

THE ACCURACY OF FITTING SURFACES AND OCCLUSION OF DIGITALLY PRINTED AND CONVENTIONALLY FABRICATED MICHIGAN OCCLUSAL APPLIANCES USING AN IN-VITRO MODEL

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Objectives

This study assessed and compared the accuracy of the intaglio and occlusal surfaces of digitally printed and conventionally fabricated occlusal oral appliances.

Methods

Articulated milled zirconia master models were used to design and fabricate Michigan Occlusal Appliances. A commercial dental laboratory fabricated Conventional Occlusal Appliances (COAs) and Digital Occlusal Appliances (DOAs) based upon a standardized prescription. Ten intraoral scans were obtained of the models, these were exported to a dental lab along with detailed instructions to fabricate ten DOAs with additive manufacturing (DLP) using KeyPrint® KeySplint Soft resin. In addition, ten alginate impressions of the models were obtained and were sent to the dental lab to fabricate ten COAs. The lab technician was instructed not to carry out any adjustments following manufacturing to avoid uncontrolled modifications. Benchtop scans were obtained for these appliances on both the intaglio and occlusal surfaces (Fig. 1) to compare and test the trueness (using the Root Mean Square (RMS)) of the intaglio surfaces and occlusal fit with those of the master models using CloudCompare (Fig. 3). Different linear measurements (D1-D10) were obtained on the Maxillary Zirconia Master Model as a reference to compare these with the measurements obtained from DOAs and COAs (Fig. 4).

