

Clinical validation of robot tested toothbrushing of deciduous dentition

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Objectives:

Computer-assisted planimetric plaque assessment for clinically validated robot toothbrushing programmes of permanent dentition was developed (Gaengler et al. JDR 92 Spec. Iss, 3326). It was, consequently, the aim (i) to validate clinically a robot simulation of toothbrushing in deciduous teeth, and (ii) to develop and test a planimetric plaque index for deciduous teeth.

Methods:

Clinical study - After ethical approval a randomized, single (examiner) blind, single centre crossover study in 25 children aged 6-8 years using two different children’s toothbrushes A (Signal Junior) and B (Oral-B Stages 3) was executed. After 48h refraining from toothbrushing, the calibrated dentist brushed their teeth 72-85 (+46) horizontally under video-support, brushing-force 3.5 N, for 15 s buccally and 15 s lingually. Plaque was disclosed (Mira-2-Ton, Hager&Werken, Duisburg, Germany) and photo documented before and after brushing, assessed by two blinded examiners according to a new planimetric index with 5 fields per smooth surface in deciduous teeth.

Robot study - All brushing conditions (movement, force, time, planimetric fields) were transferred to a 6-axis-robot (Kawasaki, Japan), artificial deciduous teeth (Frasaco, Tettnang, Germany) were covered with plaque simulation substrate. After brushing with the toothbrushes A and B (n=7, a new toothbrush was used for every cycle) the teeth were transferred to the computer-assisted planimetric plaque assessment device (percentage of plaque removal per field). Clinical vs. robot data were statistically evaluated (modified t-test, U-test, Wilcoxon test, p<0.05).

Results:

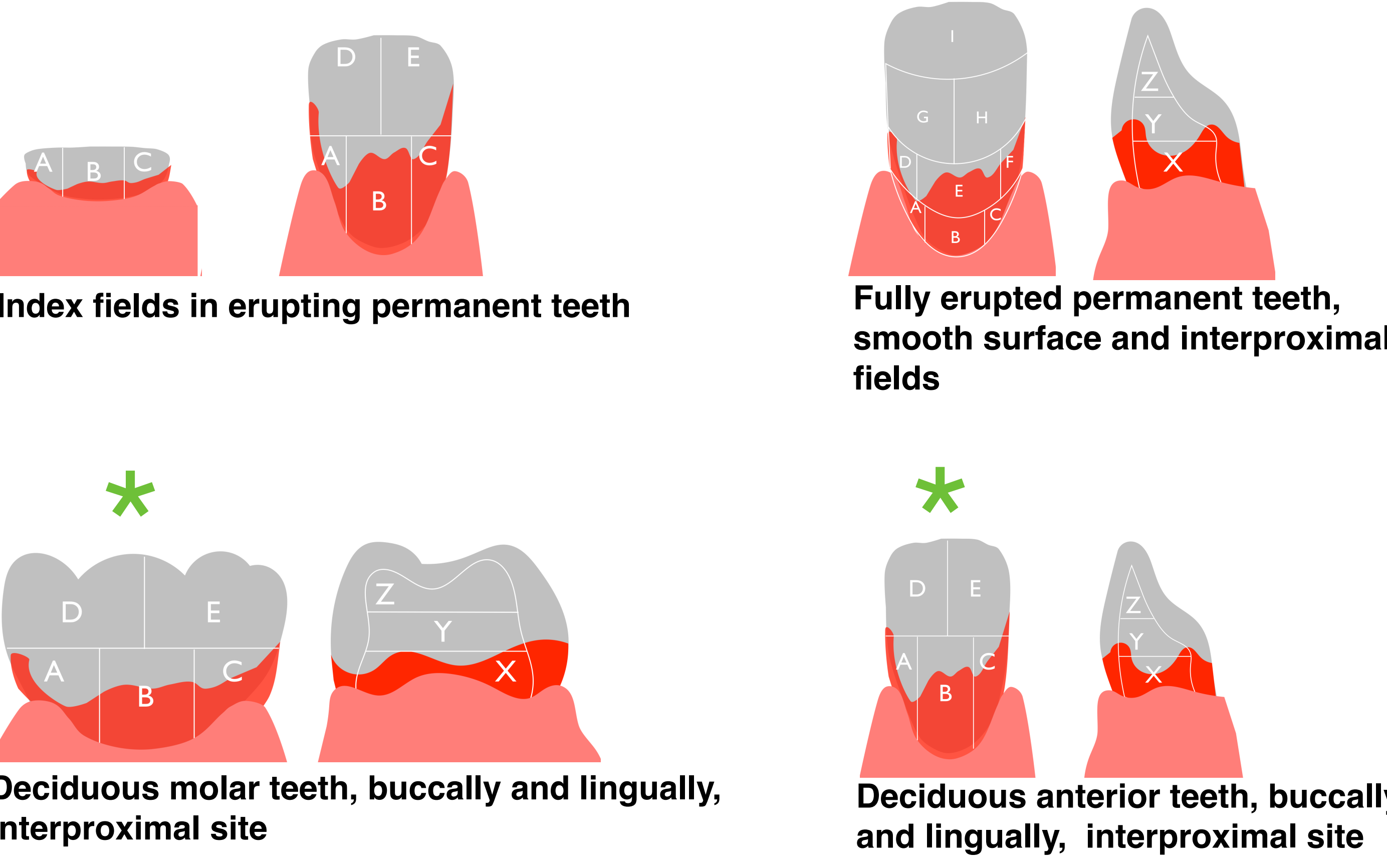
Total clinical cleaning efficacy of toothbrush A and B was 71.5% and 74.6% (p(t)=0.52), total robot brushing efficacy was 65.7% (A) and 77.6% (B) (p(t)=0.03). Further investigation has shown that differences in mean values for robot brushing efficacy were influenced by 10 out of 79 planimetric fields. In contrast to the clinical application the robot movements are exactly standardized and the 10 fields were due to their morphology less cleaned. Therefore, the robot demonstrates standardized brushing efficacy in morphologically complicated areas. At all other planimetric fields the robot provided statistically the same results compared with clinical data.

