STUDY REGARDING THE ACCURACY OF SOME METHODS USED IN THE DETECTION OF INCIPIENT OCCLUSAL CARIOUS LESIONS

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ABSTRACT

The aim of this study was to compare in vivo and in vitro accuracy (sensitivity and specificity) of visual inspection and laserfluorescence method in the detection of incipient occlusal carious lesions. Material and methods. 106 occlusal areas (mesial, distal, central) selected in a study group of 53 molars and bicusps forthcoming for extraction, were examined using visual inspection and laserfluorescence method using DIAGNodent device (KaVo, Biberach, Germany). After extraction, teeth were submitted to new clinical and paraclinical examen (visual inspection, laserfluorescence method). The teeth were cut in longitudinal axis and the slices were examined by optical microscopy. The results of histological examen were considered gold standard and were used to calculate the sensitivity and specificity of the tested detection methods. The statistical analysis used test Mc Nemar both for in vivo and in vitro results. Results. For carious lesions limited to external half of enamel, the in vivo sensitivity was 56% for visual inspection and 91% for laserfluorescence method. For carious lesions extended to inner half of enamel, the in vivo sensitivity was 57% for visual inspection and 90% for laserfluorescence method. For carious lesions limited to external half of enamel, the in vivo specificity was 66% for visual inspection and 86% for laserfluorescence method. For carious lesions extended to inner half of enamel, the in vivo specificity was 76% for visual inspection and 88% for laserfluorescence method. In vitro sensitivity and specificity values were lower than in vivo values, but it was not found significant statistical differences. Conclusions. The laserfluorescence examen, in vivo and in vitro, had higher sensitivity for incipient occlusal carious lesions limited to external half of enamel and higher specificity for incipient occlusal carious lesions extended in the inner half of enamel.

Keywords: visual detection, DIAGNOdent, occlusal carious lesions

INTRODUCTION

Along time different detection methods were introduced in dental practice for the detection of incipient occlusal carious lesions, for accurate and valid results. The visual inspection presents high specificity and low sensitivity and reproductibility values for this category of dental caries. (1, 2, 3, 4). To increase the sensitivity of visual inspection in the detection of incipient occlusal carious lesions, Ekstrand proposed a new visual index (5). Other detection methods included laserfluorescence, an examen that is actually largely used and researched in dental practice

Au (1, 3, 6, 7, 8). The researches regarding the detection of carious lesions are performed in vivo, but their validation must be performed in vitro (9, 10). The laboratory studies allow histological validation to asses more accurately the carious lesions extension (1, 9, 11, 12). For ethical reasons, the detection methods must be performed in laboratory conditions, before their application in vivo.

A few studies focused on the detection of incipient occlusal carious lesions were performed in clinical conditions. The histological validation, as gold standard, was performed after the extraction of deciduous teeth (8) or definitive teeth (9, 10, 12, 13). Some researches aimed to compare the results obtained following the examination in vitro and in vivo on the same tooth (10, 12).

THE AIM of this study was to compare in vivo and in vitro accuracy (sensitivity and specificity) of visual inspection and laserfluorescence method in the detection of incipient occlusal carious lesions.

MATERIAL AND METHODS

The study included 34 subjects with age between 18-55 years with at least one molar or bicusp forthcoming for extraction (periodontal, orthodontics reasons). Informed consent was received from every patient. The inclusion criteria were as follows: absence of sealants or direct restorations on occlusal surfaces, absence of hypolasia or fluorosis, absence of advanced carious lesions on proximal, buccal and oral surfaces. After cleansing of dental surfaces using a rotatory toothbrushing and water, visual inspection was performed with a magnification system (EyeMag Smart, Karl Zeiss). Firstly, the teeth were examined wet, than dried with air spray for 5 seconds. Using visual inspection were examined 106 occlusal surfaces from 53 molars and bicusps. The detection criteria are presented in table 1.

Table 1. Criteria of detection for incipient occlusal carious lesions using visual inspection, laserfluorescence and histological method

	Visual inspection (D)	**Laserfluorescence method (LF)**	**Histological method (H)**
Score 0	No changes of enamel translucence after air drying	0-13	Absence of demineralization or limited opaque band
Score 1	Brown discoloration or white spot after air drying	14-19	Demineralisation limited to enamel external half
Score 2	Brown discoloration or white spot visible before air drying	20-29	Demineralisation limited to inner half of enamel and dentinal external third
Score 3	Enamel loss of substance associated with brown discoloration or white spot	>30	Demineralisation limited to dentinal medium third
Score 4	Cavity with exposed dentine		Demineralisation extended in dentinal inner third

