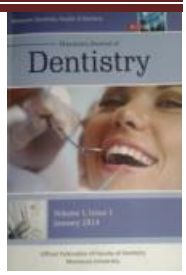

Diagnostic accuracy of cone- beam CT with different voxel resolutions in detection of buccal recurrent caries under composite restorations

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Abstract:
Objectives: The aim of this study was to compare between clasp retention in metallic versus peek RPD frameworks constructed by using
Purpose: The aim of this study was to assess the diagnostic accuracy of cone beam computed tomography (CBCT) in detection of simulated recurrent caries beneath composite restoration.
Materials and Methods: In this study, a total of 60 proximal slots of class II cavities were prepared on 60 extracted human premolars and molars. Then, 30 teeth were randomly selected out of this sample and artificial carious lesions were created on these teeth by a round diamond bur no .2(study group). All cavities were restored by using composites resin and radiographed with CBCT unit (Cranex 3D) using 5x5mm field of view at three voxel sizes 0.85mm,0.125mm,0.200mm. Intra- and inter-observer agreements were calculated with Kappa statistics (κ). The area under the receiver operating characteristic (ROC) curve was used to evaluate the diagnostic accuracy.
Results: The AUCs value for CBCT with voxel sizes 0.85mm,0.125mm, 0.200mm was 0.983 ,0.900,0.817, respectively. The kappa value for inter-observer agreement was 0.993,0.989,0.938 , respectively.
Conclusion: Diagnostic performance of CBCT was high in detecting the simulated small recurrent proximal caries under composite restoration,voxel size 0.125mm can be used to detect caries lesions with adequate accuracy and the least patient exposure dose.

Key Words: Cone-beam computed tomography, , dental caries, dental radiograph .

Introduction

Dental caries is the most common dental disease, affecting both primary and permanent teeth. , interproximal caries and caries associated with existing restoration are much difficult to detect with a clinical examination only. (1)Recurrent caries is a type of caries frequently found in restored teeth and is defined as a type of caries occurring at the margin of an existing restoration, running along the cavity walls, especially in areas of plaque stagnation.(2)

Composites are now the most frequently used materials in dental restorations because of their desirable esthetics and adhesion to dental tissue, enabling minimally invasive preparation.(3) Despite the advances in composite restorative materials and dentin bonding systems, recurrent caries is still a main cause for failure of resin restorations.(6) Accurate, early detection of recurrent caries is the key for success and longevity of dental restorations.(7)

Dental caries can be detected by different methods such as probing, visual examination, intra oral images including conventional films, and digital sensors.(8)Radiography is among the most important techniques for detection of caries. (1) Conventional and digital intraoral radiography are the most commonly used for the detection of occlusal, proximal and recurrent dental caries in routine clinical practice.(9) Bitewing radiograph plays an important role in detecting secondary caries. However, the radiopacity of the restoration and superimposition of other structures on the carious lesion may cause misinterpretation.(10) Some studies have concerned about the dental application of 3D imaging modalities to avoid the overlap of 3D anatomic structures in 2D images.(14)

CBCT is a high-quality radiography for diagnosis and treatment planning. This imaging modality provides three-dimensional (3D) images of axial, coronal and sagittal planes with excellent submillimeter resolution.(16) CBCT has been suggested as a suitable tool for detection of small carious lesions. Intraoral radiography provides 2D images of the teeth and thus, caries on the buccal and lingual walls cannot be detected using this technique.(17)

MATERIALS AND METHODS

In this study, 60 non-carious non-restored extracted human permanent premolars and molars were used. The sample teeth were extracted for orthodontic or periodontal reasons. All the teeth were randomly divided to two equal groups (n = 30); one group as the study and the other as the control group. Standard proximal slots of class II cavities were prepared on all teeth using Komet fissure bur1.2 to 1.4 mm. (figure 1) In the study group, round bur (1.0 mm in diameter) was used for preparing a hole at the buccal margin of the cavity to simulate an artificial recurrent caries.(figure 2) then filling the holes of each tooth with rose wax , the proximal cavities were filled with composite (Z250 XT, 3M ESPE Dental Products, St,Paul , MN, USA).The same procedure was done for the control group without artificial recurrent caries preparation. All the teeth were randomly embedded in the wax blocks. Each block

held four teeth consisting of two premolars and two molars and the block mounted in plaster simulating the normal

anatomical position. The radiographies were taken from the teeth using CBCT .

For taking the CBCT images, each model was placed on the chin rest to be radiographed using, CRANEX 3Dx machine (SOREDEX, PaloDEx Group Oy Nahkelantie 160 Tuusula,04300 Finland) CBCT system The CBCT system operated at 89 kVP, 6 mA with 5 cm× 5 cm field of view (FOV) and 9 s scanning time ,at three different voxel sizes (0.85,0.125,0.200mm) and the acquired data were reconstructed with 1 mm thickness All 3D sections (axial, coronal and sagittal) were evaluated.

Three observers, Oral and Maxillofacial Radiologists, experienced Operative dentist and a postgraduate student evaluated all radiographs on two separate occasions with at least 1week interval.

