

The effect of Thermocycling on the Flexural and Impact strength of 3D printed dental resins by two different Technologies

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ABSTRACT

Background and Objective: This research examines the effects of Thermocycling and various printing processes, including Digital Light Processing (DLP) and Stereolithography (SLA) 3D printing, on the mechanical characteristics of denture base resin.

Materials and Methods: Eighty denture base samples were prepared and equally distributed for two mechanical tests, 40 for the Flexural strength test and 40 for the Impact strength test. These were subsequently subdivided into two subsets based on the photopolymerization technology: DLP and SLA. Half of the samples in each group underwent 3,000 Thermocycles from 5 to 55°C. A universal testing machine and a Charpy's impact tester were used, respectively.

Results: The values of Flexural strength were 34.384, 31.591, 29.446, and 28.621 MPa; Impact strength 0.841, 0.552, 0.742, and 1.103 KJ/m² for DLP Before, DLP After, SLA Before, and SLA After Thermocycle, respectively. Before and after Thermocycling, DLP had greater Flexural strength than SLA. DLP had higher Impact strength before Thermocycling, but SLA had it after.

Conclusion: DLP demonstrated superior Flexural strength compared to SLA both before and after Thermocycling. Thermocycling had a material-dependent effect on Flexural strength, causing a statistically significant reduction in the DLP group ($p < 0.001$), while the reduction observed in the SLA group was not statistically significant. Regarding Impact strength, Thermocycling significantly decreased the values in the DLP, whereas it significantly increased the values in the SLA. These findings indicate that the effect of Thermocycling on mechanical properties varies depending on the printing technology and material characteristics.

Keywords: mechanical properties, Denture base resin, 3D printing, and Thermocycling

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INTRODUCTION

Additive manufacturing (AM) and its various applications have transformed global society, including dentistry, enabling the quick and accurate production of sophisticated structures. Additive manufacturing has been applied in various areas of dentistry since the 1980s, and its usage is growing rapidly. Additive manufacturing was originally developed by Charles Hull, who discovered stereolithography (SLA) in the 80s, which creates solid objects using UV light. Early application of clinical 3D printing in dentistry was limited to studying the natural course in the trajectory of 3D printing in the dental sector, dating back to the 1990s, when basic models served the purpose of surgery planning and teaching. Digital workflows in dentistry were brought into use at the end of the 1990s and the early 2000s, resulting in the implementation of CAD and CAM technologies. The polymerization processes in AM are correlated with the final quality and functionality of AM 3D printed objects in polymer. These processes involve melting, curing, or polymerization, which have the potential to influence the mechanical properties, surface quality, and general printability of the printed parts. Vat Photopolymerization, such as stereolithography (SLA) and digital light processing (DLP), cures a liquid photopolymer resin into a solid under light, consequently having a high resolution and surface finish. Vat photopolymerization is routinely employed in dentistry for the fabrication of custom dental prostheses, including dentures.¹ Photopolymer resins are often chosen for the 3D printing of SLA dentures, considering their mechanical and aesthetic characteristics. The resin itself, however, may result in brittle structures if it is left too long. Optimal results can only be achieved once the polymerization has ceased. Optimization techniques such as the Taguchi method and response surface methodologies aid in the determination of the optimum print parameters for highest accuracy and surface quality. With that being said, SLA is cheaper than before today and with a more accessible price-point and high-precision, smooth surface. Nevertheless, its color and fracture resistance, phonetic, and aesthetic problems can be seen. Stereolithography (SLA) is proposed to be used as one of the methods to produce denture resins, by virtue of precision, surface roughness, and economy. DLP printing is attaining greater popularity for the production of high-quality pros-

