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Article

Effect of Biofilm Removal from the Occlusal Tooth Surfaces on Fluorescence Measurements. A Clinical Study

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Abstract: *Aim:* Early diagnosis and monitoring of caries lesions are the most important issues of primary and secondary prevention policies. The intraoral Vista Cam iX (Durr Dental, Bietigheim-Bissingen, Germany) uses the fluorescence phenomenon for a non-invasive, quantitative caries diagnosis. In order to make a precise evaluation the tooth surface must be completely cleaned and without biofilm. The current study aimed to evaluate the effects of biofilm removal, using air-polishing device (Combi, Mectron SpA) with glycine, on fluorescence VistaCam iX camera quantitative measurements of caries. *Methods*: Patients with complete permanent dentition without any kind of restorative treatments in the lateral and posterior section of upper and lower dental arches were enrolled. The occlusal surfaces of molars and premolars were photographed using the fluorescence terminal Proof of the intraoral camera VistaCam iX before and after air polishing glycine procedures, registering the highest value gained for each occlusal surface. *Results:* 133 cuspidate permanent teeth of patients aged between 13 and 25were analyzed. Descriptive analysis showed an average of 0.82 (SD= 0.65; Min= 0.00; Max= 1.80; Median= 1.20) and of 0.93 (SD= 0.60; Min= 0.00; Max= 1.70; Median=1.20) for values before and after treatment, respectively. The scores assigned by VistaCam iX Proof fluorescence based camera to the occlusal surfaces, after the air-polishing treatment, are averagely higher than those before treatment, especially in the diagnosis of initial tooth decay. *Conclusion:* Biofilm removal with glycine air-polishing improves the VistaCam camera accuracy in recognizing healthy tissue from the decayed one, due to the fact that air-polishing treatment increases the decayed tissue reaction to the fluorescence.

Keywords: Occlusal caries, Fluorescence-based camera, air-polishing, VistaCam iX Proof

Introduction

Tooth decay is an etiologic multifactorial disease caused by several factors, which determine imbalance between the demineralization and remineralization processes. This imbalance occurs on the surfaces of the mineralized tissues and favors demineralization. Dental caries can affect all tooth surfaces: the smooth, interproximal and occlusal surfaces.
Beside the traditional and most used diagnostic tools for the evaluation of cavities (visual, tactile and radiographic examinations), other recently developed innovative techniques, such as intra-oral laser fluorescence and fluorescence based cameras, can help clinicians in the visual examination of caries.(1-2)
The fluorescence process is based on a phenomenon where the light is absorbed in a specific wave-length frequency and then emitted with a larger wave-length frequency. When hit by the light with a specific wavelength frequency, the decayed tissue and the healthy one emit fluorescence with different intensity. At this wavelength frequency, the porphyrin, produced by the caries-related bacteria, releases red light with a frequency that is lower than the one emitted from healthy tissues. The different wavelength frequency results in different colour detection, which, in the case of a healthy tissue, is green. The intraoral auto-calibrated camera Vista Cam iX (Durr Dental, Bietigheim-Bissingen, Germany) uses the fluorescence phenomenon for a non-invasive, quantitative caries diagnosis, by scanning demineralized lesions of enamel and dentin. In order to make a precise evaluation, according to the camera manufacturer instructions, the tooth surface must be completely cleaned and without biofilm.
Biofilm is a thin layer made of aggregate of microorganisms in which cells are frequently embedded, salivary polymers and food debris. If not monitored, the biofilm can easily organize itself in a hundreds of cells layer on the tooth surfaces. An organized biofilm is the ideal site for different species of bacteria to stick, proliferate, and create the so-called dental plaque.(3)
The biofilm removal may be executed by mechanical procedures of everyday oral hygiene performed by the individual such as manual or electronic brushing, in addition to the toothpaste. Moreover, the everyday biofilm removal should be combined with professional oral hygiene sessions, using instruments such as curettes or ultrasonic scalers. However, even if these everyday oral hygiene procedures are properly done, the biofilm can still rising up in specific areas of the tooth that are usually difficult to be reached.(4-5) The air polishing with glycine powder allows removing completely the biofilm from the enamel surface giving a whole cleanse of the tooth surfaces. In this study, we used the air-polishing protocols using the Combi device (Mectron SpA).

Aim

The current study aimed to evaluate the effects of biofilm removal, using air polishing device with glycine, on fluorescence VistaCam iX camera quantitative measurements of caries. The null hypothesis is that the presence of the bacterial biofilm on the tooth surface does not affect the values assigned by the camera VistaCam iX given to the occlusal surfaces of the analysed teeth.

