Digital Method of Evaluating Dental Plaque Accumulation

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Abstract. A computerized method for plaque area measurement has been developed. Using a computerized image analysis system, the plaque area and tooth area on color slides were digitized and the number of pixels automatically counted. The images were subjected to digital processing, the part of the surface area covered by plaque being given in per cent of the total surface area of the tooth. Plaque extension and plaque topography was studied in young adults in large collectivities. It is concluded that it is a rapid method; the use of instruments is minimal and it is useful in epidemiological studies.

Introduction

Dental plaque as a naturally occurring microbial deposit represents a true biofilm which consists of bacteria in a matrix composed mainly of extra cellular bacterial polymers and salivary and/or gingival exudate products [1].

The role of dental plaque and calculus in the etiopathogenesis of chronic marginal periodontitis is well known. The place of initial phase in the complex treatment of chronic marginal periodontitis is demonstrated by numerous studies [2]. To be able to implement specific measures for plaque removal, dental plaque must be correctly evaluated and quantified. There are many investigations of efficiency of different usual dental plaque disclosing methods. This paper describes a digital method of evaluating plaque accumulations, named PlaqueDent. The approach of these aspects has a major practical significance since motivation plays a key role in every dental treatment [3].

In order to make rapid quantification of oral hygiene in large collectivities, this paper presents an innovative method of dental plaque control. The usual disclosing methods are time-consuming and they require at least the standard dental instruments.

In most cases during the epidemiologic investigation we have no possibility to transport all the materials needed for clinical examinations. This digital method makes data acquisition that will be analyzed and statistically compared.

The purpose of this paper consisted of projecting and implementing a computer application that allows the user to quantify the disclosed bacterial plaque. The images were obtained in the same conditions with a digital camera. The PlaqDent software tends to replace the clinical method of determining oral hygiene indices especially for large groups of individuals.

The purpose of the computer program implemented and described in this paper – PlaqDent is to:
- allow for a moderate level of automation in recording and comparing of the data;
- offer calculations on extracted data from digital dental images.
Material and method

PlaqDent software has been developed in 2006, in collaboration with Adrian Tohati, DMD, UMF Tg. Mures. Implemented in Visual C++ 6.0 on a Windows platform, this software uses the MFC package (Microsoft Foundation Classes).

Tohati uses PlaqDent as a tool for epidemiological studies, during his PhD thesis. He finds it a computerized method of rapid evaluation of dental plaque on frontal sextants [2].

PlaqDent is an imaging software developed for dental imaging. It uses a special semi-automated image processing technique which allows the detection of bacterial plaque on the selected dental surfaces.

Using the labial surface of upper anterior laterals for determination, the accumulation of plaque was assessed by means of an image processing method.

The images were subjected to quantitative evaluation, the part of the surface area covered by plaque being given in per cent of the total surface area of the tooth. The surfaces can be selected by cropping the surface using a pointing device. The result of the computer analysis is presented to the user in a dialog box.

The plaque index expresses plaque area as a percentage of tooth area. The reproducibility of this method was tested and the influence of photographic technique on the index was determined.

The present method was highly reproducible for the index with an intraexaminer variation of 0.28% and intraexaminer correlation coefficient of 0.99. The results show that highly reproducible index values with a small error [4].

This method has the possibility of using different size images, and there are no strict measures in image acquisition, in advantage of shorter and more rapid examinations.

The first step of data acquisition is obtaining plaque coloration using disclosing tablets. The tablet when chewed reveals by means of coloured dye areas of plaque to be removed from the teeth. The anterior inferior and superior sextants are photographed with a usual digital camera. Once the images are being opened with PlaqDent software the user selects the region of interest by cropping the surface using a pointing device. The software evaluates automatically the percent of dental plaque (Fig. 1).

The interface is user friendly and it permits a dialog with the user, showing the dentist a few steps of the image processing before the final result is returned to the user.

Results

The PlaqDent software is fast, easy to use, robust regarding image imperfections and semi-automated, because the final purpose of “artificial vision” is to imitate human vision which is subjective by its nature. From a clinically point of view the method has the advantage of being used in collectivities with no need of a dental unit or examination tools.

The computer software has been tested by Tohati on a group of 270 subjects [2]. He finds the application useful and demonstrates also the implications of oral hygiene upon periodontal health in different age groups.

Since the results of this large study indicates an inappropriate oral hygiene in most of the examined subjects from every age category, the author reveals the necessity of initiating an immediate better dental cleaning, otherwise there is a major risk to increase the gravity of
gingival inflammation which leads in time to severe complications with difficult treatment and unfavorable prognostic.

The duration of the taking a photo is very short, this makes data acquisition from a large number of patients possible in a limited period of time. The persons being photographed are not subjected to any effort or exercise of patience.

A very important aspect is related to the facility of dental plaque data acquisition, because most times patients consider plaque disclosing methods uncomfortable. These patients may refuse a new evaluation of their oral hygiene status. Using a digitized method a new photography can be automated compared to the old one, and the doctor forms shortly an impression about oral hygiene improvement.

This method has a good motivational side by showing the patient pictures from different stages of the oral cleaning process and thus allowing him to see the improvement and the results. The quantity of bacterian plaque is represented in percents of dental surface coverage. When used in conjunction with a bicoloring pill, the software is able to calculate the percentage of new and mature bacterian plaque. The drop in percentage in successive cleaning treatments reflects an accurate progress in obtaining an optimum oral hygiene.

Fig. 1. Digital determination of dental plaque quantity on frontal sextants
As a future work, the presented method will be developed to be able to determine plaque on the lateral regions. For the lingual/palatal surfaces of anterior teeth and the buccal or lingual/palatal surfaces of posterior teeth, the slides will photographed with an image of the whole tooth surfaces in the photographic mirrors or will use an intraoral camera. In this case one needs the standard examination instruments and because the intra oral camera needs sterilization the subjects will have to be examined in the prophylaxis office.

The method introduced is a sensitive means of determining small amounts of plaque and should prove useful for in vivo investigation of plaque growth and plaque suppression, where measurements of high quality is of importance [5].

In conclusion we find useful a module of image processing as the one presented included in a dental image editor implemented in a dental office.

The dentist may find PlaqDent as a real help in his office because:

- there is no effort of the examined subject;
- it shortens the time for diagnosis;
- there is no need for the classical methods and instruments used for visualization and determination;
- allow for a moderate level of automation in recording and comparing of the data allows an access to quantitative information of analyzed elements, and exact measurements;
- automated data storing permits objective evaluations of dental deposits evolutions;
- the method eliminates subjectivity allowing examiners changing during different steps of an epidemiological investigation.

References: