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VISUAL-TACTILE EXAMINATION, DIGITAL RADIOGRAPHY AND LASER FLUORESCENCE IN THE DIAGNOSIS OF OCCLUSAL CARIES OF PERMANENT MOLARS: A CLINICAL STUDY

KEYWORDS: Visual-tactile examination, digital radiography, laser fluorescence device

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ABSTRACT An in vivo investigative study was conducted to evaluate the efficacy of laser fluorescence device in comparison with visual tactile examination and digital radiographic examination for occlusal caries detection. The sample size comprised of 100 occlusal surfaces from patients aged between 18 and 30 years visiting the Department of Conservative Dentistry and Endodontics at A. B. Shetty Memorial Institute of Dental Sciences, Nitte University, Deralakatte, Mangaluru. The laser fluorescence device was utilized for detecting and diagnosing caries on the occlusal surfaces of molars. Visual and tactile examination and radiographic examination were based on the Ekstrand classification system. Correlation was observed between the visual tactile examination and digital radiographic examination and were in tandem, however no significant statistical difference was observed, whereas when the results of the laser fluorescence was compared to the other examination methods significant statistical difference was seen.

CONCLUSION: The study demonstrated that the laser fluorescence device met most of the qualities expected of a technology to aid in caries detection and diagnosis. Thus it can be considered as a valuable adjunct to visual-tactile examination and digital radiographic examination.

INTRODUCTION

The complex anatomical structure of the occlusal surfaces of molars comprising of pits and fissures render them susceptible to the development of caries. The necessity for the identification and clinical staging of the presence, activity and severity of the occlusal caries is of paramount importance in the deployment of various treatment strategies. Reliable and accurate diagnosis of caries is fundamental requiring thorough dental examination and close attention to the clinical evidence especially of non-cavitated occlusal caries because these lesions can be arrested by preventive treatment modalities such as fluorides, antimicrobials, sealants. However, accurate diagnosis of caries of occlusal surface is difficult due to the complex anatomical nature[1].

Combination of visual and tactile examination, a subjunctive method (Lussi, 1991; Lussi, 1993)[2, 3] was the pillar of occlusal caries diagnosis for many years until it was shown that the probing pressure potentially damaged the fissures over subsurface carious lesions (Bergman and Linden, 1969; Ekstrand et al., 1987; van Dorp et al., 1988)[4,5,6], but it is not the normal hypothetical-deductive process that often is in the world of medicine. Visual examination is the most commonly used easy technique routinely performed for detecting caries lesions. This method presents high specificity but low sensitivity and reproducibility. Ekstrand et al. (1998) devised a visual scoring system showing a high correlation with a histological validation system[5].

A diagnostic system that reflects the dynamic nature of the caries disease in all its stages of progression, so that the various stages of lesion can be accurately identified is a requirement of clinical and radiographic record of occlusal caries lesions[7]. Cavitated lesions are easily diagnosed by clinical examination, however diagnosis of subsurface enamel lesions especially of those where a seemingly healthy enamel surface covers extensive progression into the dentin, is complex (Gray, Paterson; 1997). Radiographs are not sensitive in detecting early carious lesions limited to enamel. According to Machiulskiene et al. (1999), bitewing radiographs may be used as an additional information to detect clinically non-cavitated lesions. Digital radiographs in conjunction with visual-tactile examination improves the accurate diagnosis of occlusal caries significantly.

Recent years have seen a tremendous increase in research activity surrounding caries diagnostic methods, particularly in the assessment of early caries lesions and a desire has driven the uptake of the minimum intervention dentistry philosophy. Clinicians armed with the therapies to remineralize early lesions are now seeking methods to reliably detect such demineralized areas and implement true preventive dentistry[8].

Numerous innovative technologies have been developed and introduced in the last few years to aid in early caries detection and to make firm diagnosis and treat cases conservatively due to advancement in understanding of the caries process[8]. Furthermore, the development of various novel technologies may be expected to have a major impact upon clinical dental research. One such technology is the laser fluorescence system DIGANOdent (DIAGNOdent KaVo, Biberach, Germany), employing fluorescence to detect caries. The tooth is illuminated by the laser unit through a designed tip with red light of 655nm. The laser tip both emits the excitation and collects the resultant fluorescence. The system measures the degree of bacterial activity and induces fluorescence from bacterial porphyrins a metabolic byproduct.