The selected areas were also examined with laserfluorescence method using DIAGNOdent device (KaVo, Biberach, Germany). The examen was performed with A tips after device calibration. The peak value for each examined area was recorded. After this stage the teeth were stored in distilled water for 5 weeks. The in vitro visual examen

was performed on the same teeth (wet and dried) with illumination conditions specific to dental unit, at a distance of 20 cm. The laserfluorescence was performed in conditions similar with in vivo examen. The next stage of the study was represented by the preparation of teeth in longitudinal slices using diamond discs, under water cooling. The slices were polished using carbon paper with decreasing granulations (1200, 1000, 600, 400). The slices were examined under optic stereomicroscope (Neophot 21) with 20 x magnification. The carious lesions were histologically classified accordingly to criteria presented in table 1. Score 1 (visual inspection) was considered the limit for D1 stage in histological examination, score 2 was considered the limit for D2 stage. The limit values for laserfluorescence method are presented in table I. For each detection method was calculated the sensitivity and specificity for incipient occlusal carious lesions (stages D1 and D2). The test Mc Nemar was used to compare the in vivo and in vitro accuracy of both detection methods (p=0,05).

RESULTS

For carious lesions limited to external half of enamel, the in vivo sensitivity was 56% for visual inspection and 91% for laserfluorescence method. For carious lesions extended to inner half of enamel, the in vivo sensitivity was 57% for visual inspection and 90% for laserfluorescence method. For carious lesions limited to external half of enamel, the in vivo specificity was 66% for visual inspection and 86% for laserfluorescence method. For carious lesions extended to inner half of enamel, the in vivo specificity was 76% for visual inspection and 88% for laserfluorescence method. In vitro sensitivity and specificity values were lower than in vivo values, but it was not found significant statistical differences.

Accordingly to visual inspection, 16 occlusal surfaces were considered healthy (15,09%), 39 were classified as D1 (36,79%), 35 were classified as D2 (33,01%), 12 were included in category D3 (11,32%), 4 in category D4 (3,7%). Accordingly to histological examination, 19 surfaces were considered healthy 19 (17,92%) (H0), 23 (21,69%) were associated with carious lesions limited to external third of enamel (H1), 49 (46,22%) presented carious lesions in inner third of enamel and external third of dentine (H2), 13 (12,26%) presented carious lesions in dentinal medium third (H3), and 2 (1,8%) presented advanced carious lesions in internal dentinal third (H4).

From 16 carious lesions included in category D0, 11 (68%) were included in H0 after histological examen. Only 33% from carious lesions with score 1 (visual inspection) were confirmed in H1 after histological examen. 74% from carious lesions with score 2 (visual inspection) are included in category D2, while 14% are classified in an inferior score (table 2).

In table 3 is presented a comparison between the values recorded in vivo accordingly to laserfluorescence method and histological indices. From 15 carious lesions included in LF0, 14 (87,5%) were confirmed as H0 (histological examen), the other in score H1. 58% from carious lesions included in LF1 and 91% from those included in LF2 were confirmed in same score category following histological examen (table 3).

The sensitivity and specificity for each tested diagnostic method were calculated. The laserfluorescence presented higher sensitivity and specificity values comparing with visual inspection (table 4). For in vitro visual inspection the sensitivity and specificity values recorded slight decrease comparing with in vivo examen. In D1 and D2 the differences between the tested detection methods were low. The laserfluorescence had

higher sensitivity for D1 carious lesions and higher specificity for D2 carious lesions, noth in vivo and in vitro. The visual inspection had higher specificity for D2 comparing with D1 carious lesions, both in vivo and in vitro.

The values of sensitivity and specificity were analysed with statistical test McNemar. The statistical analysis did not found significant statistical differences between the parameters of the tested detection methods, in clinical and in vitro conditions (table 5).

Table 2. Comparison between in vivo values for clinical examen and histological examen

Histological examen	Visual examen					Total
	D0	D1	D2	D3	D4	
H0	11	7	1			19
H1	5	13	5			23
H2		19	26	4		49
H3			3	7	3	13
H4				1	1	2
Total	16	39	35	12	4	106

Table 3. Comparison between in vivo values of laserfluorescence and histological examen

Histological examen	LF examen				Total
	LF0	LF1	LF2	LF3	
H0	14	5			19
H1	2	18	3		23
H2		8	32	9	49
H3				13	13
H4				2	2
Total	16	31	35	24	106

Table 4. The accuracy of in vivo and in vitro visual inspection and laserfluorescence for incipient occlusal carious lesions

		Visual inspection (Vi)		Laserfluorescence (LF)	
		D1	D2	D1	D2
in vivo	sensitivity	0,56	0,57	0,91	0,90
	specificity	0,66	0,76	0,86	0,88
in vitro	sensitivity	0,57	0,55	0,82	0,78
	specificity	0,62	0,75	0,84	0,85

Table 5. Results of test McNemar for comparison of sensitivity and specificity for visual inspection and laserfluorescence

