In-vitro oral hygiene gel testing using organic plaque simulation

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Objectives:

Gels play an important role in daily oral hygiene for special care patients. Therefore, it was the aim (i) to test the cleaning efficacy of experimental gels in-vitro using a new formulation of organic plaque simulation and (ii) to compare with a dentifrice and with toothbrushes alone.

Material and Methods:

The experimental series consisted of oral hygiene agents being tested with a commercial toothbrush (Dr.Best, GlaxoSmithKline, Bühl, Germany) and an experimental toothbrush for special care patients. The experimental gels A and B were compared with Crest Pro Health Whitening (Procter+Gamble, Cincinnati, USA), Elmex Geleé (GABA, Lörrach, Germany) and the control water-wet toothbrush.

The study dentition of plastic KaVo teeth (Biberach, Germany) in anatomic position was covered with newly developed artificial plaque, consisting of organic material similar to the natural plaque. All 10 teeth were cleaned using brushes, gels or dentifrice, calibrated force 2.0 N and horizontal movement for 40 s. Each cycle was repeated seven times. The percentage of plaque removal at 30 planimetrical fields per tooth was documented by computer-assisted optical planimetry (APP). Cleaning efficacy at single teeth and selected planimetrical fields was statistically compared (Mann-Whitney test, multivariate variance analysis).

Results:

The cleaning efficacy of the experimental toothbrush was superior to the conventional toothbrush, especially in risk fields interproximally, next to gumline, at root surfaces. Dentifrice did not contribute to increased plaque removal, brushing alone was as effective as gel application. The statistical effect power of toothbrush is 72.5% vs. 41.5 % for gels. The plaque removal buccally and lingually ranged max. 46.1 % (incisors) to max. 50.7 % (premolars) and max. 54.4 % (molars), mesially and distally from min. 4.8 % to max. 40.2 %. The mean plaque reduction at root fields ranged from min. 10.0% to max. 26.3%.

Conclusions:

Oral hygiene gels in home care by nursing or family members and in institutionalized nursing are as effective as tooth brushing with water, however, they do not directly contribute to plaque control. Nevertheless they play a crucial role in substituting saliva, in providing bioavailable fluoride and other medicaments, therefore contributing to oral health. Due to the special, anatomic designed toothbrush for special care patients with bristles of different lengths, it is ensured that interproximal spaces and tooth roots can be cleaned effectively.
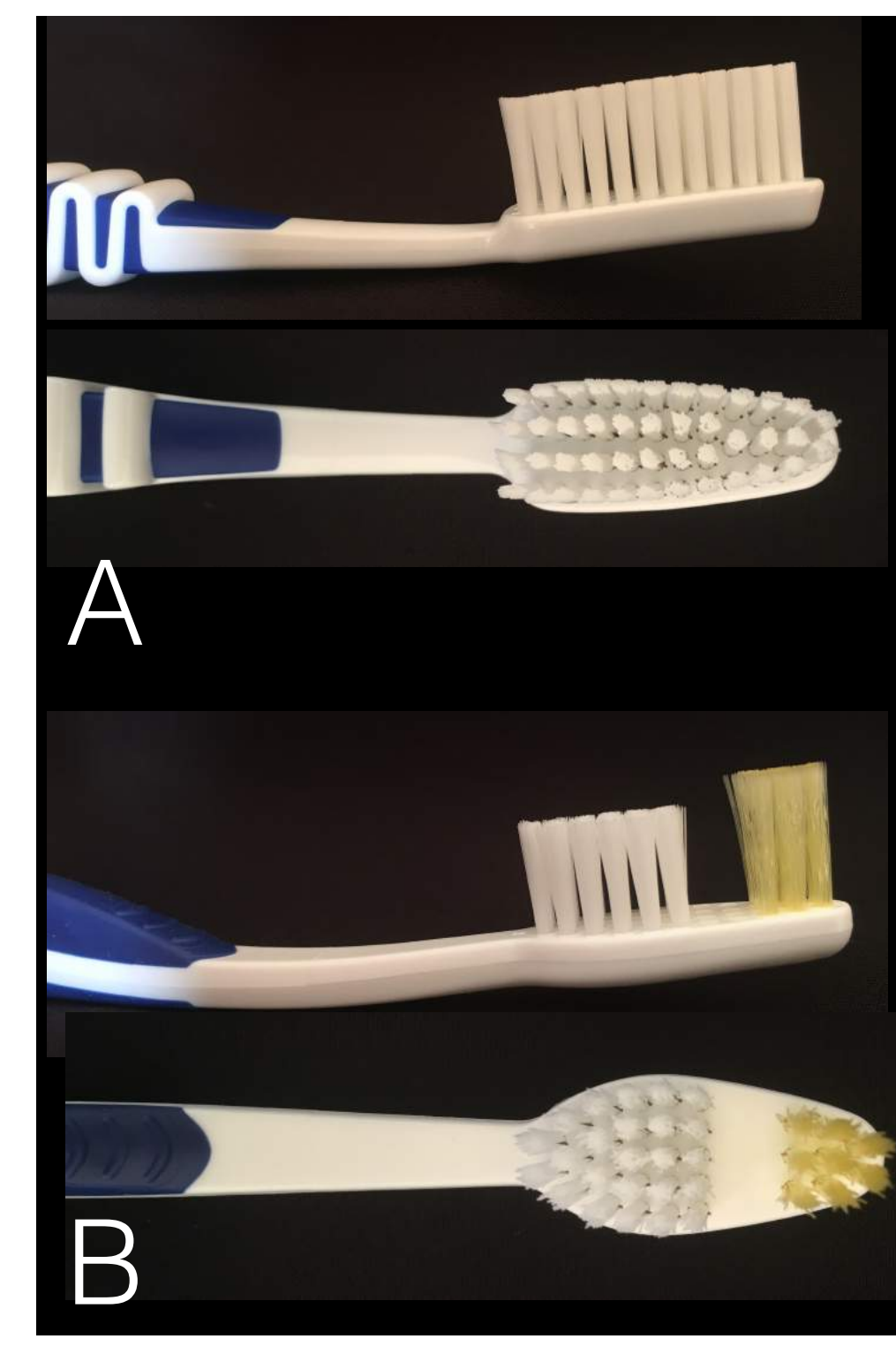
Test Material

