

COMPARATIVE EVALUATION OF THE EFFECTIVENESS OF FIVE METHODS FOR EARLY DIAGNOSIS OF OCCLUSAL CARIES LESIONS – in vitro study

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SUMMARY:

Purpose: The aim of the presented in vitro study was to evaluate the effectiveness of the device DIAGNOcam and the laser fluorescence device DIAGNOdent for early diagnosis of occlusal caries and to compare it with three traditional methods – visual and tactile, dye and radiographic examination.

Material and methods: The sample consisted of 60 extracted human teeth. Three clinicians diagnosed independently the presence or absence of early occlusal surface caries with the visible tactile method, DIAGNOcam and DIAGNOdent. Then X-rays were taken and the dentists viewed them separately, without magnification. Fuchsin was applied for 30 sec. and then washed under running water for 20 min. Places where dye was present were registered. Statistical analysis was performed with SPSS package of Windows.

Results: The results showed high level of correspondence between the authors for all the diagnostic methods. Concerning different methods applied for caries diagnosis there was a correlation between the methods, but it was diverging for the different methods. No correlation between radiographic exam and data obtained with DIAGNOdent and dye staining was observed.

Conclusions: Based on the obtained results we may conclude that the least sensitive method for fissure caries diagnosis was the dye staining, followed by the radiographic exam. The results, obtained by DIAGNOdent and DIAGNOcam were very close, but DIAGNOcam's data was better correlating with the clinical results. DIAGNOcam procedure can be judged as equivalent in the detection of occlusal dentine lesions when compared to clinical results.

Key words: early caries diagnosis, laser fluorescence,

INTRODUCTION:

The aim of minimally invasive dentistry is to keep sound tooth structure as long as possible [1]. An important

point of this concept is the paradigm that dental caries is a dynamic disease that could be reversed if diagnosed at the level of early caries lesion [2, 3]. The awareness of people of their oral hygiene and the extensive use of fluoride has led to a delay in the development and progression of caries, thus giving the dentist the chance to detect the developing lesion and reverse the process by dietary changes, personal preventive actions and professional application of remineralizing agents [4] thus sparing the patient from the continuous re-restoration cycle that could eventually compromise the long term functionality of the respective tooth [1, 6]. Unfortunately the excessive use of fluorides could lead to the so-called “hidden” caries or “fluoride syndrome” – the strengthened by the fluorides sound enamel masks relatively large dentinal lesion [5].

The classical methods for caries detection – visual and radiographic inspection have proved to be sensitive enough only in cases with substantial lesions, involving both enamel and dentin, which could be treated only operatively [6]. That is why a variety of new methods for early caries detection have been developed in the last decade [4, 7, 8].

The **aim** of the presented in vitro study was to evaluate the effectiveness of the device DIAGNOcam and the laser fluorescence device DIAGNOdent for early diagnosis of occlusal caries and to compare it with three traditional methods – visual and tactile, dye and radiographic examination.

MATERIAL AND METHODS:

The sample consisted of 60 extracted human teeth. Prior to examination the teeth were cleaned from plaque and calculus. The study was performed in the following order:

1. Three clinicians diagnosed independently the presence or absence of early occlusal surface caries with the visible tactile method.

2. The teeth were photographed with DIAGNOcam and independent diagnose of the presence/absence of caries was performed (fig. 1, 2, 3).

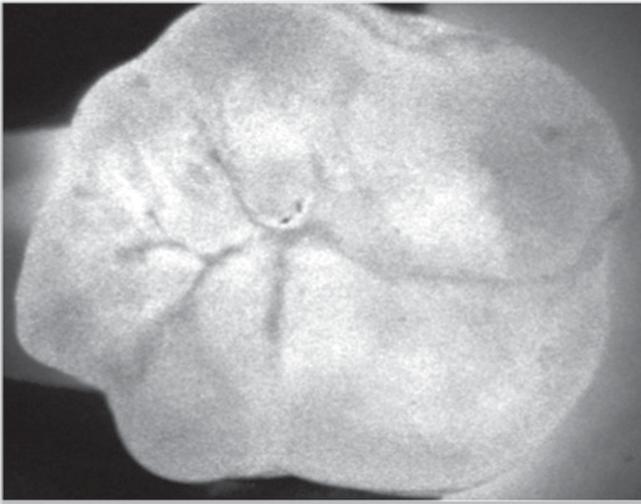


Fig. 1. Image of a sound fissure (DIAGNOcam)

