

Full Length Research Paper

Plaque removal efficacy of a novel oral care device: A microbiological assessment

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In adults with inflammatory problems, self-performed mechanical plaque removal is insufficiently effective and should be improved. The aim of this study was to determine the biofilm removal efficacy of a new oral care device, the digital brush (Enacare, Micerium), a disposable gauze product soaked in 0.12% chlorhexidine. Changes in supragingival microbiota were investigated in 30 Caucasian patients (14 males and 16 females) aged 8 to 90 years. All subjects provided written informed consent. Pre-treatment (pre-T) and post-treatment (post-T) samples of supragingival plaque were taken from the right vestibular and lingual mucosa in 15 subjects and from the buccal aspect of the anterior sextant in 15 subjects using sterile swabs flocked with sterile nylon fibers. The samples were analyzed to determine the presence of *Candida albicans*, *Candida* species, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Staphylococcus* species, oral streptococci, and *Enterobacter* species. Groups were compared using Pearson's chi-squared test. The following bacteria were detected: *C. albicans* (8 pre-T and 3 post-T), *Candida* spp. (3 pre-T and 0 post-T), *Enterobacter* spp. (2 pre-T and 2 post-T), *S. aureus* (12 pre-T and 4 post-T), *S. epidermidis* (2 pre-T and 1 post-T), *Staphylococcus* spp. (29 pre-T and 22 post-T), and *Streptococcus viridans* (29 pre-T and 22 post-T). Microbiota differed between sampling sites. Within the limits of this preliminary clinical and microbiological evaluation of biofilm reduction in a small sample, the digital brush appears to be an effective plaque removal device. Mechanical cleaning with this tool appears to be more effective on hard surfaces than on mucous membranes.

Key words: Plaque removal, home care, gauze, digital brush, chlorhexidine, bacteria, brush.

INTRODUCTION

Routine toothbrushing is the principal method used by individuals to remove biofilm and control plaque-related diseases, such as periodontitis and caries (Creeth et al., 2009; Lucchese et al., 2012a). However, in some adults, especially those with inflammatory problems, self-performed mechanical plaque removal is insufficiently effective and should be improved (van der Weijden and Hioe, 2005).

To improve dental health care, professional recommendations should always fit patients' specific needs (Silverman and Wilder, 2006). Given the strong adhesion of biofilms grown from whole saliva (Verkaik et al., 2010), a mechanical plaque removal strategy must be implemented to achieve

satisfactory oral health. The introduction of a novel device may improve patients' compliance (Chongcharoen et al., 2012; Sicilia et al., 2003).

The aim of this study was to determine the biofilm elimination capability of a new oral care device, the digital brush (Enacare, Micerium S.p.A., Genoa, Italy), a disposable gauze product containing 0.12% chlorhexidine. This device can be used as an alternative to conventional oral hygiene, when performing the latter is difficult or as additional device to improve the quality of self-performed mechanical plaque removal.

The null hypothesis of this study was that the presence

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of microbiota (representing the cleansing effect) before and after the use of a medicated gauze product on the mucosa and teeth would not differ.

MATERIALS AND METHODS

A disposable gauze product containing 0.12% chlorhexidine can serve as an alternative device for oral hygiene, even outdoors, or as an additional device for individuals with special care needs, bedridden patients, and caregivers.

Patients

The study group comprised 30 Caucasian patients (14 males and 16 females) with a mean age of 48.3 (range, 8 to 90) years. All patients provided written informed consent.

Sampling

At baseline, pre-treatment (pre-T) supragingival plaque samples were taken from the right vestibular and lingual mucosa in 15 subjects (group 1) and from the buccal aspect of the anterior sextant in 15 subjects (group 2) using sterile swabs.

The subjects were instructed in proper oral hygiene and the use of the digital brush as a cleansing device (Figures 1 and 2), using a rolling motion technique (Figure 3A and B) for ~2 min. Post-treatment (post-T) microbiological sampling was performed immediately after cleaning.

