Planimetrical assessment of simulated organic plaque removal by different flossing

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Objectives:
Interdental plaque removal plays a pivotal role in preventing caries and periodontitis in susceptible subjects. Therefore, it was the aim to test ex-vivo the cleaning efficacy of (i) a flosser with crossing filaments and to compare to (ii) a conventional flosser and to (iii) a conventional rolled floss using organic plaque simulation (Flad et al., 2016) and computer-assisted planimetrical assessment of interdental risk fields.

Material and Methods:
Plaque removal efficacy at 20 interdental planimetrical coronal and root risk fields buccally and lingually (ACDF+W) and mesially and distally (XYZ+W1W2) by prototype DenTek Cross Flosser, DenTek Triple Clean Flosser (Dentek Oral Care Inc., Tarrytown, NY, USA) and by Oral-B Glide Floss (Procter & Gamble, Cincinnati, OH, USA) was assessed. Typodont teeth (4 incisors, 1 canine, 2 premolars and 3 molars) in anatomical position were covered with organic plaque simulation. Interdental spaces were flossed with two gliding strokes below the contact point in up and down motion parallel to the tooth axis. Tests were executed seven times. Percentage of plaque removal at risk fields at four sites per tooth was documented by optical planimetry. Cleaning efficacy at all teeth underwent statistical approval between the test devices. The null hypothesis H0 was accepted for all 10 risk field parameters (KS-test) and the independent two samples t-test was applied with the Bonferroni correction.

Results:
Cross Flosser exhibited the best plaque control efficacy coronally in-between the teeth, with mean values from 26.0 to 27.5% of plaque removal, different (p≤0.05) from Triple Clean (19.0 to 20.4%) and from Glide Dental Floss (19.6 to19.7%). The total interdental plaque removal around all crowns and roots of premolars and molars was again in favor of the Cross Flosser with mean percentages of 18.2 vs.11.7 (Triple Clean) and 10.1 (Glide). Analysis of single teeth showed different cleaning percentages depending from anatomical space in-between the different geometry of tooth forms with changing concave and convex root surfaces. Cross Flosser was most effective around canines, premolars and molars. Crossing design of two filaments in angulation of 12° was decisive for the significant differences. According to single tooth analysis cleaning range interdentally at XYZ fields was from 52.2% mesially at tooth 46 to 4.0% at the incisor 41 distally.

