STUDY REGARDING THE INFLUENCE OF DIFFERENT METHODS USED TO REMOOVE THE ORGANIC DEBRIS ON THE DIAGNOSTIC ACCURACY OF DIAGNODENT

Andrei Georgescu*, Simona Stoleriu, Gianina Iovan, Claudiu Topoliceanu, Sorin Andrian

Odontology, Periodontology and Fixed Prosthodontics Department, Faculty of Dental Medicine, University of Medicine and Pharmacy "Gr. T. Popa"- Iasi, Romania

*Corresponding author: Assist. Prof. Andrei Georgescu, PhD,

Cariology and Operative Dentistry Discipline,

9, Kogălniceanu Street, Iasi, Romania

e-mail:andgeorgescu@yahoo.com

ABSTRACT

The aim of this study was to analyse the influence of different cleaning methods of occlusal dental surfaces on the values recorded with DIAGNOdent. A number of 78 pits from 42 molars and bicusps occlusal surfaces were analysed using visual method. The cleaning of dental units was then performed using prophylactic paste Detartrine (Septodont) and rotary brush. The occlusal surfaces were assessed using DIAGNOdent. After a new cleaning of residual paste using rotary brush, the occlusal surfaces were submitted to cleaning using water/air abrasion with Prophyjet (Dentsply DETREI) and the assessment with DIAGNOdent was repeated. After the visual and laser fluorescence examination, teeth were extracted. The teeth were cut, polished and a single examiner has assessed the slices using a stereomicroscope Neophot 21. The carious lesions were classified according the 5 scores in clinical and histological examination and 4 classes in DIAGNOdent examination. The values recorded using DIAGNOdent were both influenced by tooth brushing using professional cleaning paste and water/air abrasion method. The cleaning method using toothpastes determined the highest differences on the occlusal surfaces presenting incipient enamel carious lesions. The sensitivity and specificity of laser fluorescence diagnostic method were not influenced by any cleaning method used for the removal of external organic debris.

Key words: DIAGNOdent, sensitivity, specificity, professional cleaning paste, water/air abrasion

INTRODUCTION

The detection of occlusal carious lesions is more difficult comparing with dental caries localised on smooth surfaces. The diagnostic of occlusal dental caries is usually performed using conventional methods (visual, tactile). The occlusal carious lesions are detected accordingly to enamel colour changes and sensation of sickle probe „retention", both representing subjective interpretations of dental practitioner. Tactile examination can damage a superficial enamel layer and favourises the bacteria penetration and accelerates the progression of carious lesion (1).

In 1998 DIAGNOdent (KaVo, Biberach, Germany) was introduced on the dental products market, as a diagnostic device using laser fluorescence of dental hard tissues. The principle of laser fluorescence consists in the possibility of some molecules present in enamel and dentine to uptake laser energy and to emit in another wave length. Bacteria and their products also have fluorescence ability (2).

Numerous factors can influence the quality of recording with DIAGNOdent, conducting to incorrect interpretations and improper therapeutical decisions. Some of these factors are represented by bacterial biofilm, exogenous colorations and calculus (3, 4, 5, 6, 7, 8, 9, 10, 11), exogenous nutritional agents (12), toothpaste (13, 14), dental materials (15, 16). The degree of teeth hydration has also a major impact on the accuracy of recording (17, 18, 19, 20).

The aim of this study was to analyse the influence of different cleaning methods of occlusal dental surfaces on the values recorded with DIAGNOdent.

MATERIALS AND METHOD

The study group included 42 molars and bicusps selected for extraction for orthodontic or periodontal reasons without cavities on their occlusal surfaces. The teeth were cleaned with rotary brushes no. 9654 (Komet Brasseler, Lemgo, Germany) under water cooling for 20 seconds. The teeth were washed with water spray for 10 seconds and dried with air spray. A number of 78 pits from their occlusal surfaces were analysed using visual method. After visual inspection, the occlusal surfaces were assessed using laser fluorescence method (DIAGNOdent, probe A). The calibration was performed on each tooth and final average value was

obtained after 3 recordings for each examined area. The recorded values in the presence of bacterial biofilm were used as reference values. The cleaning of dental units was performed using prophylactic paste Detartrine (Septodont) and rotary brush no. 9654 (Komet Brasseler, Lemgo, Germania) for 10 seconds. The teeth were washed with water spray for 10 seconds and dried with air spray for 5 seconds. The occlusal surfaces were assessed using DIAGNOdent and the recorded value was considered an average value of maximum values recorded after three examinations. After a new cleaning of residual paste using rotary brush no. 9654 (Komet Brasseler, Lemgo, Germania), the recording of laser fluorescence was repeated to confirm reference values. The occlusal surfaces were submitted to cleaning using water/air abrasion with Prophyjet (Dentsply DETREI) and the assessment with DIAGNOdent was repeated.