The images were arranged in random, but it was the same for all three observers. Regarding the presence of recurrent carious lesion, a 5-point confidence level was used: 1 = definitely no caries, 2 = probably no caries, 3 = questionable, 4 = probably caries, 5 =definitely caries.[7] SPSS (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp) adopted for statistical analysis. The area under (AUC) the receiver operating characteristic (ROC) curve was used to evaluate the diagnostic accuracy.. Kappa analysis was used to evaluate the inter- and intra-operator agreement. Differences were considered to be statistically significant when $P < 0.05$.

figure(1)

figure (2)

RESULTS

The ROC curves are demonstrated in Figure (3). The AUC value for CBCT with different voxel sizes. 0.85mm, 0.125mm, 0.200mm was 0.983, 0.900 and 0.817 respectively. although AUC of CBCT with voxel size 0.125mm was inferior to that of 0.85mm voxel sixe , no significant difference in discrimination ability between both voxel sizes (p=0.150).While AUC of 0.200mm voxel size was significantly lower than 0.85mm voxel size(p=0.005) . Table (1).

Decrease the voxel size was associated with increased discrimination ability between caries and non caries. The sensitivity, specificity, and accuracy were highest at CBCT with voxel size 0.85mm, followed by 0.125mm voxel size, then 0,200mm voxel size. Table (2).The kappa value for inter-observer agreement was high to perfect, ranged from (0.938 to 1) The highest agreement was found at CBCT with voxel size 0.85mm, while the lowest was found at CBCT with voxel size 0.200mm. Table (3).

Table (1). AUCs of CBCT with different voxel sizes in diagnosis of caries in the buccal wall.

	Caries in the buccal wall			
	0.85mm			
voxel size	0.125 mm			
voxel size	0.200mm			
voxel sizes	The mean of all voxel sizes			
AUC	0.983	0.900	0.817	0.933
P	-	0.150#	0.005&	-
	-	-	0.192$	-

AUC, area under ROC curve; #, comparison of AUCs of 0.85mm voxel size and 125mm voxel size ; &, comparison of AUCs of 0.85mm voxel size and 0.200mm voxel size; $, comparison of AUCs of 0. 125mm voxel size and 0.200mm voxel size.

Table (2) Diagnostic performance of CBCT with different voxel size in diagnosis of caries in the buccal wall.

Caries in the buccal wall

	0.85mm			
voxel size	0.125 mm			
voxel size	0.200mm			
voxel sizes	The mean of all voxel sizes			
Sensitivity (%)	96.7	86.7	76.7	90.0
Specificity (%)	100	93.3	86.7	96.7
Accuracy (%)	98.3	90	81.7	93.3

Table (3): Inter observer agreement of CBCT with different voxel sizes for diagnosis of caries in the buccal wall.

Inter observer agreement			
0.85mm			
voxel size	0.125 mm		
voxel size	0.200mm voxel sizes		The mean of all voxel sizes
ICC between First and second observers			1
0.994	0.943	0.979	
ICC between First and third observers			0.984
0.991	0.961	0.984	
ICC between Second and third observers			0.997
0.984	0.930	0.970	
ICC between all observers	0.993	0.989	0.938
0.973			
ICC: Interclass correlation			

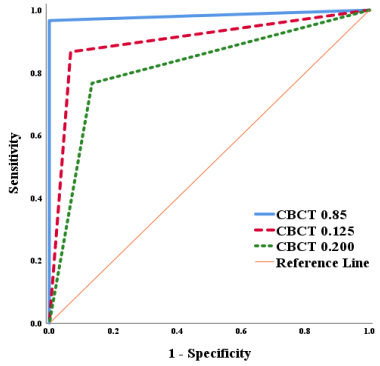

Figure (3). ROC curves of CBCT with different voxel sizes in diagnosis of caries in the gingival wall .

Discussion

Diagnosis of dental caries may cause problems for the clinician. In order to enable better detection, it is advised that visual examination and probing be combined with other diagnostic aids such as X-ray imaging, laser or light fluorescence-based method.(18)

Development of recurrent caries, which occurs under different types of restorative materials, is considered a major cause of restorative failure and replacement. It is therefore crucial to diagnose early recurrent lesions in order to prevent severe destruction of hard tissue and to enhance the prognosis for a successful treatment outcome. (19)

With the widely usage of the Cone-Beam Computed Tomography in the dental field, this current in vitro study was designed to evaluate its role in assessment of artificially secondary caries of proximal surface to aid clinicians decide the most valid and accurate technique in detecting this type of caries lesions without exposing the patient to unnecessary radiation.

In the present study, three observers evaluated 60 teeth and found that the diagnostic accuracy of the CBCT system with different voxel sizes was 0.983, 0.900 and 0.817 respectively.

although AUC of CBCT with voxel size 0.125mm was inferior to that of 0.85mm voxel sixe , no significant difference in discrimination ability between both voxel sizes (p=0.150).While AUC of 0.200mm voxel size was significantly lower than 0.85mm voxel size(p=0.005)

In this study, the small voxel size and FOV were selected for CBCT scanning because reducing field size has been reported to increase spatial resolution and image quality(20)..

In the present study the Inter-operator kappa agreement value in CBCT images was and that reveals the potential of new radiological technologies like CBCT in detecting a common dental problem like the secondary caries.

Finally, we performed this study not aiming to use or to support CBCT images in detection of secondary caries. However, a provisional guideline for CBCT application(produced by the SEDENTEXCT project in Europe in2009) (21),states that “CBCT images must undergo a thorough clinical evaluation (‘radiological report’) of the entire image dataset,” It is, therefore, possible to find suspected secondary caries on CBCT images prescribed for other dental purposes such as implants, root fractures, complex maxillofacial fractures, and so on. Our study might, at least, indicate that CBCT images had some efficiency but still had some limitations in detection of secondary caries.

Conclusion

This in vitro study, with a limited number of samples, showed the CBCT system was significantly more accurate in detecting the simulated secondary proximal caries under composites restoration.

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