



A Comparison of Dimensional Accuracy of 3D-Printed 4-Unit Fixed Partial Denture at Two Different Resolutions: An In-Vitro Study

Julia Nguyen DDS, Paul Zhivago DDS FACP, Thomas Giugliano DDS, Mijin Choi DDS MS MBA FACP

Jonathan and Maxine Ferencz Advanced Education Program in Prosthodontics, New York University College of Dentistry

INTRODUCTION

The utilization of digital technology in dentistry is rapidly increasing as new and improved digital workflows and materials are being introduced.¹ Computer-aided design and manufacturing (CAD/CAM) technology has been dominated by subtractive (milling) manufacturing. However, additive manufacturing (3D-printing) is becoming a more preferred method because of its ease of technique and lower equipment maintenance.² 3D-printing has many advantages as it allows for the fabrication of more complex and smooth structures and less material waste when opposed to milling.³ 3D-printers can have different resolutions in which the layer thickness is printed in microns (μm). The lower the microns, the better the resolution, but more time is required for printing.⁴ Though there are some studies^{5,6,7} investigating different resolutions, there are conflicting results and further research on the accuracy of printed prostheses at different resolutions is needed.

OBJECTIVES

This study aims to compare the dimensional accuracy of a 4-unit 3D-printed fixed partial denture (FPD) at 100 μm and 50 μm resolutions using a new 3D-printable ceramic-filled hybrid material: SprintRay Crown™ by BEGO (SprintRay, Los Angeles, CA).

The null hypothesis of this study is that there is no difference in the dimensional accuracy of a 3D-printed FPD at 100 μm versus 50 μm .

METHODS

A 4-unit FPD with two abutment teeth (first premolar and first molar) and two pontics was digitally designed using a scanned .stl of a metal master model on ZBrush software (ZBrush, San Francisco, CA). The resulting .stl file served as the control (Fig. 1). A total of 20 test samples were printed at two different resolutions: 100 μm (Group 1, n=10) and 50 μm (Group 2, n=10) using SprintRay Crown™ by BEGO in shade B1 (Fig. 2). Each sample was cleaned and post-cured following the manufacturer's instructions. The samples from each group were scanned using a Medit i700 scanner (Medit, Seoul, South Korea) and the resulting .stls were superimposed onto the control using Geomagic Control X (Geomagic, Durham, NC). Discrepancies in overall measurements were quantified for both groups using a color map (Figs. 3 and 4). The color map indicates both positive and negative discrepancies. An independent t-test was done to compare the averages of the two groups.

