Interproximal Caries Detection Ability of Dental Practitioners Using Direct Digital System and Conventional Films

Original Article

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Abstract

Introdouction:
The study aimed to compare the accuracy of proximal caries detection by dental practitioners using two different systems, direct digital system and conventional films, under routine environmental conditions.

Materials and methods:
Eleven extracted human posterior teeth were mounted on wax frames and were exposed using the direct digital system and conventional films. Seventy-four dental practitioners evaluated these images for proximal caries. No environmental conditions were dictated. The dental practitioners' evaluations were compared with histopathological sections that were used as the gold standard.

Results:
There were no statistically significant differences in the dental practitioners' ability to detect caries using the direct digital and conventional systems (P=0.548).No significant differences were found between groups based on the level of the dental practitioners' work experience (P=0.167).

Conclusion:
Dental practitioners work well with both direct digital and conventional systems in the diagnosis of proximal caries, although the routine environmental condition is not the ideal one. Further, this ability is so basic that it is not influenced by the level of the dental practitioner's experience. Therefore, we recommend that digital systems be considered for use in dental offices.

Key words:
•Dental Caries •Digital Dental Radiography •Dentists

Introduction

Dental caries is one of the most common diseases worldwide, and caries detection is of basic importance for every dental practitioner. Although clinical examination is essential for detecting dental caries, it has certain shortcomings even when conducted under ideal conditions, particularly in proximal areas of teeth with close interproximal contacts that lead to false negative diagnoses. Thus, the radiograph is a necessary supplement to clinical examination.[1,2]

For many years, intraoral radiographs have been taken using conventional films; however, nowadays, digital receptors are increasing in popularity. Digital receptors could be classified as solid-state sensors (CCD/CMOS) or phosphor plates (PSP).The use of direct digital systems based on CCD or CMOS receptors is far more common than phosphor plate-based digital systems because they provide real time images with more reasonable installation costs.

Under optimal conditions, digital intraoral systems enable less patient exposure, eliminate wet processing, save time, and facilitate image communication in comparison withconventional techniques.[1,3,4,5] Apart from the diagnostic ability of each system, viewing conditions would also affect the ability to detect subtle or even more extensive changes.[6] Unfortunately, this aspect has been overlooked by dental practitioners owing to either paucity of time or lack of knowledge.

At the time of introduction, the accuracy of the available digital systems was compared with that of conventional films in a number of in vitro and in vivo studies. However, the results of these studies were based on controlled viewing conditions and educated observers.[7,8]

The present study attempts to elucidate how the caries detection ability of dental practitioners could be influenced by two different intraoral imaging systems (conventional films and CCD) under routine environmental conditions and determine whether this ability is influenced by the level of the dental practitioners' work experience.

Materials and Methods

In this cross-sectional study, 74 dental practitioners evaluated two sets of radiographs obtained from 11 extracted human posterior teeth separately:1 set on the conventional radiographic film and the other on the computer screen, obtained using the CCD receptor. The exercise was repeated after an interval of 2 weeks. No special viewing conditions were dictated. The observers were asked to view both sets of radiographs under the same environmental conditions as their everyday practice and subsequently fill a questionnaire designed for reporting the caries status of each interproximal surface on the radiograph.

Teeth selection criteria

A large number of extracted human posterior teeth were evaluated radiographically by 2 oral and maxillofacial radiologists to select 11 teeth (with agreement) that could be categorized under the following 4 groups, according to their interproximal caries status:

1-Sound

2-Confined to DEJ

3-Confined to outer half of the dentinal width

4-Exceeding the outer half of the dentinal width

These teeth were also assessed histologically to determine the actual depth of the caries, which was used as the gold standard. Histological sections that were parallel to the longitudinal axis of the crown were obtained. A dental pathologist examined all the sections under a stereomicroscope(×10) in order to evaluate the caries status and determine the exact depth of the existing caries. Cases with discrepancies between radiographic diagnosis and histological evaluation were not included in the study.