theses against strains and fractures. However, there are also issues related to adaptation and retention.² As technology progresses, DLP printing becomes an interesting alternative to the limitations faced during the fabrication of conventional dentures, enhancing clinical outcomes. Numerous efforts have been undertaken to address the limitations of traditional denture manufacturing methods and to enhance the characteristics of polymethylmethacrylate (PMMA) material.³ Computer-aided design/computer-aided manufacturing (CAD/CAM) techniques have evolved to produce removable partial dentures, record bases, immediate prostheses, and implant-supported over-prostheses in fewer clinical appointments. A wide range of challenges, including poor fit, morphological grooves, and inadequate structure, may contribute to denture base breakage. In these instances, denture bases are subjected to impact or flexure fatigue, ultimately breaking when the material's maximum mechanical ability is met. The three-point flexural (transverse) test is the most widely used technique to assess the flexural features of denture bases. Numerous studies have evaluated the Flexural strength of different denture base materials using the flexural test specification. The impact test is another often-used technique for evaluating the flexural and Impact strength performance of acrylic resins.⁴ Impact strength refers to a material's capacity to withstand fracture when subjected to rapidly applied force. Impact testing differs from static strength testing. In static three-point bending tests, the loading rate is low and steady, with strength assessed at the moment of catastrophic collapse. In impact testing, a specimen is fractured by a rapidly applied force generated by a swinging or dropped standardized mass from a predetermined height. The Impact strength is determined by the absorbed energy per unit cross-section at the point of catastrophic fracture. It directly assesses the material's capacity to absorb stress and may therefore more accurately represent the material's toughness than other tests. There is a lack of documented information on dental restorative materials or biomaterials in general, and the theoretical foundation and rationale for the impact test are similarly deficient. The impact test assesses the energy absorption capacity under a suddenly applied force. 3-point bending does not provide insights into a material's deformation and failure under high-strain-rate

loading. Upon impact, the majority of materials exhibit linear elastic behavior, but at elevated strain rates, they tend to transition to a more brittle response. Impact characteristics are critically significant in the creation of novel dental and bio-materials. Factors influencing Impact strength may assist in the development of materials with enhanced durability.⁵

In light of the rapidly changing field of AM technologies, there is a limited understanding of how printing methods and processing parameters to influence the mechanical properties as well as clinical performance of denture base materials that need to be investigated further. Although SLA and DLP provide more accuracy with better aesthetics than standard methods, they have still failed to overcome existing drawbacks like brittleness, breakability, and limited fitting. Overall, the improvement of 3D-printed denture functional durability, patient comfort, and aesthetic outcomes can be achieved by optimizing printing parameters and material formulations. Therefore, it is necessary to conduct this study to comprehensively evaluate and compare the mechanical behavior of denture base materials processed with these technologies, in turn, providing evidence-based insights to enhance the overall digital denture workflow.

METHODS

This experimental investigation was carried out at the Prosthodontic Department, College of Dentistry, Hawler Medical University in Erbil City, Kurdistan Region/Iraq. Ethical approval was obtained from the Scientific Research Ethical Committee, College of Dentistry, Hawler Medical University, Kurdistan Region, Iraq (Reference Number: HMUD,2425102; Date of Approval: 14 January 2025). This research received no external funding. The study was conducted without financial support from any governmental, commercial, private, or non-profit funding agency. All research activities, including study design, data collection, analysis, interpretation, and manuscript preparation, were carried out using the authors' institutional resources. First, to compare the effect of using different 3D printers on some mechanical properties of denture base resins used in dentistry. Secondly, to compare the effect of Thermocycling on the mechanical properties of denture base resin by using a Thermocycling device, to simulate the changing temperature of the oral cavity. A total of 80 denture base samples were fabricated and divided into

four groups: DLP before Thermocycle group (Group 1 (DLP Before)), DLP after Thermocycle group (Group 2 (DLP After)), SLA before Thermocycle group (Group 3 SLA Before), and SLA after Thermocycle group (Group 4 SLA After). Denture base samples used for Flexural strength were fabricated in the form of rectangular bars with dimensions of 65 mm in length, 10 mm in width, and 3 mm in thickness, according to the recommendations outlined in ISO 1567:1999 for denture base polymers.⁶ Denture base samples used for Impact strength were fabricated as rectangular bars following the specifications outlined in ISO 179-1:2010 for Charpy impact testing of plastics.⁷ The specimens were prepared with standardized dimensions of 80 ± 2 mm in length, 10 ± 0.2 mm in width, and 4 ± 0.2 mm in thickness.⁷ The Universal tensile machine was used to test the Flexural strength shown in Figure 1, and the Charpy impact tester was used to test the Impact strength of denture base resin shown in Figure 2. The Thermocycling machine was used to replicate the effect of long-term temperature in the oral cavity.⁸



