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RESEARCH ARTICLE

INFLUENCE OF RADIOPAQUE RESTORATIVE MATERIAL ON THE DIAGNOSIS OF SECONDARY CARIES WITH THE HELP OF CBCT

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ABSTRACT

Aim: To assess the diagnostic performance of Cone beam computed tomography in the detection of secondary carious lesions under composite resin restorations. Objectives*:* To assess the diagnostic accuracy of cone-beam computed tomography (CBCT) in the detection of secondary carious lesions under composite resin restorations. Materials and methods*:* 50 Extracted human permanent posterior teeth were collected and primary cavities were created. Then all the samples were randomly divided into two groups; Group A- study group (n=25) and Group B- control group (n=25). Group A included artificially created defects mimicking secondary caries under primary cavities restored with composite restorations; Group B included primary cavities restored with composite restorations. CBCT scans of all the teeth were taken and evaluated by 3 observers for the presence of secondary caries. Results*:* Sensitivity was found to be 82.6% and specificity as 56%. ROC curve was plotted which was obtained as 0.716. Conclusion*:* Due to less specificity CBCT has a limited role in detection of secondary caries under composite restoration.

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INTRODUCTION

A major cause of failure and replacement of restorative materials is the development of secondary caries under different types of restorations. This still remains the main cause for failure of resin restorations, despite multiple advances in composite restorative materials and dentin bonding systems (Haak, 2002; Levin, 2007). If the secondary caries are not diagnosed early then there is a possibility for severe destruction of hard tissue.

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Thus, to enhance the prognosis for a successful treatment outcome, proper investigative procedure should be carried out early on. Radiography is among the most important techniques for detection of caries, particularly in the posterior teeth (Newman, 2009). The commonly used radiography technique remains the intra oral two-dimensional radiography with intraoral periapical radiograph and bitewing radiograph being usually preferred (Kamburoğlu, 2017; Murat, 2013; Okida, 2018; Ando, 2004). However, regardless of the intraoral system used, the compression of structures in intraoral two-dimensional (2D) radiography limits the diagnostic value as it is dependent upon superimposition of anatomical structures, beam angulation, distortion and patient- related factors (Kamburoğlu, 2009).

This makes it difficult to diagnose and locate the exact extent of recurrent caries under different restorations Mialhe, 2009. CBCT is high-quality radiography for diagnosis and treatment planning. This imaging modality provides three-dimensional (3D) images of axial, sagittal and coronal planes with excellent submillimeter resolution (White, 2009). Many recent studies have evaluated the efficacy of CBCT for the diagnosis of caries. Some of them found that the accuracy of CBCT may be similar to that of intraoral digital radiographic images for occlusal and proximal caries detection (Kayipmaz, 2011; Qu, 2011; Senel, 2010; Tsuchida, 2007). Also, CBCT images were found to be better in comparison with intraoral techniques in other studies for secondary caries lesions under composite and amalgam restorations (Murat, 2013; Akdeniz, 2006; Kasraei, 2017). However, some authors reported that diagnostic performance of CBCT in detecting secondary caries may have an negative impact because of the presence of dental restorations (Farag, 2011; Keriş, 2017). This is due the beam hardening artifacts that is associated with CBCT. However, till date there is no justification regarding the use of this modality for caries detection. So, as there is a limited amount of literature regarding secondary caries detection by using CBCT and composite is the most widely practiced restoration, our study was carried out to assess the diagnostic accuracy of cone-beam computed tomography (CBCT) in the detection of secondary carious lesions under composite resin restorations.

MATERIALS AND METHODS

This was a prospective in-vitro study conducted in the Department of Oral Medicine and Radiology of Dental institute after obtaining the approval from the institutional ethical committee. 50 sound extracted human permanent posterior teeth were used in this study. Teeth with tissue loss and/or restorations were excluded. All the selected teeth were randomly divided into two groups; Group A- study group (n=25) and Group B- control group (n=25). In all the teeth, Primary cavities were artificially created using straight bur and handpiece and then restored with composite restoration. All the primary cavities were restored with the same brand of composite resin material following the manufacturer's instruction and cured using curing light of Woodpecker brand. In Group A, before the composite restoration, secondary caries were created artificially. This was done by preparing random ditch on the pulpal floor of the primary cavity using a round bur of 1 mm diameter and filling it with modelling wax. All the extracted teeth in Group A and Group B were colour coded for identification before mouting on arch form made by modelling wax sheet. CBCT scan was taken using SIRONA ORTHOPHOS XG 3D machine with FOV 5x5 cm, tube voltage and tube current of 60-90 kV and 3-16mA respectively. Three Oral and maxillofacial Radiologist, having approximately same experience in interpretation, who were blinding to the colour coding and groups were asked to evaluate each tooth in the scan for the presence or absence of the Secondary caries under restoration.

