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Stain removal

In-vitro study

In-vitro pellicle-stain removal efficacy of Philips Sonicare A3 Premium All-in-One and C3 Premium Plaque Control brush heads versus manual toothbrush

Gerhardt L, Gottenbos B, Horstman P, Ummadi J, Hovenkamp R, Balakrishnan A, Mirza F, Starke M

Philips Research, NL; Philips Oral Healthcare, USA
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Objective

The objective of this study was to evaluate stain removal efficacy in vitro of the A3 Premium All-in-One and C3 Premium Plaque Control brush heads relative to Colgate Classic adult manual toothbrush in a seven-day brushing simulation on stain induced pellicle models.

Methodology

Human saliva was used as basis for the pellicle-stain model, black tea as staining agent on a plastic substrate. The staining process was performed over seven days with saliva and tea layers per pellicle built up over a 24-hour period. The initial shade levels for all samples were fixed at M3.5 per the VITA Bleached Guide 3D-Master shade guide (VBG).

Fifteen pellicle samples were divided into three experimental groups (n=15). Each experimental group was treated with one of the below brush heads:

1. Philips Sonicare A3 Premium All-in-One brush head
2. Philips Sonicare C3 Premium Plaque Control brush head
3. A flat-trim manual toothbrush

Both Philips Sonicare A3 Premium All-in-One and Philips Sonicare C3 Premium Plaque Control brush head were used with a Philips Sonicare DiamondClean Smart electric toothbrush handle operated in the Clean mode and in highest intensity under a brush load of 1.5 N. The toothpaste used for the study was Crest Cool Mint Gel (Lot: 816951, expiry date: March 2021). The toothpaste slurry consisted of one-part toothpaste and three parts distilled water: (w/w%). The brush heads were dipped in slurry for 10 seconds.

A custom brushing mount was used to treat stained substrates at times equivalent to 0.25-day, 0.5-day and 1.5-day of treatment (one day = 2 uses). A back-and-forth motion was applied at a controlled normal load, angle and motion simulating use case conditions for 0.25, 0.5 and 1.5 days of anterior tooth brushing.

After the brushing experiment, the efficacy of the cleaning process was determined by color difference measurements using a microscope and CCD camera operated under standardized and polarization filter-controlled lighting conditions. Stain removal efficacy was gauged using two stain color change-based metrics. The measured color difference (Delta B) between pre- and post-brushing tribology experiments was used to calculate % stain color reduction. This metric is indicative of the change in stain thickness. Stain volume removed was calculated as the product of change in stain color 'Delta B' and stain width 'w'. The stain volume removed metric is indicative of the change in area and change in thickness of the stain. Stain volume removed metric is non dimensional in nature.

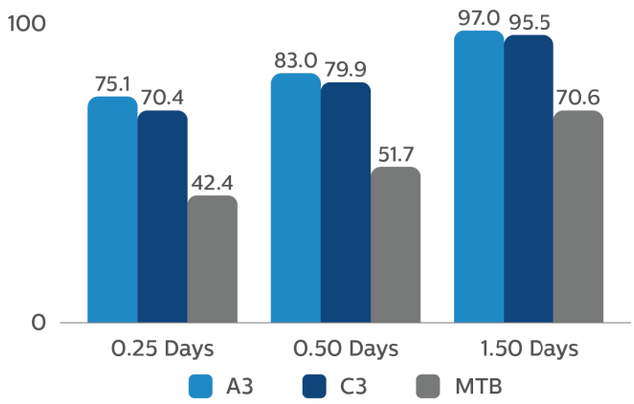
The data was analyzed statistically, and regression fits were applied to calculate % stain color reduction and stain volume removed.

Results

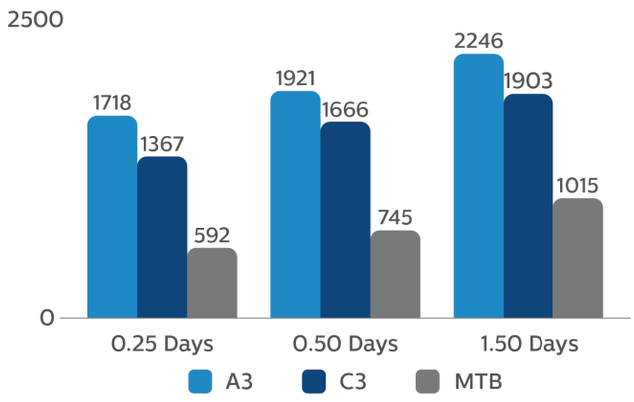
Figure 1 below depicts the % stain color reduction and the stain volume removed trends relative to duration of treatment (by brush head type). The % stain color reduction data shown in Figure 1 was used to estimate the performance of A3 relative to a manual toothbrush.

Figure 1:

Stain color reduction
Mean of % stain color reduction



Stain volume removed
Mean of stain volume (delta B xW)



Based on statistical prediction, the % stain color reduction was estimated for two days (one additional brushing session after 1.5 days). The % stain color reduction data shows that at two days, up to 100% of stains are removed.

The stain volume removed data shows that for A3, the average stain volume removed at 0.25 days and 1.5 days were 1718 and 2246 respectively. For MTB, the average stain volume removed at 0.25 days and 1.5 days were 592 and 1015 respectively. Hence, at 0.25 days, the stain volume removed by A3 is 190% more than that removed by MTB. At 1.5 days, the stain volume removed by A3 is 121% more than that removed by MTB. Thus, in less than two days, the total stain volume removed by A3 ranged between 121-190% more than that removed by a manual toothbrush.

Percent stain color reduction and stain volume removed trends show that both A3 and C3 perform statistically significantly better than MTB (p value < 0.05). In terms of stain volume removed, A3 performs statistically significantly better than both C3 and MTB (p value < 0.05).

Conclusions:

Stain removal efficacy of a Philips Sonicare A3 Premium All-in-One brush head was measured over 1.5 days using percent stain color reduction and stain volume metrics. The percent stain color reduction and stain volume removed data shows that in two days, the Philips Sonicare A3 Premium All-in-One brush head removes up to 2 times more stains than a manual toothbrush.

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