Figure 1. Universal Testing Machine



Figure 2. Charpy Impact Tester

The denture base resins used in this research are specifically designed for additive manufacturing. For the SLA 3D printers using the Formlabs printers (Formlabs Form 4B), using (Base OP V1) denture base resin. The DLP 3D printers use the Sprinray printers (Sprinray Pro 95 S). The fabrication of the sample was conducted using two additive manufacturing techniques: stereolithography (SLA) and digital light processing (DLP). To ensure consistency, the printing procedures were standardized and performed separately for each technique, following the manufacturer's protocols and relevant ISO guidelines. The design files were created using Autodesk 3ds Max 2023 and exported in STL format to preserve precise geometrical accuracy. The STL files were imported into both software (PreForm, Sprinray-RayWare), and the building position was set at 0° to reduce anisotropy against the mechanical properties. A printing resolution of 0.05mm was chosen to ensure a good surface finish and an acceptable build time. Supports were automatically created and manually edited to avoid warpage or surface defects in critical testing zones. The printers were calibrated before printing as per the manufacturer's instructions to ensure correct focus and resin tank integrity. The resin tank was checked and filled with a freshly mixed Denture Base Resin to maintain matrix homogeneity. The printing began with the build platform in place and leveled, next with a 405 nm wavelength, selectively curing the resin layer by layer for the SLA printers. The DLP selectively cured entire layers simultaneously using structured light at approximately 405 nm wavelength. The built parts were lifted vertically from the resin vat by the build platform when printing was finished. The build platform was detached, and the specimens were removed with a non-metal scraper to avoid surface damage. The parts were submerged in 99% IPA and cleaned for 10 minutes using a special type of Wash material for each type of resin to remove possible uncured resin residues. The samples were required to be post-cured after air drying in the Cure machine at 60°C for 30 min to further improve the polymerization quality and the mechanical properties. Support structures were carefully removed with the use of rotary instruments, and the specimens were hand-polished with 600-grit and then 1200-grit silicon carbide papers while water was running. For post-processing, all the samples were placed in distilled water at 37°C for 24 hours before testing for material conditioning

according to both ISO. The Flexural strength of the denture base resin samples was evaluated using the three-point bending test using a universal tensile testing device, according to ISO 1567:1999 for denture base polymers. Tensile testing was conducted with a maximum load capacity of 5 kN with a three-point bending test jig suitable for dental material. The support span measured 50 mm. A constant crosshead speed of 5 mm/min was employed, and force was applied perpendicularly to the sample's midpoint between the supports using a rounded loading nose to minimize stress concentration effects. Loading continued until fracture took place, and the maximum load (F) in Newtons (N) was utilized for the calculation of Flexural strength⁹ shown in Figure 3. The Flexural strength was expressed in (MPa) with the following formula: $FS = 3FI/2bh^2$, where F represents the maximum applied load (N), L denotes the support span length (mm), b indicates the specimen width (mm), and d signifies the specimen thickness (mm).¹⁰ The Impact strength of the denture base resin samples was assessed using the Charpy impact test according to ISO 179-1:2010.¹¹ The samples were placed horizontally between two fixators, after which it was struck by the pendulum with the direction of its swinging perpendicular to the long axis of the sample shown in Figure 4. The pendulum hit the center of the specimen one time at a fixed energy (which depended on the anticipated toughness of the material and the sample thickness). A pendulum energy of 15 J was used. The energy (E) at the time of the breakdown of each specimen was measured in joules (J). The impact was subsequently calculated in kilojoules per square meter (kJ/m²) using the following formula: $IS = E/b*d$, where E is the energy absorbed during fracture (J), b represents the breadth of the specimen (mm), and d denotes the thickness of the specimen (mm).¹⁰