$$RMS = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_1 - z_2)^2}$$

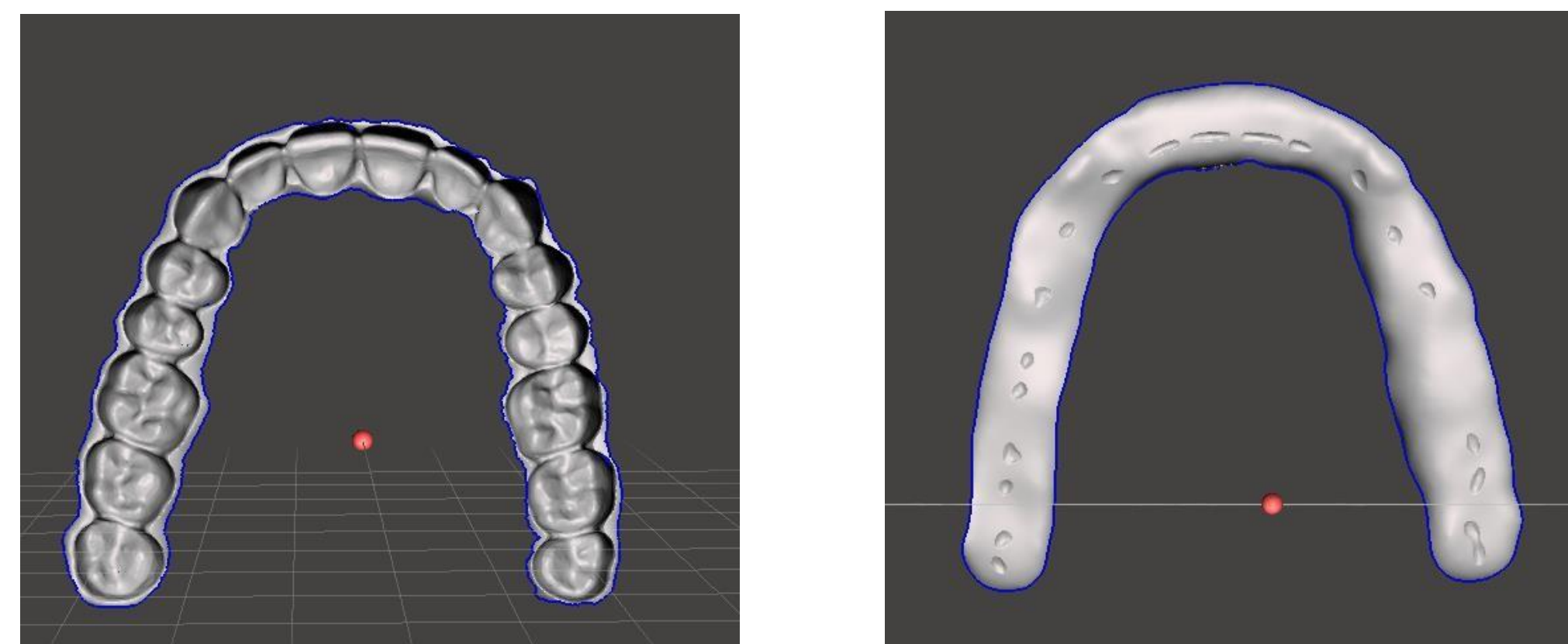


Fig. 1. Intaglio scan (Left) and Occlusal scan (Right)

