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Complex Plaque Control by Robot Testing of Four Different Toothbrushes

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Objectives:

The best plaque control in elderly/ periodontitis patients is still disputed. Therefore, it was the aim of the study (i) to compare plaque removal efficacy in a complex clinically validated robot programme (Lang et al. 2014) including manual, powered and interdental toothbrushes, (ii) to differentiate crown versus root plaque control, and (iii) to compare single toothbrush use with hybrid powered toothbrush plus interdental toothbrush.

Material and Methods:

The robot was programmed simulating 2 min brushing, force 3.5 N, movement rotating on replicated human teeth in anatomic position. Synthetic plaque simulation was used. Automated Planimetrical Plaque Assessment (Gaengler et al. 2013) was executed at 24 crown and 6 root fields per tooth. The test of manual toothbrush (MTB) Inava15/100 (Pierre Fabre, France) was compared to Curaprox 1560 (Curadent, Switzerland), and powered toothbrush (PTB) Inava Hybrid was compared to PTB Inava Hybrid plus gauge-adapted interdental toothbrushes (IDBs) (Pierre Fabre, France). All four tests were performed 7 times. Kolmogorov-Smirnov-test was applied to test 11 variables for normal distribution, H0 was rejected. Therefore, Wilcoxon-Mann-Whitney-test was used.

Results:

Brushing programmes were strictly identical. No statistical differences could be detected in plaque control at buccal and lingual smooth surfaces. Mesially and distally, next to gum line and at all root fields Inava was clearly superior to Curaprox, however, inferior to combined brushing with Inava Hybrid followed by the IDBs Blue/ Yellow. Consequently, this combination was statistically significantly better than Curaprox at all risk fields/ areas except next to gum line lingually. Most hidden areas distally of tooth roots showed plaque removal from incisors to second molars of 75.2-99.4% in analysis of single teeth. Range of total brushing efficacy was MTB Inava 71.5% and MTB Curaprox 57.3%, PTB Inava Hybrid 66.4% and PTB+IDB 81.6% Plaque control by soft brushes depends on number of filaments (Inava versus Curaprox).

Conclusions:

Complex plaque control by powered vibrating/ rotating toothbrushing followed by adapted interdental brushing of exposed root areas is highly efficient. Clinically validated robot testing and planimetrical plaque assessment at 4 sites of all teeth demonstrates standardized biophysical brushing actions. All single tooth data represent an optimal plaque control outcome with prevention ability. Adult patients with gum recession, gingivitis, periodontitis progression and root caries risks have the best home care with a high evidence level by Hybrid PLUS Interdental Brush.