The purpose of the study was to replicate intraoral aging conditions induced by changes in temperature using a Thermocycling machine. This study utilizes 3,000 cycles, which represent 3-month uses of acrylic inside the oral cavity. The samples were immersed in two water baths at different temperatures for 30 s, with a 5-10 s transfer time between the baths. Each cycle lasted 1-1.55 min, and each sample was subjected to a total of 3000 thermal cycles.¹² Thermocycling was performed using a custom-made, electronically controlled, dual-bath Thermocycler with auto-sample transfer. Af-

ter 3000 Thermocycles, the specimens were immersed in distilled water at 37°C until mechanical testing.



Figure 3. Three-point bending test for Flexural strength



Figure 4. The support of the Charpy impact tester

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and each sample was subjected to a total of 3000 thermal cycles.¹² Thermocycling was performed using a custom-made, electronically controlled, dual-bath Thermocycler with auto-sample transfer. After 3000 Thermocycles, the specimens were immersed in distilled water at 37°C until mechanical testing. This controlled artificial aging scenario was equally applied to both SLA-printed and DLP-printed samples, ensuring comparison for potential degradative effects of temperature fluctuations and water immersion on long-term material response. The Statistical Package for Social Sciences (SPSS version 23, IBM, USA) was used for data entry and analysis. A paired sample t-test was employed to evaluate the influence of Thermocycling on the DLP and SLA samples within the same group. In contrast, an independent t-test was performed to compare the effects of distinct polymerization technologies on the mechanical properties of denture base resin between SLA and DLP. A p-value less than 0.05 was considered statistically significant.

RESULTS

This section presents the results of the mechanical characteristics of denture base resin printed by DLP and SLA 3D printer, before and after Thermocycling. The investigation is centered on two important mechanical properties: Flexural strength and Impact strength. Descriptive statistics are also presented to define the sample means and standard deviations for each group, and then inferential statistical tests are based on these summary statistics to assess the significance of the change due to Thermocycling and to investigate differences in performance between the two print technologies.

Table 1 summarizes the averages, standard deviations, and sample sizes for all tested properties of both 3D printers before and after Thermocycling. Group 1 (DLP Before) exhibited the highest mean Flexural strength (34.384 ± 2.353 MPa). After Thermocycling, Group 2 (DLP After) experienced a notable reduction in mean strength to 31.591 MPa (SD = 1.269). Group 3 SLA Before samples also showed a reduction, with Flexural strength decreasing from 29.446 MPa (SD = 1.025) before Thermocycling to 28.621 MPa (SD = 1.082) after the procedure. A reduction in Impact strength was observed in Group 2 (DLP After), with the mean value decreasing from 0.841 ± 0.158 kJ/m² to

0.552 ± 0.181 kJ/m². Conversely, Group 3 (SLA Before) exhibited a notable increase in Impact strength post-Thermocycling, rising from 0.742 ±

0.285 kJ/m² to 1.103 ± 0.392 kJ/m², as shown in Figures 5 and 6.

Table 1. Descriptive Statistics of Mechanical Properties for DLP and SLA Printed Denture Resins Before and After Thermocycling

Descriptive Statistics				
Mechanical Property	Groups	N	Mean	SD
Flexural strength (MPa)	Group 1 (DLP Before)	10	34.384	2.353
	Group 2 (DLP After)	10	31.591	1.269
	Group 3 (SLA Before)	10	29.446	1.025
	Group 3 (SLA Before)	10	28.621	1.082
Impact strength (kJ/m ²)	Group 1 (DLP Before)	10	0.841	0.158
	Group 2 (DLP After)	10	0.552	0.181
	Group 3 (SLA Before)	10	0.742	0.285
	Group 3 (SLA Before)	10	1.103	0.392

