



Investigating the Ability of VistaProof Durr Dental to Diagnose Occlusal Caries

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ABSTRACT

Introduction: Initial detection of caries on occlusal surface of posterior teeth is difficult because areas of primary caries which can be detected using routine methods used by dentists may not be detected. Therefore, this study tended to examine the ability of VistaProof Durr Dental in detecting occlusal caries.

Materials and Methods: In this study, 96 molar teeth extracted for various reasons such as periodontal problems were selected randomly from a dental clinic in Tehran. Then, VistaProof Durr Dental machine was used to capture surface of each isolated tooth. Then, the teeth were sectioned perpendicular to occlusal surface for histological examination. The sectioned teeth were observed by a maxillofacial pathologist under a stereomicroscope and actual penetration rate of caries was determined.

Results: In histological evaluation, it was observed that 18 cases (18.75%) were healthy, 24 cases (25%) had caries limited to enamel, 54 cases (56.25%) had caries extended to dentine. The best diagnostic power of the machine was obtained in the area under the ROC curve at Cutoff 2 (dentine surface). Diagnostic sensitivity of the machine was 100% to detect non-carious surfaces, 45% to detect caries limited to enamel, and 92.6% to detect caries extended to dentine. Specificity values were 97.43% for non-carious surfaces, 93% for caries limited to enamel and 71.4% for caries extended to dentine.

Conclusion: The results of this study show that diagnostic value of the VistaProof Durr Dental was optimal in non-carious teeth in detecting healthy occlusal surfaces from early caries. Sensitivity was 100%, specificity was 97.43%, positive predictive value was 90%, and negative predictive value was 100%.

Key words: VistaProof Durr dental, Dental caries, Occlusal surface

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INTRODUCTION

Initial detection of caries on occlusal surface of posterior teeth is difficult because pit and fissures extend under the surface and areas of primary caries may not be detected by routine methods used by dentists, such as surface observation and probe by the catheter or radiography stereotypes [1]. The process of dental caries affects optical properties of dentin and enamel. On this basis, various tools have been introduced for detection of caries [2]. Currently, non-invasive optical methods are very considered, and various methods have been developed based on changes in dental structure and their unique characteristics in optical interactions.

Fluorescence cameras (FC) helping to detect caries are one of these methods, such as VistaProof Durr Dental

and spectra caries detection aid (Air Technique New Y) which radiates UV 450 nm wavelength to dental surface and activate metabolic products of cariogenic bacteria or endogenous fluorophores (organic structures of dental tissues and porphyrins produced by bacterial metabolism) and emit red fluorescence glow and makes it easy and reliable to detect [3].

FCs provides dental images which are visible on the computer. Enamel white spot lesions (WSLs) emit a reduced amount of fluorescence, while dentin caries have distinct fluorescence. Spectas visix has developed software which gives a false dye to these dental areas and assigns numerical values to different dyes, depending on amount of enamel demineralization and dentinal caries.

Evaluating Durr dental FCs and comparing with gold standard and its histological incision, Michele B Deniz et al. reported its specificities and sensitivities at 0.80 and 0.74 in areas with enamel and dentin caries, and 0.49 and 0.85 in dentin caries. They reported that results of ICDAS were more accurate than BW and FC. They

recommended using fluorescence diagnostic methods after clinical examinations in the treatment plan [4].

According to Kenneth Markowitz *et al.* sensitivity and specificity of spectra caries detector were comparable to clinical examinations and was reported to be equivalent to BW radiography in detecting occlusal caries [5]. This study tended to determine accuracy of VistaProof Durr Dental in detection of occlusal lesions.

MATERIALS AND METHODS

In this experimental study, 96 molar teeth extracted for various reasons such as periodontal problems were randomly selected from a dental clinic in Tehran. Inclusion criteria included no fillings or sealant on occlusal surface, absence of extensive caries on occlusal and proximal surfaces, and absence of hypoplastic lesions and fluorosis. Immediately after extracting, they were immersed in 0.1 water-phenol solution. Their surfaces were completely cleaned with scaling brush and they were kept at 4°C.

Using VistaProof Durr Dental, surface of each tooth was captured using completely dry and isolated wool roll and the results displayed on the monitor were recorded.

According to instructions of the device, each color showed a degree of caries (0-1 healthy enamel, 1-1.5 enamel surface caries, 1.5-2 deep enamel caries, 2-2.5 dental caries, >2 deep dental caries).

Then, the teeth were sectioned perpendicularly to occlusal surface using a diamond disk for histological examination as a reference. The sectioned teeth were observed by a maxillofacial pathologist under a stereomicroscope and actual rate of caries was determined (Figures 1-4).