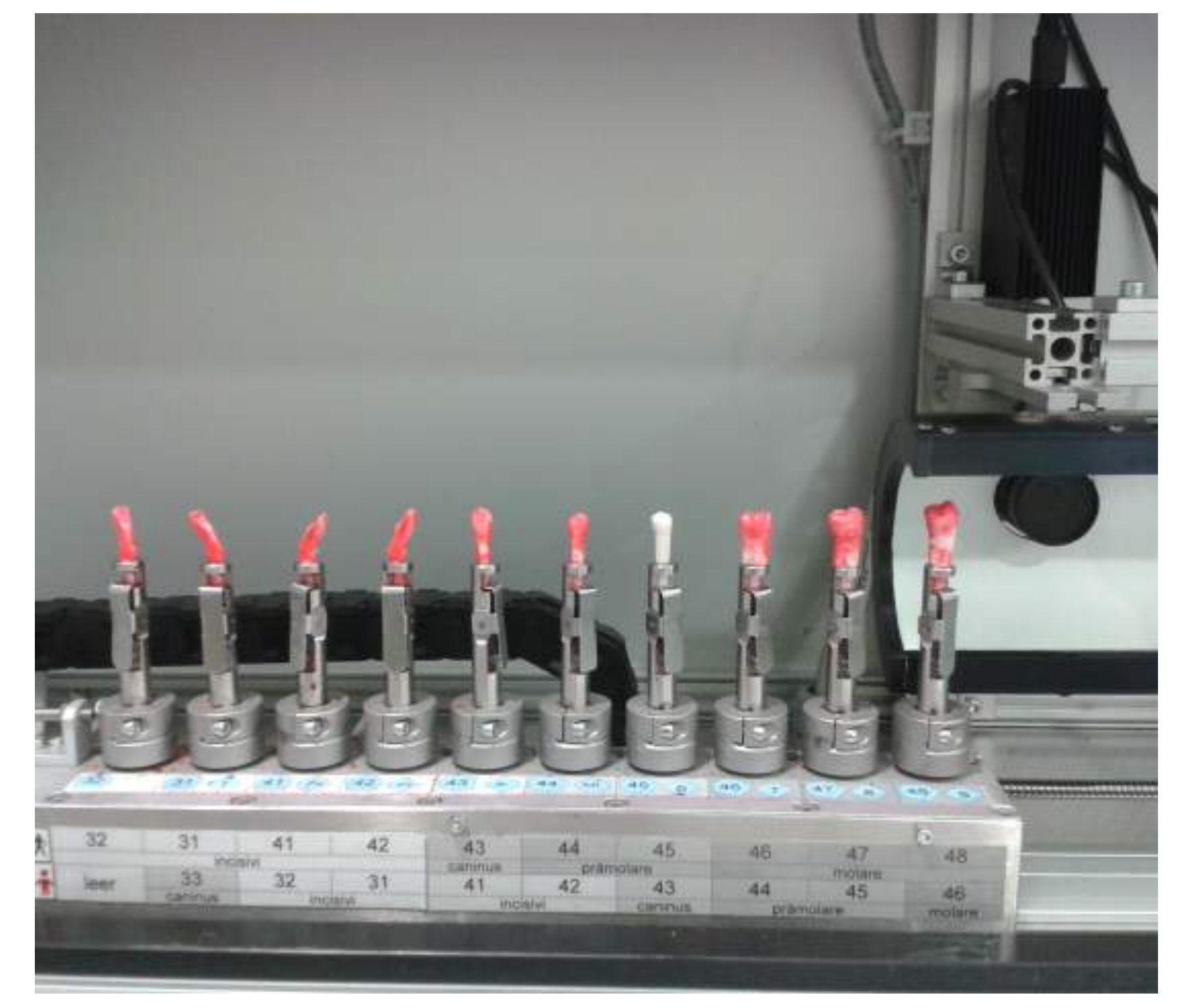**Fig. 1:** Tested toothbrushes Dr. Best Classic (A) and experimental brush (B)

