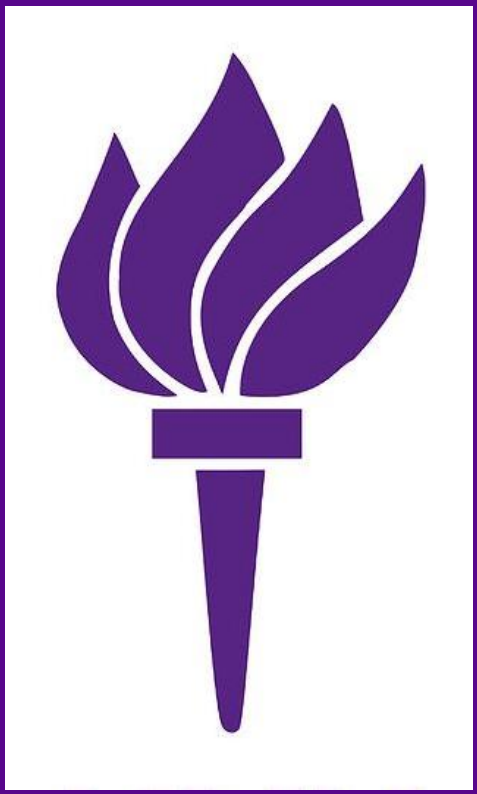




A Comparison of Flexural Strength of 3D Printed 4-Unit Fixed Partial Dentures at 50 and 100 μ Resolution: A Pilot Study

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Abstract

Understanding the flexural strength and fracture load of printed restorations is crucial for improving the durability and longevity of dental prostheses. This study assesses the fracture load of 3D printed 4-unit fixed partial dentures (FPDs) produced according to manufacturer specifications.

A master cast was scanned using a TRIOS 5 desktop scanner, which was then converted into an STL file, and a 4-unit FPD was digitally designed with Zbrush software. Four materials were tested: Sprint Ray's OnX, Crown, Ceramic Crown, and Form Lab's Permanent Crown. Ten samples of each material were printed at 50 μm or 100 μm (OnX) resolution, then washed and post-cured. Each sample underwent a three-point flexural test with cross-head speed set to 1 mm/min and data was analyzed using one-way analysis ANOVA (SPSS v29).

Results indicated that the OnX resin group was able to withstand a greater load (N) before fracturing the FPD and endured higher internal stress before failing. Significant statistical differences in both stress and load were noted among all resin groups. Understanding how resin performs under load assists clinicians in choosing optimal materials, thereby enhancing restoration longevity and patient satisfaction.

Introduction

Dental restoration fabrication methods have significantly evolved, leading to enhanced quality and longevity.¹ While traditional CAD/CAM workflows provide precise control over the final product,^{2,3} 3D printing has emerged as a transformative technology in dentistry that boosts patient satisfaction and clinician efficiency.⁴⁻⁶ The success of printed dental prostheses can be evaluated through qualitative measures such as precision and accuracy,^{7,8} while their longevity is affected by the flexural strength of the materials used.⁹

Despite the availability of new dental resins, the flexural strengths of various materials have not been comprehensively evaluated.⁸ Understanding the bending resistance of these resins is vital for informed material selection by clinicians. This pilot study assesses the flexural strength of several dental resins.

Objectives

The objective of this study is to compare the fracture load of 3D-printed, 4-unit fixed partial dentures made from the following materials: OnX, Crown, and Ceramic Crown by Sprint Ray, along with Permanent Crown by Form Lab, according to the manufacturer's recommendations.

The null hypothesis (Ho): There is no difference in the flexural strength of 3D-printed fixed partial dentures produced at 50 or 100 μm.

Methods

A master cast was scanned using a TRIOS 5 desktop scanner and saved as an STL file. This file was opened in ZBrush software, where a 4-unit FPD with one premolar abutment, one molar abutment, and two pontics—one premolar and one molar—was digitally designed. The 40 FPD samples were fabricated using four different ceramic-reinforced composite materials. The details of the test sample materials are listed in Table 1.

For each printing material, 10 samples (n=10) were printed at a resolution of 50 or 100 μm, based on the manufacturer's recommendations. The Universal Testing Machine (Instron 5560) was used to apply a 1000 Ncm over section 3, as shown in Fig. 1, at a crosshead speed of 1 mm/min. The data was collected and analyzed using a one-way analysis of variance (ANOVA) test.