Culture protocol

Saliva samples were collected with flocked swabs (Copan Italia S.p.A., Brescia, Italy) designed for biological sample collection that contained a transport medium specific to aerobic and anaerobic bacteria. Samples subjected to delayed (>24 h after collection) microbiological evaluation were transferred to cryovials and stored at -80°C to ensure preservation.

Bacterial culture was performed as follows. Using a disposable sterile loop, 10- μ l samples were streaked onto the following plates (Vacutest; Kima (ARZERGRANDE, Pd, Italy): horse blood agar (for non-selective growth of streptococci groups A to C, pneumococci, and staphylococci), azide agar (for selective growth and isolation of streptococci, including *Enterococcus* species), *Herellea* agar (for selective growth and isolation of Gram-negative bacteria), and CHROMagar *Candida* (for *Candida* identification). The plates were incubated at 37°C for 24 h, then examined to distinguish colonies on the basis of morphology, pigmentation, and macroscopic shape. In cases of positive growth, standard identification procedures were applied to selected colonies.

The isolated colonies were identified using the VITEK[®] automatic system ((bioMérieux, Inc, Hazelwood, Mo). For colony counts, samples were serially diluted to 1:10⁶. The number of colony-forming units (CFUs)/ml in the original sample was determined by multiplying the number of colonies (30 to 300) per plate by the dilution factor.

Statistical analysis

The presence or absence of microorganisms (including *Candida* species, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus viridans*, *Enterobacter* species) was determined before and after cleaning with the digital brush. Pearson's chi-

squared test was used to analyze bacterial concentrations and compare data from groups 1 and 2.

RESULTS

The results of microbiological evaluation are reported in Table 1. The following bacteria were detected: *Candida albicans* (8 pre-T and 3 post-T), *Candida* spp. (3 pre-T and 0 post-T), *Enterobacter* spp. (2 pre-T and 2 post-T), *S. aureus* (12 pre-T and 4 post-T), *S. epidermidis* (2 pre-T and 1 post-T), *Staphylococcus* species (29 pre-T and 22 post-T), and *S. viridans* (29 pre-T and 22 post-T). Microbiota differed between sampling sites.

No significant difference in the presence of bacteria was detected between groups 1 and 2. The mean post-T reduction in bacterial concentration was 2.36 log₁₀. Using this cut-off value, data from groups 1 and 2 were compared by Pearson's chi-squared test. Although more reduction was visible in group 2 samples (from the buccal aspect of the anterior sextant), no significant difference was found.

DISCUSSION

The oral cavity can serve as a reservoir of pathogens that can cause systemic infection. *C. albicans* was the most prevalent yeast found in the periodontal pockets (76.2%) and oral cavities (63.0%) of patients with periodontal disease (Cuesta et al., 2010).

Many studies have demonstrated the essential etiological role of pathogenic dental biofilm in the development of gingivitis, additionally finding that most people fail to maintain sufficient mechanical plaque control to prevent disease ((van der Weijden and Hioe, 2005; Barnett, 2006).

In adults, professional mechanical plaque removal (PMPR) in combination with oral hygiene instruction (OHI) may be more effective than no treatment, but patient compliance in combination with repeated OHI may have an effect similar to that of PMPR (Needleman et al., 2005).

Oral health care professionals generally recommend that individuals brush their teeth for at least 2 min using an appropriate technique; however, adequate interdental cleaning requires 4 min or more (Chongcharoen et al., 2012; Gjermo and Flotra, 1970). Patients' failure to comply with the correct use of cleaning devices for an adequate period of time can be a problem. **The average brushing time in the general population is ~45 to 50 s, only 10% of which is spent cleaning the lingual tooth surfaces** (Claydon, 2008).

Significantly lower dental plaque scores have been recorded immediately after an oral self-care demonstration; a mean of 27.4% plaque removal was observed after the demonstration (Yuen et al., 2009), compared with 40 to 55% plaque removal after 1 min of



Figure 1. Clinical use of a novel oral care device for plaque removal.