Fig. 2: Automated Plaque Planimetry (APP); view into the black box of site by site rotating test teeth in front of the HD focusing analysis camera followed by computer-assisted processing of data.
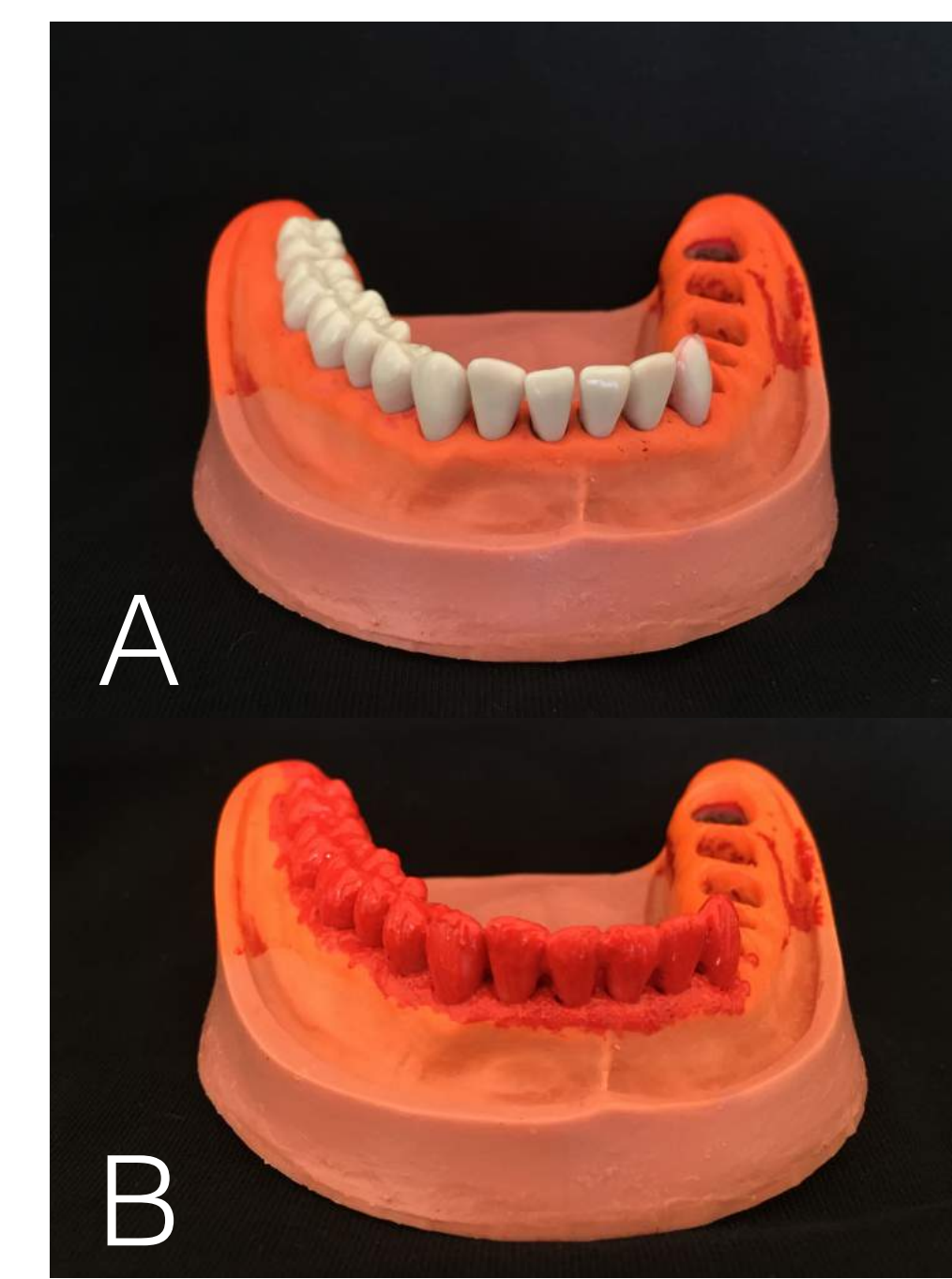