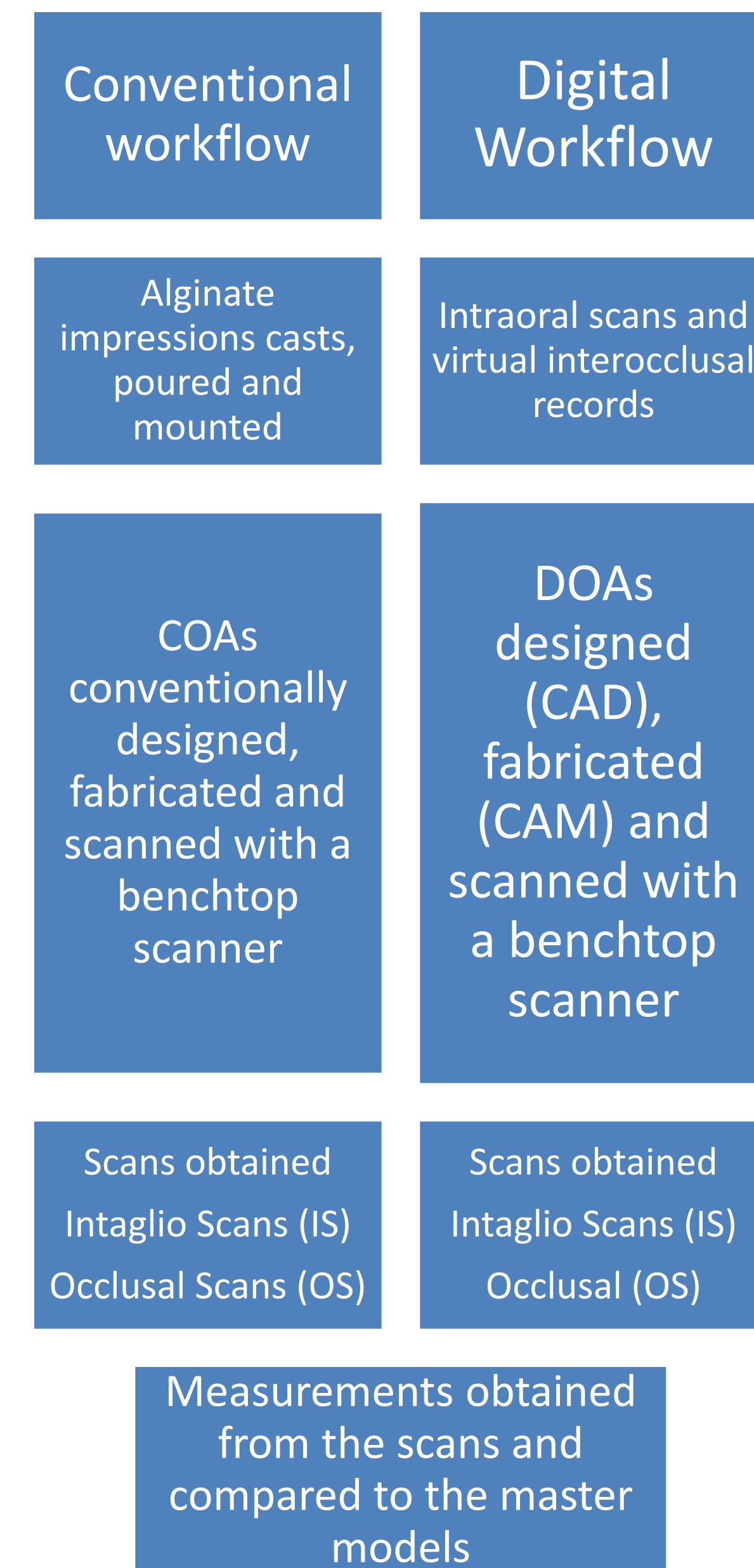


Fig. 2. Flow chart for the study

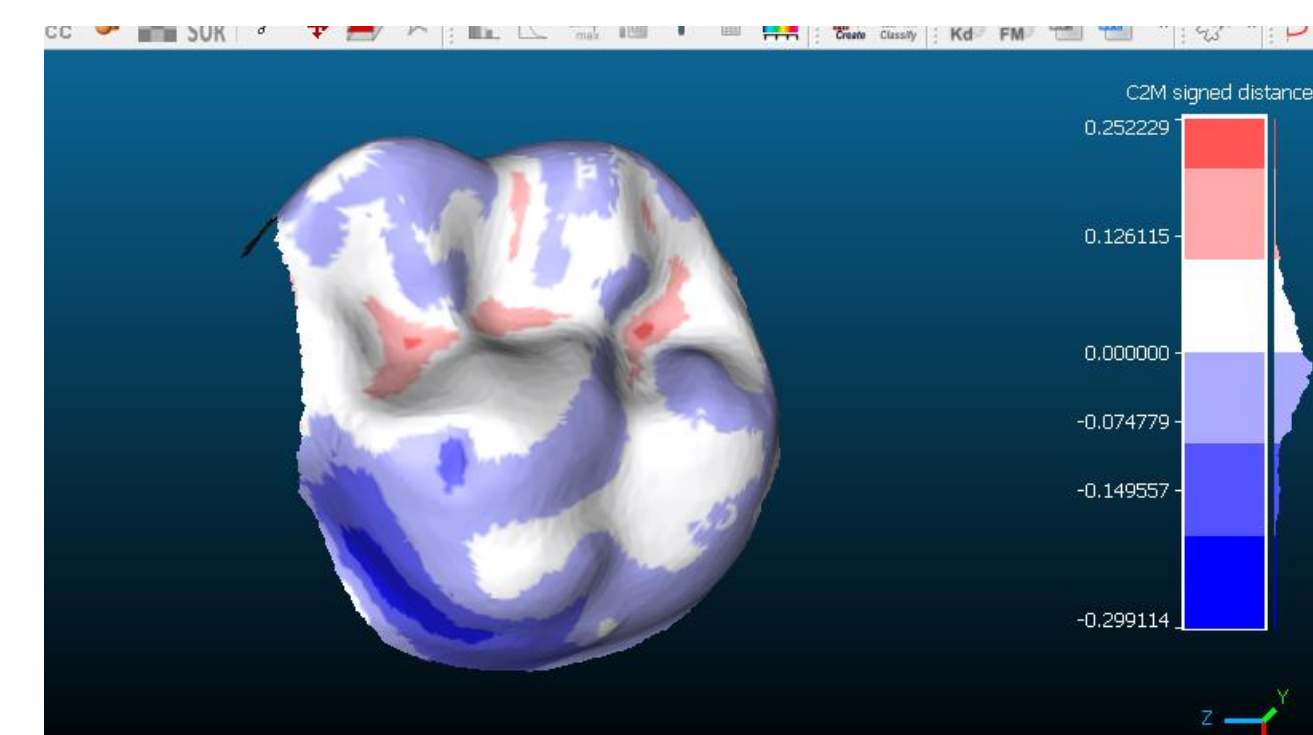


Fig. 3. Tooth #14 in DOA6 RMS obtained in CloudCompare

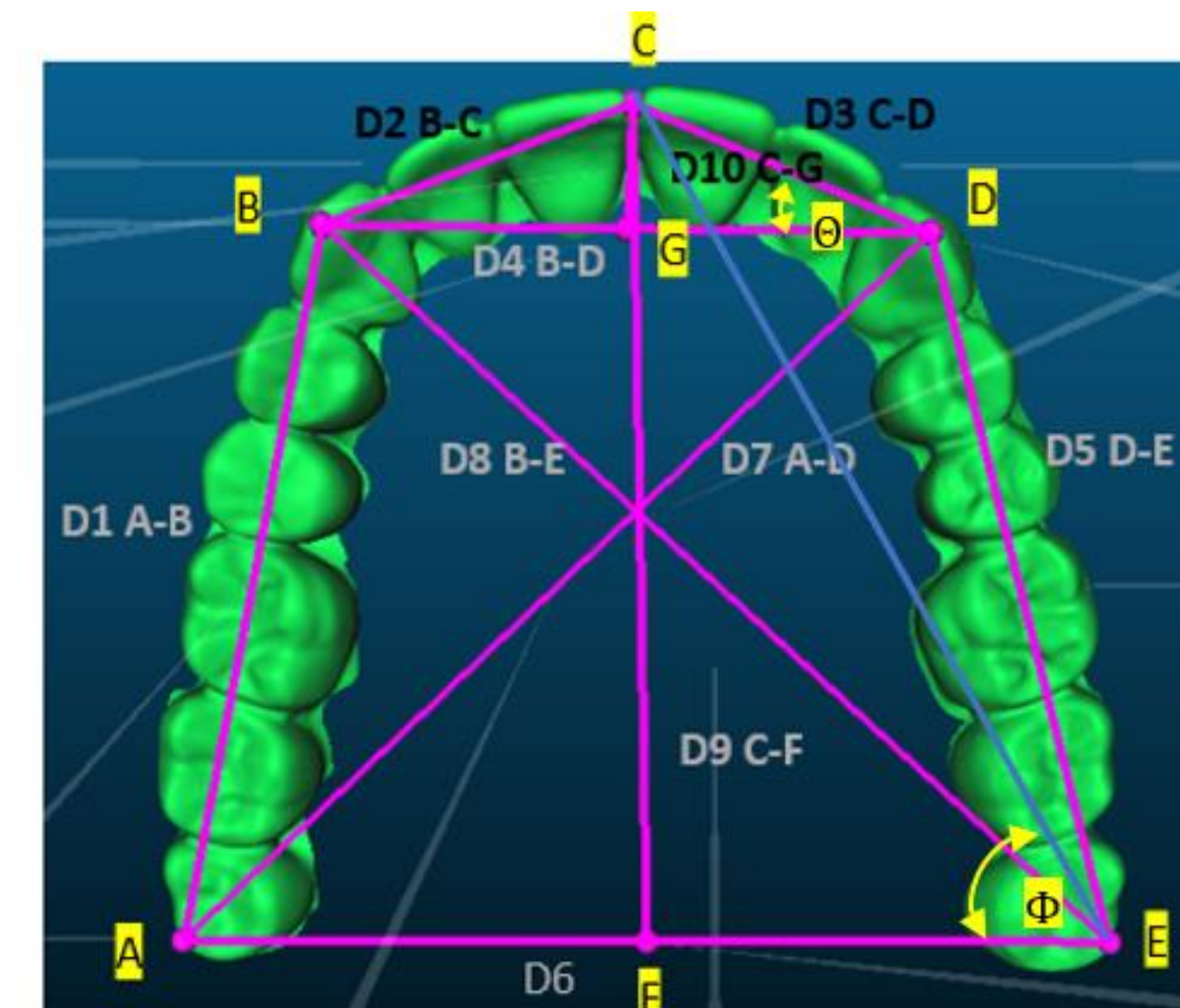


Fig. 4. Linear measurements (D1-D10) were designated on the Master model and were transferred to the intaglio meshes of DOAs and COAs to obtain linear differences.

Results

DOAs showed significantly higher trueness of the shapes of the intaglio surfaces of selected teeth (#1, #3, #6, #11, #14, and #16). Trueness for the selected teeth from DOAs ranged from 0.045 mm to 0.065 mm and was significantly ($P < 0.05$) higher than that of COAs which ranged from 0.076 mm to 0.140 mm (Fig. 5). However, DOAs had significantly ($P < 0.001$) higher linear distortion in the arch level in most dimensions; specifically, the amount of mediolateral distortion ($\Delta D6$) ($-1372 \mu\text{m} \pm 884 \mu\text{m}$) than COAs ($39 \mu\text{m} \pm 239 \mu\text{m}$). The amount of mediolateral distortion in DOAs was found to be positively correlated with increased arch length in these appliances, at least on one side of the arch (Pearson Correlation Coefficient 0.739, sig. 2-tailed 0.015) (Fig. 7).

