Clinical validation of Organic Plaque Simulation in Robot Toothbrushing Tests

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Objectives:
Robot testing of simulated plaque control is important for developing new toothbrushes and full mouth devices. Therefore, the aim was (i) to test a novel formulation of organic plaque simulating viscosity and adhesion of natural plaque and (ii) to estimate a valid accuracy of robot outcome in relation to clinical results of plaque control.

Material and Methods:
Clinical programme: After ethical approval (EK-UWH 552007), professional tooth cleaning and 5-day-plaque-regrowth was executed, and 22 calibrated subjects used in a Randomized Clinical Trial video-supported separated horizontal, and rotating, and vertical brushing movements for 20 s buccally/20 s lingually at 9 teeth 32 – 47 with force 3.5 N. Toothbrushes Dr. Best medium (TB1) and Interdentum medium (TB2) (GlavoSmithKline, Munich, Germany) were tested. Stained plaque was photographed and blind-coded at 18 planimetric fields and at 10 risk fields using modified Navy-Plaque-Index (Lang et al. 2011) with PPI-Codes 0 (0%), 1 (<50 %) and 2 (>50 %) per each field. Robot programme: The same brushes and techniques were tested. The cleaning outcome of simulated organic plaque in percentage per planimetric field was Computer-assisted Planimetric Plaque Assessment (APP) was blind-assessed with PPI. All clinical and robot data underwent statistical analysis by K-S-test, one-sample-t-test, Independent t-test of equality of means, W-M-W-U-Test of equality of medians and Agreement Rate AR of plaque removal.

Results:
Individual clinical plaque control pattern at two surfaces and two risk areas per tooth were well reproduced by robot brushing movements. The Agreement Rate of plaque removal by separated brushing movements at smooth surfaces was 85–100 % (TB1) and 89-99 % (TB2), at risk fields root to gum line 84-98 % (TB1) and 88-94 % (TB2). The single tooth analysis revealed best AR for teeth 42 (TB1 83-99 %), 42 (TB2 81-96 %) and 47 (TB2 75-96 %). Canines 43 exhibited the least AR 41 % for both brushes. All 24 tooth sites (buccally and lingually) and all risk areas exhibited in all 3 brushing movements with the 2 toothbrushes equal plaque control values (p = 0.05) or, alternatively, 21 out of 24 tooth sites showed equal values (most common p = 0.10).

Conclusions:
Robot toothbrushing with the formulation of organic plaque, simulating bio-physical parameters of natural plaque, is concordant with clinical plaque control at all teeth and all planimetric areas. The clinically validated plaque simulation is recommended for complex dry and wet robot testing.