Effect of Model Support Method on Accuracy of Thermoformed Appliances

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Objectives: Thermoforming techniques are utilized in dentistry to fabricate intraoral appliances such as orthodontic aligners and Essix retainers on physical models. Generally, the thermoplastic material determines the designation for use of solid versus pellet bed support structures. As 3D-printed working models are becoming common, manufacturers have also suggested placing both full and hollow 3D-printed models in pellets to compensate for lack of porous structure in resin models compared to conventional plaster models. This project investigated the effects of using a solid versus a pellet bed support structure on the dimensional accuracy of the thermoformed appliances fabricated upon hollow 3D-printed models.

Methods: Thermoformed appliances were fabricated on 3D-printed hollow models of 2.0 mm shell thickness using a solid and pellet bed support structure (n=12/support method). The models were optically scanned before and after thermoforming. Intaglio surfaces of the thermoformed appliances were captured by scanning polyvinyl siloxane impressions. Superimposition of model surfaces before thermoforming and impression scans as well as model surfaces before and after thermoforming were assessed and statistically analyzed using a generalized linear model.

Results: Appliances were not successfully fabricated on pellets, with consistent failure to fully capture crowns of anterior teeth. Further, support type had a statistically significant effect on accuracy of thermoformed appliances, as pellets produced a greater percentage of positive deviation ($P=0.00023$) outside of tolerance (± 0.250 mm).

Conclusion: Support type significantly affects dimensional accuracy of appliances formed on 3D-printed hollow models of 2.0 mm shell thickness. Appliances are not able to capture clinically significant structures in the anterior region, and results suggest models undergo a greater degree of movement causing appliance deformation on pellets. For fabrication of dimensionally accurate and clinically acceptable intraoral appliances, the results of this study suggest that solid support structures are preferred over pellet support structures when thermoforming on hollow models of 2.0 mm shell thickness.

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