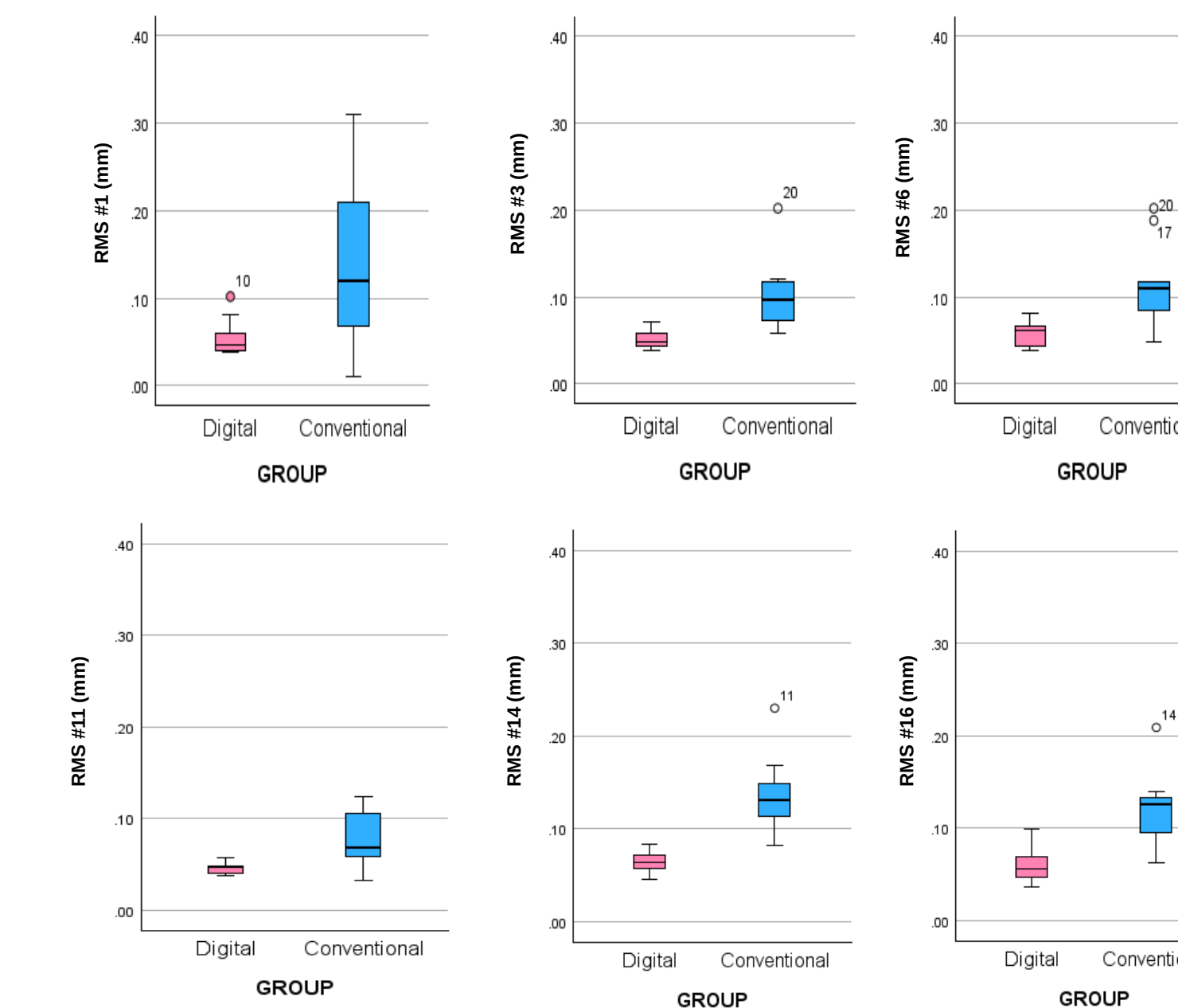


Fig. 5. Trueness obtained from selected teeth (#1, #3, #6, #11, #14, #16) in DOAs and COAs