Conclusions:

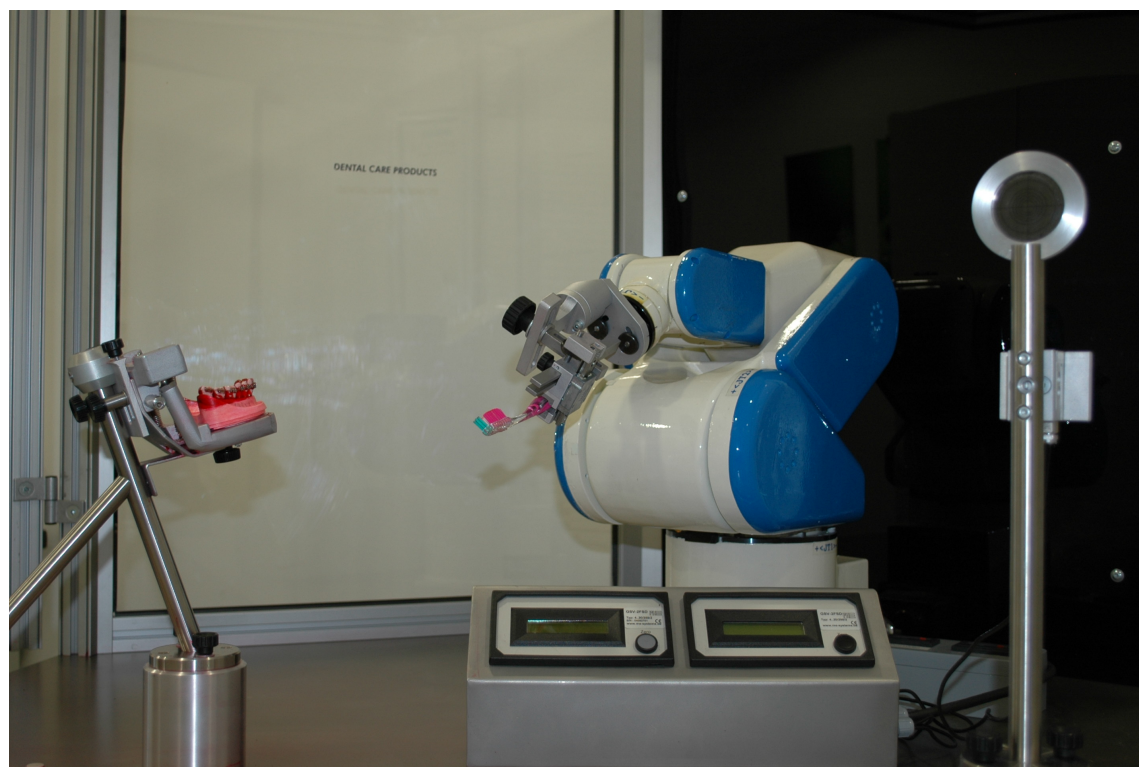
The new planimetric children’s plaque index demonstrates toothbrushing efficacy. The clinical outcome is well reproduced by the robot programme. Therefore, the robot test is recommended for rapid, reproducible laboratory testing of toothbrushes.