Materials and methods

In this in vivo study, patients with complete permanent dentition without any kind of restorative treatments in the lateral and posterior section of upper and lower dental arches were enrolled in the Oral Diagnosis Unit, Policlinico Umberto I Rome, Sapienza University of Rome". Patients with inadequate oral hygiene, orthodontic treatments and systemic diseases that could influence oral health were excluded. Informed consent was obtained from all individuals.
One skilled dentist using the fluorescence terminal Proof of the intraoral camera VistaCam iX photographed the occlusal surfaces of molars and premolars. Later the images were scanned with the Durr DSBWIN software and then the highest values were registered. A positioner given by the manufacturer was used to reach a better examination's. A professional dental hygienist performed oral hygiene with air polishing procedures using the Combi device with glycine.

In order to evaluate the influence of biofilm, fluorescence assessment was repeated after air polishing procedures by a third blind skilled dentist, with the same fluorescence terminal Proof of the VistaCam iX, registering the highest value gained for each occlusal surface.
The two different observation data were then compared according to the aim of the study.

Statistical Analysis

All recorded data have been retrieved from our institutional Excel database. Statistic analysis was made using the IBM SPSS Statistic Software 19.0 Windows based. Data distribution was examined. Since the data comes from a non-normal distribution, a non-parametric Wilcoxon signed-rank test for paired sample was performed. The statistical significance was set at $p<0,05$.

Results

In this in vivo study 133 cuspidate permanent teeth, 62 molars (46.6%) and 71 (53.4%) premolars were analysed. Patient's age ranged between 13 and 25, without any statistical difference between males and females.
The VistaCam iX Proof mean values obtained after glycine treatment were statistically significant higher than the pre-treatment values.
Descriptive analysis shows an average of 0.82 (SD= 0.65; Min= 0.00; Max= 1.80; Median= 1.20) and of 0.93 (SD= 0.60; Min= 0.00; Max= 1.70; Median=1.20) for values before and after treatment, respectively.
However, descriptive analysis and non-parametric Wilcoxon signed-rank test show that, even if the median value does not change and so do the min and max values, analysed data have statistically significant different distribution.
VistaCam iX Proof scores assigned before and after glycine treatment are showed in **Figure 1 and 2**.
Table 1 shows the different data distribution before and after the glycine treatment.

