Trueness of Occlusion in Dental Models: An In Vitro Assessment of Digital and Analog Workflows

Objectives. This study aims to evaluate the trueness of occlusion, focusing on error propagation from intraoral scanning (IOS) to additive manufacturing (AM, or 3D printing).

Materials and methods. Custom reference models were additively manufactured, articulated, and scanned using a Coordinate Measurement Machine (CMM, n=1). Positive/negative occlusal contacts were recorded. Digital impressions were collected from the reference models using a Trios 4 (3Shape) IOS with "Adjust for contacts" feature enabled (IOS_Ad, n=10) and duplicated without this feature (IOS, n=10). IOS_Ad scans were processed to create test models using MAX UV385 (Asiga) and NextDent 5100 (3DSystems) AM devices. Conventional workflow was replicated with VPS impressions and Type IV stone. AM and stone models were articulated and digitized with E4 (3Shape) in three occasions: with/without AM positioning pins and after manual occlusal correction (Co). Inter-arch distances and 3D contact area were measured in digital models and compared. Statistical tests used were Shapiro-Wilk, Levene's, Welch's t-test, and 2-way ANOVA (α=.05).

Results. IOS_Ad group had higher 3D contact trueness than IOS, Stone, Stone_Co ($p<0.05$). "Adjust for contacts" feature increased the 3D contact trueness ($p=0.00$, $\Delta=34.51 mm^2$). Effect of manual occlusion correction of stone casts was insignificant ($p>0.05$). Digital impressions had higher occlusal trueness than AM models after removal of the pins ($p<0.05$). Introduction of errors was mostly higher in AM rather than IOS ($p<0.05$). 3D contact area analysis showed similar deviations of AM and stone models ($p>0.05$).

Conclusions. The study partially approved the null hypothesis, indicating that AM and stone models have a similar trueness of occlusion.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the study.

Keywords: Intraoral scanner; Additive manufacturing; Trueness; Dental Occlusion

Figure 1. Study scheme

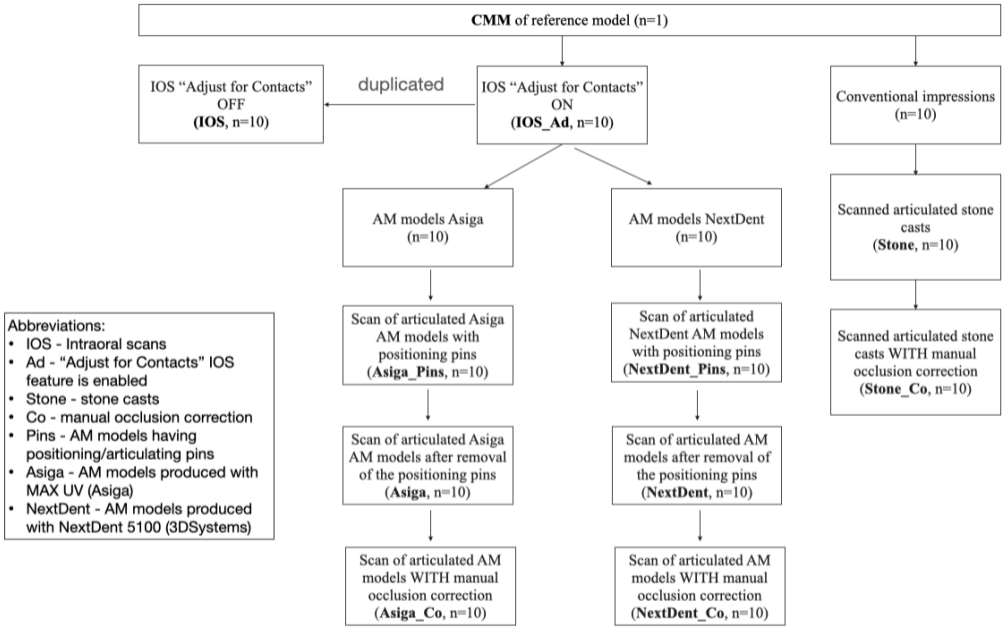

Figure 2. Articulated AM models with positioning pins

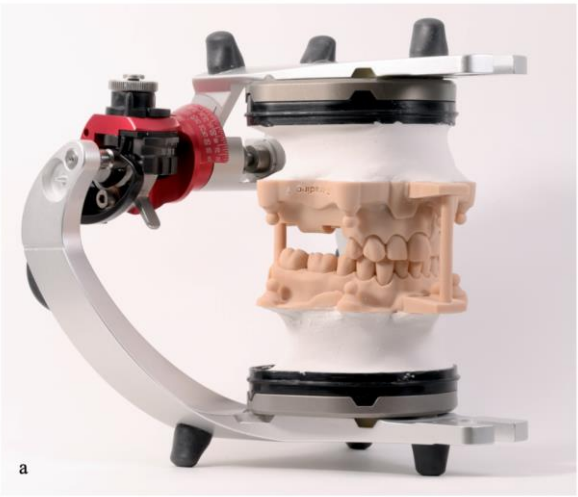

Figure 3. Numeration of the inter-arch distances

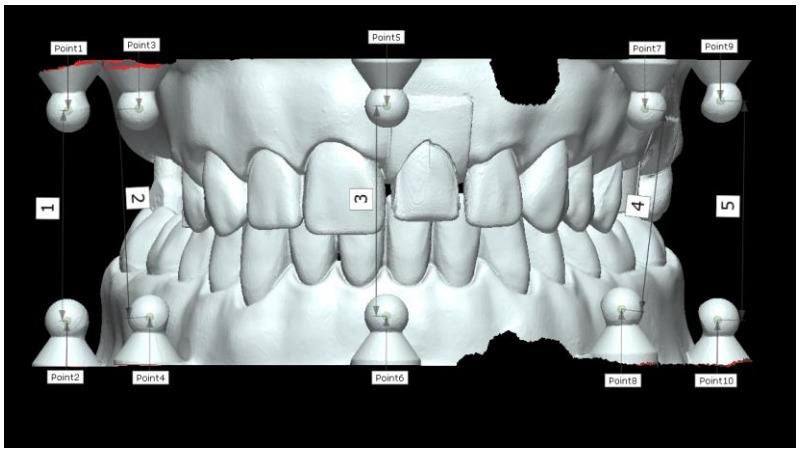

Figure 4. 3D contact area analysis (mm)