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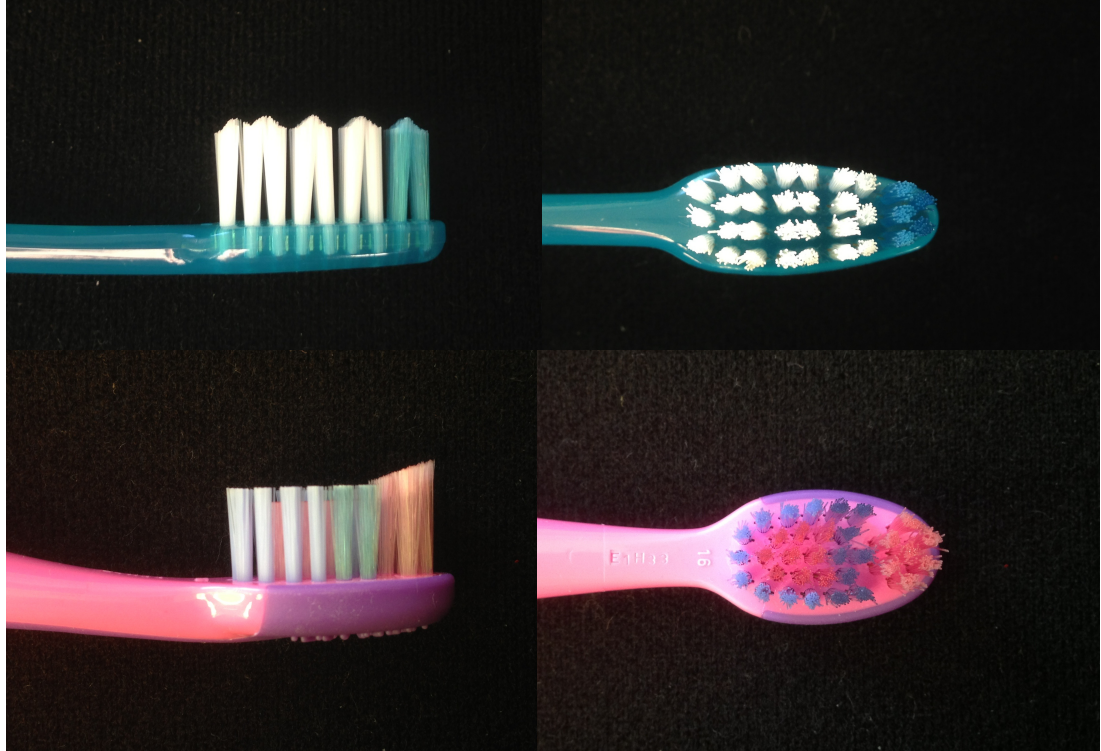
New planimetric index fields in deciduous dentition and mixed dentition (Lang and Gaengler, 2012)