Figure 2. Drawing of the Digital Brush (Enacare, Micerium S.p.A., Genoa, Italy), a disposable gauze product containing 0.12% chlorhexidine. This device can be utilized as an alternative tool when conventional oral hygiene is unfeasible or as an additional method to improve the efficacy of self-performed mechanical biofilm removal.

manual toothbrushing in the general (young and middle-aged) healthy, nondisabled population, as reported in a meta-analysis (van der Weijden GA, Hioe, 2005). Consistently, no more than 60% of the overall plaque is removed during each episode of cleaning (Claydon, 2008). Less plaque was removed from mandibular teeth and lingual tooth surfaces than on the maxillary teeth and buccal surfaces (Claydon, 2008; Yuen et al., 2009).

A previous dental review (van der Weijden and Hioe, 2005) proved that self-performed mechanical plaque removal is insufficiently effective and should be improved. Treatment procedures should always include customized patient education and OHI. In some instances, such instruction can be used as appropriate to reduce, eliminate, or change the nature of microbial pathogens and to remove bacterial plaque, although only from the supragingival regions.

User skill is a more important factor than the design of the toothbrush for the efficacy of cleaning (Yuen et al., 2009). Thoroughness may be improved by the use of tactile receptors in the fingers to guide a device, such as the digital brush, the novel home care device used in this study. The use of the digital brush with a wiping motion enables an individual to reach frequently neglected dental surfaces.

Studies of the oral microbial environment have demonstrated that oral mucosal tissues act as reservoirs of the bacteria that colonize tooth surfaces (Silverman and Wilder, 2006; Verkaik et al., 2010; Needleman et al., 2005; Gjermo and Flotra, 1970; Claydon, 2008). This finding supports the incorporation of an effective antimicrobial mouth rinse into the daily oral hygiene regimen to complement mechanical plaque control (Silverman and Wilder, 2006; Verkaik et al., 2010; Yuen et al., 2009; West and Moran, 2008; Gunsolley, 2006).