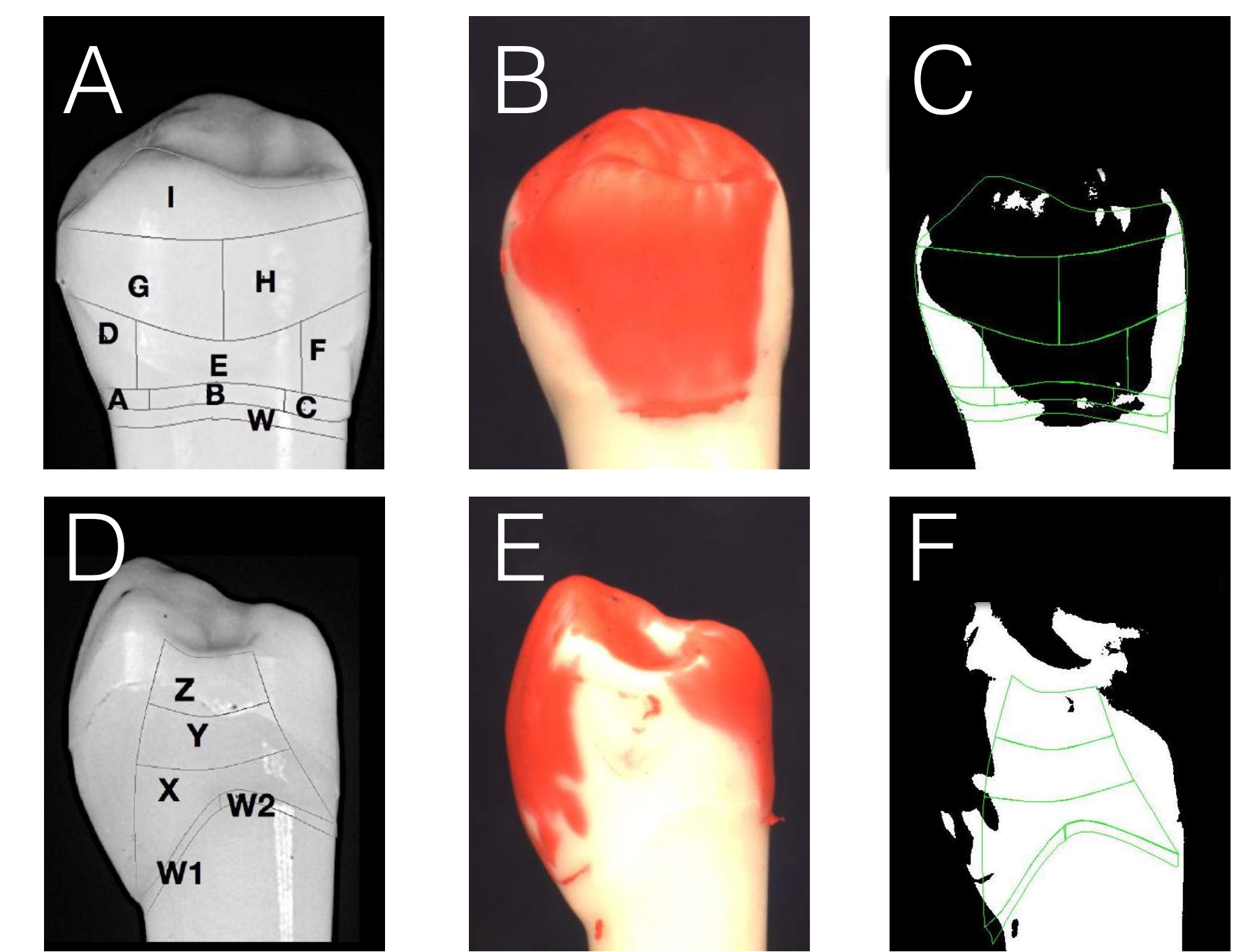**Fig. 3:** Typodont before (A) and after (B) test preparation with organic plaque simulation

Fig. 4: Example of APP assessment with organic plaque simulation: (A) Lingual crown fields (A - I) and one root field (W) at lower premolar, (D) proximal crown fields (X - Z) and root fields (W1 - W2), (B, E) same premolar; clinical view of cleaning efficacy, (C, F) computer-generated image for pixel counting of each planimetrical filed
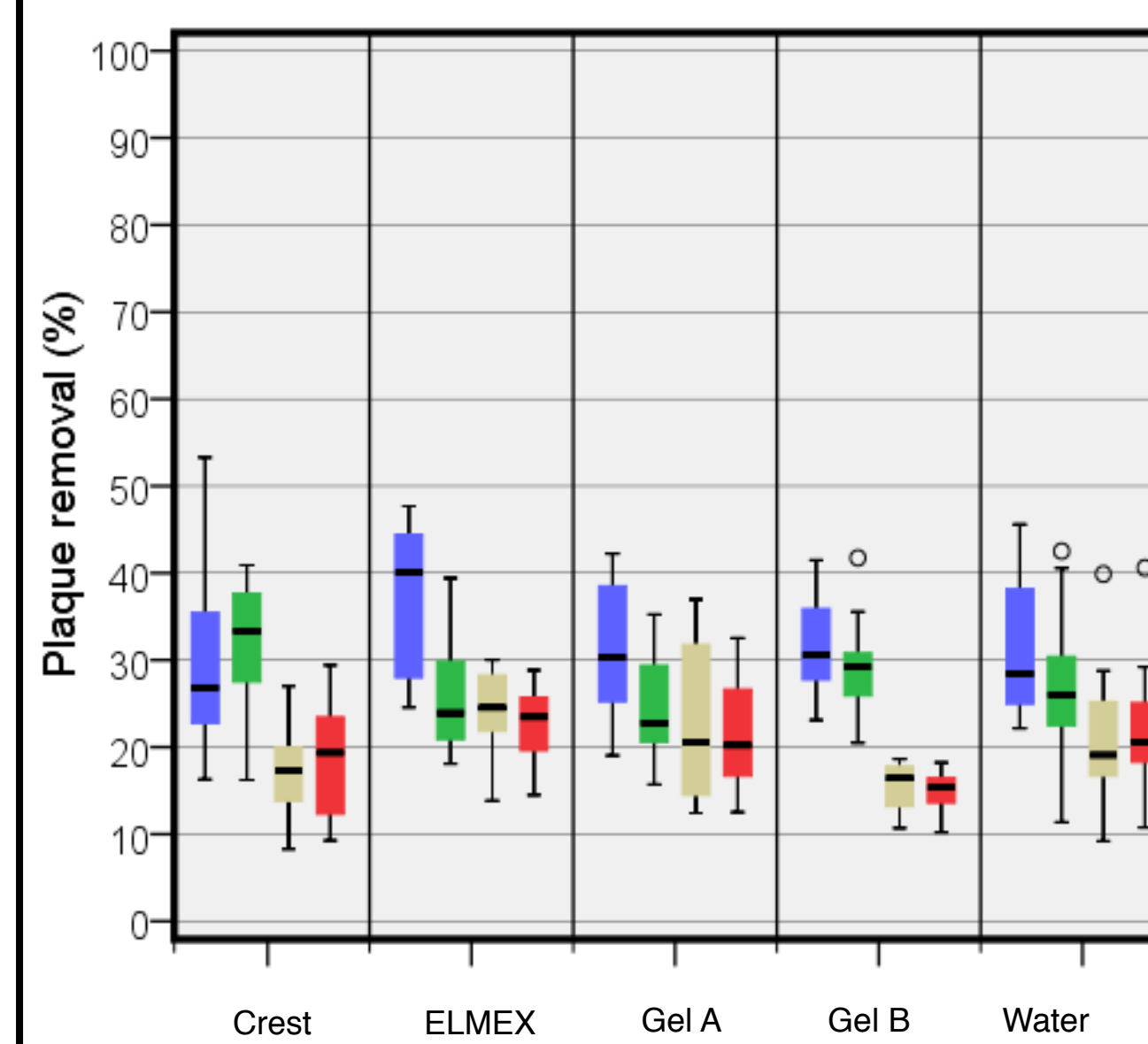