Planimetric fields used for the validation study



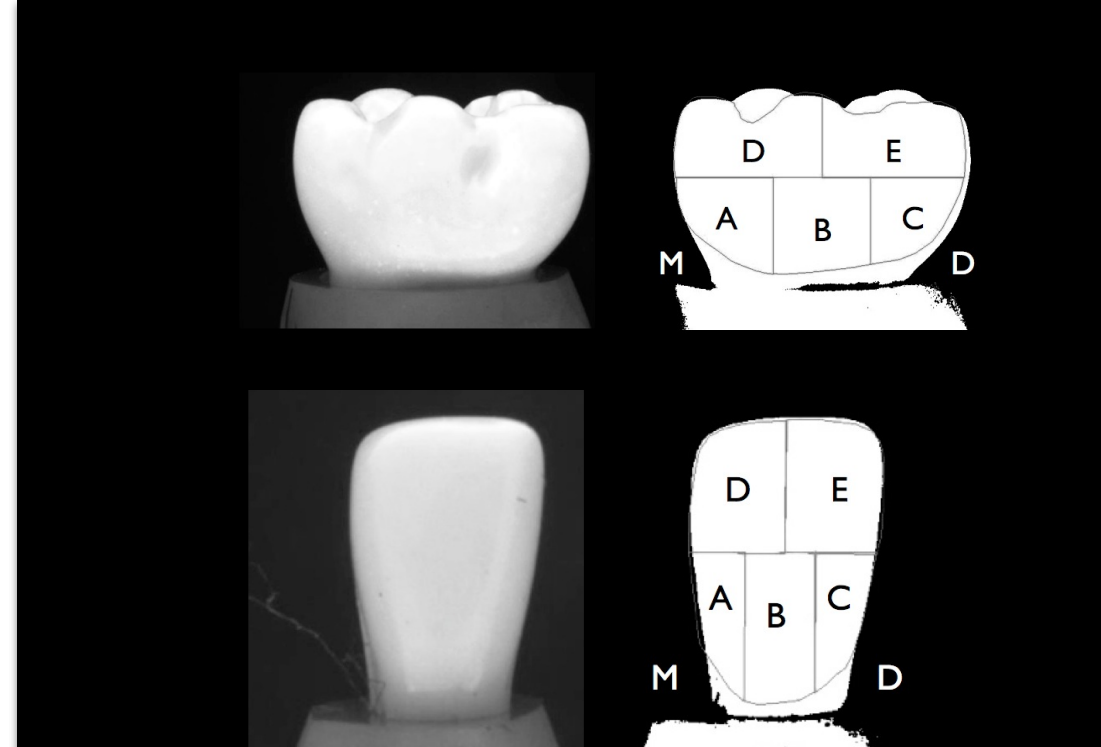
Robot device



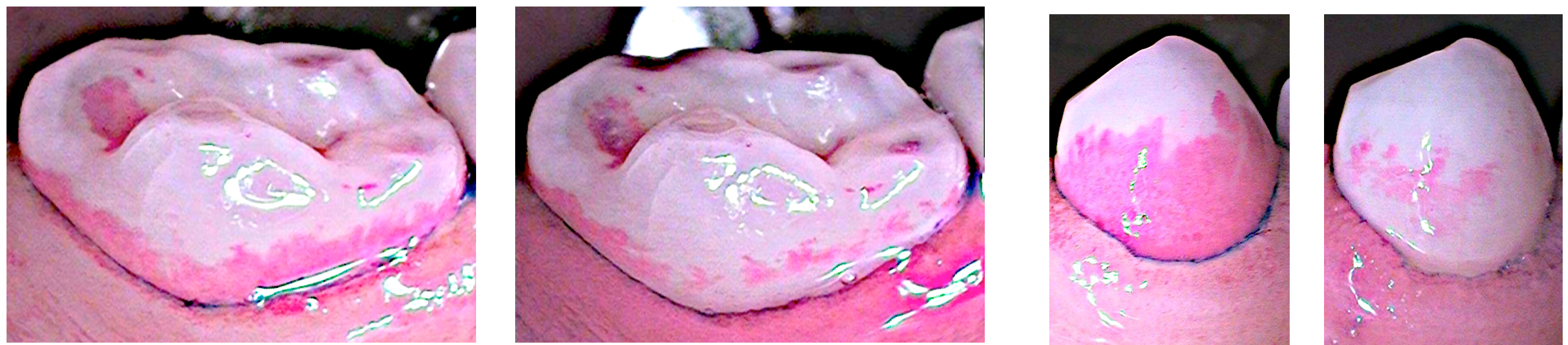
Brush A: Signal Junior (Unilever)
Brush B: Oral-B Stages 3 (P&G)



