Diagnostic accuracy of Digital Bite Wing radiography in interproximal carious lesion detection of posterior teeth

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ABSTRACT

Background and purpose: Dental decay is the most prevalent infectious disease. One of the dentists' major disturbances is accurate diagnosis of small proximal decay in posterior teeth. Different diagnostic methods have been offered to detect decay since before. One of them is radiography that consists of different methods and machines. The purpose of this study was to evaluate the diagnostic accuracy of intra-oral digital radiography in detection of interproximal decay of posterior teeth. Materials and methods: This cross-sectional In vitro study was conducted with the 140 interproximal surfaces of patients' molar as sample size. In half of them, decay was simulated by drilling and were mounted on the cast and then digital bite wing radiography was taken using PSP diagora optime sensor. Results: Diagnostic specifity was 71% and 69% for mesial and distal surfaces respectively. No significant relationships between detecting interproximal decays in mesial and distal surfaces of teeth were observed after statistical analysis using digital BW radiography. Conclusion: Results of this study concluded that there are no meaningful statistical differences in diagnosis of interproximal decays between mesial and distal surfaces of teeth while using BW radiography. Sensitivity and specialty of BW technique in diagnosing interproximal decays is lower than diagnosing decays larger than 0.5mm, however considering the positive and negative predictive value, this technique can still be used to for periodic examinations and patients` follow-ups in society due to its high sensitivity

Keywords: Oral Diagnosis, Dental caries, Digital Radiography

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INTRODUCTION

Dental caries is the most common infectious disease that its prevalence has been reported by 95% [1] .In the past, caries detection was conducted using dental mirror, explorer and light and the decision to restore the teeth was made only based on clinical signs and using tactile sensation. Gradually by understanding caries dynamical progression, new invasive methods were suggested [2].

One of the main dentists` concerns is accurate diagnosis of small caries that cannot be diagnosed only by clinical examination [3], because invisible decay may occur under an apparently intact enamel surface [4]. So relying on Clinical examinations without using radiography leads to inaccurate prevalence estimation of caries in dental tissues [5, 6].The first digital receptors in dentistry were used in 1980[7].

Conventional radiography techniques using films which are used to diagnose decays and Periodontal and root lesions and etc. require a darkroom and chemical solutions, the projection dose is more than digital systems and have problems such as archiving radiographs, retrogration of image quality due to passing of time, the possibility to

lose them and leaving dangerous waste (plumb) [8]. Considering these limitations, digital imaging development caused a change in radiology [9]. Trophy used intraoral digital receptors for the first time. This breakthrough is due to technology change in image obtaining procedures and creating computerized connection systems to evaluate and transfer images [9].

Digital radiography has numerous advantages. This type of radiography is different from the film-using radiography because in digital radiography image receptor isn't a film. Actually radiation detectors are used that their electric output is proportionate to the radiation intensity. Finally, Produced signals are converted from analog to digital. This image is displayed on a monitor after a computed process [11]. Common radiography films show twice more proximal caries that extended to dentin compared to clinical examinations in posterior teeth [12].

Now, the question is "Can digital radiography be used as a rapid and non-aggressive method to diagnose proximal caries?" There are contraindications in diagnosing proximal caries. For instance, in Peymai et al's study it`s been stated that digital radiography can be used as an accurate and specific diagnostic method to diagnose proximal lesions[13], however, other studies suggested that digital radiography cannot be sued to detect small proximal and occlusal caries [14]. Thus, considering the contraindications found in previous studies, this study has investigated the diagnostic power of digital radiography in detecting proximal caries in posterior teeth.

MATERIALS AND METHODS

This sectional analytical descriptive study was conducted in vitro that considering similar diagnostic studies, 70 permanent posterior teeth (140 surfaces) were selected [4, 6,15–19]. Most of these teeth were extracted due to orthodontic treatments. These teeth were classified based on alveolar region (up, down, left or right) in a way that the number of teeth was almost equal in any quadrant. So the possibility to simulate the space similar to oral cavity for experimental studies was provided. Teeth were kept in water and after detailed examinations, absence of caries, cracks and previous restorations were investigated. In half of teeth proximal surfaces, cavities were randomly created with 0.5mm depth and the same extension by the round diamond ¼ drill and in order to reconstruct the decay appearance they were filled by sticky wax. Then contacts between molars and premolars were simulated.

Teeth were embedded in triad casts similar oral cavity. Cast were consisted of stone plaster and immediate polymethylmethacrylate with the ratio of 2 to 1 that creates a porous view similar to alveolar bone. Also, water phantom was used to simulate soft tissue. In this study, the PSP diagora (soredex, Helsinki, Finland) digital radiography system was used which is valid to intraoral imaging and applied technique was BW that according to all reference books and presented articles, is the best method to observe interproximal caries yet[9,15-17,20-25].