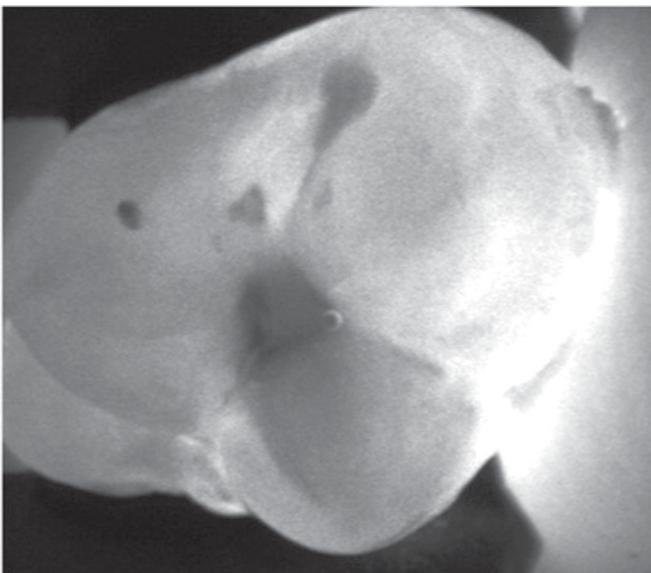


Fig. 2. Caries lesion in the central fissure (DIAGNOcam)

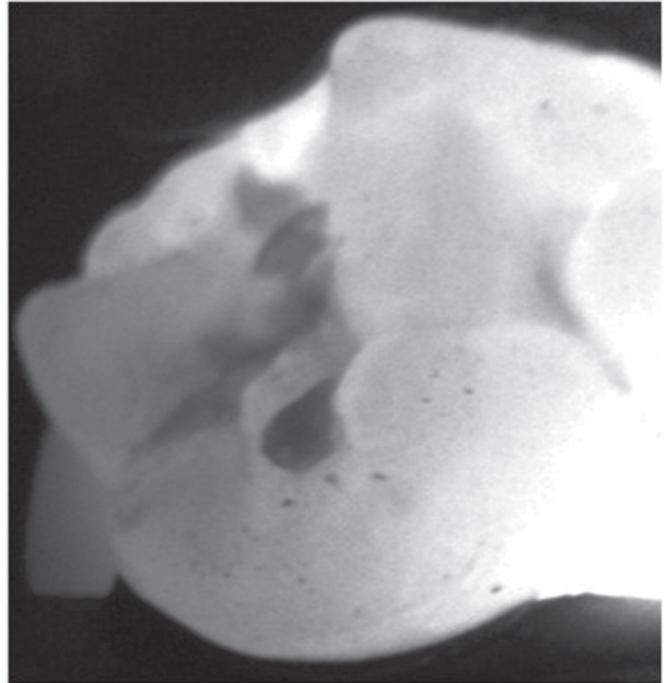


Fig. 3. Caries on the occlusal surface (DIAGNOcam)

3. Laser fluorescence was measured with DIAGNOdent. The presence of caries was diagnosed when values above 15 were measured.

4. X rays were taken – the clinicians viewed them separately, without magnification.

5. Fuchsine was applied for 30 sec. and then washed under running water for 20 min. places where dye was present were registered.

Statistical analysis was performed with SPSS package of Windows.

RESULTS:

The results showed high level of correspondence between the authors for all the diagnostic methods (table 1). Comparing the different methods, applied for caries diagnosis there was a correlation between the methods, but it was diverging for the different methods (table 2). Comparing the results for DIAGNOcam and the clinical examination the level of correlation was .508 – correlation being significant at 0.01 level. Comparing the results for DIAGNOcam, DIAGNOdent and the radiographic exam and the dye staining the level of correlation was a little lower - .367, .362 and .391 respectively. The correlation of the results obtained with DIAGNOdent was most pronounced with clinical exam data, while no correlation with the radiographic exam was observed. The results obtained with the fuchsine correlated with DIAGNOcam, DIAGNOdent and the visual tactile method, but also did not correlate with the X-ray exam.