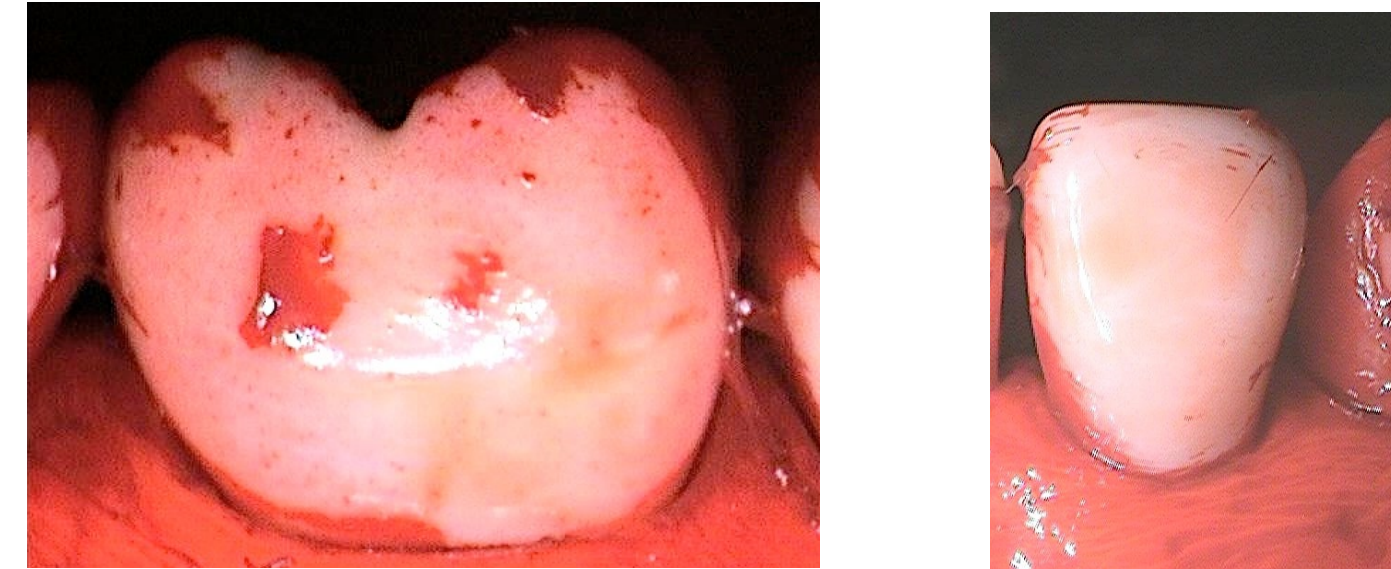
Automated Plaque Planimetry device (APP)