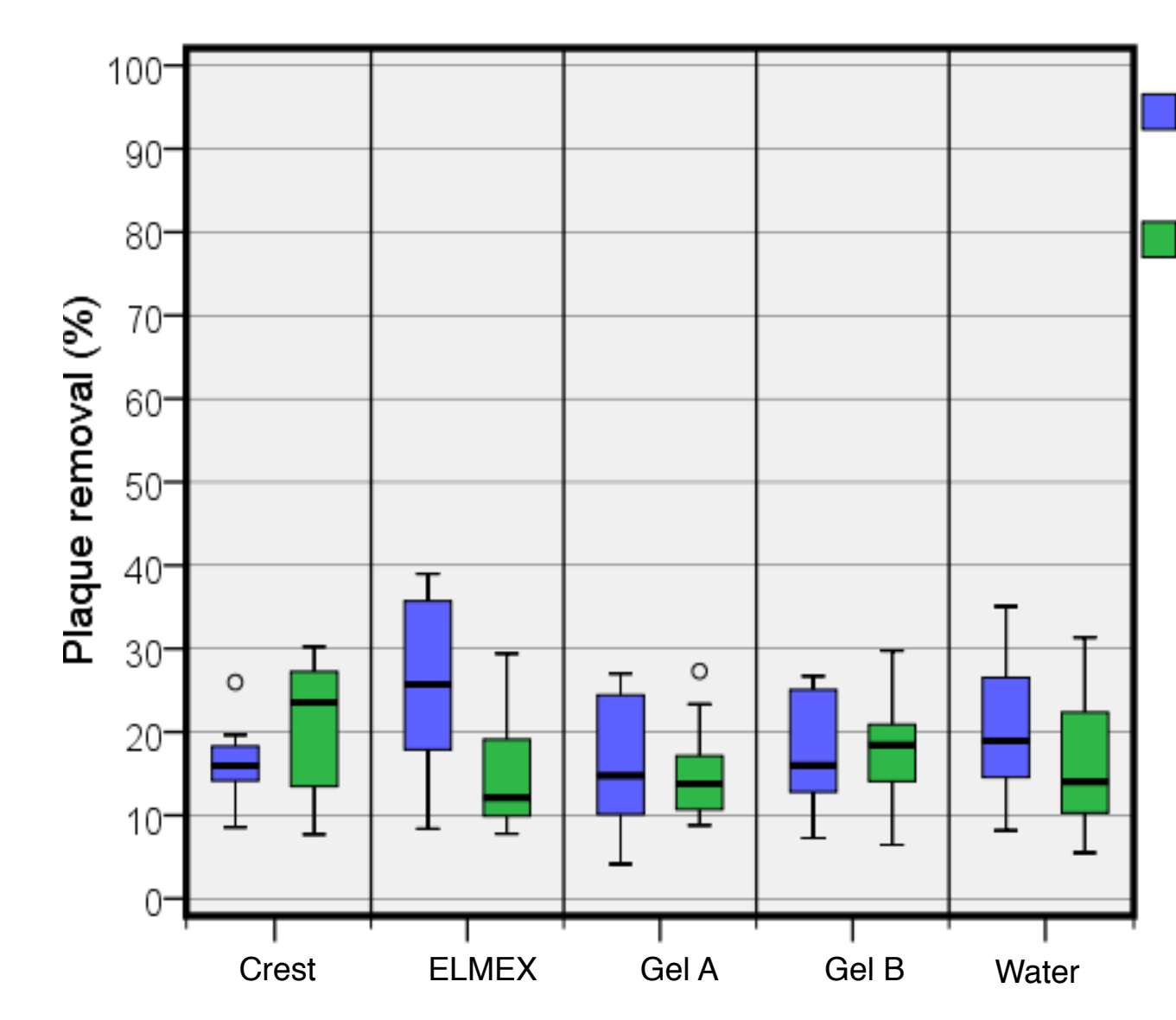**Fig. 5:** Box plots of plaque removal buccally, lingually, mesially and distally for the gels/ H2O

