

# Impact of model base design and 3D print settings on the quality of orthodontic retainers

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*2024 Research Aid Awards (RAA)*

*Dr Kenneth Lee Stephen III*

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# FollowUp Form

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## *Award Information*

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*In an attempt to make things a little easier for the reviewer who will read this report, please consider these two questions before this is sent for review:*

- Is this an example of your very best work, in that it provides sufficient explanation and justification, and is something otherwise worthy of publication? (We do publish the Final Report on our website, so this does need to be complete and polished.)*
- Does this Final Report provide the level of detail, etc. that you would expect, if you were the reviewer?*

### **Title of Project:\***

Impact of model base design and 3D print settings on the quality of orthodontic retainers

### **Award Type**

Research Aid Award (RAA)

### **Period of AAOF Support**

July 1, 2024 through June 30, 2025

### **Institution**

University of Pittsburgh-Of the Commonwealth System of Higher Education

### **Names of principal advisor(s) / mentor(s), co-investigator(s) and consultant(s)**

Wellington Rody, Co-PI and Research Mentor; Suvendra Vijayan, Co-I

### **Amount of Funding**

\$6,000.00

## Abstract

(add specific directions for each type here)

Orthodontists around the country have begun utilizing three-dimensional (3D) printers to replace stone models in their private practice; nevertheless, the current literature suggests that 3D-printed models are subject to inaccuracies based on the printing technology and have also been shown to be statistically different than stone casts. When using additive manufacturing processes, the choice of the numerous settings and design parameters significantly influences the build and production time of the end product. By and large, there is an overall agreement in the dental literature that the most important parameters that affect accuracy and speed are the thickness of the layer (also called Z-layer) and the configuration of the model base. As there are many different edits that can be done in the digital model, and many different types of 3D printers, many questions remain unanswered. Therefore, the main purpose of this study is to investigate the influence of three base designs and Z-layer thickness on the manufacturing of 3D printed models and in the fit of thermoformed appliances (TAs). This includes using the least amount of resin necessary and keeping print times low to facilitate same day retainer delivery following debonding of fixed appliances. Our hypothesis is that working casts printed with thicker Z-layers (i.e., lower resolution) can produce accurate working models for orthodontic applications in a timely fashion. We also hypothesize that there will be no difference in the quality of retainers fabricated over 3D printed models with different base designs. We believe the results from this study will be of immediate value in the development of efficient orthodontic digital workflows.

## *Respond to the following questions:*

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### Detailed results and inferences:\*

If the work has been published, please attach a pdf of manuscript below by clicking "Upload a file".

OR

Use the text box below to describe in detail the results of your study. The intent is to share the knowledge you have generated with the AAOF and orthodontic community specifically and other who may benefit from your study. Table, Figures, Statistical Analysis, and interpretation of results should also be attached by clicking "Upload a file".

Statistical analysis using Kruskal-Wallis and Dunn's pairwise tests revealed significant differences in RMS values (HS vs. HH,  $p = 0.0000$ ; HS vs. HHB,  $p = 0.0000$ ; HH vs. HHB,  $p = 0.0146$ ), InTol% ( $p < 0.0001$  for HS vs. HH and HH vs. HHB), OverTol% ( $p < 0.0001$  for HH vs. HS and HH vs. HHB), and UnderTol% ( $p < 0.0001$  for HH vs. HS and HH vs. HHB). Linear measurements showed statistically significant differences in intercanine distance ( $p = 0.0021$ , HS vs. HHB) and arch length ( $p < 0.0001$ , HS vs. HH and HHB), though intermolar distances were not significantly different ( $p > 0.05$ ). Despite statistical differences in model accuracy, no significant differences were observed in retainer fit across all five criteria ( $p > 0.10$ ), indicating that all designs yielded acceptable outcomes in an in vitro model.

### Were the original, specific aims of the proposal realized?\*

Our aims for this study were two fold:

Aim 1 - To evaluate dimensional accuracy and production time of 3D printed dental models

produced at a lower resolution using different base designs.

Aim 2 - To evaluate the fit of thermoplastic retainers fabricated from 3D printed dental models produced at a lower resolution using different base styles.

Our aim 1 results showed there were statistically significant differences in dimensional accuracy using the different base designs, with the solid horseshoe model being the most accurate. Most of the deviation in the models were noted in the soft tissue area of the first and second molars with limited changes in the teeth themselves. Our aim 2 results demonstrated that although there were statistically significant differences, when thermoplastic essix retainers were fabricated to simulate the clinical use, no differences were noted. To confirm these findings, next steps would include a patient based clinical study to evaluate if patients notice any kind of difference with these retainers and if their equally effective.

### **Were the results published?\***

No

### **Have the results of this proposal been presented?\***

Yes

### **To what extent have you used, or how do you intend to use, AAOF funding to further your career?\***

I have used this funding to expand upon my initial interest in orthodontic research. By completing this project, I have not only gained experience in formulating a research project, but I have learned how to look critically at research. I have interests in becoming a faculty member in an orthodontic department one day, and I will use this experience to help residents formulate projects that can have the same impact on them.

### **Accounting: Were there any leftover funds?**

\$0.00

## ***Not Published***

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### **Are there plans to publish? If not, why not?\***

Yes we are hoping to publish the results in an orthodontic journal.

## *Presented*

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Please list titles, author or co-authors of these presentation/s, year and locations:\*

Dr. Ken Stephen presented as an Oral Research Presentation at the AAO in Philadelphia.

## **Was AAOF support acknowledged?**

If so, please describe:

Yes the first slide cited that AAOF support made this project possible.

## *Internal Review*

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Reviewer comments

Reviewer Status\*

## File Attachment Summary

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### *Applicant File Uploads*

*No files were uploaded*