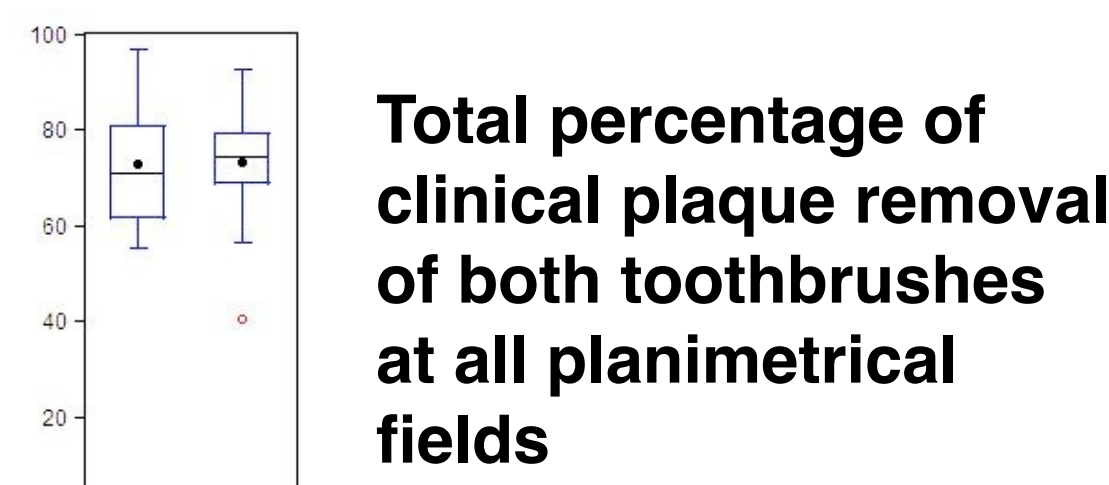
Planimetric fields on a deciduous molar and incisor (buccal view, M - mesially, D - distally)



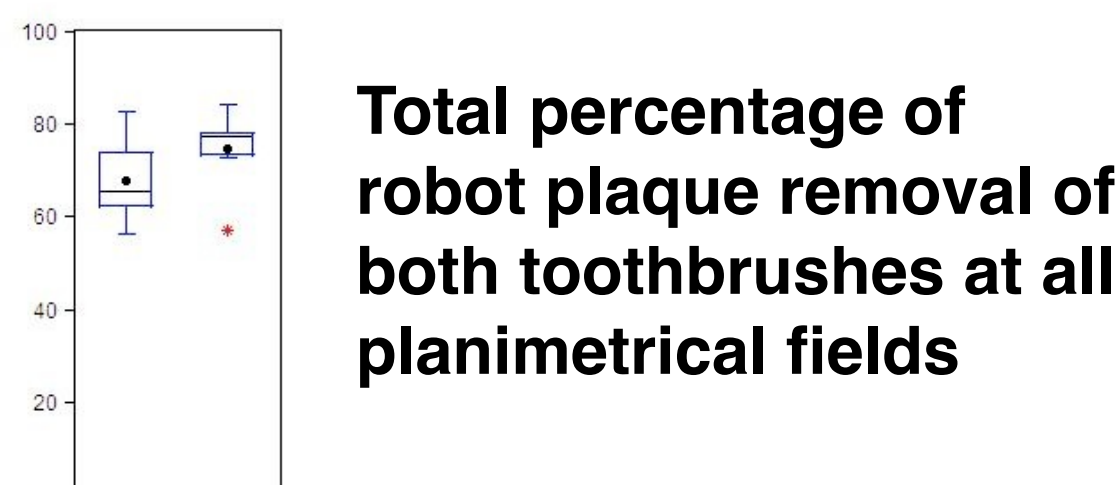
Revealed plaque before and after clinical brushing of a deciduous molar and canine



