IN VITRO EVALUATION OF LASER FLUORESCENCE FOR DENTAL CALCULUS DIAGNOSIS

Fabiano Bassalobre Valera[1]
Gesilda Correia de Melo[2]
Gustavo Nardi Nogueira[3]
Helderjan de Souza Mendes[4]
Patrícia Pinto Saraiva[5]
Evandro Franco da Rocha[6]

[1]*Graduation course on Odontopediatry. UNESP School of Dentistry at Araçatuba - SP, Brasil.*

[2]*. Graduation course on General Basis of Surgery and Experimental Surgery – UNESP School of Medicine at Botucatu – SP. Chief, Discipline of Periodonty – Course of Dentistry - USC.*

[3]*Course of Dentistry, USC – Bauru*

[4]*Dentist, USC – Bauru.*
[5] *Graduation course on Physiopathology in Clinical Medicine. UNESP School of Medicine –UNESP-.*

[6]*Assistant professor, Discipline of Periodonty. Course of Dentistry, USC*

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ABSTRACT

Due to the increasing search for more efficient methods of diagnosis with non-invasive and harmless methods to the patient, this study aims to evaluate the in vitro use of laser fluorescence (KaVo DIAGNOdent) in the diagnosis of dental calculus. Twenty-one human teeth removed and stored in formal 10% were used, which were submitted to preoperative clinical evaluation and determination of two sites in each tooth (control site and test site). Than the teeth were examined with the KaVo DIAGNOdent and the obtained values were recorded. After the exam teeth were submitted to root scratching and smoothening by means of Gracey curette until the radicular surfaces were clean, plain, hard and showing no calculus under visual inspection. After that, each control and test site was examined and the obtained values recorded. Results showed a 100% agreement to all measures obtained with the laser fluorescence equipment. Considering the experimental conditions it is concluded that the laser fluorescence is efficient in the diagnosis of dental calculus.

KEY WORDS: laser fluorescence; dental calculus, diagnosis

INTRODUCTION

The need for more effective diagnosis by means of less invasive techniques led to an increasing search for more accurate diagnostic methods, which favors a more precise intervention and the adoption of a more coherent plan of treatment according to the real stage of the lesion.

One of the methods used in periodonty is X-ray, mainly the conventional intra-oral X-ray, since it allows an evaluation of the bone tissue. However, with this technique the diagnosis of dental calculus is limited since it is a bi-dimensional method, which makes difficult the diagnosis in certain areas of the tooth, such as the sub-gingival area. On the other hand, Lindhe (1997) refers that the supragingival calculus can be visually diagnosed due to its texture and color.

In 1980 Grantt et al. concluded that xeroradiography was superior to the conventional X-ray in the periodontal diagnosis due to its characteristics of low radiation emission and high accuracy. However, in a study by White et al., (1984) comparing xerography and conventional X-ray results were not statistically significant.

Buchanan et al (1987) conducted a study on the possible divergences in the diagnosis of calculus concluding that the available X-ray techniques are not appropriate to the detection of sub-gingival calculus.

Searching for a new method of diagnosis Tamissalo et al., (1996) used multidirectional tomography for the diagnosis of periodontal disease; however, while comparing with periapical X-ray, the conclusion was that the technique was less precise in the detection of calculus.

Following the evolution on methods of diagnosis, the measurement of tissue fluorescence induced by laser light arises as a new method allowing a quantifiable and non-invasive exam. According to the manufacturer of KaVo DIAGNOdent the method is based on the fact that demineralized hard substances and bacteria become fluorescent when excited by laser radiation with wavelength between 550 and 670 nm. KaVo DIAGNOdent is the instrument to allow quantification of dental registers.

Recent research have demonstrated that the use of laser fluorescence for caries diagnosis has given false positive results due to the presence of dental calculus in the examined surface (HIBST; PAULUS, 1999; SHEEHY et al., 2001; LUSSI et al., 1999; SHI et al., 2000), and that, according to Hibst and Paulus (1999), soft tissues, such as gingiva, skin and blood show little or no fluorescence. Howe-

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ver, Ferreira et al. (2001) report that the technique is useful in the detection of caries although not showing correlation with its depth.

The objective of this study is to evaluate the effectiveness of the laser fluorescence in the *in vitro* diagnosis of dental calculus.

MATERIAL AND METHODS

SAMPLE SELECTION

Twenty-one teeth were randomly selected from the teeth bank of the Exodontic Clinic of the University of the Sacred Heart. Teeth were selected according to the criteria of presence of radicular calculus that were far from caries lesions in order to avoid false positive diagnosis induced by demineralization and the presence of bacterian colonies from the caries.

SITE SELECTION

Teeth, stored in 10% formaldehyde, were dried in a sterile tissue and submitted to a pre-operative clinical evaluation for the determination of two sites – the control and the test site (FIGURE 1).

FIGURE 1 - Classification of sites to be examined.

