Poster #: 6-R

Marginal Fit of Milled and 3D-Printed Definitive Crowns

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INTRODUCTION

Three-dimensional (3D) printing technology, also known as additive manufacturing (AM), is becoming increasingly versatile in dentistry because of its ability to produce precise and customizable dental products.[1] It is particularly popular in prosthodontics for digitally fabricating removable prostheses, crowns, and fixed partial dentures.[2] While existing research has compared the marginal fit of printed crowns made with temporary restorative resin to that of milled crowns[3], there is limited focus on how the use of permanent crown resin combined with 3D printing technologies affects the quality of indirect restorations.[4] It is crucial to understand that different dental 3D printers rely on distinct technological principles and specific resins, which can significantly impact the marginal fit of permanent crowns.[5]

OBJECTIVE

This in vitro study aimed to compare marginal fits of crowns fabricated using permanent crown resins from three different vat photopolymerization additive manufacturing technologies—masked stereolithography (mSLA, Form 4B, Formlabs), stereolithography (SLA, Form 3B, Formlabs), and digital light processing (DLP, Pro S, SprintRay)—with lithium disilicate crowns fabricated using subtractive manufacturing technology (CEREC, Primemill, Dentsply Sirona) , a positional 4-axis mill.

MATERIALS and METHODS

A typodont tooth (#19) was prepared with dimensions (1.5 mm occlusal and 1.2 mm axial reduction, chamfer finish line, 6° convergence angle) and scanned to create a master die. Forty crowns of the same dimension and source file were fabricated (n=10 per group) using four manufacturing methods: milling (control group) with lithium disilicate, SLA, DLP, and mSLA (experimental groups) with respective ceramic crown resins. All 3D-printed crowns were programmed to be fabricated at 50 µm layer thickness and occlusal surfaces facing print platforms. The master die and crowns were scanned and digitized for data collection. Marginal gaps were measured using a triple-scan protocol with digital analysis software (Geomagic Control X), capturing 25,000-30,000 data points per sample. Data were analyzed using Kruskal-Wallis and Steel-Dwass post-hoc tests (α=0.05).