Fig. 6: Box plots of plaque removal at buccal risk fields next to the gum line and at root surface (blue); at lingual risk fields (green) for the gels/ H2O
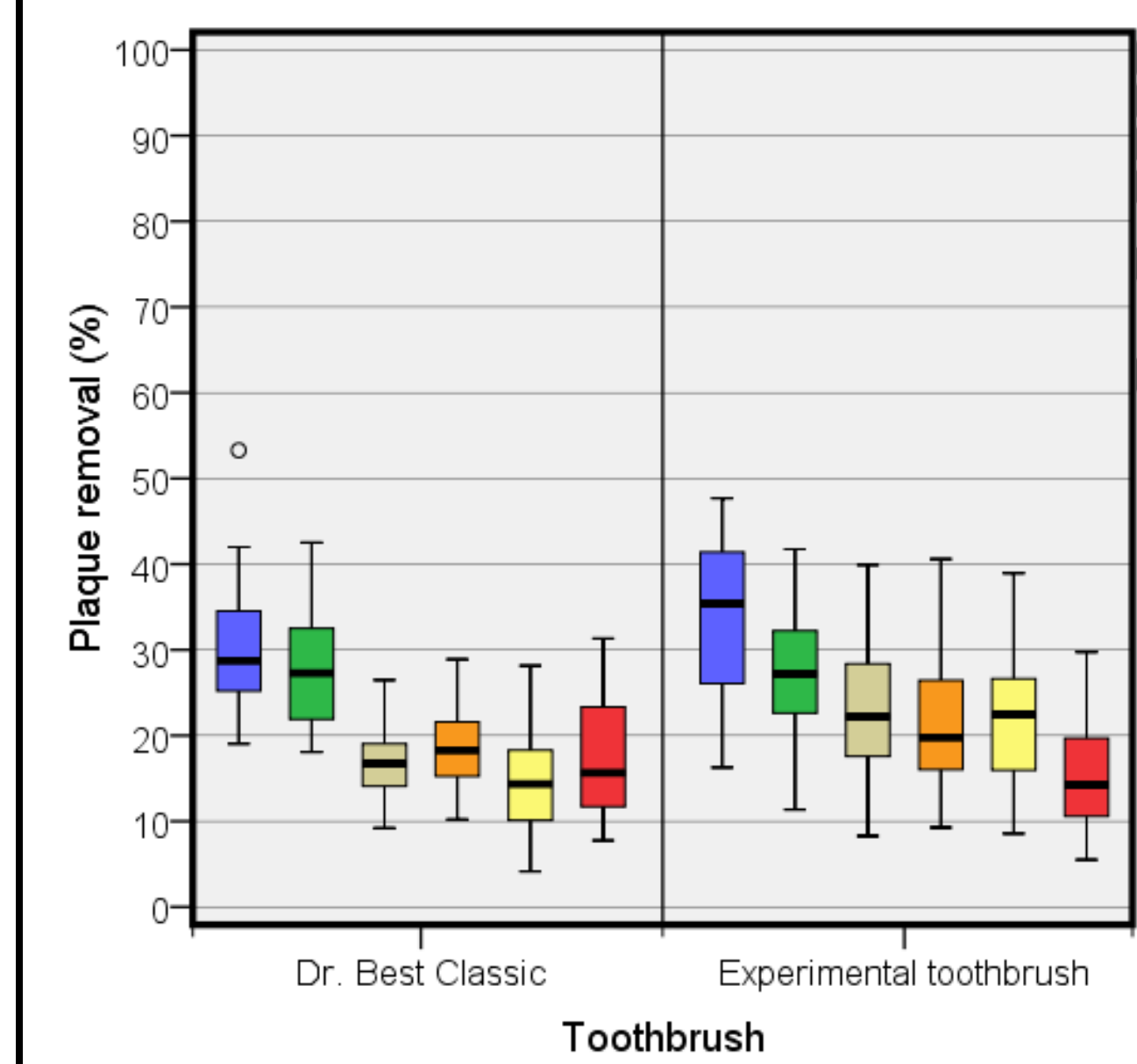