CONTROL SITE	Teeth region without calculus
TESTED SITE	Teeth region with calculus

KaVo DIAGNOdent

Details on the functioning of the KaVo DIAGNOdent can be found in the manufacturer's manual. A 655 nm wave laser light is transported by a central fiber from the point of the equipment to the surface to be examined. Around the central fiber there are additional fibers to collect the fluorescent light form the examined tissue. Reflected and ambient lights are eliminated by means of a filter with specific characteristics. A photodiode evaluates the amount of fluorescent light going through the filter. A digital viewer shows the present and the peak value for a specific exam.

EXAMS FOR DIAGNOSIS

Teeth were randomly selected and a sole observer made the exams.

The A point of the KaVo DIAGNOdent was selected due to the fact that its anatomical shape favors a better adaptation to the root surface, mainly in the region near the furca. At each exam the equipment was calibrated in a healthy portion of the teeth according to the instructions of the manufacturer. After the calibration the control and test sites were examined in the crown-root sense were the point of the equipment touched the region to be examined. The peak value for each site was recorded in a separated form.

After examining the 21 teeth their roots were scratched and smoothened with a Gracy curette until the root surfaces became clean, plain, hard and no calculus were observed by visual inspection.

After that, the control and test site were reexamined and obtained values were recorded.

RESULTS

DATA PROCESSING

The obtained values were transformed into qualitative data based in cut-off points determined in a pilot study according to FIGURE 2.

FIGURE 2 - Cutt off for diagnosis of calculus in the KaVo DIAGNOdent.

ABSENCE OF CALCULUS	SCORE = 0
PRESENCE OF CALCULUS	SCORE = 1

In order to facilitate the comparison of data obtained in the present study, each measure was then transformed into scores as can be seen in FIGURE 3.

FIGURE 3 - Binary score to the classificaiotn of the tested sites.

SCORES	PROBABLE CONDITION OF THE EXAMINED SITE
0 - 5	Absence of calculus
6 - 99	Presence of calculus

STATISTICAL ANALYSIS

The concordances of the KaVo DIAGNOdent were calculated in relation to the control and test sites and before and after root scratching and smoothening. The obtained concordance was 100% to all measures measures made with the equipment.

DISCUSSION

The 100% of concordance obtained by the laser fluorescence system means that when, by visual examination, examined sites did not reveal the presence of calculus, the equipment has also not detected calculus. Conversely, it means that when the visual exam did detect calculus the equipment has also detected its presence. These results are corroborated to those by Ferreira et al.,(2001) using the equipment jointly with clinical evaluation in the detection of altered tissues.

However, the readiness to determine, *in vitro*, the presence or absence of calculus by visual inspection is not found *in vivo* due to many factors that make difficult the diagnosis such as access and lighting of some regions inside the mouth. The clinical exam, when used to evaluate the efficacy of the root scratching and softening procedures, showed poor intra and inter-examiners concordance, besides many false-positive results (SHERNAB et al., 1990).

X-rays have been also mentioned as an auxiliary method to the diagnosis of calculus (MODEER; WONDIMU, 2000; TUGNAIT et al., 2000) both in the initial planning and in the corrective and maintenance phases of the periodontal therapy (TUGNAIT et al., 2000). However, Buchanan et al. obtained a high specificity and a limited sensibility concluding that X-rays are not an adequate method to the diagnosis of calculus. Besides that, X-rays have the inconvenient of exposing patients to ionizing radiation and to be a bi-dimensional method, which makes difficult the diagnosis in some regions of the tooth.

The use of laser fluorescence equipment as a method for periodontal diagnosis was based in the intense fluorescence of the dental calculus due to the presence of porphyrines (DOLOWY et al., 1995; SAILER et al., 2001) while exposed to a determined wavelength (600 to 750 nm) (SAILER et al., 2001).

Several studies using the laser fluorescence to the diagnosis of caries lesions have given false-positive results due to the present of calculus in the examined dental surface (HIBST; PAULUS, 1999; SHEEHY et al., 2001; LUSSI et al., 1999; SHI et al., 2000), which favors the results of the present study.

The concordance of 100% obtained in this study indicates that the use of fluorescence induced by laser light can be used to the diagnosis of calculus, which is in accordance to the findings of Krause et al. (2000). Due to the non-fluorescence of the gingiva and blood (HIBST; PAULUS, 1999) and by diagnosing lesions up to 1 mm in depth it is possible to suggest the indication of laser fluores-

cence for the diagnosis of sub gingival calculus although clinical research should be made to test its efficacy.

Being a method that allows the monitoring of the diagnosed calculus, by means of quantitative scores, laser fluorescence may be indicated in the maintenance therapy of periodontal health with the advantage of not exposing patients to the ionizing radiations of X-rays.

The literature does not determine beyond disput the effectivity of the procedures of root scratching and smoothening (SHERMAN et al., 1990) mainly by X-ray (TUGNAIT et al., 2000). The present study, by assessing results in two periods – pre and post root scratching and smoothening – by obtaining a concordance of 100% *in vitro* between the laser fluorescence equipment used and the real situation at the examined site, by showing the above mentioned advantages, has made it possible to stress the possibility of using laser fluorescence to determine the efficacy of root scratching and smoothening procedures.

CONCLUSION

Based on the results obtained and taking into consideration the experimental conditions it is possible to conclude that the laser fluorescence is efficient in the diagnosis of dental calculus.

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