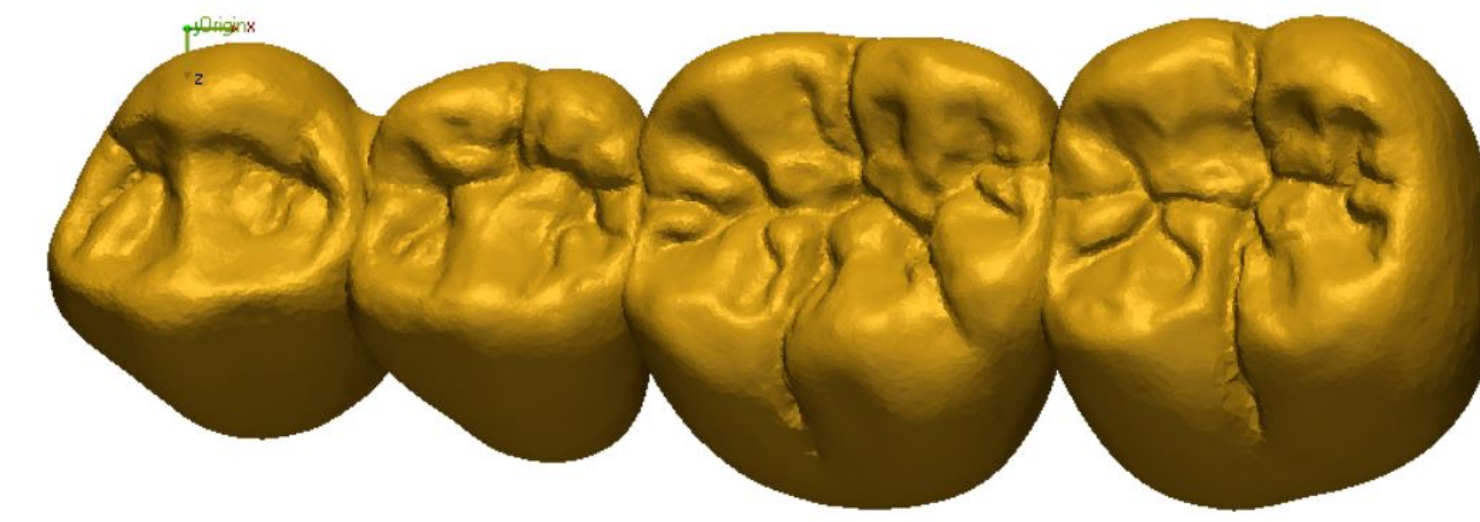


Fig 1. Control .stl



Fig 2. SprintRay Crown™ by BEGO 3D-printed 4-unit fixed partial denture

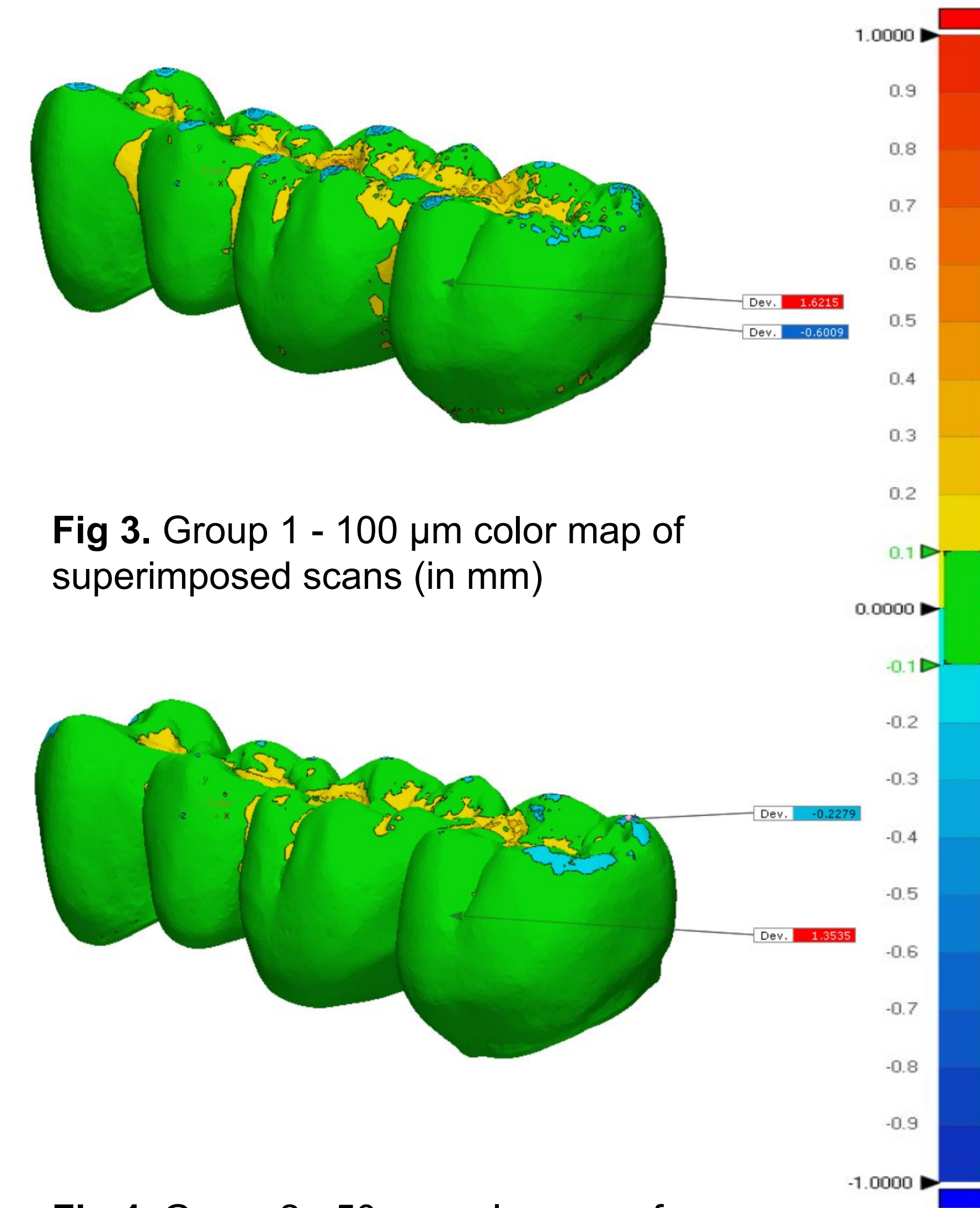


Fig 3. Group 1 - 100 μm color map of superimposed scans (in mm)