After the visual and laser fluorescence examination, teeth were extracted. The teeth were cut using active diamond discs to obtain slices of the assessed occlusal areas. The slices were polished using carbon paper with decreasing graining (1200, 1000, 600 and 400, respectively). A single examiner has assessed the slices using a stereomicroscope Neophot 21 (20x). The carious lesions were classified using criteria presented in Table 1.

	Visual method (D)	Laserfluorescence (LF)	Histological analysis (H)
Score 0	No enamel changes after prolonged desiccation	0-13	The absence of demineralisation or presence of opaque thin area
Score 1	Brown colour or white colour of enamel after desiccation	14-19	Demineralisation limited to the external half of enamel
Score 2	Brown colour or white colour of enamel in the absence of desiccation	20-29	Demineralisation extended to the external half and internal half of enamel
Score 3	Enamel cavity associated with brown or white colour or grey coloration of enamel associated with dentine alteration	>30	Demineralisation extended to the medium third of enamel.
Score 4	The presence of cavity with dentine exposure		Demineralisation extended to the internal third of enamel.

Table 1. Criteria used for visual inspection, laser fluorescence method and histological exam

RESULTS

The laser fluorescence method classified the 78 examined dental areas as follows: 23 areas as LF0, 17 areas as LF1, 29 areas as LF2 and 9 areas as LF3. The histological exam confirmed 83% from 23 LF0 areas as H0, 81% from 17 LF1 areas as H1 and 85% from 29 LF2 areas as H2 (Table 2).

The average values recorded with DIAGNOdent on dental surfaces presenting bacterial biofilm and after its removal with prophylactic paste (PP) or water/air abrasion (W/AAB) are presented in Table 3. The table shows an increasing tendency of average values recorded after the removal of biofilm using both methods, with teeth cleaned using water/air abrasion presenting the lowest values.

	0-13 (LF 0)			14-19 (LF 1)			20-29(LF 2)			>30 (LF3)		
	With BF	After PP	After W/AAB	With BF	After PP	After W/AAB	With BF	After PP	After W/AAB	No Plaque	After PP	After W/AAB
H0	17	20	21	5	4	3	1					
H1	4	2	2	8	10	13	2	1	1			
H2	2	1		4	3	1	13	16	18			
H3							10	10	9	2	1	1
H4							3	2	1	7	8	8
total	**23**	**23**	**23**	**17**	**17**	**17**	**29**	**29**	**29**	**9**	**9**	**9**

Table 2. Results of LF method comparing with histological exam

0-13(23 cases)			14-19(17 cases)			21-30(29 cases)			>31(9 cases)		
With biofilm	After W/AA	After PP	With biofilm	After W/AA	After PP	With biofilm	After water/air abrasion	After PP	No plaque	After water/air abrasion	After PP
7,9	8,5	9,2	14,6	15,8	17,5	22,8	24,6	25,6	31,2	32,1	33,9

Table 3. The average values recorded with DIAGNOdent in the presence of bacterial biofilm, after removal of bacterial biofilm using prophylactic paste or water/air abrasion.

The sensitivity and specificity of laser fluorescence method after removal of bacterial biofilm with both specified methods were statistically analysed using McNemar test.

The results regarding sensitivity of DIAGNOdent before and after tooth brushing with prophylactic paste were not significantly statistical at a chi^2 17.633 with a significance threshold 0.06>0.05 (Table 4). The results regarding sensitivity of DIAGNOdent before and after biofilm removal with water/air abrasion were not significantly statistical at a chi^2 19.862 with a significance threshold 0.07>0.05 (Table 5).

The results regarding specificity of DIAGNOdent before and after tooth brushing with prophylactic paste were not significantly statistical with a significance threshold 0.508>0.05 (Table 6). The results regarding specificity of DIAGNOdent before and after biofilm removal using water/air abrasion were not significantly statistical at a chi^2 6.5 with a significance threshold 0.50>0.05 (Table 7).

