Effect of Model Print Orientation on Accuracy of Thermoformed Appliances

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Objectives:
Three-dimensionally printed dental models are commonly used in the fabrication of thermoformed intraoral appliances, and the build angle of the models during the 3D-printing process can be tuned to increase operational efficiency. However, the effects of build angle on the deformation of 3D-printed hollow models during thermoforming remain unknown and could affect the dimensional accuracy and clinical utility of the fabricated appliances. This study investigated the effects of the build angle of hollow 3D-printed models on the dimensional accuracy of appliances thermoformed upon them.

Experimental Methods:
Thermoformed appliances were fabricated on 3D-printed hollow models of 2.0 mm shell thickness, with models printed at 0, 30, 65, and 90-degree build angles. The model surfaces were optically scanned before thermoforming. Intaglio surfaces of the thermoformed appliances were registered with polyvinyl siloxane (PVS), which was optically scanned. Superimpositions of model surfaces before thermoforming and PVS scans were assessed with metrology software applying tolerances of ±0.250 mm, and data were statistically analyzed using a generalized linear model.

Results:
Build angle had a statistically significant effect on dimensional accuracy of thermoformed appliances (P=0.005). The percentage of surface points in-tolerance generally increased with increasing build angle and ranged from 92.6±4.5% for 30 degrees to 98.0±1.7% for 90 degrees. Color coded deviation maps of samples from each group confirmed these findings, showing greater areas of surface deviations in samples from lower build angles (0 and 30 degrees).

Conclusion:
Build angle significantly affects the dimension accuracy of thermoformed appliances formed on 3D-printed hollow models of 2.0 mm shell thickness. For fabrication of thermoformed intraoral appliances with clinically acceptable accuracy on hollow models of 2.0 mm shell thickness, the results of this study suggest that build angles of 65 and 90 degrees are preferred over models formed with build angles of 0 or 30 degrees.

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