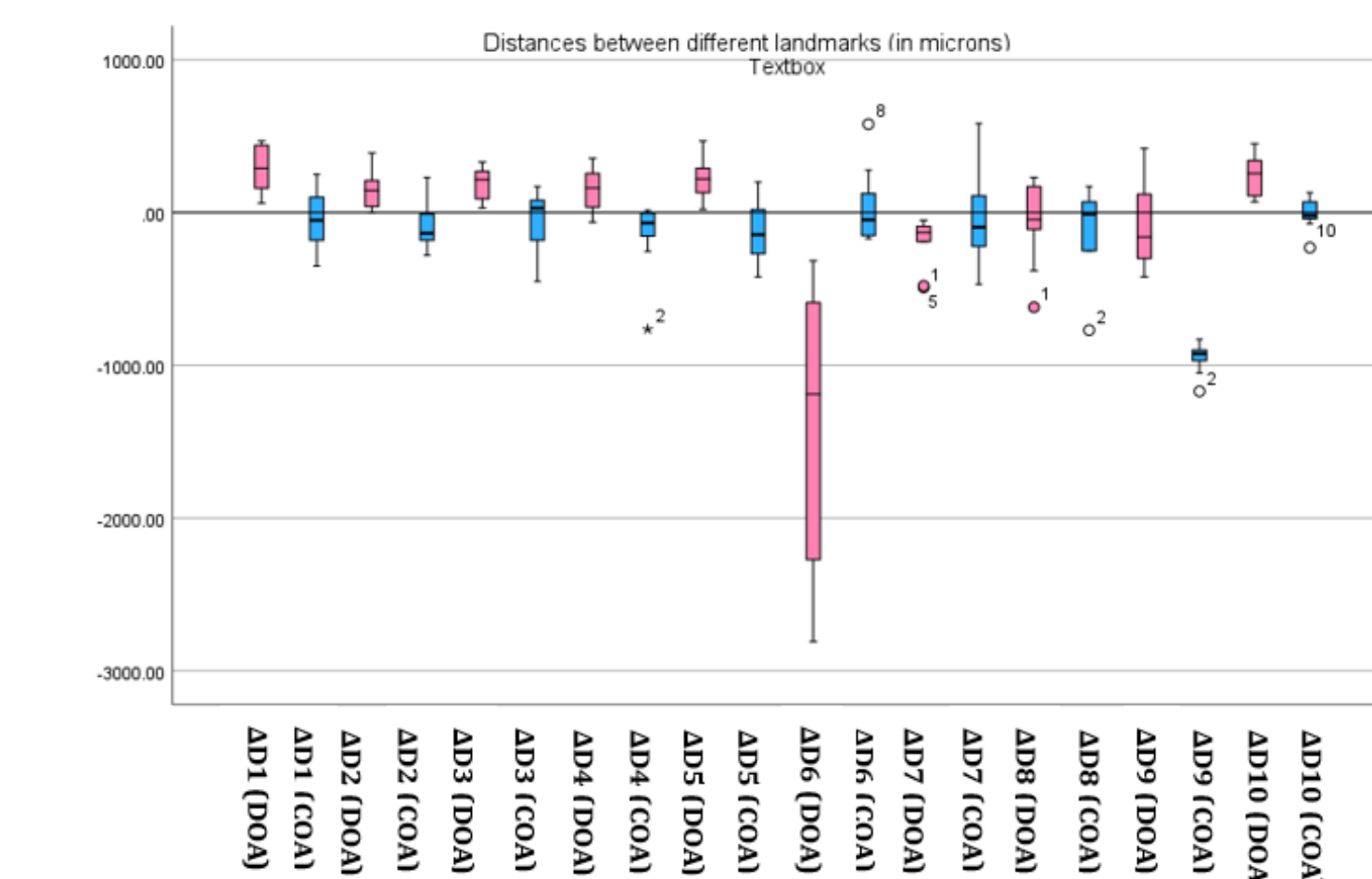


Fig. 6. Differences in linear measurements ($\Delta D1$ - $\Delta D10$) for DOAs and COAs from linear measurements obtained from the Master Model

