximal caries via a five-point confidence scale.

Results: The difference between digital panoramic and digital bitewing views in the detection of caries was significant for maxillary and mandibular premolars. The difference was also significant for the mesial surface of first molars and the distal surface of second molars. However, the difference between the two techniques did not prove significant for the distal surface of first molars, the mesial surface of second molars, and third molars.

Conclusion: Digital panoramic radiography cannot compete with the digital bitewing approach in the diagnosis of proximal caries. Thus, digital bitewing radiographs are still the best option for evaluating proximal surfaces.

Keywords: Bitewing radiography; Panoramic radiography; Proximal caries

Introduction

As caries diagnosis is sometimes impossible clinically, especially in proximal areas at primary stages, the clinician is obliged to use a variety of radiographic techniques. Choosing the best method for diagnosing caries is a major issue for researchers. The explanation of dental radiographs is a mental ability, and there are always some errors in their explanation.[1]

One of the most commonly used intra-oral radiographs in the detection of proximal caries is the bitewing view, which is considered the best technique for this purpose because of its high accuracy in showing carious lesions.[2] However, this method has some disadvantages such as causing patient discomfort, requiring variable levels of operator expertise, and exposing the patient to additional radiation due to the need for retakes. Moreover, the sensitivity of bitewing radiography in caries diagnosis is about 40% to 60% of that of histologic cuts.[3]

For the reasons outlined above, it is sometimes necessary to use extra-oral radiographic images instead. The commonest technique in this category is the panoramic view, which has many advantages, including showing large carious proximal lesions. Panoramic images are useful for children, handicapped patients, and those having an extremely active gag reflex.[4,5] This modality, however, is somewhat less accurate than the bitewing view due to the low resolution of detectors, image distortion emanating from the geometry of imaging, and overlapping proximal surfaces.[6]

Although conventional radiography has an acceptable diagnostic ability in the assessment of anatomical structures and pathological lesions, we can obtain more information using digital radiography.[7] This alternative has advantages such as higher imaging speed, reduced patient exposure, ease of use, image manipulation, image enhancement, and not needing processing.[8-12] Furthermore, using digital imaging requires less archiving space and is easier to access or transmit.[3,10] Modern technology enables us to take high-quality panoramic views owing to better imaging geometry and digital facilities.

The present study is designed to draw a comparison between digital bitewing and digital panoramic radiographies in terms of the accuracy with which they detect proximal caries. What motivated this study is the fact that proximal caries in the posterior teeth is usually difficult to identify on radiographs due to the large size of the proximal surfaces of the posterior teeth and the subtle mineral loss.[5] It is also important to note that because this study was done in vivo, it was not possible to have histologic cuts.

Methods

The digital bitewing and digital panoramic radiographs of the proximal surfaces of the posterior teeth of the patients referring to a private office in the city of Qazvin in Iran were evaluated. Exclusion criteria were teeth already receiving root canal therapy, teeth with crowns, and overlapping and distorted surfaces. Also excluded were the third molars because some of their surfaces were present in the panoramic radiographs, but not in the bitewing radiographs. These criteria resulted in the selection of 1000

surfaces. There were a total of 100 digital bitewing radiographs and 25 panoramic radiographs.

All the views were taken in an oral and maxillofacial radiology clinic equipped with a CRANEX™ D digital panoramic system (Soredex, Tuusula, Finland) and a Planmeca ProMax® digital bitewing system (Planmeca Oy, Helsinki, Finland) with a DIGORA™ Optime Photo Stimulable Phosphor (PSP) imaging plate (Soredex, Tuusula, Finland) as the detector. The radiographs were observed on a 17″ NW1733 Samsung monitor with a resolution of 1440×900.

For the sake of patient privacy, the CDs containing the radiographs were obtained from the archives and coded with numbers before being separately shown to two observers in August 2016. One of the observers was an oral and maxillofacial radiologist, and the other was a professor of operative dentistry. Both had at least 13 years of working experience. The bitewing radiographs were presented first, and then two weeks later the panoramic images were shown.

The observers were asked to examine the proximal surfaces of the teeth and decide on the presence or absence of caries according to a five-point confidence scale with the following choices: 1 = Caries definitely absent, 2 = Caries probably absent, 3 = equal likelihood of caries being present or absent, 4 = caries probably present, 5 = caries definitely present.