Because of the increasing tendency of recorded values after biofilm removal using both specified methods, the values were statistically compared using paired-sample Wilcoxon test.

The average values recorded in the presence of biofilm, after tooth brushing and water/air abrasion for LF0, LF 1 and LF2 present significantly statistical differences (Tables 8, 9, 10).

Test Statistics[b]

	treatment & H12
N	66
Chi-Square[a]	17.633
Asymp. Sig.	**.06**

a. Continuity Corrected

b. **McNemar Test**

Table 4. McNemar test results regarding sensitivity of DIAGNOdent before and after tooth brushing

Test Statistics[b]

	treatment & H12
N	71
Chi-Square[a]	19.862
Asymp. Sig.	**.07**

a. Continuity Corrected

b. **McNemar Test**

Table 5. McNemar test results regarding sensitivity of DIAGNOdent before and after water/air abrasion

Test Statistics[b]

	treatment & 0
N	47
Exact Sig. (2-tailed)	**.508[a]**

a. Binomial distribution used.

b. **McNemar Test**

Table 6. McNemar test results regarding specificity of DIAGNOdent before and after tooth brushing

Test Statistics[b]

	treatment & H0
N	47
Chi-Square[a]	6.500
Asymp. Sig.	**.06**

a. Continuity Corrected

b. **McNemar Test**

Table 7. McNemar test results regarding specificity of DIAGNOdent before and after water/air abrasion

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Biofilm (LF0 – FO) after W/AAB (LF0)	**.7000**	.3490	.0728	.5491	.8509	9.618	22	**.000**
Pair 2	Biofilm (LF0 –FO) after PP (LF0)	**1.3000**	.3261	.0680	1.1590	1.4410	19.117	22	**.000**
Pair 3	After PP (LFO) – After W/AAB (LF0)	**.6000**	.3954	.0825	.4290	.7710	7.277	22	**.000**

Tabel 8. Results of comparing test of values recorded with DIAGNOdent after biofilm removal in LF0

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Biofilm (LF1) – After W/AAB (LF1)	1.7000	.3758	.0912	1.5068	1.8932	18.650	16	**.000**
Pair 2	Biofilm (LF1) – After PP (LF1)	2.9000	.3041	.0738	2.7436	3.0564	39.314	16	**.000**
Pair 3	After PP (LF1) – After W/AAB (LF1)	1.2000	.2739	.0664	1.0592	1.3408	18.067	16	**.000**

Table 9. Results of comparing test of values recorded with DIAGNOdent after biofilm removal in LF1

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Biofilm (LF2) – After W/AAB (LF2)	1.0000	.1626	.0302	.9382	1.0618	33.125	28	**.000**
Pair 2	Biofilm (LF2) – After PP (LF2)	2.8000	.3262	.0606	2.6759	2.9241	46.220	28	**.000**
Pair 3	After PP (LF2) – After W/AAB (LF2)	1.8000	.3151	.0585	1.6801	1.9199	30.763	28	**.000**

Table 10. Results of comparing test of values recorded with DIAGNOdent after biofilm removal in LF2

DISCUSSIONS

The review of studies focused on the DIAGNOdent efficiency proves the increasing interest generated by the possibility of accurate diagnostic regarding the occlusal non-cavitary dental caries (21). Attril and Ashley (2001) prove the efficiency of DIAGNOdent in detection of occlusal non-cavitary dental caries comparing laser fluorescence method with clinical and radiographical exam (18). Their study showed highest values of sensitivity (0.78) comparing with clinical examen, radiography and ECM as well as a specificity value of 0.83. Researchers find also a high rate of false positive diagnostic for teeth that are not submitted to cleansing using prophy-jet or air-abrasion. Shi XQ (2001) proved also the superior correlation between the carious lesion deep (0.83) and total loss of minerals (0.89) when DIAGNOdent is used for in clinical studies (8). The Lussi A (2001) study showed a maximum value of sensitivity (0.96) in the detection of non-cavitary occlusal caries extended in dentine (5). The in vivo study performed by Pinelli (2002) demonstrates a 0.72 value for sensitivity and 0.73 value for specificity in the detection of active white-spot carious lesions (22). DIAGNOdent can also detect carious lesions localized under occlusal sealants (15).