Conclusions:
The new ex-vivo test methodology of interdental cleaning with flossers compared to flossing is highly standardized. The planimetrical plaque control at four sites of teeth results in precise efficacy values. The innovative Cross Flosser removes more plaque compared to the conventional single filament flosser and to flossing. Therefore, X-floss filaments are superior in cleaning open interdental spaces.
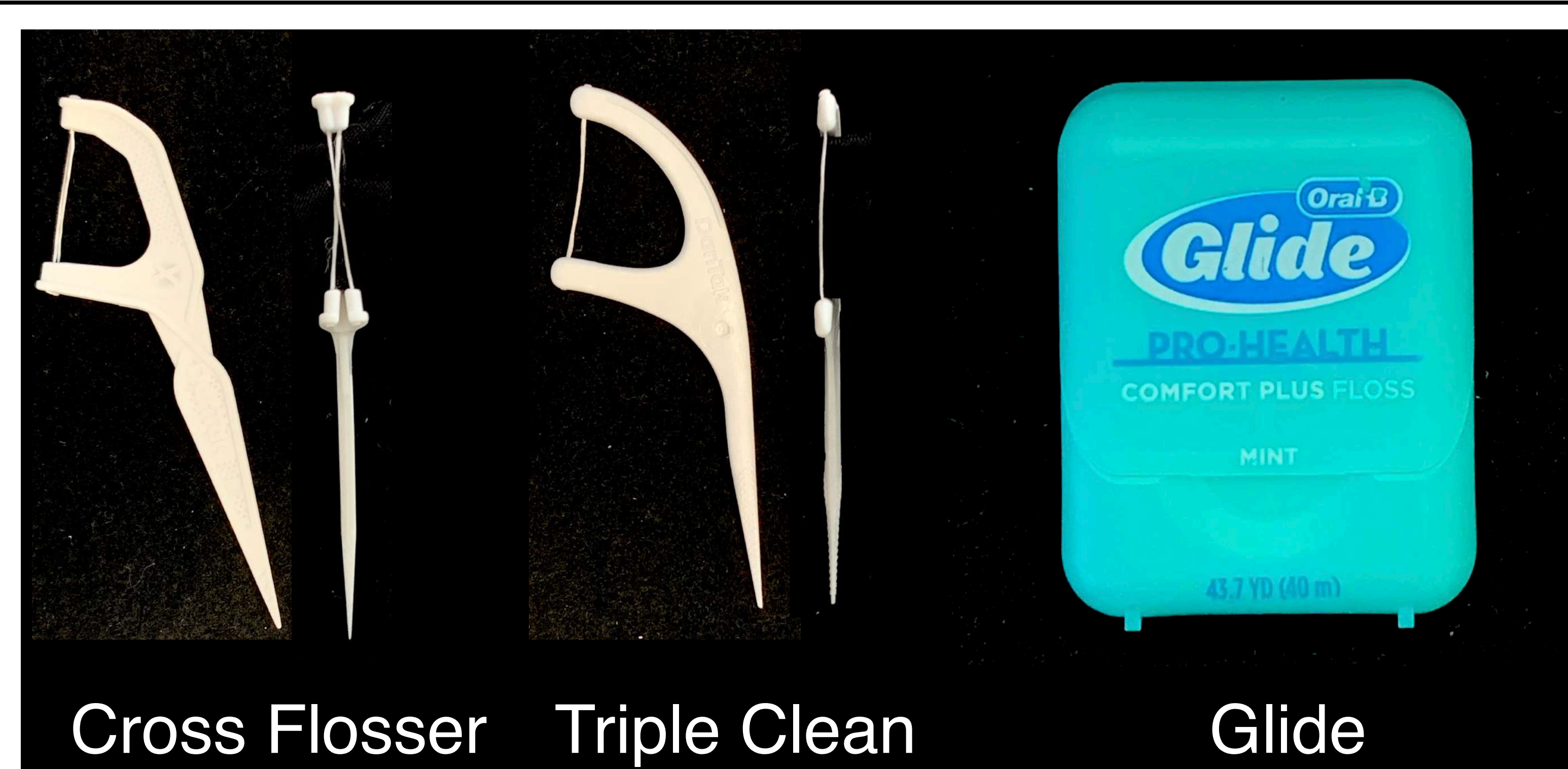
Figure 1 : Tested products form left to right: DenTek Cross Flosser (**Cross**), DenTek Triple Clean Flosser (**Triple Clean**) and Oral-B Glide Floss (**Glide**).
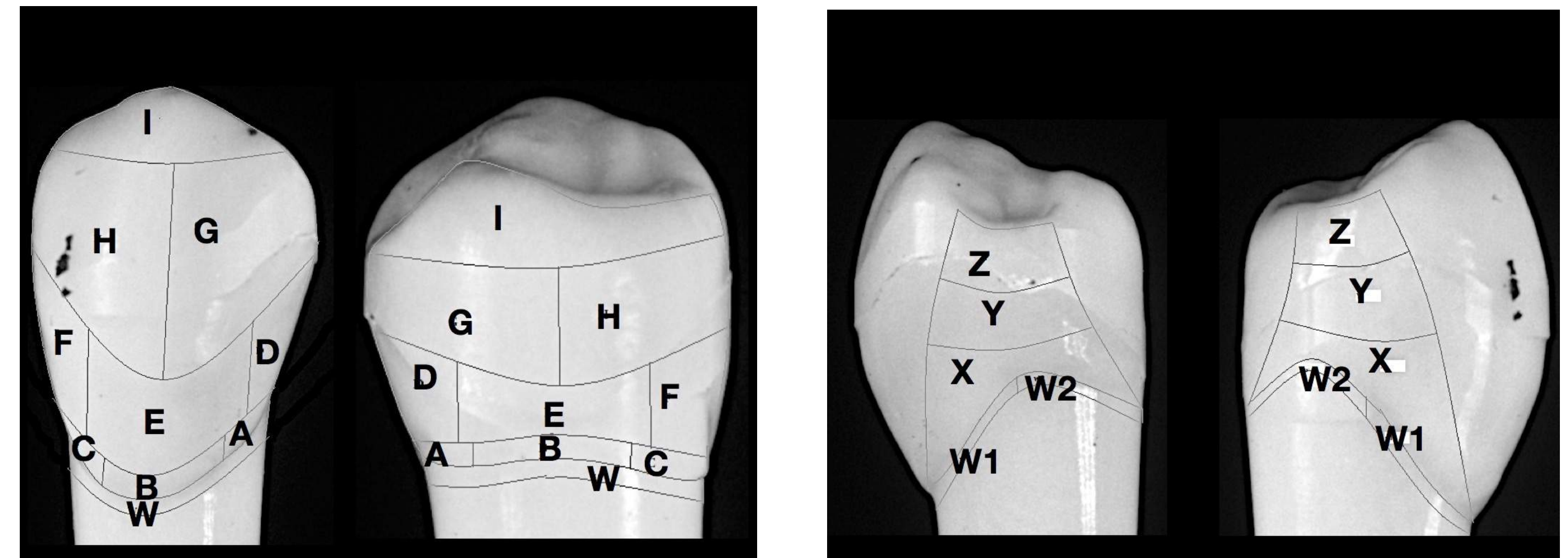