All experimental films were exposed at 60 KVp and 2mA in 0.07 second. Then radiography images were displayed to 5 observers consisting of radiology, Oral and Maxillofacial, restorative and *community-oriented* specialists that were expert in dental caries diagnosis field. They recorded presence or absence of proximal decays in special forms as fallowing; "definitely not caries, probably not caries, questionable, probably caries, definitely caries". Then scores of 0 to 4 were attributed to them respectively. Observers didn't have any information about absence or presence of caries and had same time and monitor. To prevent the differential bias between diagnostic power observer weren`t included. Whilst the study statistics of inter and intra observer didn`t show a meaningful difference between observers (the agreement coefficient of inter observer equaled 0.998 and the agreement coefficient for intra observer equaled 0.81).

After detecting intact and decayed cases, obtained information were compared to gold standard which were the cavities created in 509 teeth in only mesial surfaces, 596 teeth in only distal surfaces, also 909 teeth in both surfaces. To compare the obtained information, Contingency table was used and sensitivity level, specialty, Positive predictive value and negative predictive value were calculated [2]. To determine each of above indexes, the ratio test was used. All statistical analyzes were performed using SPSS 21 software

RESULTS

Results of diagnostic tests in mesial and distal surfaces have been stated in table 1.

Table 1. Digital radiography diagnosis value in caries detection of mesial and distal surfaces

Negative predictive value	Positive predictive value	Diagnostic specialty	Sensitivity	Diagnostic test
64%	61%	71%	53%	Mesial surface
61%	61%	69%	54%	Distal surface

Also, results of statistical analysis indicate no significant relationship between diagnosis of interproximal caries with BW radiography between mesial and distal surfaces of teeth.

DISCUSSION

Findings of this study indicate that sensitivity is 0.53 for mesial surfaces and 0.54 for distal surfaces, specifity is 0.71 for mesial surfaces and 0.69 for distal surfaces. Also positive predictive value for mesial and distal surfaces were calculated as 0.61 and negative predictive value as 0.64 for mesial surfaces and 0.61 for distal surfaces.
In Dalili et al`s study in 2011, it has been stated that super BW technique can never be an alternative of intraoral BW [20], and also according to Kamburoglu's studies, intraoral BW diagnostic power in caries investigation is considerably more than super BW and panoramic technique and it also says that there are no differences between super BW and panoramic techniques in detecting decays [17].

In a comparison between digital BW and analog technique, numerous articles were reviewed. According to Xavier studies, indirect digital system with any digital camera and any scanner is less sensitive than intraoral films [26]. In a comparison between direct digital system and films studies of Wenzel [11, 25], Peker [21] Naitho suggested that the diagnostic power of the film is equal to PSP digital system[23].

Ludlow [24] and Van der Stelt stated that the intraoral digital system indicates the caries better than the analog system[27]. There are contraindications only in imaging deciduous teeth. The studies of Peymani [14] et al and Uprichard et al suggested that conventional radiography using films detects dental caries better than digital techniques in deciduous teeth during mixed dentition period [28].

In the present study, the digital BW radiography system with PSP DIAGORA sensor was used and the fact that Wenzel investigated the diagnostic power of 4 digital system in an assessment which was conducted in 2004, approves this issue [22].

Also, Wenzel stated that the best systems to detect the depth of interproximal caries are DIGORA and DIXI systems and also suggested that also in the best situations there is a possibility of wrong estimations in measuring caries depth and the caries depth in radiography is never exactly the same as the histopathologic shape of the lesion [22]. Kamboroglu et al suggested that intra oral BW radiography is more accurate in caries detection than extra oral BW and panoramic which both have similar accuracy [17].

Glenn and et al in study by the title of "A clinical comparison of extra oral panoramic and intraoral radiographic modalities for detecting proximal caries and visualizing open posterior interproximal contacts" in 2016, stated that there was no significant difference in posterior proximal surface caries detection between the modalities. Extra oral panoramic BWs were much better than panoramic radiographs in visualizing open posterior interproximal contacts, 81.7% vs 48.5%, but below the 95.9% value for intraoral BWs [29].

CONCLUSION

Findings of this study suggested that there isn`t significant statistical differences in BW caries detection between mesial and distal surfaces, and this technique has high diagnostic accuracy, sensitivity (0.53), specifity (0.70), even about very small caries with 0.5 mm depth.

In general, the present study suggested that although the sensitivity and technique specifity of digital BW technique in investigating interproximal caries is less than caries with ≤0.5 dimensions but considering its positive and negative predictive values and high sensitivity, we can use BW technique for periodic examinations and patients` follow-up as the most valuable method for investigating dental caries in society.

Other advantages of this technique are the ease of conduction, lower cost and its lower dose of radiation than panoramic images.

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