The literature data regarding sensitivity and specificity of laser fluorescence varies widely accordingly to the types of studies (in vivo, in vitro), validation techniques and working protocol. Bader performed a critical review of 25 studies focused on the clinical performance on laser fluorescence in the detection of non-cavitary occlusal carious lesions (24). The studies included in this review showed sensitivity values over 0.80 for non-cavitary occlusal carious lesions extended in dentine, while carious lesions limited to enamel presented values between 0.52-0.99. All studies showed for laser fluorescence method superior values for sensitivity and lower values for specificity comparing with visual inspection. Kayvadia (2008) examined 405 sites using laser fluorescence method, visual inspection and byte-wing radiography (24). For carious lesions limited to enamel laser fluorescence presented high specificity values (0,88) comparing with visual inspection (0,76). For dentinal carious lesions laser fluorescence presented high sensitivity (0.78) while byte-wing radiography presented high specificity values (0.98). Huth KC (2008) determined the clinical performance of DIAGNOdent for the depth assessment of occlusal carious lesions (D0-D(1-4) and D(0-2)-D(3,4), on 120 healthy/non-cavitary carious lesions sites, comparing results with visual inspection and radiographical exam (25). Regarding differentiation between healthy sites and sites with values D(1-4), sensitivity was 0,88 and specificity 0.85. Regarding differentiation between sites with values D(0-2) and sites

with values D(3-4), sensitivity was 0,67 and specificity was 0.79. Lussi A (2006) showed, for occlusal carious lesions, in a study validated through histological exam, specificity values between 0.69 (D1) and 0.89 (D3) and sensitivity values between 0.78 (D1) and 0.96 (D3) (26).

Costa AM (2008) performed an in vivo study on 26 patients with 199 occlusal surfaces. After the dental surfaces were cleaned with prophyjet, were assessed using visual inspection, radiographic exam and laser fluorescence method (27). The validation method was represented by the preparation of a small cavity using a diamond bur, on the surfaces where the examiner agreed that is possible the extension in dentine of carious lesion. The laser fluorescence method presented high values of sensitivity (0.93) and specificity (0.75). The in vivo study performed by Khalife (2009) focused on the assessment of correlation between laser fluorescence values and presence of carious dentine on the teeth suspected to be associated with carious lesions (28). The study was performed on 20 patients with 60 occlusal surfaces. The golden standard was represented by the clinical detection of carious dentine at the level of enamel-dentine junction. The study proved a low correlation with carious lesion depth and volume. The researchers proved that values between 35 and 40 are correlated with presence of affected dentine and the necessity of invasive intervention.

The fluorescence can be induced both by bacteria and agents like calculus and exogenous colorations. Different prophylactic pastes contain agents that induce fluorescence when excited by a 655nm wavelength. When laser fluorescence method is used on teeth with retentive occlusal anatomy, the presence of residual paste can favours false interpretation and improper therapeutical decisions.

CONCLUSIONS

1. The values recorded using DIAGNOdent were both influenced by tooth brushing using professional cleaning paste and water/air abrasion method.
2. The cleaning method using toothpastes determined the highest differences on the occlusal surfaces presenting incipient enamel carious lesions.
3. The sensitivity and specificity of laser fluorescence diagnostic method were not influenced by any cleaning method used for the removal of external organic debris.

BIBLIOGRAPHY

1. Akarsu S, Koprulu H. In vivo comparison of the efficacy of DIAGNOdent by visual inspection and radiographic diagnostic echniques in the diagnosis of occlusal caries. J Clin Dent. 2006;17(3):53-8.
2. Hibst R, Paulus R. Caries detection by red excited fluorescence: investigations on fluorophores. Caries Res. 1999;33:295.
3. Alwas-Danowska HM, Plasschaert AJ, Suliborski S, Verdonschot EH. Reliability and validity issues of laser fluorescence measurements in occlusal caries diagnosis. Journal of Dentistry 2002;30:129–34.
4. Heinrich-Weltzien R, Ku¨hnisch J, Oehme T, Ziehe A, Stosser L, Garcia-Godoy F. Comparison of different Diagnodent cut-off limits for in vivo detection of occlusal caries. Oper Dent 2003; 28: 672–680.
5. Lussi A, Megert B, Longbottom C, Reich E, Francescut P. Clinical performance of a laser fluorescence device for detection of occlusal caries lesions. Eur J Oral Sci 2001; 109: 14–19.
6. Ross G. Caries diagnosis with the DIAGNOdent laser: a user's product evaluation. Ont Dent 1999; 76 (2): 21-24
7. Sheehy EC, Brailsford SR, Kidd EA, Beighton D, Zoitopoulos L. Comparison between visual

examination and a laser fluorescence system for in vivo diagnosis of occlusal caries. Caries Res 2001; 35 (6): 421-426

