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Red fluorescence of dental plaque in children —A cross-sectional study☆

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ABSTRACT

Objectives: The relation between the presence of red fluorescent plaque and the caries status in children was studied. In addition, the microbial composition of dental plaque from sites with red fluorescent plaque (RFP) and from sites with no red fluorescent plaque (NFP) was assessed.
Methods: Fluorescence photographs were taken from fifty children (6–14 years old) with overnight plaque. Full-mouth caries scores (ICDAS II) were obtained. The composition of a saliva sample and two plaque samples (RFP and NFP) was assessed using 16S rDNA sequencing.
Results: At the site level, no clinically relevant correlations were found between the presence of RFP and the caries status. At the subject level, a weak correlation was found between RFP and the caries status when non-cavitated lesions were included ($r_s = 0.37$, $p = 0.007$). The microbial composition of RFP differed significantly from NFP. RFP had more anaerobes and more Gram-negative bacterial taxa. The most discriminative operational taxonomic units (OTUs) for RFP were *Corynebacterium*, *Leptotrichia*, *Porphyromonas* and *Selenomonas*, while the most discriminative OTUs for NFP were *Neisseria*, *Actinomyces*, *Streptococcus* and *Rothia*.
Conclusions: There were no clinical relevant correlations in this cross-sectional study between the presence of RFP and (early) caries lesions. There were differences in the composition of these phenotypically different plaque samples: RFP contained more Gram-negative, anaerobic taxa and was more diverse than NFP.
Clinical significance: The study outcomes provide more insight in the possibilities to use plaque fluorescence in oral health risk assessments.

1. Introduction

Dental caries is a common oral disease [1,2], which only progresses when dental plaque is present [3]. Therefore, frequent plaque removal is the most important preventive measure in maintaining oral health [4,5]. Another aspect involved in caries development and progression is the diet of the person [6]. Especially a high frequency intake of carbohydrates in the diet can result in a change of the oral microbiome towards more aciduric species [7]. The presence of a more aciduric dental plaque can disturb the demineralisation/remineralisation balance in a specific niche of the oral cavity, eventually resulting in caries.

To prevent caries from developing, it can be helpful to determine high-risk niches and high-risk patients [8]. When caries and caries risk are identified at an early stage, fewer operative dental procedures need to be performed [9,10]. So far, no specific tools are available to predict which niche is at high risk or which patient is at high-risk for developing tooth decay based on biological characteristics of a causal factor of the disease.

Some dental plaque fluoresces red when excited with 405 nm light (visible violet light) without the use of a disclosing solution [11]. This red fluorescence has been observed from cavitated caries lesions [12–14], non-cavitated caries lesions [15–17] as well as

☆ The Temple University Health Sciences Institutional Review Board approved this study protocol (protocol number 21916).

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from bacteria related to dental caries [18–20]. Recent studies suggest that old and cariogenic plaque causes this red plaque to fluoresce [21–23], while mature plaque is also related to caries progression [24]. This red fluorescence can be observed and recorded using a dedicated fluorescence camera, which allows easy detection and recording of the fluorescence. With this camera, a tool to determine the caries risk of a patient on the basis of plaque characteristics may be within reach.

No clinical studies have been conducted so far that study the differences in the oral microbiome in relation to the presence or absence of red fluorescence of dental plaque or that link red fluorescent plaque to the presence of caries. Therefore, the main objective of this study was to study the relationship between the presence of red fluorescent plaque and the caries status in children. The secondary aim was to assess if there was a difference in the bacterial composition of dental plaque from sites with and without red fluorescent plaque. The study results may provide an insight in the potential to use plaque fluorescence for caries risk assessment.

2. Materials and methods

2.1. Study design

The data for this cross-sectional study were collected in April and May 2014 at the Pediatric Dental Clinic of the Kornberg School of Dentistry, Temple University in Philadelphia, USA. The Temple University Health Sciences Institutional Review Board approved the study protocol (protocol number 21916). The study was conducted in accordance with the ethical principles of the 64th WMA Declaration of Helsinki (October 2013, Brazil) and the Medical Research Involving Human Subjects Act (WMO), approximating Good Clinical Practice (CPMP/ICH/135/95) guidelines. Potential participants received oral and written information about the study and they could only join after signing an informed consent form. Informed consent was obtained from the parent or legal caregiver of the child, and a written assent was obtained from the child. Participation comprised a visit of approximately 60 min to the clinic, for which the parent received a money order (USD 25) as incentive and as a reimbursement for the costs of, for example, transportation, time off work.