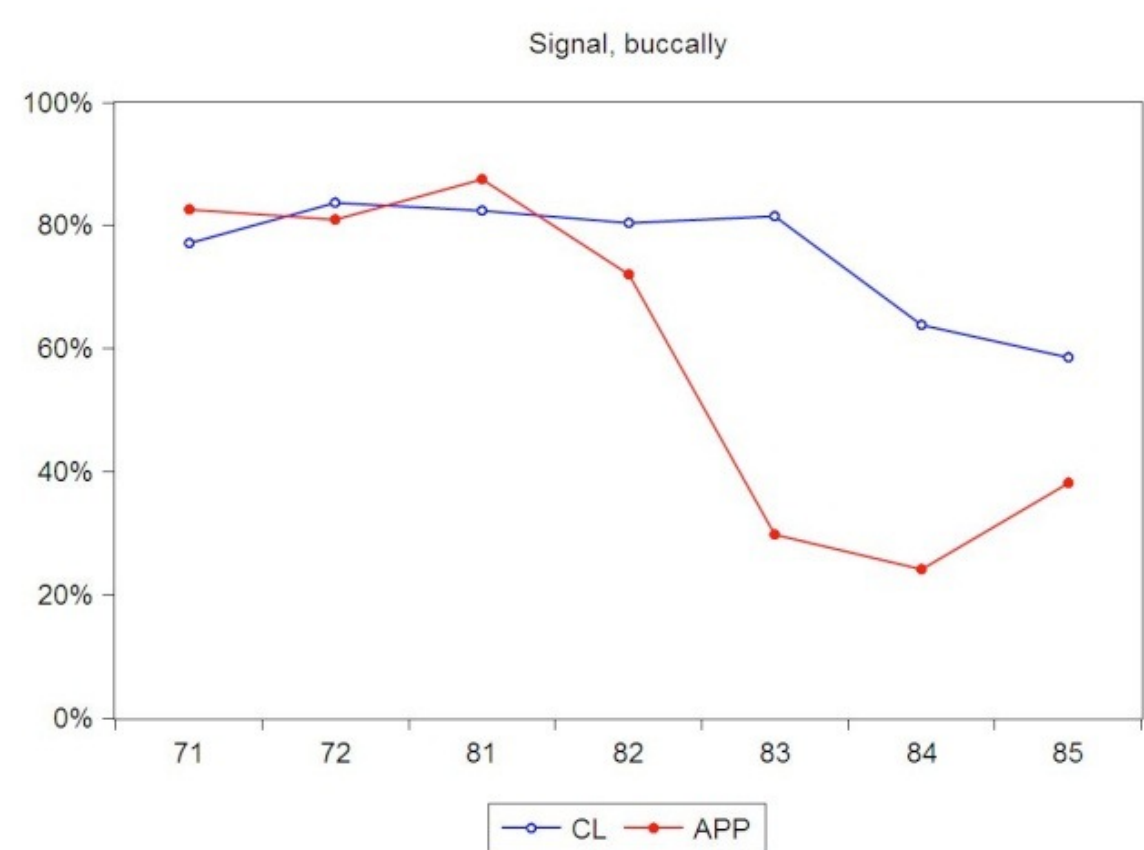
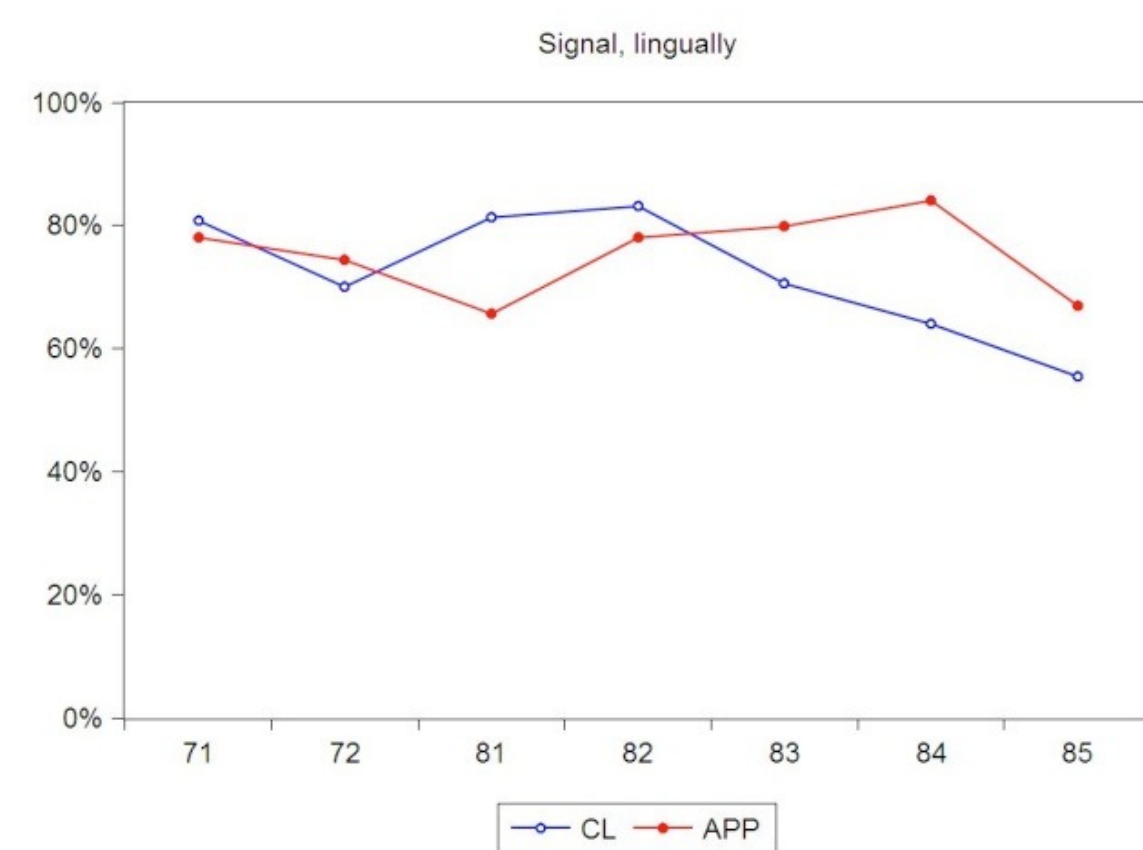
Residual plaque after robot brushing of a deciduous molar and incisor