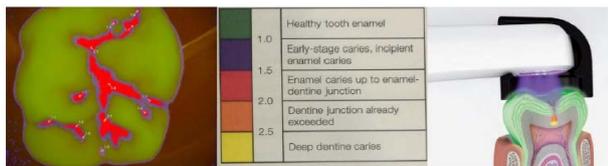


Figure 1: An example of captured tooth using the device



Figure 2: The device for sectioning teeth



Figure 3: An example of the sectioned tooth



Figure 4: Stereomicroscope

RESULTS

In histological evaluation, it was found that 18 cases (18.75%) were healthy, 24 cases (25%) had caries limited to enamel, and 54 cases (56.25%) had caries extended to dentin. The best diagnostic power of the device was at Cutoff 2 (dentine surface) given the area under the ROC curve.

Diagnostic sensitivity of the device was determined for detecting non-carious surfaces and differentiating them from early caries (100%) (Table 1), caries limited to enamel (45%) (Table 2), and caries extended to dentin (92.7%) (Table 3). Specificity values were determined for detecting non-carious surfaces (97.43%), caries limited to enamel (93%) and caries extended to denting

Table 1: Comparison of the results of detection by VistaProof Durr Dental and (standard) histopathology in detecting non-carious surfaces

		Histopathological results (standard)		
		Non-caries	Carious	Total
VistaProof Durr dental	Non-carious	18	2	20
	Carious	0	76	76
	Total	18	78	96

Table 2: Comparison of the results of detection by VistaProof Durr Dental and (standard) histopathology in detecting caries limited to enamel

		Histopathological results (standard)		
Limited to enamel		Positive	Negative	Total
Vista ProofDurr Dental	Positive	10	5	15
	Negative	12	69	81
	Total	22	74	96

Table 3: Comparison of the results of detection by Vista Proof Durr Dental and (standard) histopathology in detecting caries extended to dentin

		Histopathological results (standard)		
2 mm extended to dentin		Positive	Negative	Total
Vista ProofDurr Dental	Positive	50	12	62
	Negative	4	30	34
	Total	54	42	96

Table 4: Sensitivity, specificity, positive and negative predicted value

Occlusal surface status	Sensitivity	Specificity	PPV	NPV
Differentiate non-carious from early caries	100	97.43	90	100
Caries limited to enamel	45	93	66	85
Caries limited to dentin	92.6	71.4	80.64	88.23

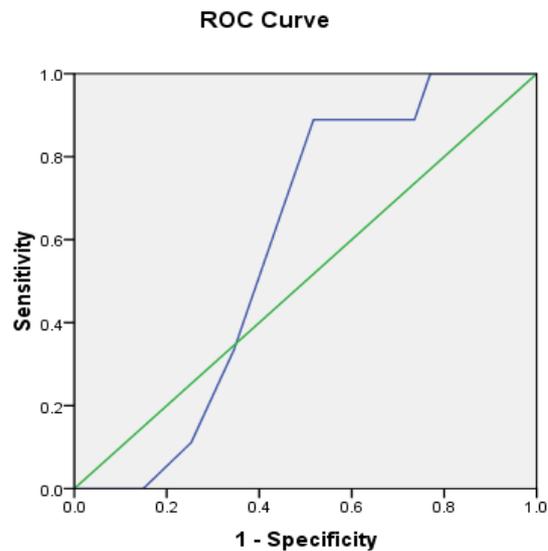
(71.4%) (Table 4). Positive predictive values were determined for detecting non-carious surfaces (90%), caries limited to enamel (66%) and caries extended to denting (80.64%). Negative predictive values were determined for detecting non-carious surfaces (100%), caries limited to enamel (85%) and caries extended to denting (88.23%).

DISCUSSION

In histological assessment as golden standard, 18 cases of occlusal surface (18.75) were healthy, 24 cases (25) had caries limited to enamel, and 54 cases (56.25) had caries limited to dentin. According to results of ROC curve, the highest diagnostic power of VistaProof Durr Dental was at cutoff 2 given the area under the ROC curve.

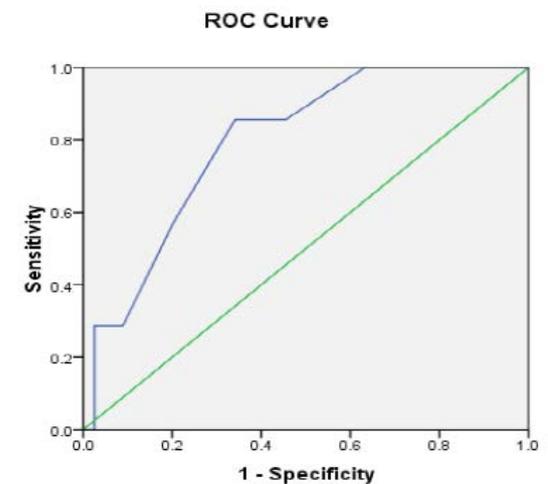
The area under the ROC curve represents differentiation power or precision of the device, which means ability of the tool to differentiate caries and non-caries. In the next step, sensitivity and clinical specificity of the test should be determined with the cut off determined. In this study, device power was evaluated at three cutting points including Cutoff 1 (caries at enamel surface), Cutoff 1.5 (caries at deep enamel) (Figure 5), and Cutoff 2 (caries

at dentin) (Figure 6); sensitivity, specificity, positive and negative predictive value were examined at these levels.