8. Shi XQ, Tranaeus S, Angmar-Mansson B. Comparison of QLF and DIAGNOdent for quantification of smooth surface caries. Caries Res 2001; 35 (1): 21-26

9. Sultanov DJ. Diagnosis and treatment of dental caries: a microdentistry approach. Dent Today. 2001;20(7):66-8, 70-1.

10. Francescut P, Lussi A. Correlation between fissure discoloration, Diagnodent measurements, and caries depth: an in vitro study. Pediatr Dent. 2003;25(6):559-64.

11. Mendes FM, Hissadomi M, Imparato JC. Effects of drying time and the presence of plaque on the in vitro performance of laser fluorescence in occlusal caries of primary teeth. Caries Res. 2004;38(2):104-8.

12. Welsh GA, Hall AF, Hannah AJ, Foyle RH. Variation in DIAGNOdent measurements of stained artificial caries lesions. Caries Res. 2000;34:324.

13. Hosoya Y, Matsuzaka K, Inoue T, Marshall GW Jr. Influence of tooth-polishing pastes and sealants on DIAGNOdent values. Quintessence Int. 2004;35(8):605-11.

14. Lussi A, Longbottom C, Gygax M, Braig F. Influence of professional cleaning and drying of occlusal surfaces on laser fluorescence in vivo. Caries Res 2005; 39: 284–286.

15. Takamori K, Hokari N, Okumura Y, Watanabe S. Detection of occlusal caries under sealants by use of a laser fluorescence system.JClin LaserMedSurg2000;19:267-71

16. Reich E, Al Marrawi F, Longbottom C, Lussi A. Fluorescence of a different dental materials in a laser diagnostic systems. J Dent Res. 1998;77:821.

17. Amaechi BT, Highham SM, de Josselin de Jong E, Possible factors influencing the use of quantitative light-induced fluorescence for caries detection and assessment. Caries Res. 2000;34:325.

18. Attrill DC, Ashley PF. Occlusal caries detection in primary teeth: a comparison of DIAGNOdent with conventional methods. Br Dent J 2001; 190 (8): 440-443

19. Bamzahim M, Aljehani A, Shi XQ. Clinical performance of DIAGnodent in the detection of secondary carious lesions. Acta Odontol Scand. 2005;63(1):26-30.

20. Anttonen V, Seppa L, Hausen H. Clinical study of the use of the laser fluorescence device DIAGNOdent for detection of occlusal caries in children. Caries Res. 2003;37(1):17-23.

21. Tam E, Mccomb D. Diagnosis of occlusal caries. Part II. Recent diagnostic technologies. J Can Dent Assoc 2001; 67: 459–463.

22. Pinelli C, Campos Serra M, de Castro Monteiro Loffredo L. Validity and reproducibility of a laser fluorescence system for detecting the activity of white-spot lesions on free smooth surfaces in vivo. Caries Res 2002; 36(1):19-24

23. Bader JD, Shugars DA. A systematic review of the performance of a laser fluorescence device for detecting caries. J Am Dent Assoc 2004; 135: 1413–1

24. Kavvadia K, Lagouvardos P. Clinical performance of a diode laser fluorescence device for the detection of occlusal caries in primary teeth. Int J Paediatr Dent. 2008;18(3):197-204.

25. Huth KC, Neuhaus KW, Gygax M, Bücher K, Crispin A, Paschos E, Hickel R, Lussi A. Clinical performance of a new laser fluorescence device for detection of occlusal caries lesions in permanent molars. J Dent. 2008; 36(12):1033-40.

26. Lussi A, Hellwig E. Performance of a new laser fluorescence device for the detection of occlusal caries in vitro. J Dent 2006; 34: 467–471.

27. Costa AM, Yamaguti PM, De Paula LM, Bezerra AC. In vitro study of laser diode 655–nm diagnosis of occlusal caries. Journal of Dentistry for Children 2002; 69:249–53

28. Khalife MA, Boynton JR, Dennison JB, Yaman P, Hamilton JC. In vivo evaluation of DIAGNOdent for the quantification of occlusal dental caries. Oper Dent. 2009; 34(2):136-41.