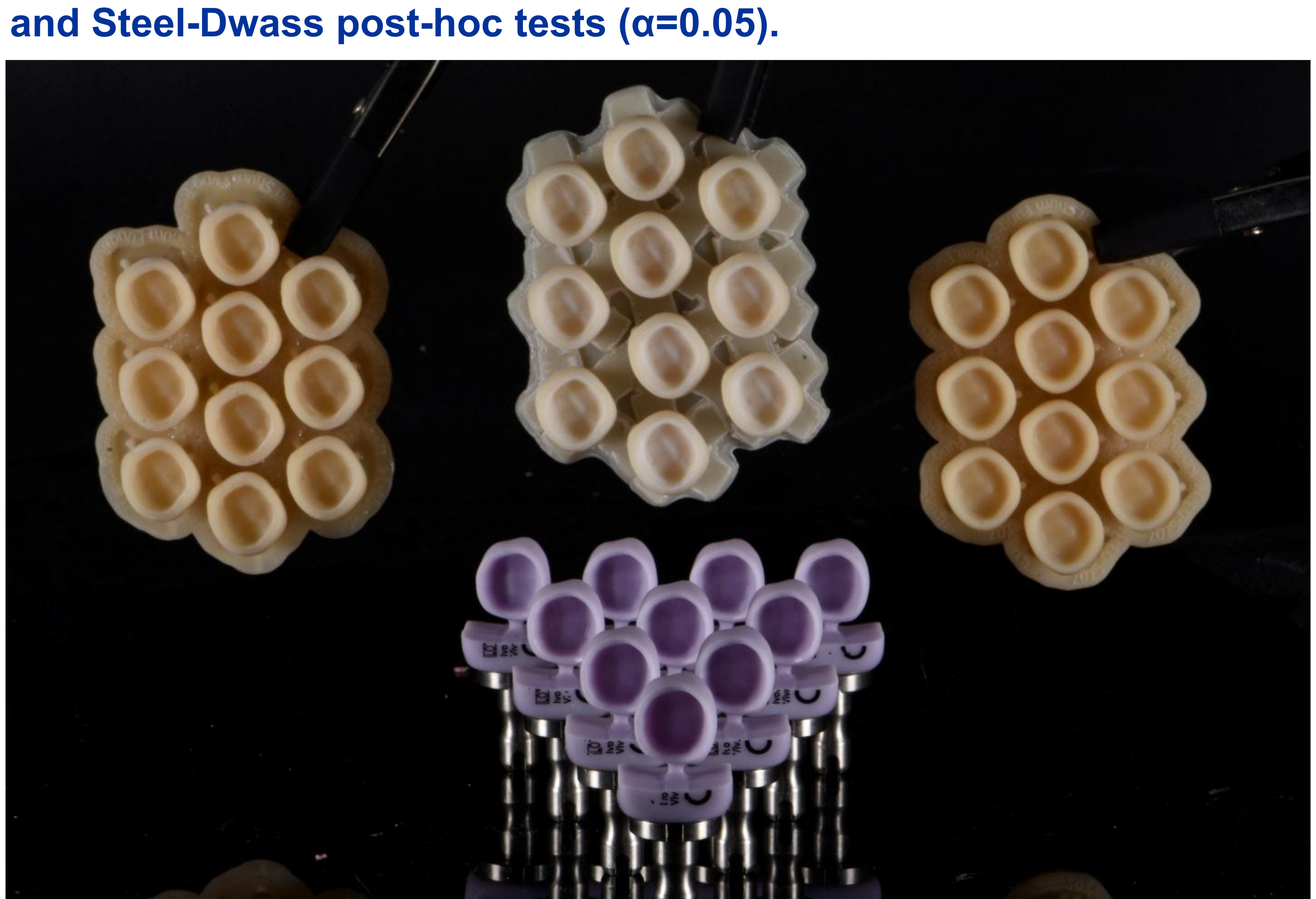

Figure 1 Samples fabricated from SLA, DLP, mSLA 3D printing and CEREC Milling.