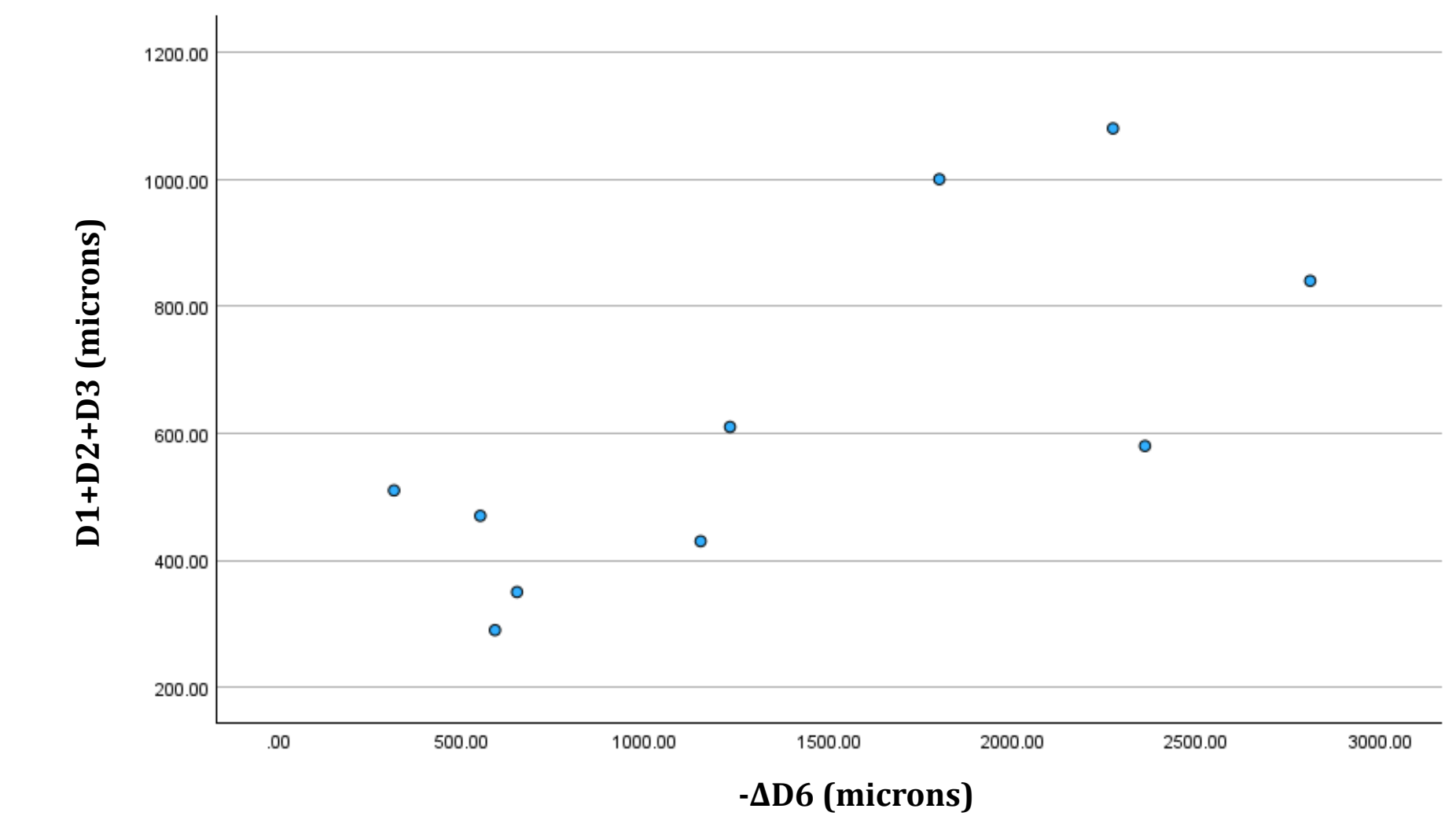


Fig. 7. Correlation between the amount of mediolateral negative distortion $-\Delta D6$ and increase in arch length ($D1+D2+D3$) in DOAs

Conclusion

Within the limitation of this study, DOAs can reproduce tooth surfaces at significantly higher trueness than COAs but produce higher linear distortion on the arch level. The negative distortion was higher on the mediolateral dimension and was found to be positively correlated to the amount of increase in arch length in the appliance.

References

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