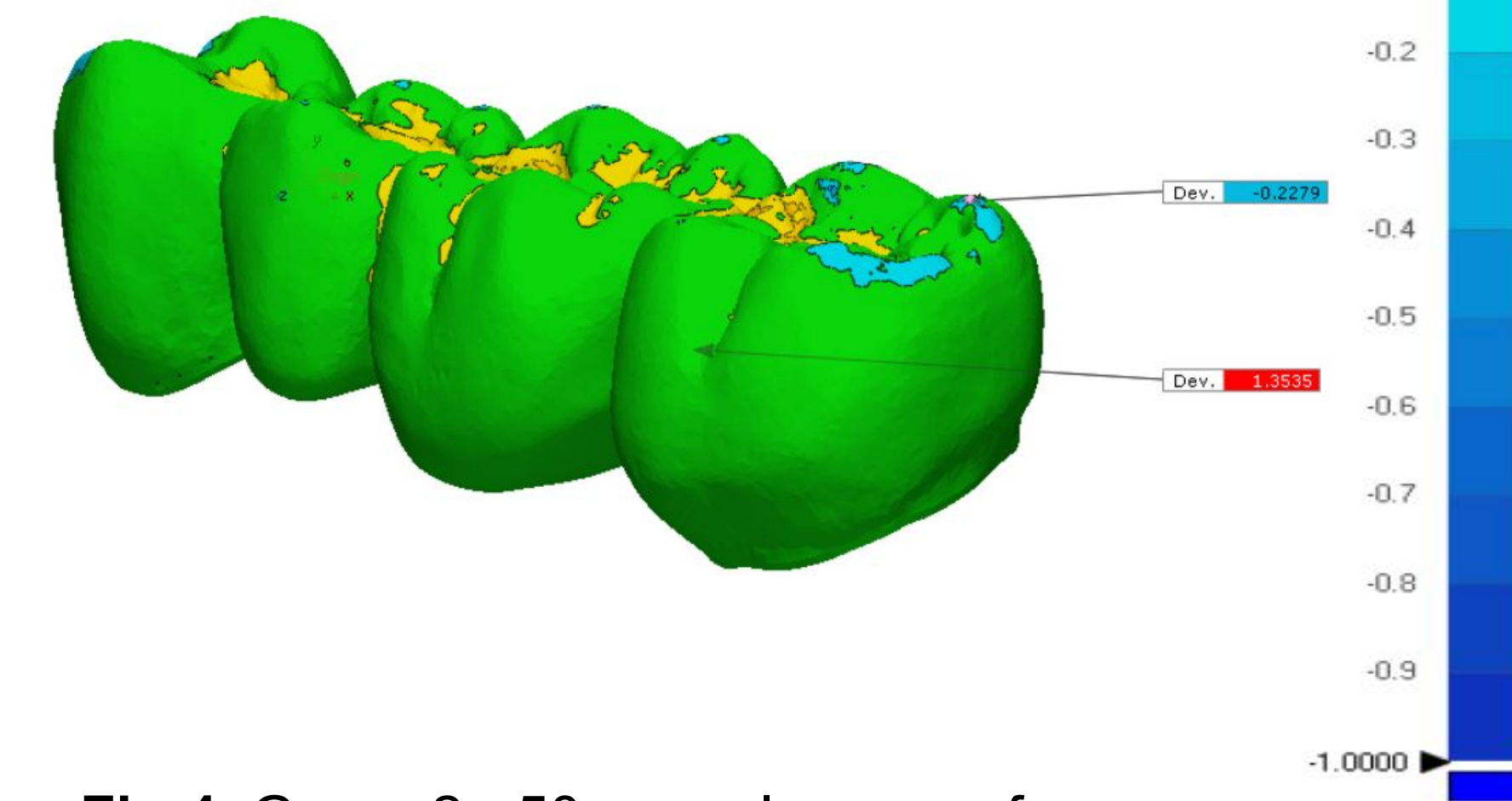
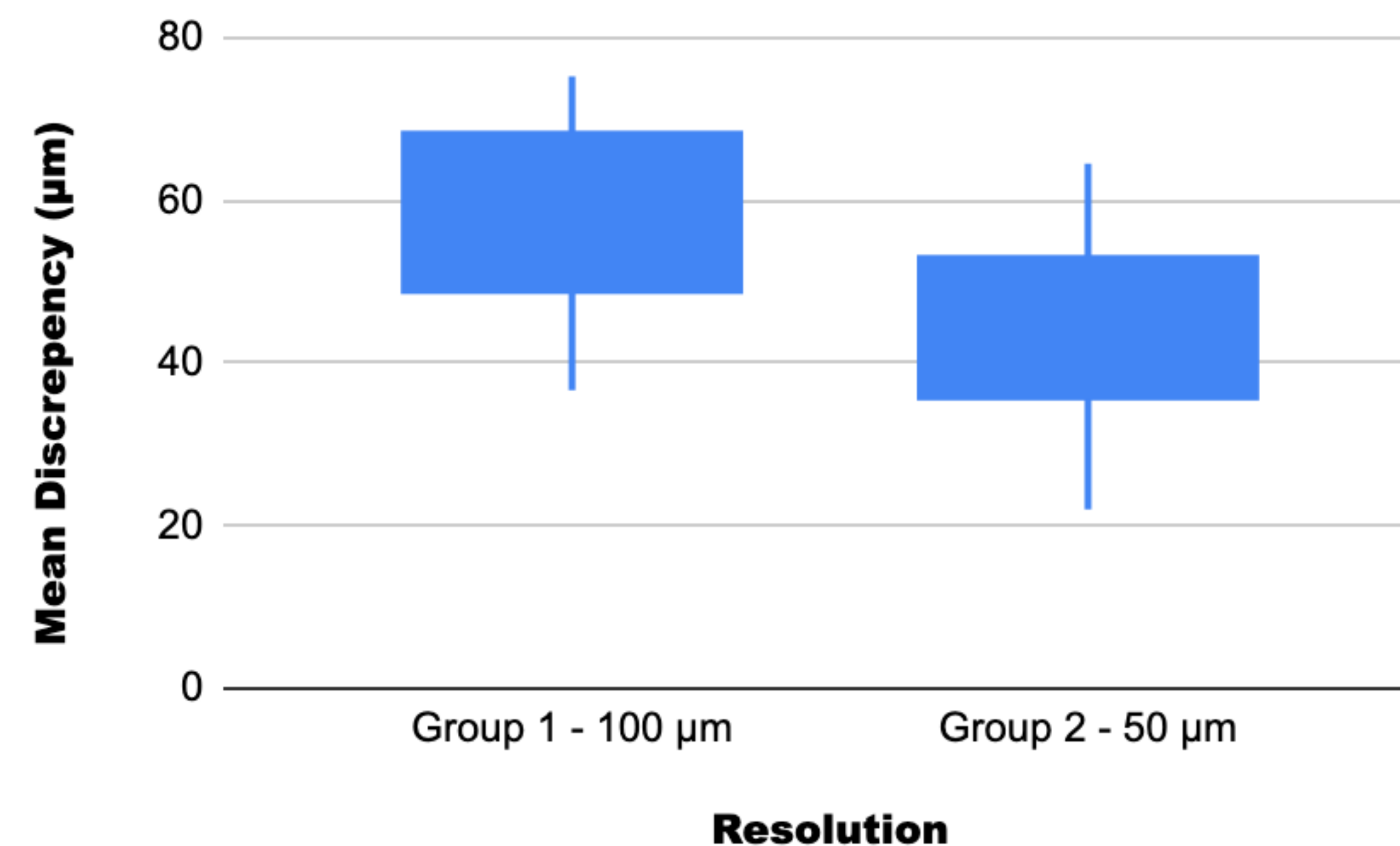