Radiographs

All the teeth were mounted on 3 wax blocks with the proximal surfaces in contact with each other. The blocks were then adjusted and attached to the bite plate of a Dentsply XCP film holding system (Rinn Corp., Elgin, IL, USA) to standardize the focal-to-object distance (FOD) and focal-to-film distance (FFD) in all the radiographic examinations including conventional and digital projections.

For conventional projections, we used E-speed Kodak film (Eastman Kodak, Rochester, NY, USA) and for digital projections, we used Dr. Suni direct digital intraoral CCD sensor (Suni Medical Imaging, San Joe, CA, USA).

The x-ray unit that was used for all projections was Planmeca IntraX-ray machine (Planmeca Oy, Helsinki, Finland). Exposure factors including KVp, mA, and time were determined by con-

ducting a pilot study to obtain an acceptable optical density. For both systems, the teeth blocks were exposed under different technical conditions and two oral & maxillofacial radiologists decided on the radiograph that had better optical density for the diagnosis of carious lesions. In the case of absence of any difference, the lower exposure factor was chosen.

For processing conventional films, we used an automatic processor (Hope; Dental Max, USA) using fresh Champion processing chemicals (Tehran, Iran).

Statistical Analysis

The Wilcoxon signed rank test was used to compare the diagnostic abilities of dental practitioners in detecting dental caries using the two methods.The Kruskal–Wallis H test was employed to compare the diagnostic abilities of groups with different levels of work experience. The significance level was set at 0.05.

The statistical software SPSS v.15.0 (SPSS Inc., Chicago, IL, USA) was used for data analysis. ($p < 0.05$).

The MDW measurements, ratios and combina tion charts of the upperand lower central incisors obtained from the Vitapan, Ideal Makoo, and Ivoclar product catalogs, are illustrated in Tables 1, 2, and 3, respectively.

Results

The true proximal surface status of the studied teeth according to histological sections included 12 sound surfaces(S),2 surfaces in which dental caries was restricted to enamel up to the dentinal-enamel junction (DEJ), 2 surfaces in which dental caries involved less than half of the dentin thickness (<1/2 Dentin), and 5 surfaces in which dental caries extended to half or more than half of the dentin thickness (≥1/2 Dentin).

Table1 shows the median, mean, and standard deviation values of correct diagnosis of proximal surface status using both digital and conventional forms. There was no statistically significant difference in the correct diagnosis of proximal surface status between(sound, dental caries up to DEJ, Dental caries up to half of dentin and dental caries at or more than half of dentine)digital and conventional intraoral radiographs (P =0.54).

Table 1: Correct diagnosis of proximal surface status using digital and conventional forms

Method Caries	Conventional Median Mean±SD	Digital Median Mean±SD	P value
Sound	11.5 11±1.49	12 11.04±1.76	0.560
DEJ	1.00 0.68±0.68	1.00 0.84±0.64	0.071
<1/2 Dentin	0.50 0.73±0.86	1.00 0.77±0.87	0.714
>1/2 Dentin	1.00 1.20±0.76	1.00 1.15±0.70	0.498
Total	15.00 14.34±2.54	15.00 14.50±2.54	0.548

Table 2 summarizes the median, mean, and standard deviation values of correct diagnosis of proximal surface status using digital and conventional intraoral radiographs by 3 groups of dental practitioners with different levels of experience(≤ 5 years, 5–10 years, and ≥ 10 years). There was no statistically significant difference in the correct diagnosis of proximal surface status between the 3 groups (P =0.2 for conventional films; P = 0.16 for digital systems).