The observers were also asked to judge caries depth using a four-grade scale as follows: (A) Enamel caries, (B) Caries involving Dentin-enamel junction (DEJ), (C) Caries involving less than halfway through the dentin, and (D) Caries penetrating more than halfway through the dentin toward the pulp cavity. The depth of decay was considered only when the observers provided a rating of 4 or 5 on the presence-or-absence scale.

The data were analyzed using ANOVA and Cohen's Kappa coefficient on SPSS 16 (IBM Corporation, NY, USA, 2008). A significance level of $P = 0.05$ was used. A Kappa coefficient of $\kappa = 1$ indicates complete agreement between the observers, and $\kappa \leq 0$ shows that there is no inter-observer agreement.

Results

The total number of evaluated proximal surfaces is given in Table 1 (maxillary molars and premolars) and Table 2 (mandibular molars and premolars). The difference between bitewing and panoramic views in terms of caries detection was significant in the maxillary premolar region ($P = 0.000$), the mandibular premolar region ($P < 0.05$), and the mesial surface of first molars ($P = 0.000$). The two types of radiographs were also significantly different considering the distal surface of the second maxillary molar ($P = 0.003$) and that of the second mandibular molar ($P = 0.001$).

Method	1st Maxillary Premolar		2nd Maxillary Premolar		1st Maxillary Molar		2nd Maxillary Molar		3rd Maxillary Molar	
	M	D	M	D	M	D	M	D	M	D
Bitewing	65	92	93	82	76	72	70	54	14	20
Panoramic	3	2	3	21	25	68	76	89	12	24
p-value	0.00	0.00	0.00	0.00	0.00	0.735	0.619	0.003	0.695	0.546

Table 1: Evaluated mesial (M) and distal (D) surfaces of maxillary molars and premolars ($p < 0.05$)

Method	1st Mandibular Premolar		2nd Mandibular Premolar		1st Mandibular Molar		2nd Mandibular Molar		3rd Mandibular Molar	
	M	D	M	D	M	D	M	D	M	D
Bitewing	43	89	85	91	75	73	77	51	20	20
Panoramic	26	15	14	15	17	56	60	89	21	20
p-value	0.04	0.00	0.00	0.00	0.00	0.134	0.146	0.001	0.876	1

Table 2: *Evaluated mesial (M) and distal (D) surfaces of mandibular molars and premolars ($p < 0.05$)*

However, the difference between the two modalities did not reach significance for the distal surface of first molars ($P > 0.05$). Moreover, no significant difference was observed for the mesial surface of second molars ($P > 0.05$). Finally, there was no difference between the two imaging techniques considering the proximal surfaces of third molars ($P > 0.05$).

Table 3 presents Kappa values for the general inter-observer agreement regarding the detection (presence or absence) and depth of caries in different regions. As for detection, maximum and minimum agreement was observed for mandibular molars ($\kappa = 0.467$) and mandibular premolars ($\kappa = 0.217$), respectively. In addition, the data for caries depth show that the two observers were in maximum and minimum agreement for mandibular molars ($\kappa = 0.831$) and maxillary premolars ($\kappa = 0.143$).

	Maxillary Premolars	Mandibular Premolars	Maxillary Molars	Mandibular Molars
Presence or Absence of caries	0.426	0.217	0.242	0.467
Depth of caries	0.143	0.534	0.401	0.831

Table 3: Kappa values for the general inter-observer agreement about the detection and depth of caries in different regions

Table 4 gives Kappa values for the agreement between the two observers about the presence or absence of caries in different regions through the imaging modalities under discussion. As this table shows, in both techniques, the

maximum and minimum Kappa values were obtained for maxillary and mandibular premolars, respectively.

Modality	Maxillary Premolars	Mandibular Premolars	Maxillary Molars	Mandibular Molars
Bitewing	0.798	0.760	0.762	0.776
Panoramic	0.589	0.411	0.478	0.568

Tablel 4: Kappa values for the inter-observer agreement about the presence or absence of decay in different regions via the bitewing and panoramic radiographs

Table 5 presents Kappa values for the agreement between the two observers over the depth of caries in different regions by virtue of the dental radiographs at issue. It is clear from this table that in the case of panoramic radiographs, the maximum and minimum values were obtained for maxillary premolars ($\kappa = 1$, complete accord) and mandibular premolars ($\kappa = 0.400$), respectively. As for the bitewing technique, the maximum and minimum values belong to mandibular premolars ($\kappa = 0.704$) and maxillary molars ($\kappa = 0.515$), respectively.