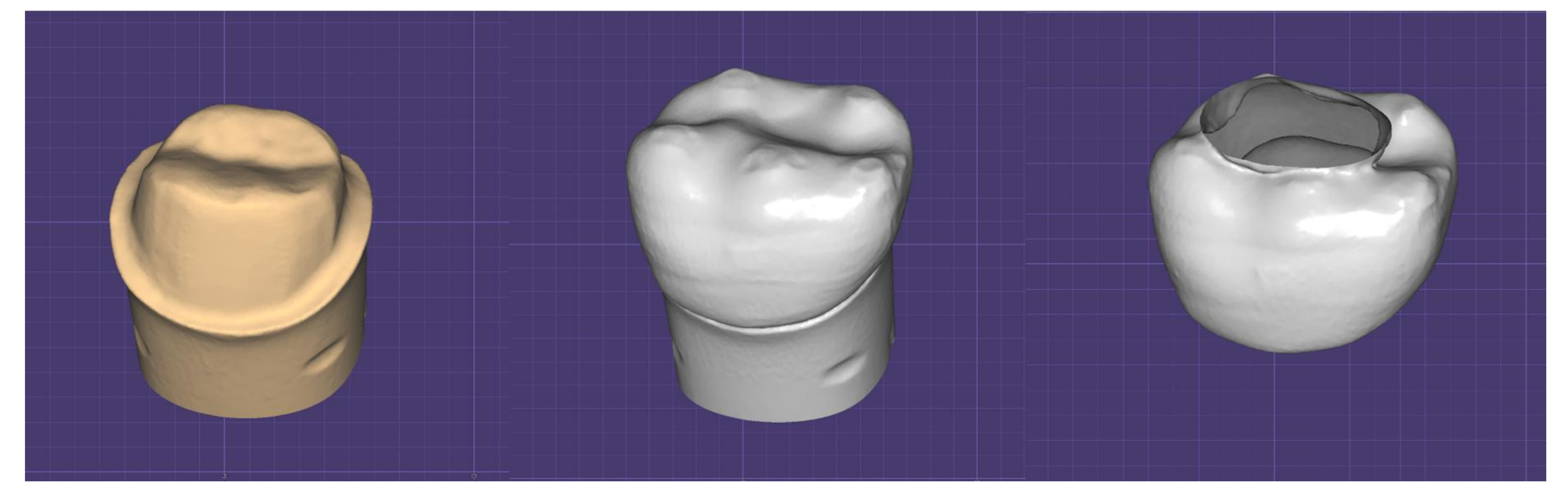

Figure 2. Digitized master die, sample crown on master die and sample crown. (From left to right)

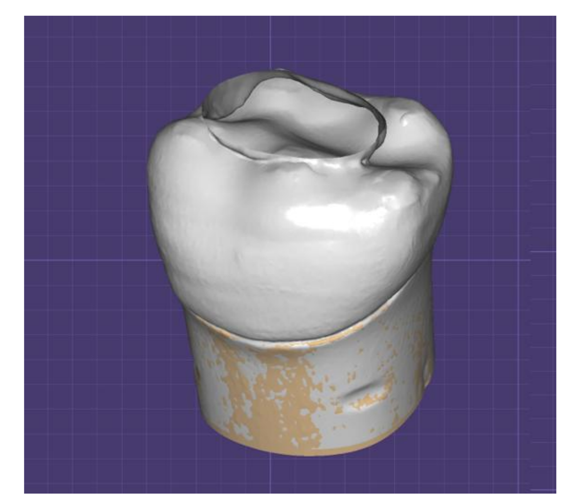

Figure 3. Merged STLs stacked together.

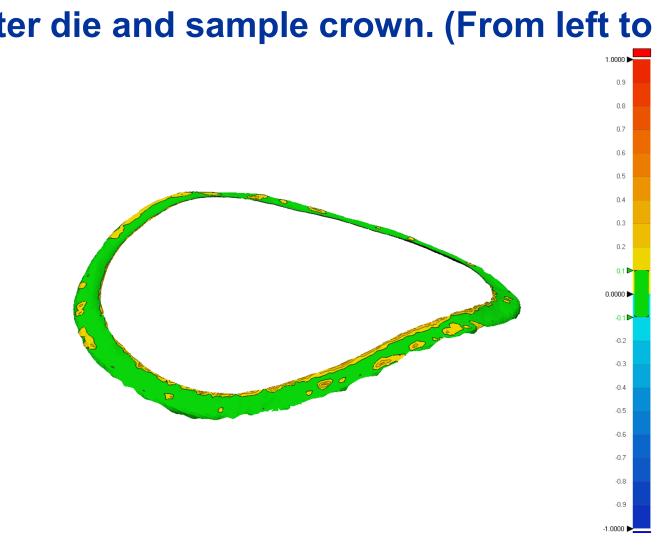

Figure 4. Geomagic Control X findings of marginal gap.

RESULTS

The control group demonstrated the smallest mean marginal gap (171.95 ±21.36 µm), followed by SLA (218.74 ± 15.58 µm), DLP (221.21 ± 15.68 µm), and mSLA (234.43 ± 7.54 µm). The Kruskal-Wallis test revealed significant differences among groups ($\chi2=24.00$, df=3, *p*<.0001). Post-hoc comparisons showed that all three 3D-printed groups exhibited significantly larger marginal gaps than the control group (mSLA vs. control: *p*=0.0010; SLA vs. Control: *p*=0.0033; DLP vs. Control: *p*=0.0043). No statistically significant differences were found among the three 3D-printing technologies (all *p*>.05).