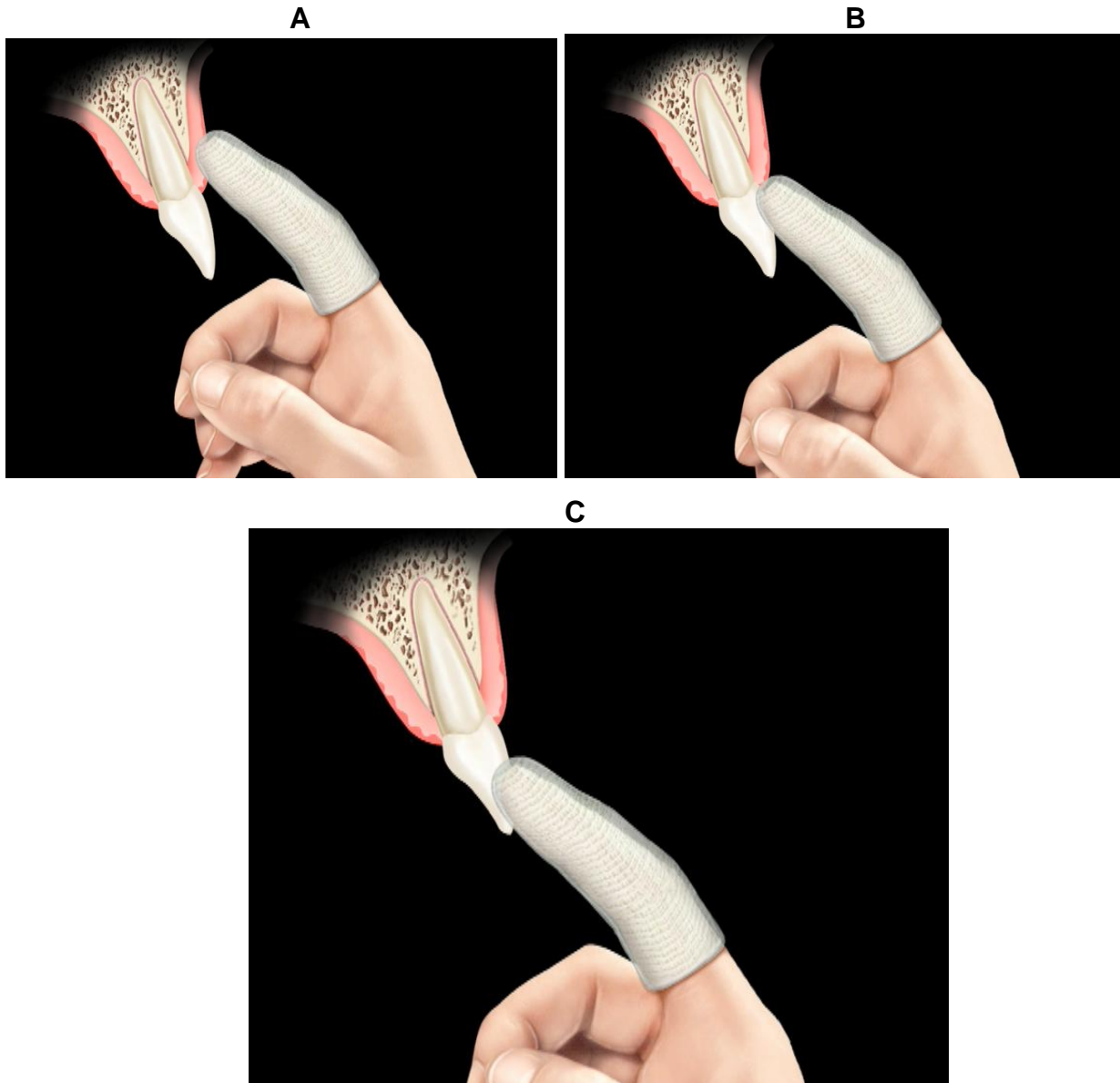


Figure 3. The digital brush is wrapped around the index finger and utilized with a sweeping motion in an apico-occlusal direction from the oral mucosa to the tooth surfaces, similar to the roll brushing technique. Finger tactile receptors can guide cleaning movements to better reach frequently neglected dental surfaces in the posterior lingual/palatal areas. This device may improve the thoroughness and efficiency of cleaning.

Chlorhexidine remains the gold standard of antiplaque agents (Silverman and Wilder, 2006). According to one meta-analysis, seven studies have documented the strong antiplaque, anti-gingivitis effects of mouth rinses with 0.12% chlorhexidine (Verkaik et al., 2010). The gingival index has also been used to demonstrate the significant anti-gingivitis effects of these mouth rinses (Raul, 2008). Twice-daily oral care with 0.12% chlorhexidine gluconate may hold promise for the prevention of nosocomial infection (Bopp et al., 2006).

The persistence of staining on natural dentition after the use of chlorhexidine gluconate mouth rinse is a well-known side effect of this antimicrobial agent that counter indicates long-term use (Bagis et al., 2011). This staining effect should be expected to be most pronounced in the first few days of use. Other reported side effects of chlorhexidine use include pain, burning sensation, pruritus, xerostomia, taste disturbance, mucosal irritation, and discoloration of tooth and tongue surfaces (Gürgan et al., 2006).

In the present study, a greater reduction in microbial concentration occurred in group 2 (samples taken from the buccal aspect of the anterior sextant) than in group 1 (samples taken from the right vestibular and lingual mucosa), although this difference was not significant. Mechanical cleansing with the digital brush tended to be more effective on hard surfaces than on the mucous membranes.

The lack of significant findings may be due to the small sample size. Further research may support our findings by detecting significant differences.

Conclusions

Within the limits of this clinical and microbiological evaluation of a small sample, the digital brush seems to be an effective plaque removal device. Its use as an alternative tool when conventional oral hygiene is difficult to implement or as a supplementary device to improve the quality of self-performed mechanical plaque removal can be recommended (Lucchese et al., 2012b). Further studies with larger samples are necessary to more fully evaluate the cleansing effectiveness of this novel device.

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