

Ability of E-Speed Film, Complementary Metal Oxide Semiconductors and Storage Phosphor Systems in the Detection of Proximal Caries of the Posterior Teeth

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Abstract

Original Research Article

Background: Dental surgeons very frequently encounter the cases of dental caries are one of the most commonly encountered conditions. Such lesions remain undetected when confined to the vicinity of inter-proximal surfaces. **Aim:** To test the ability of E-speed film, complementary metal oxide semiconductors and storage phosphor systems in the detection of proximal caries of the posterior teeth. **Methods:** Carious surfaces with demineralization appearing as chalky white or brownish discoloration on proximal surfaces were included in this study. Conventional films, CMOS and PSP images were used in detecting proximal caries on mesial and distal surfaces of teeth. **Results:** Lesions were equally distributed on both PSP and CMOS images (sixty nine each) that means the lesion is more accurately visible in digital receptor and presence of initial caries is more appreciated in PSP (26) than in CMOS (25) and IOPA (23) which shows that PSP is more accurate in detecting early lesions and the deeper lesions were more visible in IOPA images (12) in comparison with CMOS (8) and PSP (7) that means IOPA have lesser ability to detect the presence of initial forms of caries and also in delineating the actual depth of the caries. **Conclusion:** PSP is more accurate in detecting early lesions and the deeper lesions were more visible in IOPA images. Lesion is more accurately visible in digital receptor and presence of initial caries is more appreciated.

Keywords: E-speed film, CMOS, PSP, proximal caries.

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INTRODUCTION

The current decade is decade for technology transition. Latest advances in computer technology had witnessed a positive impact on dental radiography. There are two fundamentally different concepts for direct digital image acquisition, the CCD-based (charged-coupled device) and the storage phosphor (SP) systems [1]. In the CCD system, a chip is used as a sensor for the radiation. In the SP system, a phosphor plate is exposed and a latent image stored [2]. The information contained in the plate is released by exposure to a laser scanner.

Two methods used in direct digital image acquisition are Charge coupled devices (CCD) that uses a thin wafer of silicon for image production and Complementary metal oxide semiconductor (CMOS) that has a light sensitive chip with a scintillation detector[3,4]. In indirect digital image acquisition storage phosphor system (PSP plate) were used which

consists of polyester base coated with crystalline halide composed of europium-activated barium fluorohalide compounds [5, 6]. By using these systems, captured information is converted to electrical signals, which were subsequently digitalized and final image is displayed [7, 8].

Dental surgeons very frequently encounter the cases of dental caries are one of the most commonly encountered conditions. Such lesions remain undetected when confined to the vicinity of inter-proximal surfaces. Radiography plays a key role in the detection of interproximal caries especially in tight contacts. Therefore, the present study was to test the ability of E-speed film, complementary metal oxide semiconductors and storage phosphor systems in the detection of proximal caries of the posterior teeth.

METHODS

This cross-sectional study was conducted at a dental hospital of Jammu region. In this study adult patients from both sexes with premolar and molar teeth with proximal caries, which have been extracted were recruited. Carious surfaces with demineralization appearing as chalky white or brownish discoloration on proximal surfaces were included in this study. Those teeth with restorations on proximal surfaces, extensive buccal or lingual caries, dental wear, presence of fractures or anomalies, grossly decayed or with deep dental caries in proximal surfaces were excluded from the study.

Calculus and debris were removed and were disinfected and stored in distilled water. Then these teeth were embedded in blocks of dental stone with three teeth in each block ensuring to maintain the contact between the proximal surfaces and each block was assigned a number. The mesial and distal surfaces of the teeth in contact were assessed for presence of proximal caries. Detection of proximal caries was performed using visual examination, conventional E-speed film, CMOS and PSP images.

Imaging study of the blocks was initiated using three intraoral periapical receptors. Under standardized conditions at 60kvp, 8 mA and 0.2 sec for E-speed film with 10mm tooth receptor distance, 30cm target-to-receptor distance using rectangular collimation and paralleling technique were used. A 10 mm thick acrylic block was placed behind the teeth in each block in order to stimulate the soft tissue. After exposure all the films were simultaneously developed by using developer and fixer solution, according to the instructions recommended by the manufacturer. For digital radiographic exposure, all adjustments for teeth and

radiography apparatus were done similar to that of E-speed film, but the exposure time was reduced.

All images were evaluated separately by a team of oral and maxillofacial radiology surgeons. Assessment of the proximal caries was done as per radiographic criteria using following scale: 0:- no caries detected in the proximal surface; 1:- surface with caries involving only enamel; 2:- surface with caries involving up to the dentino- enamel junction; 3:- surface with caries extending up to dentin.

Written and informed consent was obtained from study subjects. Permission of ethical committee was obtained from the Institutional Ethics Committee. All the questionnaires were manually checked and edited for completeness and consistency and were then coded for computer entry. After compilation of collected data, analysis was done using Statistical Package for Social Sciences (SPSS), version 21 (IBM, Chicago, USA). The results were expressed using appropriate statistical variables.

RESULTS

Three teeth on each radiograph were evaluated. Lesions were equally distributed on both PSP and CMOS images (sixty nine each) that means the lesion is more accurately visible in digital receptor and presence of initial caries is more appreciated in PSP (26) than in CMOS (25) and IOPA (23) which shows that PSP is more accurate in detecting early lesions and the deeper lesions were more visible in IOPA images (12) in comparison with CMOS (8) and PSP (7) that means IOPA have lesser ability to detect the presence of initial forms of caries and also in delineating the actual depth of the caries (Table 1).