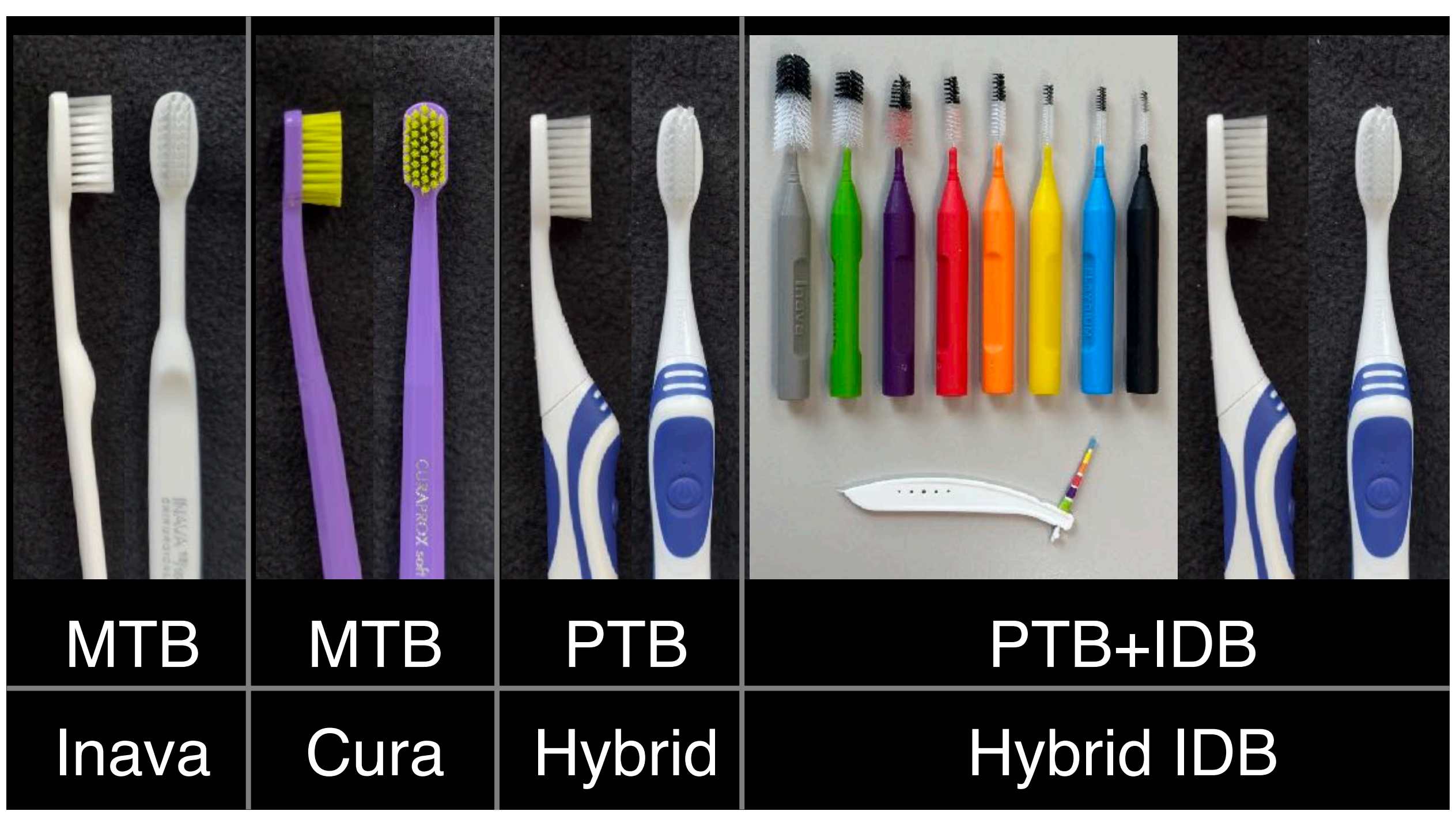

Fig. 1: Tested toothbrushes: Manual toothbrush (MTB) Inava15/100 (**Inava**), MTB Curaprox 1560 (**Cura**), powered toothbrush (PTB) Inava Hybrid (**Hybrid**) and PTB Inava Hybrid combined with gauge-adapted interdental toothbrushes (IDB) (**Hybrid IDB**).