The in vivo study was conducted with the aim of evaluating and comparing visual-tactile examination, digital radiography and laser fluorescence device.

MATERIALS AND METHODS

Study Sample

The in vivo study involved 100 occlusal sites of molars from patients aged 18 to 30 years of age referred to the Department of Conservative Dentistry and Endodontics of A. B. Shetty Memorial Institute of Dental Sciences, Nitte University following the approval of the Institutional Ethical Committee and subsequent to consent from the patients. The teeth of the selected patients met the following criteria: where fully erupted, no restoration on the occlusal surfaces, devoid of hypoplastic surfaces and pathological abrasions or structural defects.

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Parameters of assessment

Visual-tactile clinical examination

Visual-tactile clinical examination was performed by experienced dental practitioner according to the criteria established by Ekstrand et al.*.

**Criteria used to record the visual appearance of teeth (Ekstrand et al., 1998)*

SCORE	CRITERIA
0	No or slight change in enamel translucency after prolonged air drying (>5s)
1	Opacity hardly visible on the wet surface, but distinctly visible after air drying
1a	Discolouration hardly visible on the wet surface, but distinctly visible after air drying
2	Opacity distinctly visible without air drying
2a	Discolouration distinctly visible without air drying
3	Localized enamel breakdown in opaque or discoloured enamel and/or grey discolouration from the underlying dentin
4	Cavitation in opaque or discoloured enamel exposing the dentin

The tooth surface was observed first, when wet and later after 5 seconds of drying utilizing a ball ended explorer without application of pressure to confirm the cavitation.

Laser fluorescence examination

The occlusal surface was scanned by the same operator using laser fluorescence device (DIAGNOdent, KaVo, Biberach, Germany). The preselected occlusal site was cleaned and air dried. The cone shaped tip designed for occlusal caries was placed perpendicular to the long axis of the tooth and the maximum fluorescence reading (peak value) was recorded for the site following standard calibration and following the manufacturer's criteria* and instructions.

**DIAGNOdent manufacturer's criteria*

SCORE	CRITERIA
0-14	No caries – healthy tooth tissue
15-20	Enamel caries – early demineralization
>21	Dentinal caries – strong demineralization

Digital radiographic examination

Bitewing radiographic technique was performed subsequent to visual-tactile and laser fluorescence examination by experienced dental radiologist. The analysis of the bitewing radiographs were performed using the criteria set down by Ekstrand et al. (1997)*.

**Scoring criteria for digital radiographic examination according to Ekstrand et al.*

SCORE	CRITERIA
DR0	No intracoronal radiolucency
DR1	Radiolucency present within crown (<1/3 dentin width)
DR2	Radiolucency present within the crown (1/3 - 2/3 dentin width)
DR3	Radiolucency present within the crown (>2/3 dentin width)

Statistical analysis

The scores of all the examination techniques employed in the diagnosis of occlusal caries were analysed statistically using SPSS Version 16 software. Multiple comparison involving mean difference, standard error, significance and confidence interval between the examination techniques were done by Tukey, Scheffe and Bonferonni tests.

RESULTS

Comparison involving mean difference, standard error, significance and confidence interval between visual-tactile examination, digital radiographic examination and laser fluorescence examination of 100 occlusal surfaces is represented in Table 2.

Table 1: ANOVA test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	133504.167	2	66752.083	342.595	.000
Within Groups	57868.270	297	194.843		
Total	191372.437	299			

