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Validating Precision of Three Tooth-Wear Measurement Approaches Using Intra-Oral Scans

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Objectives Aims of this study were to evaluate the precision of three different 3D Wear Analysis Approaches (3DWAAs) using intra-oral scans (IOSs) and to investigate the inter-operator precision in applying these approaches.

Methods To evaluate precision, IOSs of patients treated within the scope of a prospective observational study on the progression of tooth and dental materials' wear from baseline (intake/after restorative treatment) and after three years were superimposed. Two independent observers evaluated height-loss over time using three approaches: 1) 3D-measurement software (GeomagicQualify2013, 3D-Systems), 2) algorithm-based automated segmentation method combined with 3D-measurement software, and 3) commercial system (TriosPatientMonitoring, 3shape). Measurement areas were defined as tooth surfaces, specifically chosen for different tooth types and locations, and the respective highest value per area was noted [mm]. The inter-approach precision and inter-operator precision were calculated using paired t-tests ($p<0.05$) reporting correlation, structural error, and duplicate measurement error (DME). Outliers with a disagreement > 0.2 were excluded for numerical analysis and descriptively analysed.

Results In six patients 163 teeth equaling 364 measurements were evaluated and visualized in scatterplots. Outliers were mainly caused by large height-differences due to fracture, inaccuracies in necessary 2D-measurements, and errors in the commercial system. Comparing the approaches, both the automated segmentation method (reliability=0.983, DME=0.026, diff./95%-CI=-0.012[-0.015...-0.010]mm; $p<0.001$) and the commercial software (reliability=0.986, DME=0.022, diff./95%CI=-0.004[-0.006...-0.001]mm; $p=0.003$) resulted in larger height-loss values than using only the 3D-measurement software. The largest difference between observers was found using solely the 3D-measurement software, although the differences were still low concerning clinically relevant height-losses (reliability=0.986, DME=0.024, diff./95%CI=-0.015[-0.018...-0.011]mm; $p<0.001$).

Conclusions When outliers due to software/measurement errors are handled as such, all 3DWAAs presented clinically comparable precision (differences < 18µm) in

measurements independent of the operator and can therefore be equally recommended for height-loss measurements using IOSs.