Table 2.Correct diagnosis of proximal surface status by three groups of dentists with different work experience using digital and conventional forms

Caries group	Experience	≤ 5 years Median Mean ±SD	5–10 years Median Mean ±SD	≥ 10 years Median Mean ±SD	P value
Sound	Conventional	11.00 10.63±1.79	12.00 11.13±1.58	12.00 11.22±1.05	0.356
	Digital	12.00 11.04±1.63	12.00 11.04±1.89	12.00 11.04±1.83	0.994
DEJ	Conventional	1.00 0.63±0.65	1.00 0.78±0.74	1.00 0.63±0.69	0.702
	Digital	1.00 0.83±0.64	1.00 1.00±0.60	1.00 0.70±0.67	0.244
<1/2 Dentin	Conventional	0.00 0.46±0.72	1.00 0.83±0.94	1.00 0.89±0.89	0.148
	Digital	0.00 0.71±0.91	1.00 0.83±0.94	1.00 0.78±0.80	0.848
>1/2 Dentin	Conventional	1.00 1.17±0.76	1.00 1.30±0.70	1.00 1.15±0.82	0.777
	Digital	1.00 0.96±0.69	1.00 1.17±0.65	1.00 1.30±0.72	0.207
Total	Conventional	14.00 13.63±2.55	15.00 14.91±2.64	15.00 14.48±2.39	0.227
	Digital	14.00 14.17±2.37	15.00 14.83±2.95	15.00 14.52±2.36	0.167

Discussion

Various studies have compared the accuracy of different direct digital sensors with conventional films.[8,9,10,11,12] All of these studies were conducted under ideal environmental conditions: conventional films were viewed on a view box under subdued environmental light and digital images were viewed on a monitor of specific size and resolution under subdued environmental light .The observers were well trained and instructed for calibration purposes.[7,8] Most of these studies concluded that the diagnostic accuracy of direct digital and conventional images were comparable.[4,7,8, 13–16]

However, in everyday dental practice, dental practitioners usually view and interpret radiographs in conditions that are different from those used in experiments for various reasons, among which are paucity of space and time, and this can affect the result.

In agreement with the above statement is the study by Haak et al.[17] They concluded that smaller gray scale differences could be detected on LCD monitors compared with CRT monitors. In another study ,Hellen-Halme et al.6 found that multiple environmental factors could affect the diagnostic accuracy of digital radiography. They mentioned ambient light, screen reflection,and clean monitors among those factors. They concluded that although brightness and contrast settings could affect the diagnosis, ambient light remained a more important factor. Further, Li et al.[18] demonstrated that the length of an endodontic file was more accurately measureable under subdued lighting. However, a questionnaire study showed that 40% of general dental practitioners do not use any quality control for their digital images.[19] In our study, dental practitioners viewed both conventional and digital images under routine environmental conditions and no quality control conditions were dictated. Our results showed that dental practitioners diagnosed interproximal caries in direct digital images with the same accuracy as with conventional E-speed film, and experience (evaluated in terms of years of work experience) did not have a significant effect on this result. In other words, experienced dental practitioners did not show significant differences in their ability to detect interproximal caries as compared with inexperienced ones.

This finding is in contrast with a study by Upriched et al.[9] that showed that with increasing experience, accuracy in detection of proximal caries in mixed dentition using digital systems

increased. However, they also concluded that over time, as digital systems become more popular and dental practitioners get familiar with their use, the accuracy of diagnosis using direct digital images could become comparable with that of conventional films. This seems to be the case with our study conducted 14 years after the mentioned study. During this period, dental practitioners got accustomed to this modality and its quality control options, and this improved their diagnosis, as expected by Upriched et al.[9]

Wenzel[20] reviewed 9 questionnaire studies on the use of digital radiography by dental practitioners. In his study, most general dental practitioners preferred using digital systems for different reasons, most common among which were avoidance of chemicals, reduced patient exposure, lesser time, and remote communication, although in some of the reviewed studies, more errors and retakes took place while using digital systems.

Conclusion

Since dental practitioners perform well and comparably using both direct digital and conventional images we recommend that the use of digital systems in dental offices be considered for dif ferent reasons, most important amongst which are avoidance of chemicals, reduced patient exposure, lesser time, and remote communication.

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