Table 2: Multiple Comparisons

Tests	(I) Type of Examination	(J) Type of Examination	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Visual-tactile	Digital radiograph	.00000	1.97404	1.000	-4.6499	4.6499
		DIAGNOdent	-44.75000*	1.97404	.000	-49.3999	-40.1001
	Digital radiograph	Visual	.00000	1.97404	1.000	-4.6499	4.6499
		Diagnodent	-44.75000*	1.97404	.000	-49.3999	-40.1001
	DIAGNOdent	Visual-tactile	44.75000*	1.97404	.000	40.1001	49.3999
		Digital radiograph	44.75000*	1.97404	.000	40.1001	49.3999
Scheffe	Visual-tactile	Digital radiograph	.00000	1.97404	1.000	-4.8564	4.8564
		Diagnodent	-44.75000*	1.97404	.000	-49.6064	-39.8936
	Digital radiograph	Visual-tactile	.00000	1.97404	1.000	-4.8564	4.8564
		DIAGNOdent	-44.75000*	1.97404	.000	-49.6064	-39.8936
	DIAGNOdent	Visual-tactile	44.75000*	1.97404	.000	39.8936	49.6064
		Digital radiograph	44.75000*	1.97404	.000	39.8936	49.6064
Bonferroni	Visual-tactile	Digital radiograph	.00000	1.97404	1.000	-4.7527	4.7527
		DIAGNOdent	-44.75000*	1.97404	.000	-49.5027	-39.9973
	Digital radiograph	Visual-tactile	.00000	1.97404	1.000	-4.7527	4.7527
		DIAGNOdent	-44.75000*	1.97404	.000	-49.5027	-39.9973
	DIAGNOdent	Visual-tactile	44.75000*	1.97404	.000	39.9973	49.5027
		Digital radiograph	44.75000*	1.97404	.000	39.9973	49.5027

* The mean difference is significant at the 0.05 level

A strong correlation was observed between visual-tactile examination and digital radiographic examination and were in tandem, however no significant statistical difference was observeed. The results obtained when comparing laser fluorescence device with that of visual-tactile and digital radiographic examination was of great statistical significance (p value = .000).

DISCUSSION

Occlusal caries detection still relies for the vast majority on visual-tactile examination and radiographic examination thereby

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hampering clinician's ability to diagnose and monitor early caries lesions. The development and advent of non-invasive techniques or devices has led to the detection of early demineralization, one of the desirable aims of clinicians and dental researchers[2,4].

The use of detailed visual indices such as the ones put forth by Ekstrand et al. (1998) employed in the present study proves to be an important factor in minimizing the examiner's interpretation of the clinical characteristics of a lesion. However, most of the disagreements between the examiners in several studies have been generated by initial carious lesions.

Shortcomings in visually identifying the caries below the sound enamel has led to the advent of technique of bitewing radiography in the case of occlusal caries. Digital radiography has offered the potential to enhance the diagnostic yield of radiography in dentistry. Digital radiographs offer numerous opportunities for image enhancement, processing and manipulation. However, certain disadvantages are present and must be considered when diagnosing the carious lesions and making treatment plans[6]. The radiographs underestimate the depth of the lesion and unable to show the early stages of enamel caries lesions. Another factor to be taken into consideration is that the radiographs do no indicate the activity of the carious lesion hence should not be used in isolation to decide the type of treatment to be used.

Laser fluorescence device employs laser excitation to distinguish between carious and healthy tooth structure. This device is based on the fluorescence caused by porphyrins present in carious lesions and not the amount of demineralization which may be found in healthy sound tooth structures. The DIAGNOdent evaluation criteria used in this study were those defined by the manufacturer. Like many caries detection devices the DIAGNOdent requires the surface to be examined to be clean and dry. Presence of stains, calculus, plaque have shown to have an adverse effect on the readings. Literature based on the laser fluorescence device suggest that it performed well in the diagnosis of early enamel lesions and dentinal caries although a great deal of heterogeneity was observed and that most of the studies were undertaken in vitro. It was also observed that the results could not be extrapolated into the clinical set up detecting a trend for the device to produce false positive[6,7,8].

The results of the present study demonstrated that visual-tactile examination and digital radiographic examination were in tandem. The laser fluorescence device provided an appealing approach to chair side examination of occulsal caries detecting caries lesion at its earliest stage. However in clinical application false positive readings were recorded due to positive response to any substance that emitted fluorescence.

CONCLUSION

No significant difference between visual tactile examination and digital radiographic examination was observed. The difference between laser fluorescence examination and the other methods were of significance. The study demonstrated that the laser fluorescence device met most of the qualities expected of a technology to aid in caries detection and diagnosis. Thus it can be considered as a valuable adjunct to visual-tactile examination and digital radiographic examination.

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