Effect of Model Support and Design on Accuracy of Thermoformed Appliances

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Objectives:
Thermoforming techniques are utilized in dentistry to fabricate intraoral appliances such as orthodontic aligners on physical models. As 3D-printed dental models become increasingly common, some manufacturers of thermoforming devices recommend use of a pellet bed support for 3D-printed models to mitigate air inclusion between the models and thermoformed appliances. While many clinicians use solid 3D-printed models, some manufacturers also recommend use of a hollow model with a 3.0 mm shell thickness for thermoforming. The aim of this study was to investigate the effect of model support type (solid versus pellet bed) and design (solid versus 3.0 mm shell) on the dimensional accuracy of thermoformed appliances fabricated upon 3D-printed models.

Methods:
Solid and hollow models (3.0 mm shell thickness) were fabricated using a SprintRay Pro 95 3D printer. Thermoformed appliances were fabricated with Essix Ace films (0.030" thickness) on solid and hollow models using a solid and pellet bed support structure on a Biostar VI pressure molding machine (n=12/group). Model surfaces were optically scanned before thermoforming, and the intaglio surfaces of thermoformed appliances were registered with polyvinyl siloxane impression material and scanned. Superimposition of model and appliance surface scans was accomplished with Geomagic Control X metrology software applying a tolerance of ±0.250 mm, and generalized linear models were applied for statistical analyses.

Results:
All appliances thermoformed using the pellet support failed to include the complete crown surfaces at the anterior region of the arch. Complete crown anatomy was captured for all appliances thermoformed using the solid support. Model design (solid versus 3.0 mm shell) did not have a significant effect on the proportion of appliance surface points in tolerance bounds.

Conclusion:
Contrary to manufacturer recommendations, the pellet bed support structure did not adequately support 3D-printed models during thermoforming to enable complete capture of dental crown anatomy in thermoformed appliances.

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