Total percentage of clinical plaque removal of both toothbrushes at all planimetric fields



Total percentage of robot plaque removal of both toothbrushes at all planimetric fields



Mean percentage of clinical versus robot plaque removal tooth by tooth for both toothbrushes Signal and Oral-B at the two smooth surface sites (CL - clinical planimetry; APP - robot planimetry).
Brushing efficacy at three deciduous teeth (83 - 85) for toothbrush Signal buccally is clinically different due to the brush head design (10 out of 79 planimetric fields are involved).

	Signal (CL)	OralB (CL)	Signal (APP)	OralB (APP)	test	prob (test)	sign. (p=0,05)
mean	x	x			t=-1,17	0,25	no
median	x	x			W=1,21	0,23	no
mean			x	x	t=1,01	0,32	no
median			x	x	U=0,79	0,43	no
mean	x		x		t=0,68	0,51	no
median	x		x		U=0,73	0,46	no
mean		x		x	t=0,73	0,47	no
median		x		x	U=1,17	0,24	no
No statistical differences on lingual sites							

	Signal (CL)	OralB (CL)	Signal (APP)	OralB (APP)	test	prob (test)	sign. (p=0,05)
mean	x	x			t=0,33	0,74	no
median	x	x			W=0,21	0,63	no
mean			x	x	t=4,53	<0,01	yes
median			x	x	U=2,36	0,02	yes
mean	x		x		t=4,34	<0,01	yes
median	x		x		U=3,28	<0,01	yes
mean		x		x	t=-0,01	0,99	no
median		x		x	U=0,13	0,90	no
Statistical differences on buccal sites due to toothbrush A (Signal) at teeth 83 - 85 only							

Tables: Equality tests of brushing efficacy in clinical and robot study lingually and buccally
Explanation: Number of observations: Signal (CL): n=25, OralB (CL): n=24, Signal (APP): n=7, OralB (APP): n=6. (CL): clinical study. (APP): robot study. x: tested variables. t-test: Standard-/SATTERTHWAIT-WELCH-t-test of the mean. U-test: MANN/WHITNEY-U-test of the median. W-test: WILCOXON-test of the median. prob(test): sign. level of the estimated test-value. sign. (p=0,05)= yes: the null hypothesis of an equal mean /median of the series can be rejected at a significance level of 5 %.