Statistical analysis: Data was analysed using statistical package for Social Science (SPSS) version 21, IBM inc. Descriptive data was reported for each variable. Descriptive statistics such as mean and standard deviation for continous variables and frequency along with percentages of categorical variables were calculated. For the calculation of sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated using standard formulae. Chi square test was used determining the diagnostic accuracy of all three observers.

RESULTS

When overall comparison was made for two groups by the three observers, statistical significant difference was observed as p value 0.0001 and sensitivity was found to be 82.6% and specificity as 40.8%. Receiver operating curve (ROC) was plotted to illustrate the diagnostic ability or to distinguish between two groups i.e. study and the control group. Overall ROC for all the three observers was obtained as 0.716

DISCUSSION

The aim of the study was to assess the diagnostic performance of CBCT in the detection of secondary carious lesions under composite resin restoration. Diagnostic accuracy for detection of the presence or absence of the carious lesion using CBCT was carried out. One mm diameter round bur was used to create an artificial secondary caries under the composite restoration. This was in accordance with the studies given by Murat *et al*[5], Nair *et al*. (2001) and Karis *et al*. (2017). the use of larger bur was avoided as they were ineffective in simulation of the carious lesion. In group A, we created random artificial holes on the pulpal before the composite restoration. This was in consistence with the study given by Karis *et al*. (2017) However, a few studies standardized the position of artificial caries lesions (Murat *et al*., 2013; Charuakkra, 2011). Random location of these carious lesions was done to simulate the realistic clinical situation. The small voxel size and FOV were selected for the scans as the reduced field size has been reported to increase the image quality and the spatial resolution (Tohnak, 2011). As x-ray beam passes through an object, low energy photons from the x-ray beam become more likely to be absorbed than high energy photons and this is called as beam hardening. Metal objects like amalgam restorations lead to artifacts in CBCT images related to beam hardening because absorption of x-ray beam is greater for metal objects than human tissues. This is when the cupping, as well as streaking artifacts may occur. Cupping artifacts are seen as distortion around the metallic objects and streaking artifacts are seen as dark and bright bands between two objects with high density (Jaju, 2013). The low attenuation values of the composite resin restoration have suggested them to be more useful for improving the diagnostic accuracy of CBCT (Keriş *et al*., 2017; Nabha, 2014). However, recent studies have shown that there is no difference in detection of secondary caries under composite filling or amalgam with CBCT (Murat, 2013; Charuakkra, 2011). Thus, it can be stated that the clinical performance of CBCT in the detection of secondary caries under composite resin fillings still remains unclear. In the present study three oral and maxillofacial radiologists evaluated the teeth for the presence of absence of the secondary caries under composite restoration. Sensitivity is defined as the ability to detect those with disease correctly that is true positive rate where as specificity is the ability to detect those without disease that is true negative rate. The overall sensitivity and the specificity of all the observers was 82.6% and 56% respectively. The areas under the ROC curves (Az values) were found to be 0.716. The ROC value of less than 0.60 indicates that CBCT may not be an ideal modality for the detection of caries under restoration[4]. Similar to our study, the Az curve found in the study given by Karis *et al*. (2017) for the similar sample showed between 0.813 and 0.875.

Fig 1a. Group A (study group)

Fig1b. Group B (Control group)