Fig. 7: Differences between the two toothbrushes in plaque removal efficiency at the four tooth sites and two risk fields
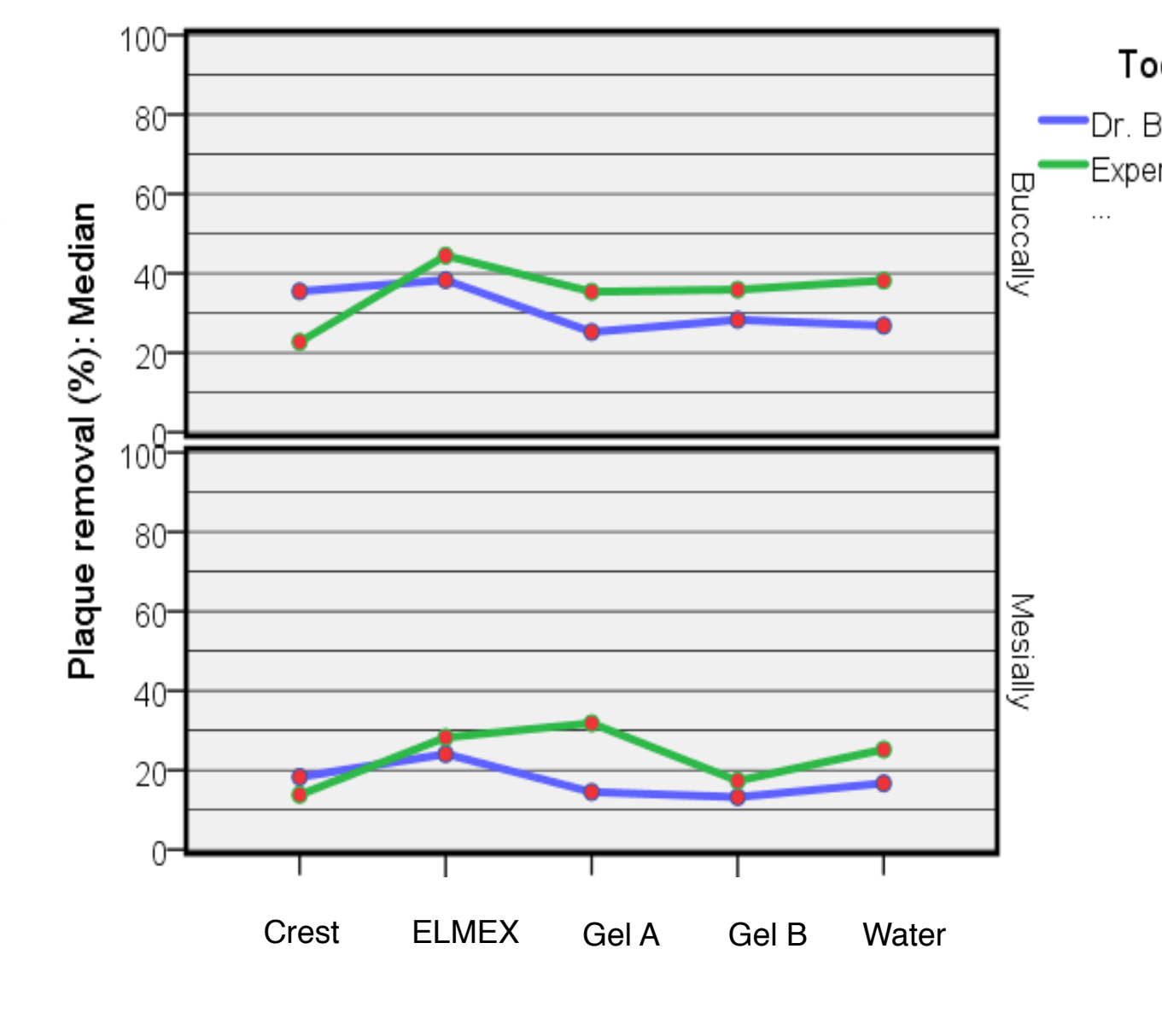

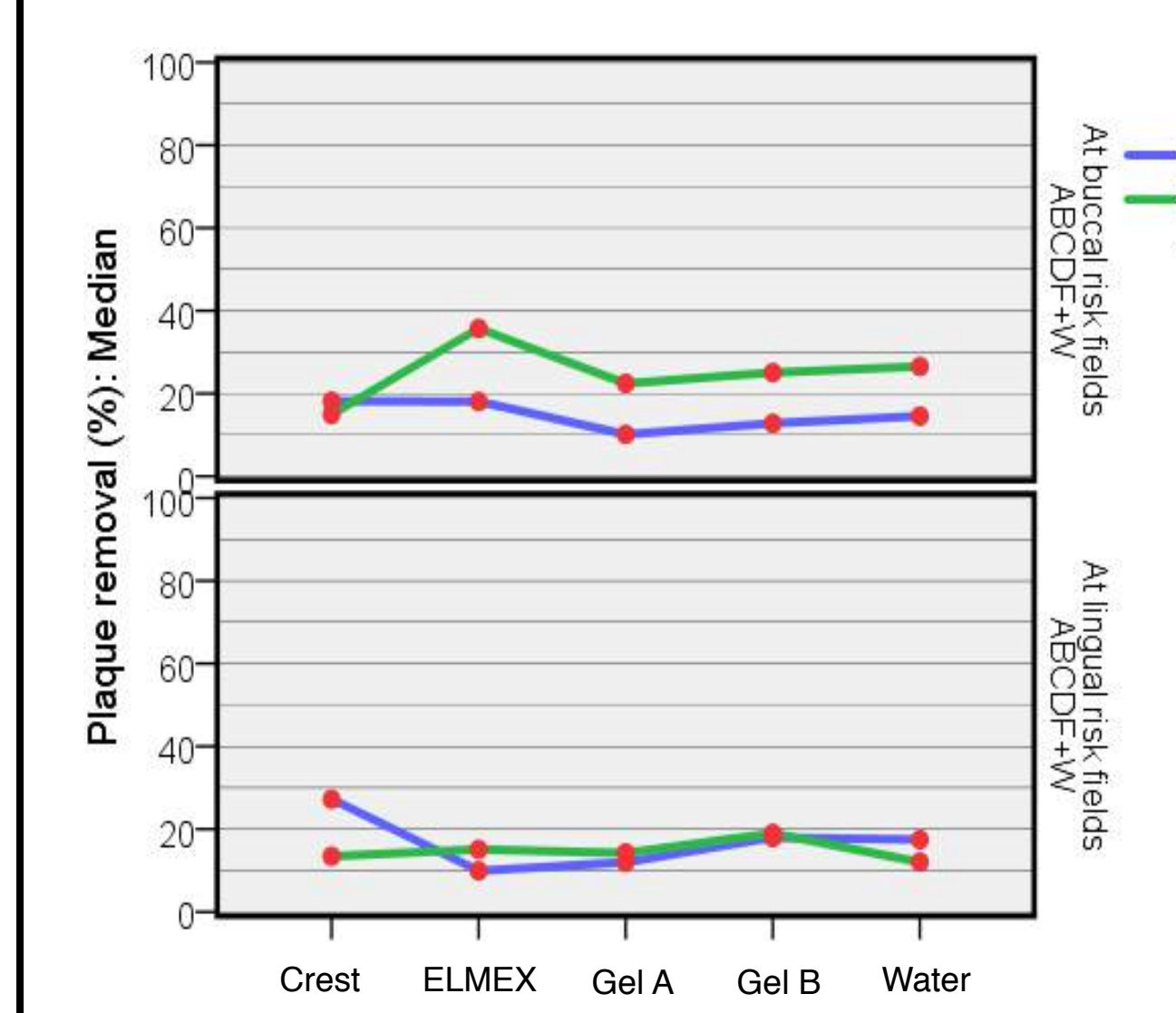**Fig. 8:** Comparing the medians of the two toothbrushes, plaque removal at smooth surfaces