Table 1. Inter-examiner level of correspondence

Examiners	Examiner I			Examiner II			Examiner III		
	Pearson Correlation	Sig. (2-tailed)	N	Pearson Correlation	Sig. (2-tailed)	N	Pearson Correlation	Sig. (2-tailed)	N
Examiner I	1	-	60	0,796**	0,000	60	0,561**	0,000	60
Examiner II	0,796**	0,000	60	1	-	60	0,577**	0,000	60
Examiner III	0,561**	0,000	60	0,577**	0,000	60	1	0,000	60

Table 2. Correlations between the studied methods for early caries diagnosis.

	Visual-tactile		DIAGNOcam		DIAGNOdent		X-ray exam		Dye staining	
	Pearson Correlation	Sig.(2-tailed)	Pearson Correlation	Sig. (2-tailed)						
Visual-tactile	1	/	.508**	.000	.413**	.001	.514**	.000	.361**	.005
DIAGNOcam	.508**	.000	1	/	.362**	.004	.367**	.004	.391**	.002
DIAGNOdent	.413**	.001	.362**	.004	1	/	.130	.323	.394**	.002
X-ray exam	.514**	.000	.367**	.004	.130	.323	1	/	.217	.097
Dye staining	.361**	.005	.391**	.002	.394**	.002	.217	.097	1	/

DISCUSSION:

The tested in the presented study devices use the differences in the optical properties of sound and carious tissue.

DIAGNOdent measures laser fluorescence within the mineral structure of the tooth. At the wavelength that DIAGNOdent laser operates (655nm), healthy tooth structure exhibits little or no fluorescence, resulting in very low scale readings on the display (less than 15). Decayed tooth tissue exhibits fluorescence at longer wavelengths, proportional to the degree of lost tooth structure, resulting in elevated scale readings on the display of the DIAGNOdent. There are two theories concerning the mechanism of fluorescence. According to the first one the reason for the emission of fluorescent light with different wavelength are the porosities presented in decayed and demineralized dental tissues. The second theory presumes that the changes in DIAGNOdent readings are due to metabolic products of cariogenic bacteria [4]. A number of in vitro studies have claimed the device to be effective in measuring demineralized tooth structures [9, 10, 11]. In the meantime Astvaldsdóttir et al. found out that demineralization of enamel did not affect the DIAGNOdent measurements and changes in measurements are due to bacteria, but they are dependent on bacterial metabolites rather than the type of bacteria [12]. In a review of the data presented in the literature Ricketts found out that DIAGNOdent demonstrated greater sensitivity but poorer specificity compared with visual caries diagnosis [13]. False positive results were measured. Based on his study he recommends the device to be used as an adjunct method [13]. In our study the data obtained with DIAGNOdent did not correlated only with the data from the radiographic exam. It could be speculated that

this is due to the fact that X-rays could give false negative results if the lesion is not advanced enough, while DIAGNOdent is more likely to give false positive readings.

DIAGNOcam uses laser diode with wavelength 780nm for transillumination of the tooth. Carious tissue scatters and absorbs more light than surrounding healthy tissue. A camera digitally images the light emerging from the opposite surface. The images are displayed on a monitor and stored. Affected by caries areas appear like dark spots. Concerning this method high level of correlation with all investigated methods was observed. As a shortcoming of this method as occlusal caries diagnostic tool, compared with X-ray exam it could be pointed out that the depth of the caries lesion could not be pointed exactly.

The dye staining method proved to be the least effective by often giving false positive results, due to the retention of dye in fissures.

CONCLUSIONS:

Based on the obtained results we may conclude:

1. The least sensitive method for fissure caries diagnosis was the dye staining, followed by the radiographic exam.
2. The results, obtained by DIAGNOdent and DIAGNOcam were very close, but DIAGNOcam's data was better correlating with the clinical results.
3. DIAGNOcam procedure can be judged as equivalent in the detection of occlusal dentine lesions when compared to clinical results.
4. We recommend both tested devices to be used as an adjunct method to visual inspection for obtaining better results in early caries diagnosis.

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