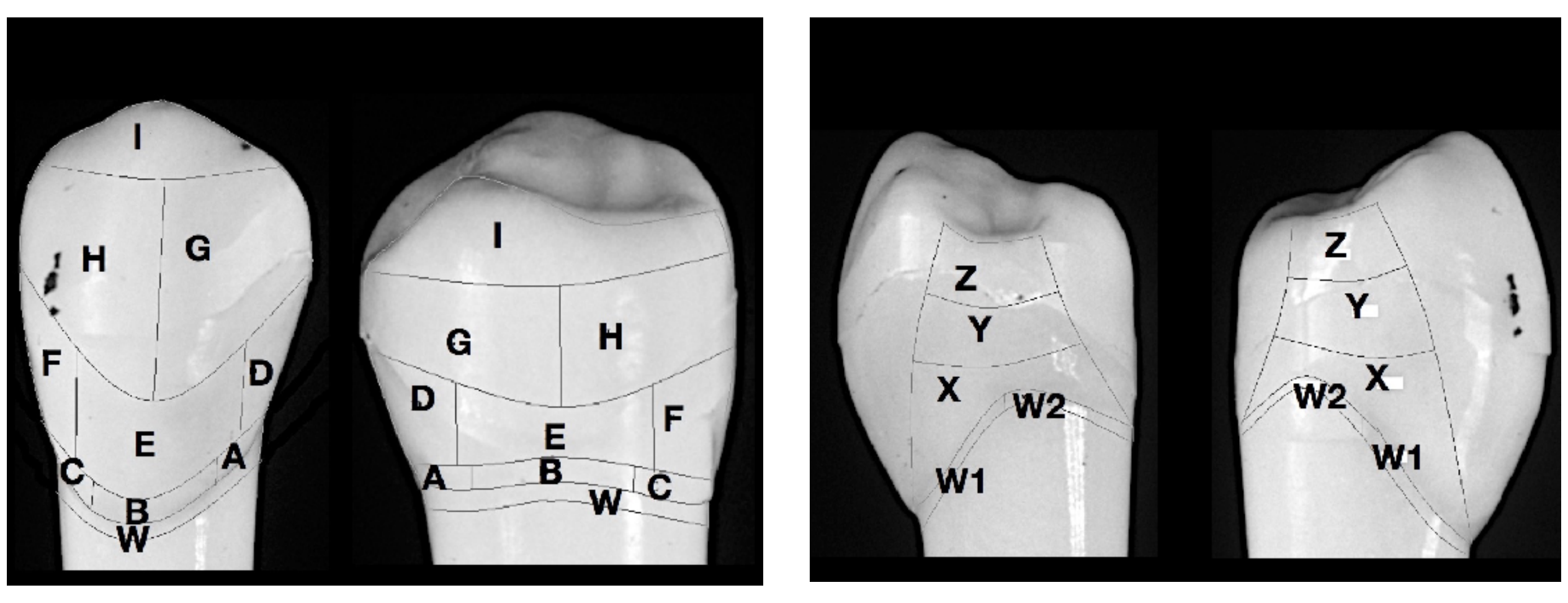

Fig. 2: Planimetrical fields at tooth crowns and roots of smooth surfaces (left) and mesially and distally in-between the teeth (right) for plaque assessment in percent per field, per risk area or per tooth site with automated plaque planimetry APP according to the Planimetrical Plaque Index PPI (Gaengler et al., 2013).