The analyzed data can be seen in Fig. 2 with reported fracture loads (N) and flexural strengths (MPa).

Results

Test Groups	Product Brand Name	Manufacturer	Main components	Recommended Printing Resolution (Micron)	Manufacturer's Reported Flexural Strength (MPa)
OnX	OnX	Sprint Ray	Nanoceramic hybrid class II resin	50	147
Ceramic	Crown		Ceramic filled hybrid resin	100	≥ 100
CCrown	Ceramic Crown		Nanoceramic hybrid resin, over 50% inorganic, ceramic content	100	150 ± 25
Flex	Permanent Crown	Formlabs	Ceramic filled resin	100	116

Table. 1. Sample resin manufacturer details

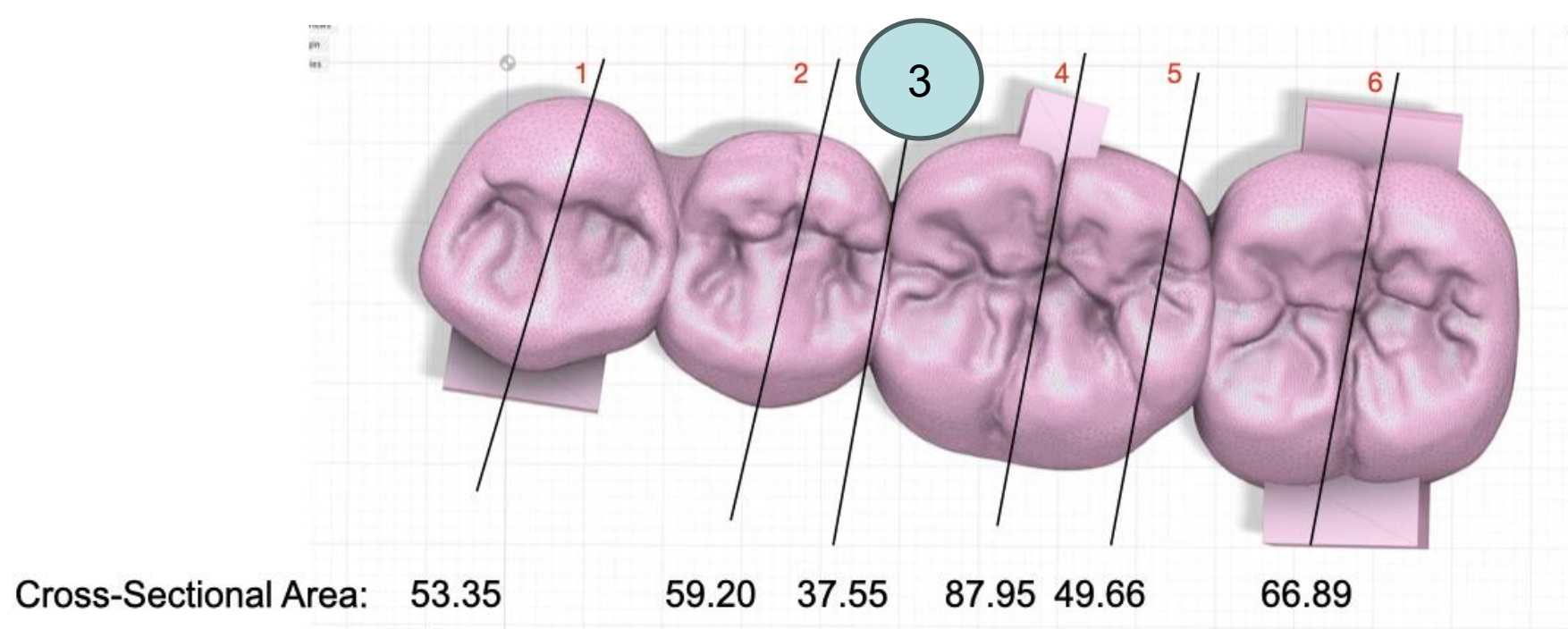


Fig. 1. Digital sample 4-unit FPD. The load was applied to cross section 3.