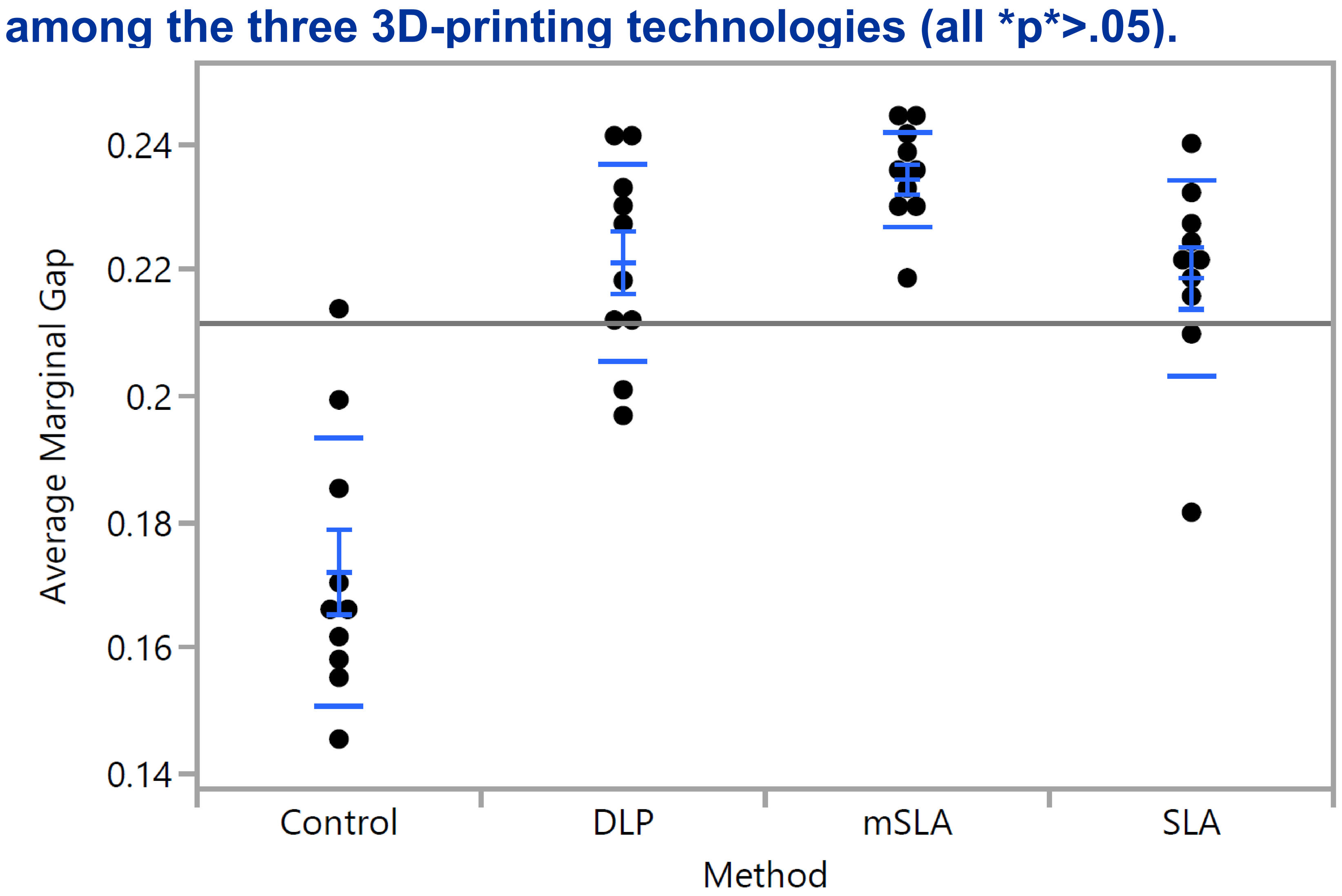

Figure 5. One-way Analysis of Average Marginal Gap By Method

CONCLUSIONS

Subtractive manufacturing processes produced superior marginal fit compared to all 3D-printing methods. However, all three 3D-printing technologies demonstrated comparable marginal fit to each other.

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