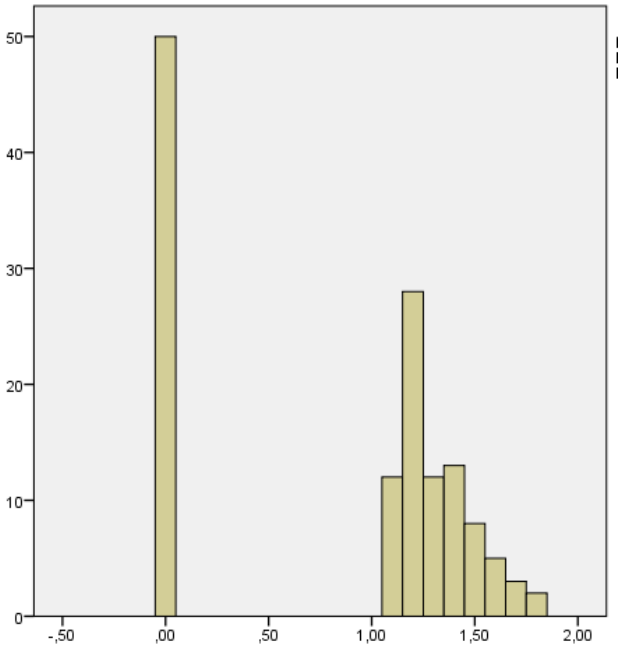

Figure 1: VistaCam iX Proof scores assigned before glycine treatment

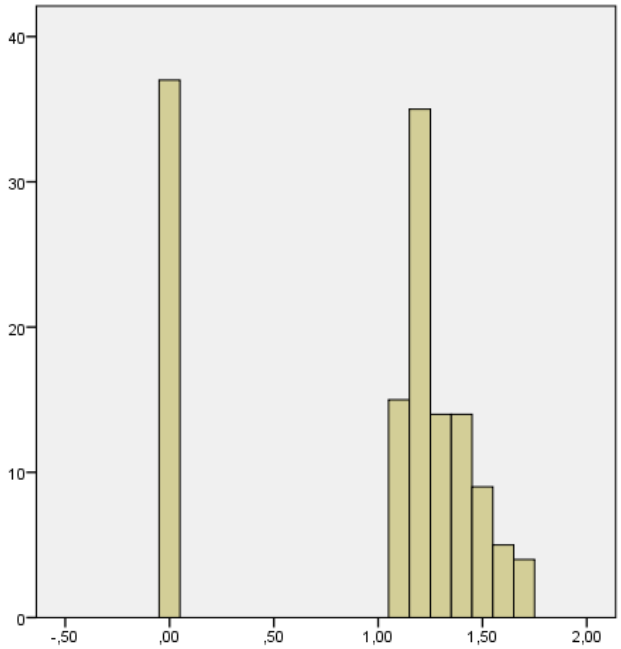

Figure 2: VistaCam iX Proof scores assigned after glycine treatment

VistaCam iX Proof scores	**Pre- glycine**		**Post- glycine**	
	n.	%	n.	%
,00	50	37,6	37	27,8
1,10	12	9,0	15	11,3
1,20	28	21,1	35	26,3
1,30	12	9,0	14	10,5
1,40	13	9,8	14	10,5
1,50	8	6,0	9	6,8
1,60	5	3,8	5	3,8
1,70	3	2,3	4	3,0
1,80	2	1,5	0	0

Table 1: VistaCam iX Proof different data distribution before and after the glycine treatment

Discussion

Early diagnosis and monitoring of caries lesions are the most important issues of primary and secondary prevention policies. This is crucial especially in case of initial lesions that if not recognized or underestimated could be delayed in treatment and can evolve in destructive dentine lesions.
Methods of diagnosis and evaluation of caries have gradually evolved over time, focusing firstly only on visual / tactile examination, which were subsequently supported by radiographic surveys. In recent years, however, additional new diagnostic technologies have been proposed. The Proof terminal of the intraoral camera VistaCam iX allows evaluating patient's oral hygiene status and the presence of caries lesions with the fluorescence technique. It results in a digital image showing lesions using different colours and a score that represents the lesion extension and depth. The manufacturer instructions suggest removing impurities from dental surfaces, such as food debris, calculus, fluoridation and polishing paste. In addition, in order to evaluate correctly cavities, it has been specified the necessity of a professional oral hygiene session before the examination.
In fact, recent studies suggest that, when using fluorescence evaluations, the longstanding and cariogenic plaque emitted a red light.(6-7-8)
Shakibaie investigated saliva and blood contamination effects on the numeric measurements obtained by the VistaCam fluorescence system. While the saliva influence in the fluorescence measurement did not allow us to demonstrate a statistically significant correlation, the blood on dental surfaces implemented the score given by the fluorescence-based camera VistaCam. This led us to the conclusion that this camera is capable of distinguish the healthy from the decayed enamel, with or without saliva, while the presence of blood compromises this capability. (9)
The results showed by this study demonstrated that, the scores assigned by VistaCam iX Proof fluorescence based camera to the occlusal surfaces, changes in with statistical significance, before and after the air-polishing treatment. Overall, from these results we can conclude that the measurements obtained by VistaCam after the air-polishing treatment, are averagely higher than those before treatment, especially in the diagnosis of initial tooth decay.
The major differences are encountered in the score 0 and in those in the values between 1.10 and 1.20.In fact after treatment, the scores around 0 decrease, going from the 37.6% to 27.8%, and so does the scores between 1.10 and 1.20,going from the 21.1% to the 26.3%.
From the data obtained, we can affirm that the biofilm removal with glycine air-polishing improves the VistaCam camera accuracy in recognizing the healthy tissue from the decayed one, due to the fact that the air-polishing treatment increases the decayed tissue answer to the fluorescence.
Therefore, the air-polishing gives us a better reliability on the fluorescence camera. It results crucial for clinic purposes, in order to manage correctly tooth decay, and also for risk evaluation purposes, that can help us to decide which preventive strategy would be the best for the patient.
The main criticisms of this in vivo study is the lack of evidences from in vitro studies conducted to evaluate the influence of oral biofilm models on fluorescence assessment

Conclusions

In conclusion, the fluorescence intraoral camera is a useful device in monitoring occlusal surfaces and it allows formulating a specific personal patient's database. It gives us also the opportunity to monitor remineralised lesions and improve the visual examination, in an effort to reduce at minimum mistake in diagnostic evaluations. In addition, every clinician can use properly VistaCam iX Proof because it does not require a preliminary calibration.
Based on our results, the VistaCam intra-oral camera use as a support to the visual/tactile examination of occlusal surfaces lesions should be associated with the clinician awareness about the effects of the biofilm on the fuorescence-based assessments. The operator should consider that the highest scores given by the camera could be due to the presence of biofilm on dental surfaces. Therefore, in order to enhance diagnostic protocols by intra-oral camera use, the appropriate conditioning and cleaning of the dental surfaces are mandatory.

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