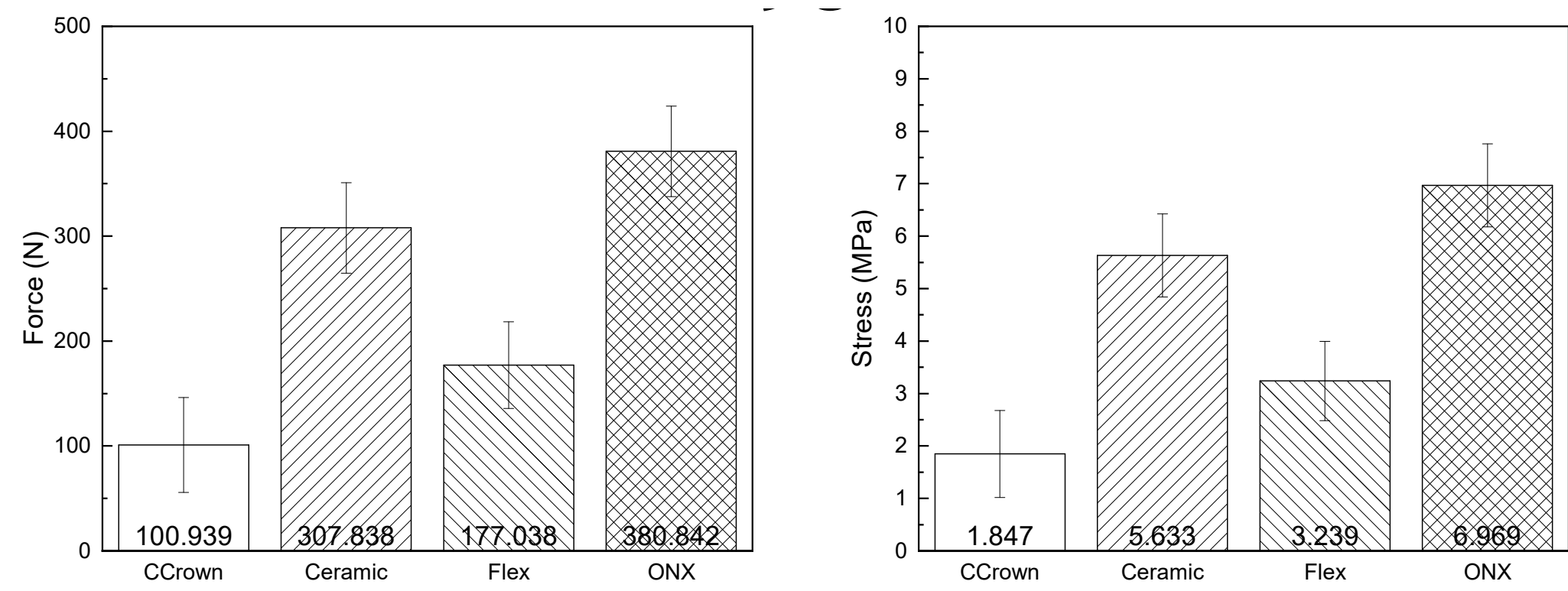


Fig. 2. Fracture force (N) and stress (MPa) of different resins materials. Results: Mean ± 95% CI

		Fracture Load	Flexural Strength
CCrown	Ceramic	<0.001*	<0.001*
	Flex	0.016	0.016
Ceramic	OnX	<0.001*	<0.001*
	Flex	<0.001*	<0.001*
Flex	OnX	0.020	0.020
	OnX	<0.001*	<0.001*

Table. 2. p-values for statistical differences in fracture load and flexural strength between different printed resin materials.

* Statically significant

Conclusion

All samples show statistical differences in fracture load and flexural strength as shown in Table 2 (p-value). As shown in Fig. 2 and Table 2 the highest fracture load and flexural strength was OnX followed by Ceramic, Flex, and CCrown. The least amount of difference is shown between CCrown and Flex (p=0.016) and between Ceramic and OnX (p=0.020). The greatest amounts of statistically significant differences were seen between the OnX group and CCrown/Flex Groups (P<0.001).

Understanding how different resins respond to load and stress allows the clinician to select the appropriate material in the clinical situation. This can contribute to the longevity and durability of the restoration, and in turn, patient satisfaction.

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