Fig. 9: Comparing the medians of the two toothbrushes, plaque removal at risk fields next to gum line and at root surface

Tab. 3: Descriptive statistics of cleaning efficacy for both toothbrushes (plaque removal in %)

Statistics →	Toothbrush							
	Dr. Best Classic				Experimental Brush			
Situs/ Planimetrical Fields ↓	Mean	Stand dev.	Median	IQR	Mean	Stand dev.	Median	IQR
buccaly	30,52	7,11	28,75	10,32	33,60	8,68	35,37	15,50
lingually	28,28	7,40	27,29	12,26	27,22	7,11	27,21	9,76
mesially	16,93	4,25	16,69	5,38	23,02	7,43	22,20	11,09
distally	16,71	4,76	18,30	6,92	21,43	7,31	19,78	10,62
ABCDF+W buccally	15,18	6,34	14,35	8,17	23,02	8,33	22,43	10,82
ABCDF+W lingually	17,83	7,19	15,63	11,94	15,88	6,81	14,24	9,69
W buccally	14,23	7,16	14,62	8,65	21,38	7,75	20,92	10,46
W lingually	23,07	9,69	22,75	8,88	17,71	9,04	15,22	13,66
W1+W2 mesially	11,69	5,47	9,94	6,81	19,47	8,66	19,70	11,97
W1+W2 distally	16,14	6,21	16,57	7,61	15,49	6,90	13,30	11,38
total	19,33	3,86	18,70	6,15	21,82	5,54	21,32	7,79

Tab. 4: Wilcoxon-Mann-Whitney- U test: effect of two different toothbrushes. Five out of 11 parameters demonstrate significant (*)and highly significant differences (***) between the brushes in favor of the experimental toothbrush, see Tab 3

Situs/ Planimetrical Fields	Z	p
buccaly	-1,556	0,120
lingually	-0,217	0,828
mesially	-3,647***	0,000
distally	-1,486	0,137
ABCDF+W buccally	-3,769***	0,000
ABCDF+W lingually	-1,110	0,267
W buccally	-3,637***	0,000
W lingually	-2,390*	0,017
W1+W2 mesially	-4,023***	0,000
W1+W2 distally	-0,734	0,463
total	-1,791	0,073

Tab. 1.: Descriptive statistics of cleaning efficacy for dentifrice, gels and water (plaque removal in %)

Situs/ Planimetrical Fields	Statistics	Gel / Water				
		Crest	Elmex	Gel A	Gel B	Water
buccaly	Mean	29,19	37,55	31,02	31,22	31,33
	Stand. dev.	9,48	7,88	7,51	5,35	7,83
	Median	26,83	40,05	30,30	30,58	28,42
	IQR	12,70	16,45	13,26	8,15	13,18
lingually	Mean	32,21	26,27	24,48	28,77	27,02
	Stand. dev.	7,88	6,67	5,46	5,59	8,67
	Median	33,32	23,92	22,77	29,20	26,00
	IQR	10,17	8,97	8,80	4,88	7,91
mesially	Mean	16,89	24,08	22,50	15,52	20,88
	Stand. dev.	4,79	4,59	6,44	2,59	7,89
	Median	17,29	24,54	20,55	15,46	19,09
	IQR	6,18	6,43	17,29	4,58	8,52
distally	Mean	19,21	22,50	21,98	14,83	21,83
	Stand. dev.	6,39	4,06	6,71	2,27	7,57
	Median	19,36	23,47	20,22	15,35	20,59
	IQR	11,12	6,09	9,94	2,84	6,76
ABCDF+W buccally	Mean	16,32	25,03	16,05	17,44	20,74
	Stand. dev.	4,32	10,22	7,49	7,04	8,74
	Median	15,96	25,67	14,75	16,04	18,89
	IQR	4,13	17,81	14,31	12,27	11,99
ABCDF+W lingually	Mean	20,85	15,09	14,78	17,51	18,06
	Stand. dev.	7,79	6,94	5,51	6,20	7,58
	Median	23,49	12,06	13,82	18,48	13,88
	IQR	13,77	9,19	6,44	6,81	12,07

Tab. 2: Kruskal-Wallis-H test: effect of dentifrice and gels, five out of 11 parameters demonstrate significant (*),very significant (**) and highly sign. differences (***), see Tab 1

Situs/ Planimetrical Fields	Chi-Quadrat	p
buccaly	9,244	0,055
lingually	9,490*	0,050
mesially	18,213***	0,001
distally	18,683***	0,001
ABCDF+W buccally	8,836	0,065
ABCDF+W lingually	6,087	0,193
W buccally	8,310	0,081
W lingually	7,853	0,097
W1+W2 mesially	10,929*	0,027
W1+W2 distally	16,346**	0,003
total	5,508	0,239