Table-1: Presence of the lesion among study subjects

Presence of lesion	IOPA (n)	CMOS (n)	PSP (n)
Sound tooth	71	69	69
Enamel caries	23	25	26
DEJ	28	29	33
Dentinal caries	12	8	7

Inter-group comparison was made to detect the presence of carious lesion with the help of correlation coefficient showing positive correlation between all the

groups. This observation was found to be statistically highly significant (Table 2).

Table-2: Intergroup comparison in detecting the presence of carious lesion among study subjects

Radiograph	Spearman rank correlation coefficient	p-value
IOPA	1.000	<0.001
CMOS	0.962	
IOPA	1.000	<0.001
PSP	0.953	
CMOS	0.969	<0.001
PSP	0.954	

DISCUSSION

Dental caries is one of the most regularly encountered conditions in clinical dentistry. Among them Inter-proximal carious lesions, which develop between the contacting surfaces of two adjacent teeth were often missed during routine clinical examination. They appear as opaque regions clinically which are caused by loss of enamel translucency at the outermost portion of enamel, between the contact points and just coronal of the free gingival margins.

Radiography is a well established procedure in daily dental practice and is still the most basic and an important diagnostic tool available. Radiographs play an integral role in the assessment of periodontal diseases. Conventional bitewing and intra oral periapical radiographs are commonly used to detect alveolar bone loss associated with periodontal disease. They provide unique information about the status of the periodontium and a permanent record of the bone throughout the course of the disease. However, the quality of an X-ray sensitive film can be affected by multiple variables such as improper exposure, under or overdeveloping and poor fixing. The key advantage of digital radiography is reduction in processing time.

In the present study, there is no statistically significant difference observed between the digital systems and conventional films while diagnosing the presence of inter-proximal caries. Several studies have measured that diagnostic ability of intraoral digital sensors and the conventional film in the detection of carious lesions. Senel B *et al.* [9] compared conventional films and digital sensors in detecting the proximal caries and revealed that no statistically significant difference exists, which are in accordance with present study. Abesi F *et al.* [10] conducted a study and results obtained showed that conventional film is more accurate in detecting the proximal caries, which is in contradictory to present study.

In this study we observed that lesions were equally distributed on both PSP and CMOS images (sixty nine each) that means the lesion is more accurately visible in digital receptor and presence of initial caries is more appreciated in PSP (26) than in CMOS (25) and IOPA (23) which shows that PSP is more accurate in detecting early lesions and the deeper lesions were more visible in IOPA images (12) in comparison with CMOS (8) and PSP (7) that means IOPA have lesser ability to detect the presence of initial forms of caries and also in delineating the actual depth of the caries. Similar result was obtained with the work done by Wenzel *et al.* [11] even if the initial caries present on the proximal surfaces they are not radiographically detected and deeper lesions were more easily detected than the superficial ones.

According to Pereira AC *et al.* [12] a radiograph was unable to detect initial occlusal enamel

and dentin lesions, resulting in low sensitivity which is analogous to results of present study. In accordance with present study, studies conducted by Syriopoulos *et al.* [13] revealed deeper caries lesions were easier to detect using radiographic systems than relatively superficial ones. As the lesions penetrate dentine, observers were able to detect their presence more consistently. Clinical diagnosis of enamel caries was even harder to perform than radiographic diagnosis.

In present study the intergroup comparison shows the positive correlation exists between all the groups that is when comparing IOPA with CMOS, CMOS with PSP and PSP with IOPA groups where p-value is ≤ 0.05 and the presence of caries is almost equal in each group which is similar to study conducted by Pontual AA *et al.* [14] wherein no significant difference was observed in diagnostic accuracy among the insight film and Digora and Denoptix digital systems for proximal enamel caries. Study conducted by Abesi *et al.*, also demonstrated that no significant difference between digital and conventional radiographic modalities in detection of interproximal caries [10].

In this study, inter-group comparison was made to detect the presence of carious lesion with the help of correlation coefficient showing positive correlation between all the groups. This observation was found to be statistically highly significant. In present study the intergroup comparison shows the positive correlation exists between all the groups that is when comparing IOPA with CMOS, CMOS with PSP and PSP with IOPA groups where p-value is ≤ 0.05 and the presence of caries is almost equal in each group which is similar to study conducted by Pontual AA *et al.* wherein no significant difference was observed in diagnostic accuracy among the insight film and Digora and Denoptix digital systems for proximal enamel caries [14]. Study conducted by Abesi *et al.*, also demonstrated that no significant difference between digital and conventional radiographic modalities in detection of interproximal caries [10].

A very high Interobserver kappa coefficients found in the present study suggested excellent interobserver agreement. Study done by Senel B *et al.* [9] showed excellent interobserver agreement (kappa coefficient 50.89) with a kappa coefficient of 0.79 and reported that intraobserver agreement using bitewing film in an in vitro detection of proximal caries. The differences in intra and interobserver agreement kappa values among the different studies may be related to observer experience, radiographic quality, viewing conditions, study design and study material, all of which are important factors in determining observer agreement.

CONCLUSION

On the basis of findings of this investigation, it can be concluded that PSP is more accurate in detecting early lesions and the deeper lesions were more visible in IOPA images. Lesion is more accurately visible in digital receptor and presence of initial caries is more appreciated in PSP. Overall performance of PSP images were found better. Further larger studies are needed to support our findings.

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