Exact Sig. (2-tailed) Mc Nemar test results	in vivo		in vitro	
	sensitivity LF	specificity LF	sensibility LF	specificity LF
Sensitivity of visual inspection	0.06	-	0.05	-
Specificity of visual inspection	-	0.08	-	0.07

DISCUSSIONS

Some previous clinical researches reported lower values for sensitivity and specificity for in vivo visual inspection comparing with in vitro visual examen (1, 3, 14, 15). The studies that used the caries code proposed by Ekstrand, recorded an increasing tendency of sensitivity values, especially for enamel occlusal carious lesions localized (7, 8, 9, 14). Accordingly to the system of visual scores after Ekstrand, the color changes visible only after drying are associated with demineralization localized in external half of enamel, and color changes visible without drying are associated with demineralization localized in internal half of enamel (7), corresponding to incipient lesions without dentinal implication. In our study we recorded a moderate accuracy for visual inspection. The results were valid both for carious lesions D1 and D2, result similar with other studies (7, 8, 9).

The visual inspection allowed the assessment of color changes like white-spot (acute caries) and brown-spot (chronic caries) or black-spot. Because color changes are also present on healthy occlusal surfaces, these are not clinical indications for a diagnostic of carious lesion. There are studies that proved low sensitivity (<30%) of visual examen (16). For incipient occlusal caries extended in dentinal external third, the sensitivity values were over 60% and specificity values over 80%, accordingly to Downer (17). The use of accurate visual criteria increases significantly the sensitivity (9). These criteria are related to opacity degree, translucence changes and extension degree of enamel caries. The use of color changes as exclusive visual criteria conduct to a percent of 55% false positive diagnostic (16).

Previous studies, regarding the detection accuracy of incipient occlusal caries, proved higher sensitivity values for laserfluorescence method (3, 4, 7, 8, 14, 15, 18). It is possible that the absence of a standardized protocol regarding the use of laser tips on the occlusal surface to be responsible for this result. Most studies, focused on the laserfluorescence, reported higher values of sensitivity comparing with visual method (3, 4, 14, 18). We must consider that laserfluorescence method can be associated with a tendency for high percent of false positive responses because of the presence of organic material in occlusal fissures and pits (19). Visual inspection presented lower values for specificity comparing with laserfluorescence (1, 3, 4, 15, 18). A low number of studies compared visual inspection and laserfluorescence, in vivo and in vitro conditions, on the same teeth. Our study did not recorded significant statistical differences between results in vivo and in vitro. Regarding the laserfluorescence method, it was recorded a minim statistical difference between in vitro and in vivo values. The values recorded in vitro were lower comparing with values recorded in vivo. This can be explained by better cleansing of bacterial biofilm in extracted teeth comparing with cleansing performed in clinical conditions. Another factor that can be implied is represented by the storage conditions of the extracted teeth. The storage solutions can determine some changes of the organic content of the incipient carious lesions (20). The storage solution can be responsible for low changes between in vitro and in vivo values because laserfluorescence examen records the organic changes better than mineral changes (20, 21, 22, 23). The limit values used in vitro conditions should not be used in vivo conditions. The values over 19-20 indicate dentinal implication and are used to differentiate healthy areas from carious areas. (14, 18, 24). Some clinical studies aimed to establish the ideal limit values (18). The dental practitioners must focus especially

on the clinical data, the laserfluorescence method should be considered additional diagnostic method (6, 24). Our study also concluded that detection methods should be tested firstly in vitro conditions and then assessed in clinical conditions, before their introduction in dental practice (1, 25, 26).

In our study, we used two examination areas for each occlusal surface and between one or two teeth forthcoming for extraction for each subject included in study. The occlusal surfaces with cavitary carious lesion were excluded to avoid interference with values recorded by laserfluorescence method (4, 7, 8, 15, 18). A limit of our study should be represented by the use of third molars and bicusps that present occlusal surfaces less significant for the aims of our study, considering that their occlusal system of fissures and pits are less retentive than molars 1 and 2. For this last category of teeth, the detection of incipient caries lesions is performed in more difficult conditions.

Despite the fact that principal detection method remains visual inspection, this must be completed with paraclinical methods. Each investigatory procedure can be associated with false positive or false negative responses. The dental caries diagnostic imposes a careful interpretation of all recorded detection data. It is recommended to obtain additionally data using special investigation procedures, especially in cases of incipient dental caries.

CONCLUSIONS

1. The laserfluorescence method presents higher accuracy than clinical examen in the in vivo and in vitro detection of incipient occlusal carious lesions.

2. The in vivo and in vitro sensitivity of laserfluorescence method was higher for carious lesions with demineralisation limited to enamel external half. The in vivo and in vitro specificity of laserfluorescence method was higher for carious lesions with demineralisation extended in the inner half of enamel.

3. The in vivo and in vitro specificity of visual inspection was higher for carious lesions extended in the inner half of enamel comparing with carious lesions limited in the external half of enamel.

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