

In-vitro plaque removal by Quad Stream and Standard nozzles tested on a Philips Sonicare Cordless Power Flosser

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Study completed in 2021

Objective

The objective of this study was to determine the levels of in-vitro plaque removal by the Quad Stream and Standard nozzles, when used on a Philips Sonicare Cordless Power Flosser.

Methodology

Dental plaque biofilms were grown from pooled human saliva on enamel disks for four days. The biofilms (n=6 samples per nozzle) were treated with Philips Sonicare Cordless Power Flosser for three seconds at setting 3 in Clean mode. Two nozzles were tested—Quad Stream and Standard. Both nozzles were positioned at a distance of 3 mm from the biofilm sample.

To quantify the number of bacteria before treatment, the biofilm volume was measured using optical coherence tomography (OCT) and the bacterial cell density was determined from untreated control samples (n=6) using confocal laser scanning microscopy (CLSM). After treatment, the number of remaining bacteria was counted using CLSM. From the cell density and the biofilm thickness measurements before and after treatment, the % plaque removal was calculated.

Results

Before treatment, the thickness of plaque biofilm was 0.35 ± 0.16 mm on average. The cell counts in the non-treated biofilm images ($77.5 \mu\text{m} \times 77.5 \mu\text{m}$) were 3081 ± 665 (mean \pm standard deviation), leading to cell densities of $3.7 \pm 0.9 \times 10^8$ cells per mm^3 . Figure 1 shows full 3D OCT scans of a sample before treatment (upper left image, size is $4 \times 4 \times 1$ mm) and after treatment with the Quad Stream nozzle (upper right). 2D OCT cross-sections (bottom image, size = 4×1 mm) show that the thickness of the plaque was approximately 0.35 mm before treatment. No plaque biofilm is visible after treatment (bottom right image).

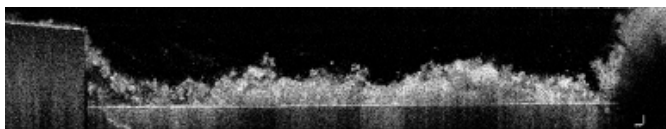
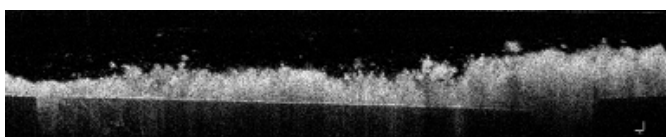
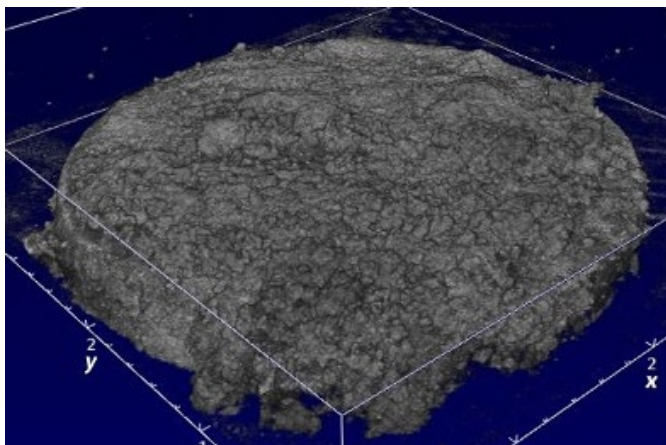
Table 1 shows the plaque removal data. The calculations for biofilm volume removal show that:

- A. With the Quad Stream nozzle, the average biofilm removal measured was 99.98% with a standard deviation of 0.01%.
- B. With the Standard nozzle, the average biofilm removal measured was 99.96% with a standard deviation of 0.03%.

Figure 1:

3D OCT scans of enamel samples (untreated on left and treated with Quad Stream nozzle on right)

Before treatment



After treatment

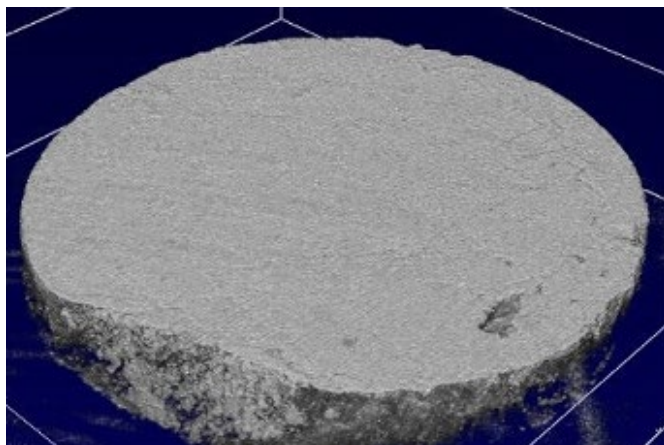


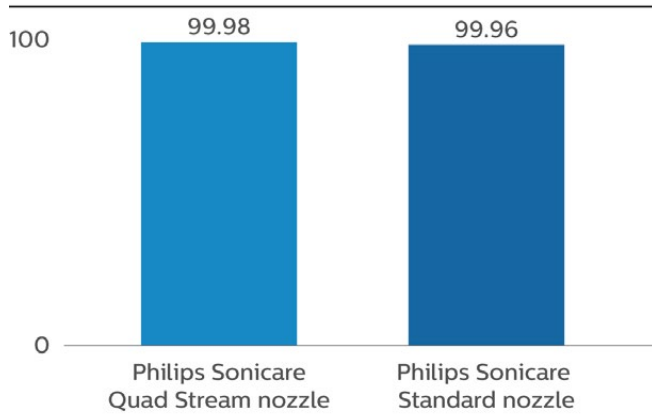
Table 1:

Plaque removal statistics: Quad Stream and Standard nozzle data

Sample	Biofilm thickness		Pre # cells/mm ²		Post # cells/mm ²		% Biofilm removal	
	Quad Stream	Standard	Quad Stream	Standard	Quad Stream	Standard	Quad Stream	Standard
1	0.334	0.201	9.17E+07	1.24E+08	2.34E+04	2.47E+04	99.974	99.980
2	0.297	0.175	1.84E+08	1.10E+08	4.78E+04	1.01E+05	99.974	99.908
3	0.405	0.308	9.18E+07	1.50E+08	2.97E+04	6.55E+03	99.968	99.996
4	0.248	0.310	1.15E+08	7.43E+07	2.63E+04	1.89E+04	99.977	99.975
5	0.496	0.777	2.88E+08	6.47E+07	1.53E+04	3.57E+04	99.995	99.945
6	0.248	0.450	1.67E+08	1.14E+08	7.46E+03	4.50E+04	99.996	99.961
Average	0.34	0.37	1.56E+08	1.06E+08	2.50E+04	3.86E+04	99.98	99.96
SD	0.10	0.22	7.51E+07	3.17E+07	1.38E+04	3.33E+04	0.01	0.03

Figure 2:**Plaque removal**

% Biofilm removal

**Conclusions**

The in-vitro plaque removal efficacy of Philips Sonicare Cordless Power Flosser, when used with the Quad Stream nozzle and the Standard nozzle, was characterized via OCT/CLSM on a plaque biofilm model. The measured plaque removal by both Quad Stream nozzle and the Standard nozzle was 99.9%.