Fig 4. Group 2 - 50 μm color map of superimposed scans (in mm)



Graph 1. Distribution of discrepancies for Groups 1 and 2

RESULTS

Graph 1 shows the distribution of the average discrepancies of each scan to the control. The average discrepancy in overall measurements between the printed samples and the control were 61 μm and 45 μm for groups 1 and 2 respectively (Table 1). Group 1 - 100 μm had a range of discrepancy from 36.7 μm to 75.3 μm . Group 2 - 50 μm had a range of discrepancy from 22 μm to 64.6 μm . The standard deviation of both groups was 13 μm . An independent t-test comparing the averages of each group resulted in a p-value of 0.031 ($p < 0.05$).

Resolutions	Average Discrepancy	Standard Deviation
Group 1 - 100 μm	61 μm	13 μm
Group 2 - 50 μm	45 μm	13 μm

Table 1. Average discrepancy and standard deviation of measurements of each sample to the control

DISCUSSION

Most of the discrepancies were observed on the occlusal surfaces. This discrepancy pattern may have resulted from the struts being attached to the occlusal surfaces. The location of the struts for this study was designed according to the previous study by Ryu et al., in which a 180° build orientation (from the intaglio surface) showed the best accuracy.⁸ Furthermore, the clinical significance of the printed FPD at 50 μm resolution on its marginal fit, flexural strength, and surface finish needs to be investigated in future studies.

CONCLUSION

Within the limitation of the study, there was a statistically and clinically significant difference in dimensional accuracy between 4-unit FPDs printed with SprintRay Crown™ by BEGO at 100 μm versus 50 μm .

REFERENCES

