

ABSTRACT

Surprisingly, there is minimal published data to confirm the quantitative benefits of conventional dentifrice (abrasive/surfactant) in enhancing plaque removal associated with manual toothbrushing (Forward, *Int. Dent. J.* 41: 164-170, 1991). This study reports on the use of digital plaque image analysis (DPIA) to assess the comparative effects of manual toothbrushing (without paste) to toothbrushing with dentifrice on plaque removal. Nine subjects participated in this cross-over experiment. The evening before each scheduled examination, subjects refrained from oral hygiene. In the morning of the examination subjects presented between 7 a.m. - 8 a.m.. Subjects were not permitted to eat, drink or undergo morning hygiene until completion of the exam. On presentation, subjects rinsed with UV disclosure solution and plaque was assessed via DPIA. Subjects then brushed for one minute (supervised) with either a wet toothbrush (Crest Complete®) or a wet toothbrush (Crest Complete) and Crest®, dentifrice. Following a water rinse, subjects disclosed plaque again and were re-assessed by DPIA. Pilot testing *a priori* confirmed a) reproducible actions in 'brushing without paste' and b) no effects from toothpaste on plaque disclosure/grading. Test results show that toothbrushing with water alone removed 41% plaque from the anterior, facial tooth surfaces. Toothbrushing with dentifrice removed 68% plaque from the anterior, facial tooth surfaces. On average, toothpaste usage significantly enhanced plaque removal compared with toothbrushing with water alone (ANOVA with subject and treatment as the main effects, $p < 0.05$). **These results demonstrate that conventional dentifrice significantly enhance the plaque removal effectiveness of manual toothbrushing. Studies are in progress to determine if all toothpastes provide a similar benefit and to determine by what means the benefits are derived (e.g. product aesthetics vs. cleaning action).**

INTRODUCTION

The toothbrush alone has long been considered the primary tool in overall plaque control. The dentifrice has been primarily viewed as a delivery vehicle for fluoride, tartar and breath control components.

The benefit of dentifrice usage during normal toothbrushing on plaque removal has not been extensively evaluated. This study compared plaque removal effectiveness of toothbrushing with water alone versus toothbrushing with a dentifrice. Advanced digital plaque imaging techniques were used to quantify the plaque coverage before and after brushing, eliminating grader error.

OBJECTIVE

The purpose of this study was to compare the plaque removal effectiveness of toothbrushing with a dentifrice versus toothbrushing with water alone.

MATERIALS AND METHODS

Products Tested

1. Crest Complete, large, soft toothbrush and water
2. Crest Complete, large, soft toothbrush and Crest, Regular dentifrice

Entrance Criteria

Subjects were excluded if they were:

- Using antibiotics or chlorhexidine within 1 week of study dates
- Received an oral prophylaxis within 2 weeks of study dates.

Study Design

Nine subjects participated in a single cross over study. Subjects refrained from brushing the evening before and the morning of the treatment days. Subjects were not permitted to eat or drink until completion of the morning exam. Prior to any treatment, subjects rinsed with 25ml of a buffer solution for 10 seconds.

Then they rinsed with 0.8ml of fluorescein dye solution in 5ml phosphate buffer solution for one minute followed by three, ten second rinses with 25ml buffer solution. Plaque levels were then assessed via DPIA. Immediately after the initial image capture, subjects brushed their entire mouth for one minute with their assigned treatment regimen. The plaque disclosure and image capture regimen was then repeated. Subjects returned to their normal oral hygiene routine for 48 hours and then repeated the pre- and post-brushing image capture sequence using the second treatment regimen.

Data Collection

Digitally captured images are fed directly to a Macintosh Power PC 8100/100 for immediate analysis of plaque coverage. Each image pixel is classified as teeth, tooth plaque, gingival plaque, gingiva or lip retractors using a least squared distance discriminant classification model based on Red, Green and Blue values (0-255 scale). The model parameters are established based on pre-measures of the average RGB values and co-variance between RGB values for each of the five classes. A Fuji HC-1000 digital camera is used to capture images and provide subject repositioning on the chin rest. The subject is repositioned by self alignment of a live image superimposed on a stored baseline image and the subjects adjust their position to match the baseline position. In addition to the HC-1000 camera, the repositioning system includes Sony RGB monitors and Nu Vista+ video card. Lighting for the system is provided by Balcar Uv flashes powered by a Balcar Starflash 2400. Capture and storage of the images is accomplished with Capture Manager Hypercard program. A customized software package (Oncor) is used to analyze the images.*

* *Plaque Assessment Via Computer Aided Image Analysis*. P.A. Sagel, J.M. Miller, M.E. Rubush (Procter and Gamble Co., Cincinnati, Ohio), R. Armstrong (Sun Sabre Software).

Statistical Analysis

A paired comparison of means and standard deviations was performed for percent plaque removed when brushing with water alone versus brushing with Crest dentifrice. Statistical significance was established at a p value less than or equal to 0.05%.

RESULTS

Treatment performance was based on the percent reduction in overall plaque coverage after treatment. Percent plaque coverage reduction is calculated as:

$$\frac{\text{Pre-treatmnt plaque pixels} - \text{Post-treatmnt plaque pixels}}{\text{Pre-treatmnt plaque pixels}} \times 100$$

These data show that brushing with a dentifrice is significantly more effective than brushing with water alone for overall facial surface plaque reduction. The results are outlined below in Table 1.

Table 1. Mean Percent Plaque Reduction (Standard Deviation)

Treatment	N	% Plaque Removed
Crest Complete	9	40.7
with water		(28.3)
Crest Complete	9	68.4*
with Crest dentifrice		(25.0)

* denotes statistical significance at p<0.05

CONCLUSION

These data show that brushing with Crest Complete in combination with Crest dentifrice provides a significant improvement in overall plaque reduction compared to brushing with Crest Complete and water alone.