Modality	Maxillary Premolars	Mandibular Premolars	Maxillary Molars	Mandibular Molars
Bitewing	0.524	0.704	0.515	0.568
Panoramic	1	0.400	0.448	0.495

Table 5: Kappa values for the inter-observer agreement about the depth of decay in different regions through the bitewing and panoramic imaging modalities.

Discussion

The results of the present study were indicative of the overall superiority of bitewing radiography over panoramic dental imaging considering both detection and depth of proximal caries.

There are several studies comparing intra-oral and extra-oral imaging. However, we did not come across, to the best of our knowledge, any study to directly compare our results with it. For instance, in a study by El-Ela *et al.*, intra-oral and extra-oral digital bitewing radiographs were compared in terms of the accuracy with which they detected enamel proximal caries.[13]

Bitewing radiography is very useful as it diagnoses small proximal lesions owing to the high resolution of intra-oral films and the imaging procedure which makes it possible to have a parallel view. Although this method is a bit more operator-sensitive and has a narrower scope, it is the best choice for exploring proximal lesions.[14]

Nikneshan *et al*. compared three different digital systems in term of accuracy of detection of proximal caries using the parallel technique. However, the present study compared two different modalities which are common in radiographic clinics, where only one digital system is used.[15]

A major finding of the present study is that maximum inter-observer agreement was obtained for mandibular molars considering the detection and depth of caries, an observation which concurs with the agreement reported by Modirfalah *et al*. for the same region.[16]

Moreover, minimum agreement was obtained for mandibular premolars considering the presence or absence of decay and for maxillary premolars regarding the depth of decay. This finding is in contrast with Modirfalah's study, which observed minimum agreement for maxillary molars ($\kappa = 0.21$).[16] It is worth noting that the agreement found in the present study in the maxillary molar region was also low ($\kappa = 0.242$). This similarity can be associated with the superimposition of glossopalatal space on the crowns of maxillary molars or ghost images. This shows that panoramic radiography is of less diagnostic value compared to the bitewing technique for the maxillary molar region.

As for inter-observer agreement, the highest value was obtained for the maxillary premolar region in panoramic radiography (Kappa = 0.426). This can be attributed to overlapping proximal surfaces, which reduces the number of observable surfaces. This finding is in agreement with the study by Modirfalah *et al* (Kappa = 0.4).[16]

However, these results do not remove the limitations of the panoramic technique in evaluating the premolar region. For the inter-observer agreement considering presence or absence of caries, in bitewing radiology, the maximum level of agreement was observed in the maxillary premolar region (Kappa = 0.798), and the minimum was seen in the mandibular premolar region (Kappa = 0.760), but the difference was not statistically significant ($P > 0.05$). These findings concur with Modirfalah's study.[16]

Akarslan *et al*[4] study reported a total inter-observer agreement of about 94%, which was higher than in the present study, but in Akarslan's study, the agreement was not calculated individually. The advantage of the present study is that the agreement values are individually calculated for each technique.

The highest level of agreement between the two observers considering region and caries depth was in the bitewing approach, and this was in agreement with Akarslan's study. However, in Terry *et al* study, there was no significant difference between panoramic and digital bitewing techniques regarding there were four observers in Terry's study.[17]

Generally, in both techniques, the more caries depth increased, the higher the inter-observer agreement values were, but considering depth of caries, there was less agreement between the two observers in the bitewing

modality than in the panoramic method. The reason is that the panoramic technique is not capable of showing the exact details of carious lesions, and the diagnostic accuracy of this technique decreases in small proximal lesions. In addition, the number of observable surfaces in bitewing radiographs is higher in all the regions except for some surfaces of maxillary and mandibular molars.

Conclusion

The use of digital panoramic radiography (instead of analog) increases diagnostic accuracy, but it still not comparable to the bitewing approach in detection of proximal caries. Therefore, bitewing radiography is still the best option in the evaluation of proximal surfaces.

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