Figure 2: Planimetrical fields at tooth crowns and roots of smooth surfaces (left) and mesially and distally in-between the teeth (right) for plaque assessment in percent per field, per risk area or per tooth site with automated plaque planimetry APP according to the Planimetrical Plaque Index PPI (Lang et al., 2011).
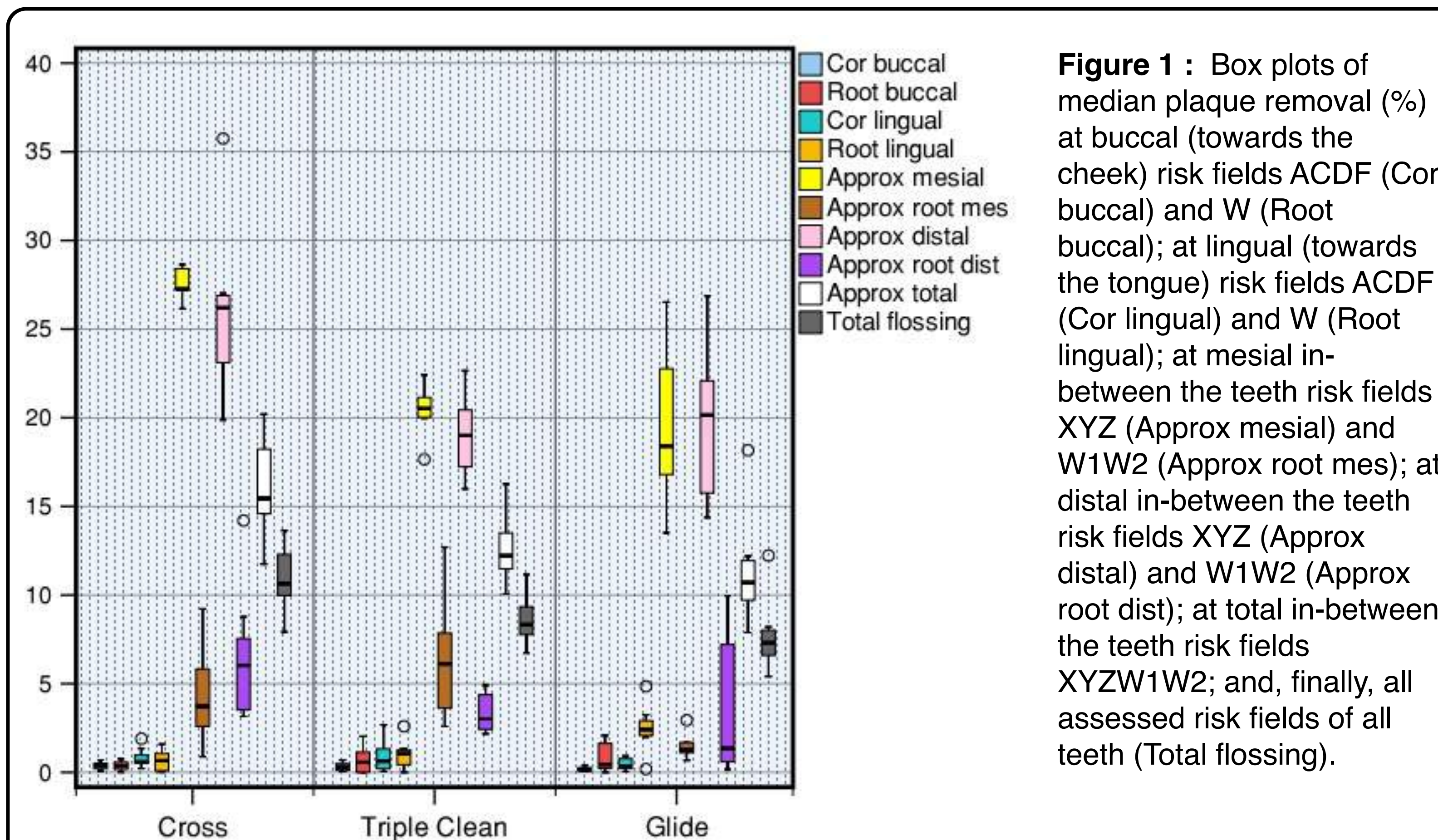