2.2. Study population

Children between 6 and 14 years old in good general health were eligible to participate in the study. The neighbourhood where the pediatric clinic is situated, is considered a developmental district of one of the poorest big cities of the U.S.A. with a high caries population.Volunteers for the study had to understand the English language sufficient enough to fill in the questionnaire and were excluded if they had oral lesions, active orthodontic treatment or removable (partial) dentures, had used antibiotics during the last three months or had periodontal pockets with attachment loss. The caregiver was called by phone one day before the appointment to remind them of the appointment.

2.3. Clinical procedures

Participants were instructed not to brush their teeth or to perform any oral hygiene measures on the evening and morning before the appointment. A questionnaire was handed to the caregiver to collect data on oral health behaviours of the child, such as when the child last brushed his/her teeth. Thereafter, red fluorescent plaque (RFP) on the buccal surfaces of all teeth up to the first molars was recorded using a QLF-D camera (Fig. 1, Inspektor Research Systems BV, Amsterdam, the Netherlands). The QLF-D Biluminator system consists of an illumination tube (Biluminator; Inspektor Research Systems) fitted onto an SLR-camera (Canon model 550D, fitted with a 60 mm macro lens; Canon, Tokyo, Japan). The illumination tube is composed of a ring, mounted with eight violet-blue-light-emitting diodes (LEDs 405 ± 20 nm) and four white LEDs (broad spectrum, 6500 K) with filtering optics in front of the camera lens. The camera system is controlled using dedicated software to capture both fluorescence photographs and white-light photographs (C3; Inspektor Research Systems). The photographs were named with a unique identifier to guarantee anonymity of the participants.

Saliva samples were taken using a sterile cotton roll (Salivette, Sarsted AG & Co KG, Numbrecht, Germany), which was held under the tongue of the participant with sterile tweezers to absorb the present saliva until the roll was saturated. Thereafter, two plaque samples per child were taken: one from a site with red RFP and one

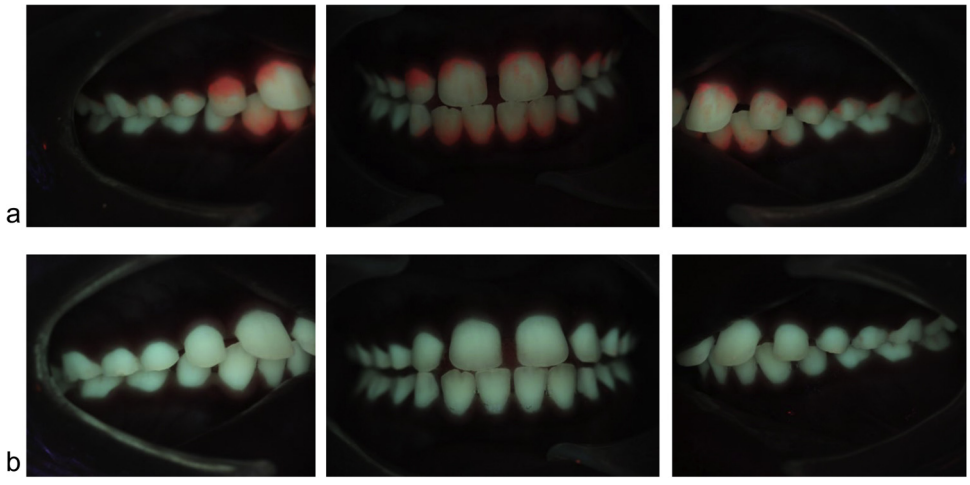

Fig. 1. An example of fluorescence photographs of the buccal surfaces of the teeth of a child before (a) and after (b) professional cleaning, demonstrating that red fluorescence originates from removable plaque and calculus.