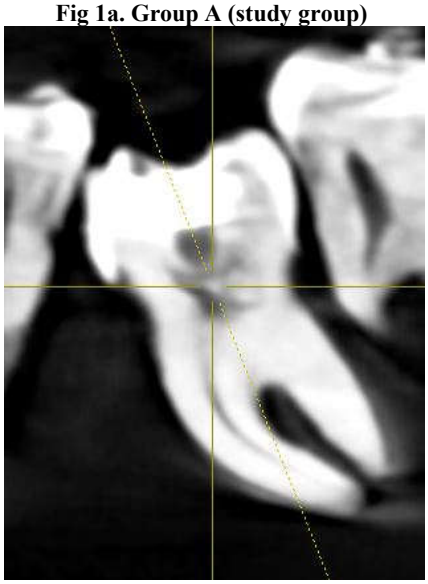


Fig2a. True positive

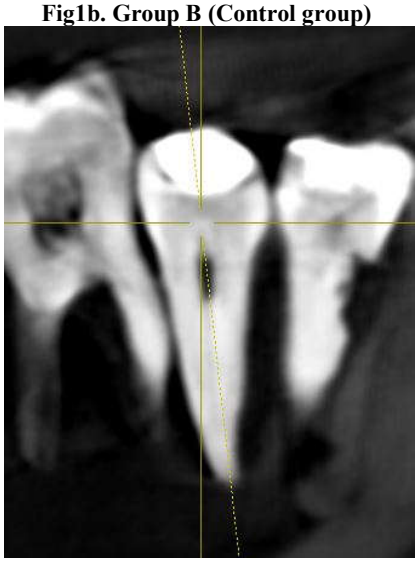


Fig 2b. True negative

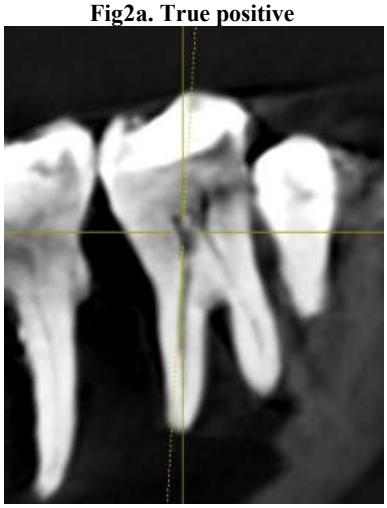


Fig. 2c. False positive

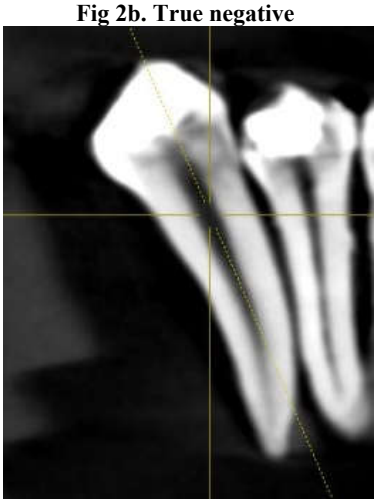
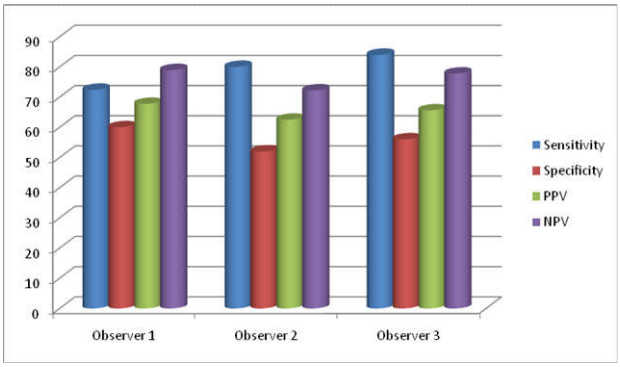


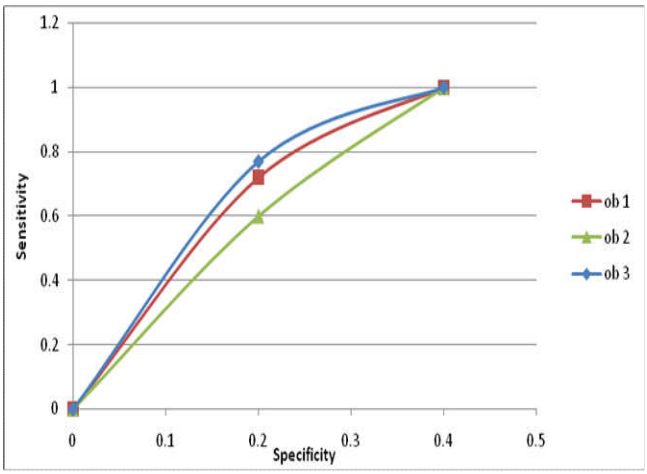
Fig 2d. False negative

Table 1. Overall diagnostic accuracy

OVERALL			Caries		Total
			Absent	Present	
Groups	Group A	N	13	62	75
		%	17.3%	82.7%	100.0%
	Group B	N	42	33	75
		%	56.0%	44.0%	100.0%
Total		N	55	95	150
		%	36.7%	63.3%	100.0%
P value					<0.0001
Sensitivity					82.6%
Specificity					56%
PPV					26 %
NPV					76.36%
ROC					0.716



Graph 1. Diagnostic accuracy among different observers



Graph 2. ROC values among different observers

The fact that there was reduced specificity might be associated with the increased false positive results due to the increased intensity of the artifacts. Thus, in our present study, composite resin restoration has seen to cause marked beam hardening artifacts and made the detection of secondary caries under the restoration difficult. This is in consistent with the study given by Karis *et al*. (2017) and inconsistent with the study given by Nabha *et al*. (2014) that claim the improvement of diagnostic accuracy with that of composite resin. In the present study, the accuracy of CBCT for determination of secondary caries under composite resin restoration is found to be questionable. Kamburoglu *et al*. (2017) in the year 2017 tried nine different setting in terms of tube voltage and tube current in CBCT machine for the detection of secondary caries under amalgam restoration however no statistically significant difference was obtained. Also, recent studies have shown the use of beam hardening correction software, anti scatter grids, scatter correction algorithm and wedge or bowtie filters effective in reduction of metal artifacts (Jaju, 2013; Fakhar, 2018; Barrett, 2004; Graham, 2007; Neitzel, 1992). This can benefit and improve in diagnostic accuracy of detection of the secondary caries under restoration.

Conclusion

Within the scope of our study, it was found that CBCT can be a useful modality for the identification of the secondary caries under restoration. However, as the caries excavation is a irreversible treatment modality, other softwares for artifact reduction will be useful for the improvement of specificity associated with cone beam computed tomography.

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