Figure 1 : Box plots of median plaque removal (%) at buccal (towards the cheek) risk fields ACDF (Cor buccal) and W (Root buccal); at lingual (towards the tongue) risk fields ACDF (Cor lingual) and W (Root lingual); at mesial in-between the teeth risk fields XYZ (Approx mesial) and W1W2 (Approx root mes); at distal in-between the teeth risk fields XYZ (Approx distal) and W1W2 (Approx root dist); at total in-between the teeth risk fields XYZW1W2; and, finally, all assessed risk fields of all teeth (Total flossing).

Figure 2: Error bars of plaque removal (%: Means and SD) at buccal (towards the cheek) risk fields ACDF (Cor buccal) and W (Root buccal); at lingual (towards the tongue) risk fields ACDF (Cor lingual) and W (Root lingual); at mesial in-between the teeth risk fields XYZ (Approx mesial) and W1W2 (Approx root mes); at distal in-between the teeth risk fields XYZ (Approx distal) and W1W2 (Approx root dist); at total in-between the teeth risk fields XYZW1W2; and, finally, all assessed risk fields of all teeth (Total flossing).
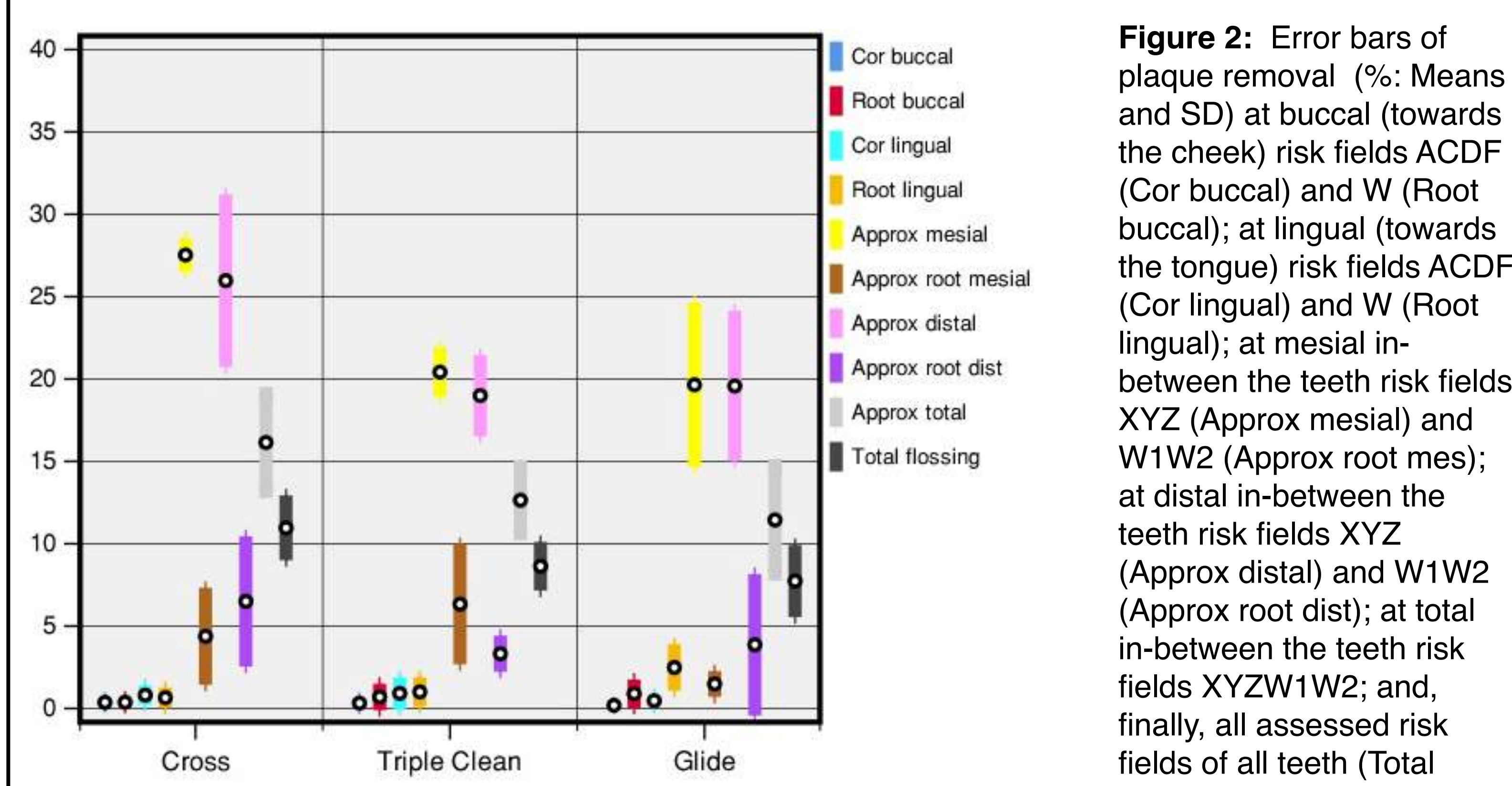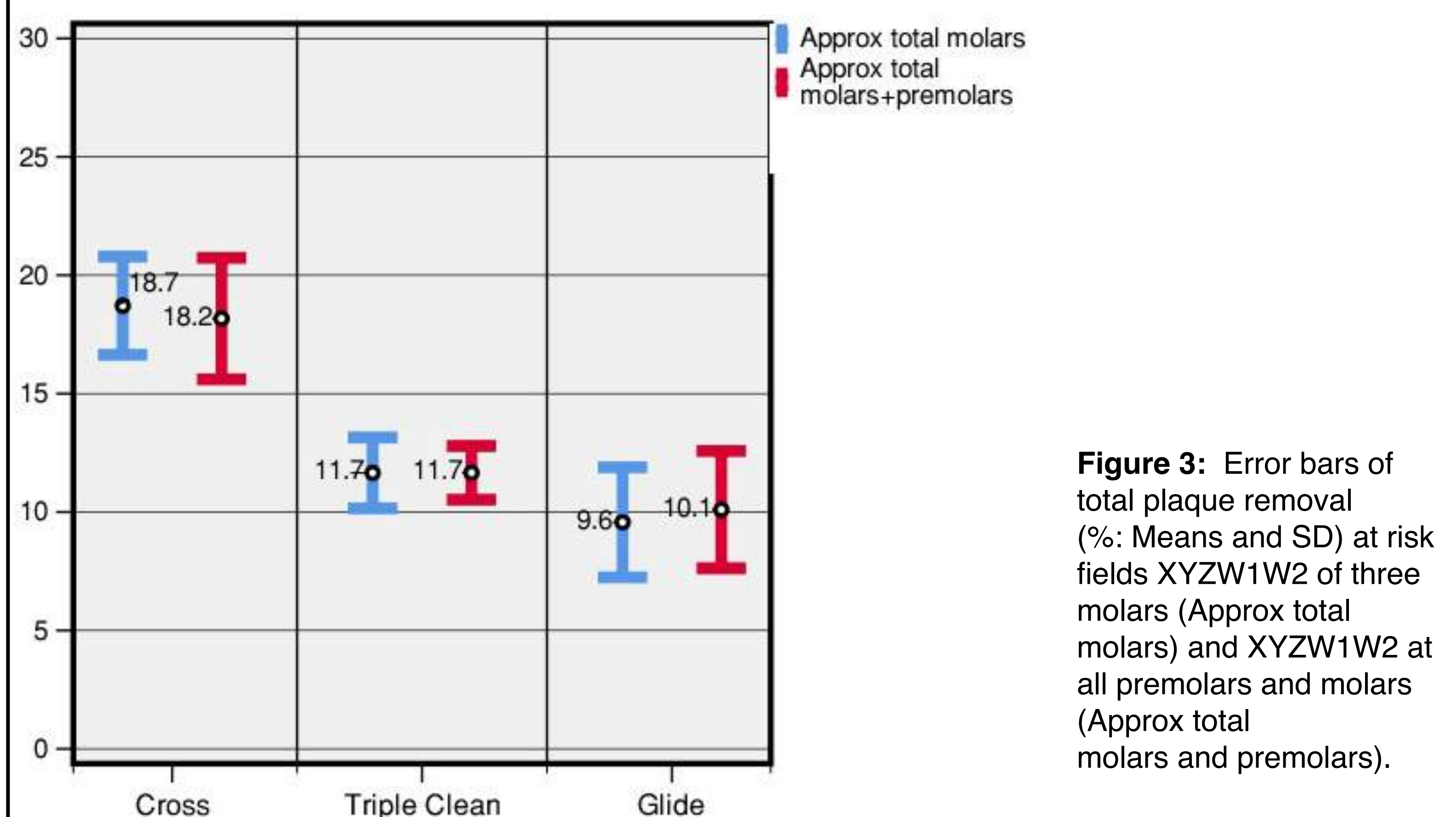