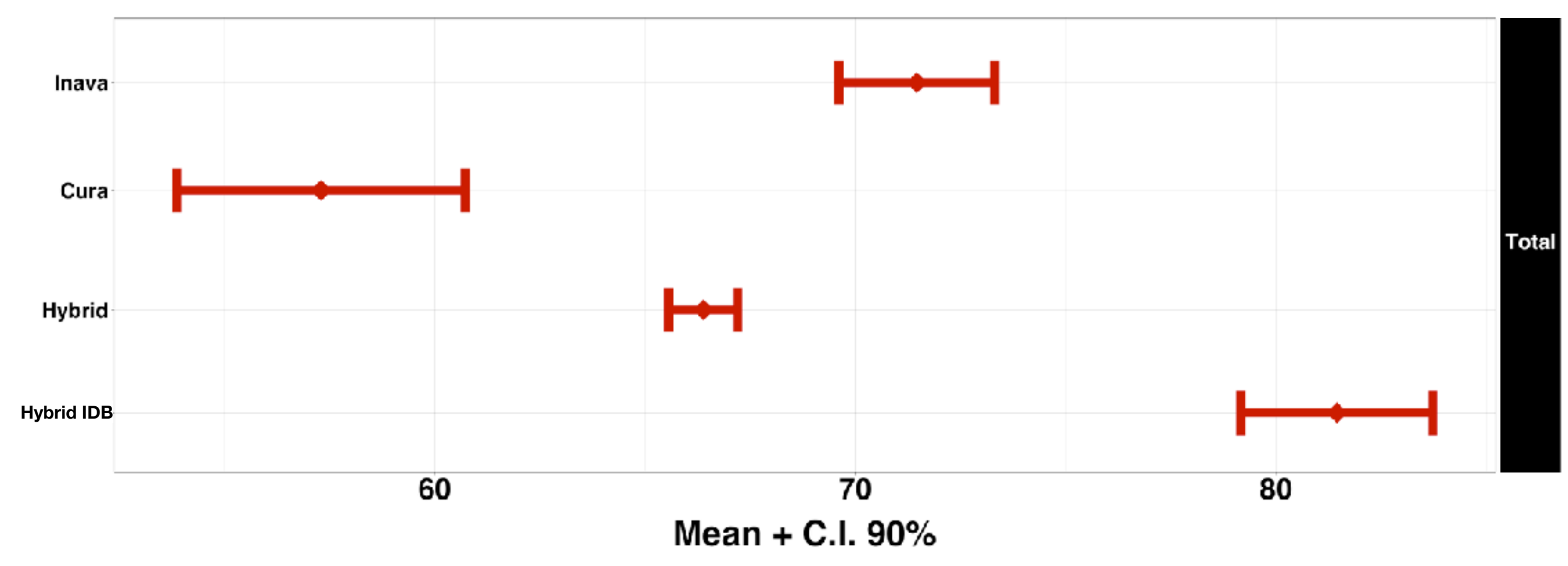

Fig. 3: Error bars of plaque removal buccally (towards the cheek), lingually (towards the tongue), mesially (anterior, in-between the teeth), distally (posterior, in-between the teeth) and at buccal and lingual risk fields ABCDF (next to the gum line) for the tested toothbrushes. Number of observations per each toothbrush: n=7

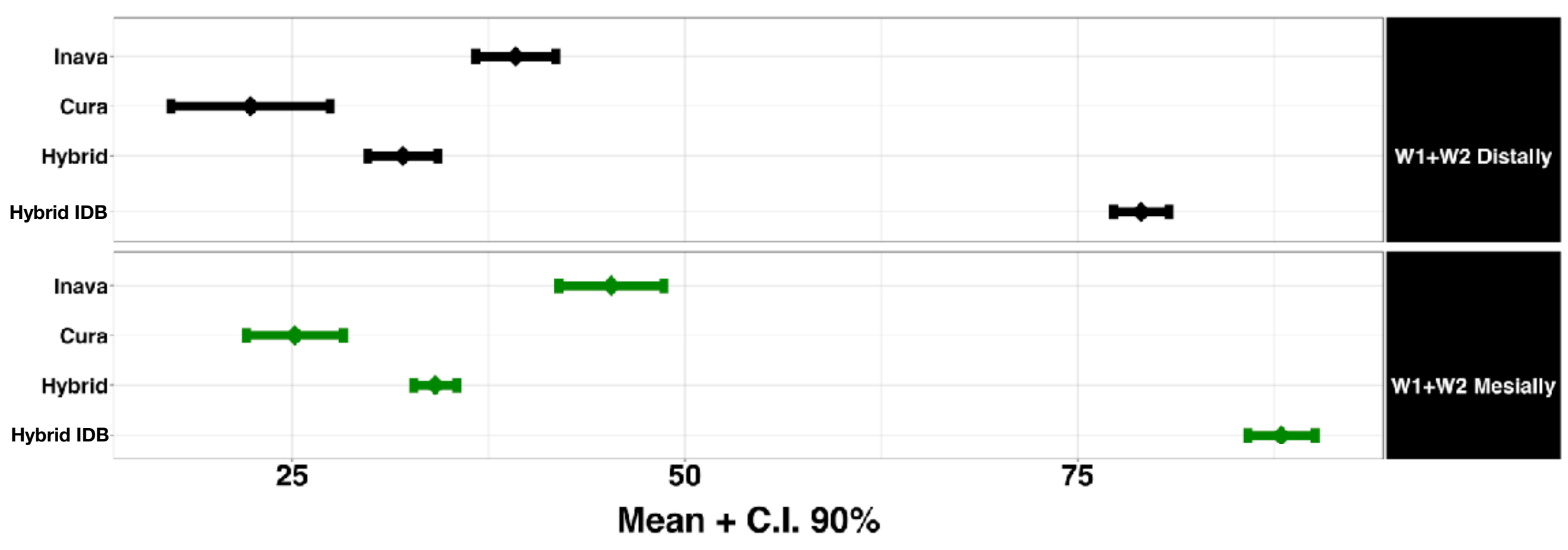

Fig. 4: Error bars of plaque removal on root fields (W1+W2) mesially (anterior, in-between the teeth), distally (posterior, in-between the teeth) for the tested toothbrushes.
Number of observations per each toothbrush: n=7.

