

# In Vitro Evaluation of the Interproximal Penetration of Four Manual Toothbrushes

D.W. Volpenhein<sup>2</sup>, Gräber<sup>\*1</sup>, W.F. Landrigan<sup>2</sup>

<sup>1</sup>Klinikum der RWTH, Aachen, Germany; <sup>2</sup>Procter & Gamble Co., Mason, OH, USA

## SUMMARY SENTENCE

An *in vitro* study of a new "wave profile" manual toothbrush with raised perimeter bristles showed superior interproximal penetration both overall and at the gumline relative to three German manual toothbrushes.

## BACKGROUND

Mechanical scrubbing of the tooth surfaces via the action of toothbrush bristles is essential for the removal of plaque. However, effective plaque removal interproximally can be difficult with traditional, "flat profile" manual toothbrushes. Manufacturers have been striving to develop improved bristle tuft designs to facilitate better plaque removal in these hard to reach areas. One such toothbrush has been developed for Germany which utilizes a "wave profile" bristle pattern and raised bristles on the perimeter of the brush head.

The "wave profile" brush was evaluated in an *in vitro* penetration model relative to three other German brushes. This model was developed by Volpenhein (1994, *J Clin Dent*) to measure the interproximal penetration effectiveness of various toothbrush bristle designs.

## PRODUCTS TESTED

The new "wave profile" brush (blend-a-dent<sup>®</sup> Professional) was tested twice in this study; first vs. Oral B<sup>®</sup> Advantage (with a full size head), and then vs. Oral B<sup>®</sup> 35 and Dr. Best (both compact heads). Interproximal penetration was measured both overall and at the gumline.

## PROTOCOL

Tooth numbers 12, 13, 14 and 15 from the maxillary left quadrant of a Columbia Dentoform (Model #R861) were coated with artificial plaque solution, then placed in the dentoform, which was secured to a brushing machine. The brushes were wetted and fastened to the brushing arm of the machine at the desired angle. Teeth were wetted with 0.1 ml of water, brushed for 10 seconds, rinsed with 5 ml of water,

then allowed to dry. The teeth were removed from the dentoform, and each of the six interproximal surfaces (mesial of the second molar-tooth #15, distal and mesial of the first molar-#14, distal and mesial of the second premolar-#13, and distal of the first premolar-#12) was evaluated. *In vitro* penetration was measured using four different brush strokes (back-and-forth at 45° and 90°, and up-and-down and circular at 90°).

A Windows-based image analysis system (Optimas) was used to measure plaque removal/penetration on the interproximal surfaces. Each tooth was secured in a holder for consistent repositioning and an image of the appropriate surface was captured. Macros were created to calibrate, generate masks, and acquire and store measurement areas. Masks are areas of interest within which the analysis occurs for each image. The area of interest for each interproximal surface was defined as the area bordered by the gumline, the line-angle, the occlusal surface and the midline of the tooth (see photos). Contrast between areas with and without stain was used to quantify the degree of penetration/cleaning. This was done both for the overall interproximal area, as well as for a 1 mm wide band above the interproximal gumline. Results are based on the average interproximal area penetrated (for the six interproximal surfaces, tested with each of the four brush strokes). An analysis of means model and student's t test were used to determine significance.

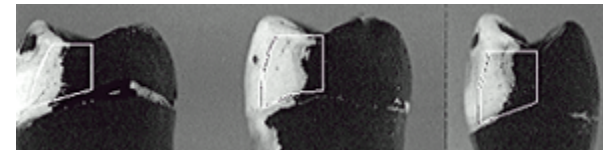
## RESULTS\*

Test #1: Products	Overall Penetration	Gumline Penetration
blend-a-dent <sup>®</sup> Professional	6.35 ± 0.3**	1.56 ± 0.14**
Oral B <sup>®</sup> Advantage	4.21 ± 0.45	0.89 ± 0.13
Test #2: Products	Overall Penetration	Gumline Penetration
blend-a-dent <sup>®</sup> Professional	6.19 ± 0.84**	1.78 ± 0.37**
Oral B <sup>®</sup> 35	4.20 ± 0.65	1.07 ± 0.23
Dr. Best	3.81 ± 0.52	0.96 ± 0.15

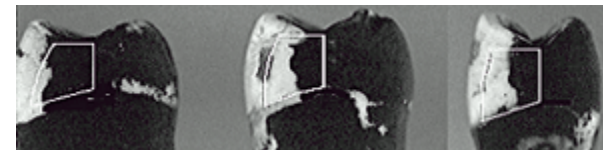
\* Results are mean values (sq mm X 10<sup>-4</sup>) ± s.d.

\*\* Mean values are significantly greater (two-tailed test; alpha = 0.05) than the corresponding mean values for the other brush(es) in each test

blend-a-dent<sup>®</sup> Professional



Oral B<sup>®</sup> Advantage



## CONCLUSION

The new blend-a-dent<sup>®</sup> Professional brush, with the improved wave profile and longer outer bristles, provides significantly better interproximal penetration/cleaning both overall and at the gumline relative to three other popular German toothbrushes. These results are consistent with previous research on interproximal penetration of the new blend-a-dent Professional brush vs. "flat profile" brushes (most recently the study reported by de Bruyne at the European Academy of Paediatric Dentistry, Bruges, Belgium, June, 1996).