Figure 3: Error bars of total plaque removal (%: Means and SD) at risk fields XYZW1W2 of three molars (Approx total molars) and XYZW1W2 at all premolars and molars (Approx total molars and premolars).

Test device	Tooth surface	Statistic				
		M	SD	Med	IQR LL	IQR UL
Cross	Approx total molars	18.71	2.07	19.11	17.90	19.55
	Approx total molars and premolars	18.17	2.56	18.21	15.86	19.86
Triple Clean	Approx total molars	11.65	1.50	11.63	11.05	12.64
	Approx total molars and premolars	11.66	1.13	11.39	10.86	12.26
Glide	Approx total molars	9.57	2.33	10.04	7.75	11.60
	Approx total molars and premolars	10.10	2.48	10.73	9.24	11.87

Tab. 1: Means (M), standard deviations (SD), medians (Med) and interquartile ranges (IQR; LL = lower limit, UL = upper limit) of cleaning efficacy parameters (% plaque removal) for the three test devices.

Contrast	Tooth surface	t-Test			Mean difference
		t	df	p	
Cross vs. Triple Clean	Approx total molars	7.129***	11	0.000	7.06
	Approx total molars and premolars	6.147***	8.261	0.000	6.51
Cross vs. Glide	Approx total molars	7.196***	10	0.000	9.15
	Approx total molars and premolars	5.746***	11	0.000	8.07
Triple Clean vs. Glide	Approx total molars	1.955	11	0.076	2.09
	Approx total molars and premolars	1.499	11	0.162	1.56

Tab. 2: t-test of cleaning efficacy (% plaque removal): Multiple contrasts of the three test devices.