Diagonal segments are produced by ties.

Figure 5: ROC curve at cutoff 1.5 (area=0.76)



Diagonal segments are produced by ties.

Figure 6: ROC curve at cutoff 2 (area=0.88)

The results of this study indicate that diagnostic value of VistaProof Durr Dental was optimal in non-carious teeth and differentiating areas with early caries from healthy occlusal surfaces (green area). Values of sensitivity, specificity, PPV and NPV were 100%, 97.41%, 90% and 100%, respectively. However, this is not true for caries limited to enamel, because sensitivity and specificity of these teeth were 45% and 93%, respectively. Low sensitivity indicates low power of the device in determining depth of caries limited to enamel (blue and red areas). PPV and NPV was 66 and 85, respectively. A low PPV indicates that the results are not consistent with actual results. Moreover, diagnostic value of the device was also suitable in caries extended to dentin (yellow area), because sensitivity and specificity were 92.9%

and 71.4% respectively. Positive and negative predictive values were 80.64 and 88.23, respectively.

Some scientists, similar to the present study, reported diagnostic accuracy of fluorescence laser methods in dentin caries more than enamel caries. Mendes FM et al. concluded that DIAGNOdent has a good performance in deep caries than superficial caries [6]. Matos R et al. also reported the fluorescence laser performance in detecting dentin caries similar to other methods, although false positives are usually more pronounced [7]. A. Lussi et al. also reported sensitivity and specificity of LFPen in detecting dentin caries than enamel caries [8]. Castilho LS et al. reported DIAGNOdent fluorescence lasers as a repeatable method for detecting dentinal caries on the occlusal surface [9].

In a study by Kenneth Markowitz et al. sensitivity (0.68) and specificity (0.78) were comparable to clinical examinations using Spectra and more and better than BW radiography in discovery of occlusal caries [10]. The results of this study are consistent with the present study.

In the present study, diagnostic value of the VistaProof Durr Dental was completely acceptable in detecting early enamel caries from healthy surfaces. However, it was not acceptable in determining depth of caries limited to enamel and localizing caries correctly. Some scientists reported different results in fluorescence laser performance in detecting caries in enamel and dentin surfaces.

Alwas-Danowska HM et al. reported that DIAGNOdent is suitable for controlling small caries and has a greater sensitivity than direct observation; to increase specificity; direct observation is preferred for detecting caries [11].

The reason for inconsistency in the results can be due to the fact that various studies use different fluorescence laser devices which do not have the same accuracy. It should also be noted that detection of caries by fluorescence laser machines partly depends on experience of the practitioner and the device must be carefully probed. Any stains, plaque and mass on the tooth surface should be removed before examination, as these can cause false positives. On the other hand, research is done separately on dandelion and permanent teeth, which results in different results.

Function of the device partly depends on determining cut off points. In case of increase in values for detecting dental caries, it is likely to reduce sensitivity and increase specificity. It also reduces PPV and reduces the risk of excessive treatments. This is important in populations at low risk of caries.

In Betrisey et al. study red and green sections of fluorescence images were quantitatively examined and ranged from 0 to 3, indicating severity of the lesion [12]. In this study, cutoff points were selected in the range of 1 to 2, which determined the depth of caries and dye penetration.

Clinical function of the fluorescence laser system is different in terms of sensitivity and specificity in laboratory conditions. Because the results of this system are influenced by oral environmental factors such as saliva, oral microflora or body temperature; consequently, its repeatability decreases [13]. In clinical conditions, the range of amberurgers may be less readily available than laboratory conditions [14]. Other limitations in clinical studies include imitated rotation of the head and adjustment of its angle in the mouth. In the mouth, drying and cleaning the teeth is not similar to laboratory conditions. The above can lead to a poor agreement with standard gold methods. In FCs, ultraviolet radiation emits to the teeth surface, activates metabolic products of the cariogenic bacteria or endogenous fluorophores, emits red fluorescence glow and makes detection easier and more reliable [5].

In the present study, diagnostic value of VistaProof Durr Dental was very high in detecting surface caries from non-cariou areas (100% sensitivity, 97% specificity, 90% PPV, 100% NPV). In cases where the device reports non-cariou surface, checkup graph is not required, while it performs weakly in determining depth of enamel caries. However, most studies on different devices were merely for ability of the device in detecting cariou areas and did not evaluate device estimate of caries depth. To provide a proper treatment plan, it is highly important to consider that the caries are limited to enamel or dentin to prevent aggressive treatment plans.

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