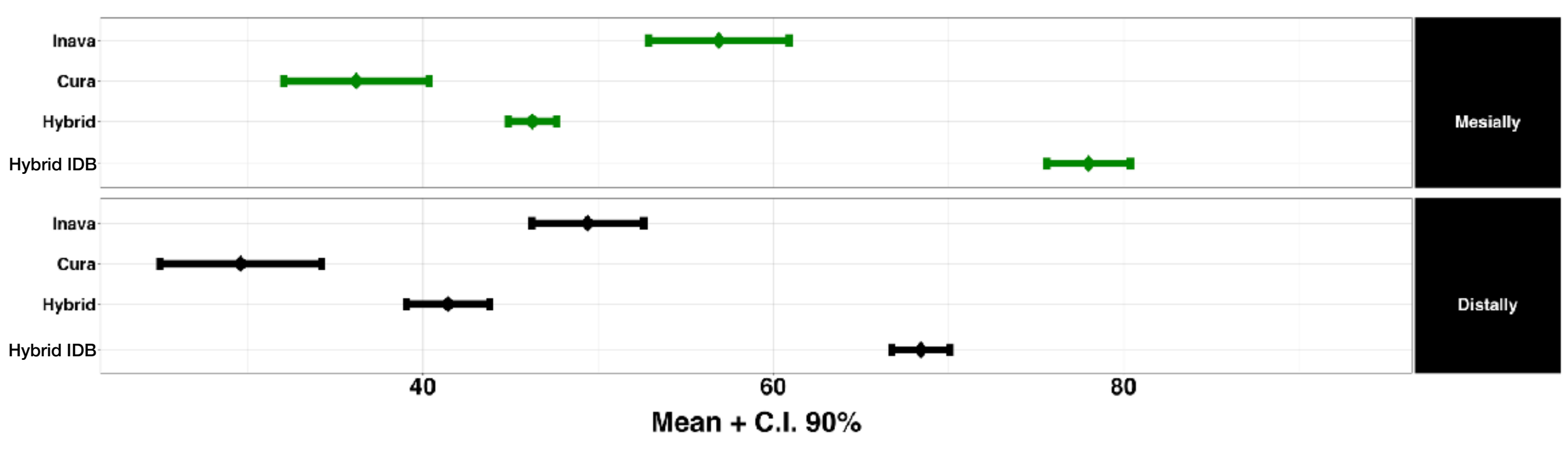

Fig. 5: Error bars of plaque removal mesially (anterior, in-between the teeth), distally (posterior, in-between the teeth).
Number of observations per each toothbrush: n=7.

# PAIR		PAIR_7		PAIR_15		PAIR_18		PAIR_11	
PAIRS		Inava Cura		Hybrid IDB Cura		Hybrid IDB Hybrid		Hybrid IDB Inava	
#	SITUS	IFO	p	IFO	p	IFO	p	IFO	p
1	Buccal	~	0.018	~	0.085		0.406		0.482
2	Lingual	~	0.035		0.180		0.406		0.225
3	Mesial	2	0.004	7	0.002	7	0.002	7	0.002
4	Distal	2	0.004	7	0.002	7	0.002	7	0.002
5	ABCDF buccally	2	0.002	7	0.003	~	0.035		0.565
6	ABCDF lingually	2	0.004	~	0.006		0.110		0.848
7	W buccally	2	0.002	7	0.004	~	0.048		0.482
8	W lingually	2	0.003	7	0.002	7	0.003	~	0.009
9	W1W2 mesially	2	0.002	7	0.002	7	0.002	7	0.002
10	W1W2 distally	2	0.004	7	0.002	7	0.002	7	0.002
11	TOTAL	2	0.003	7	0.002	7	0.002	7	0.004

IFO = ır of # of brush	
p = ' probability	
n pairs	231
n of p1 pairs	56
n of p2 pairs	109

p1 =	0.1
# pairs =	21
corrected p	0.005
sig. @ p1	~
sig. @ p2	#

Tab. 1: Mann-Whitney-Test of cleaning efficacy (% plaque removal): tests of significant contrasts of the toothbrushes MTB **Inava** (2) and PTB + IDB **Hybrid IDB** (7).

The **Bonferroni correction** sets the valid significance level for the U-contrasts in table 1 at $\alpha / m = \alpha' = 0.005$, where α = planned significance level of the study, and m = total number of multiple contrasts of the toothbrushes. In consequence a number of 7 significances / significant differences have to be ignored (see '~' markings in table).

References:

P. GAENGLER, T. LANG and B. JENNES, Computer-assisted planimetrical plaque assessment of robot tested toothbrushing. Journal of Dental Research, 2013, Vol. 92, (Spec. Issue A), Abstract No. 3326

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