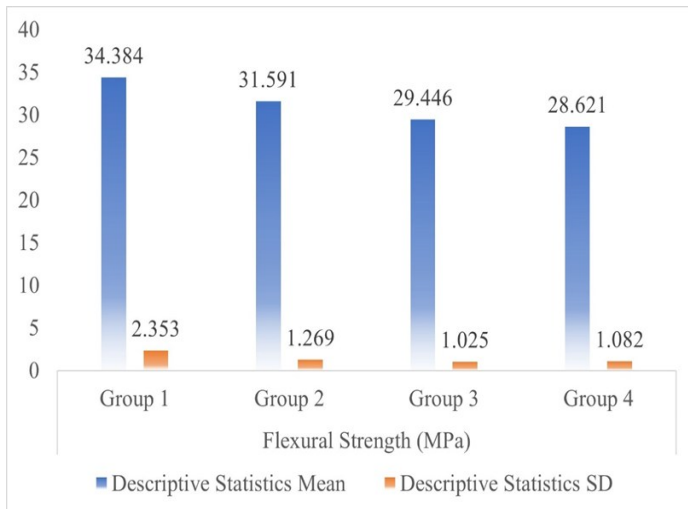


Figure 5. Graph represents the mean and SD of Flexural strength (MPa)

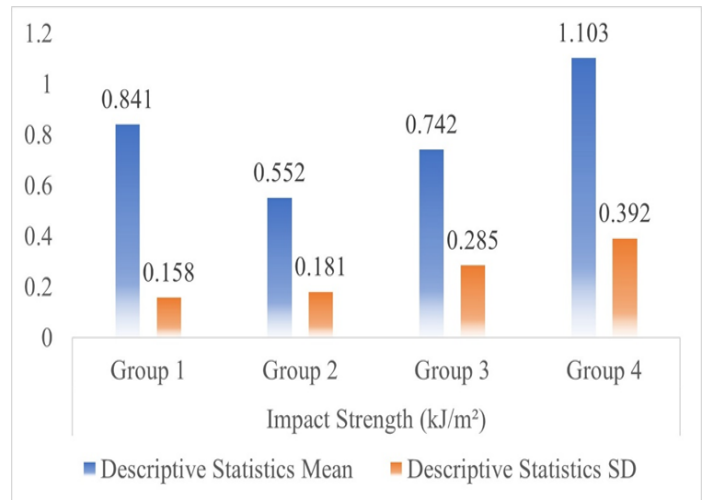


Figure 6. Graph represents the mean and SD of Impact strength (kJ/m²)

The study found that the Flexural strength of Group 1 (DLP Before) significantly decreased from 34.384 MPa to 31.591 MPa after Thermocycling, while Group 3 (SLA Before) showed a decrease from 29.446 MPa to 28.621 MPa. However, this change was not statistically significant.

Group 1 (DLP Before) also experienced a significant decrease in Impact strength from 0.841 kJ/m² to 0.552 kJ/m², while Group 3 (SLA Before) experienced an increase from 0.742 kJ/m² to 1.103 kJ/m², both statistically significant as shown in Table 2.

Table 2. Paired Samples test of Mechanical properties for DLP and SLA Printed Denture Resins Before and After Thermocycling

Paired Samples Test					
Mechanical properties	Groups	Mean	SD	SE	P-value
Flexural strength (MPa)	Group 1 (DLP Before)	34.384	2.353	0.744	0.014
	Group 2 (DLP After)	31.591	1.269	0.401	
	Group 3 (SLA Before)	29.446	1.025	0.324	0.099
	Group 4 (SLA After)	28.621	1.082	0.342	
Impact strength (kJ/m ²)	Group 1 (DLP Before)	0.841	0.158	0.050	0.003
	Group 2 (DLP After)	0.552	0.181	0.057	
	Group 3 (SLA Before)	0.742	0.285	0.090	0.033
	Group 4 (SLA After)	1.103	0.392	0.124	

The study compared the Flexural strength of Group 1 (DLP Before)/ Group 3 (SLA Before), with Group 1 (DLP Before) showing a higher mean Flexural strength (34.384 MPa) compared to Group 3 (SLA Before) (29.446 MPa). The difference was statistically significant ($p < 0.001$). Group 2 (DLP After) had a higher mean Flexural strength (31.591 MPa), while Group 4 (SLA After) had a lower mean of 28.621 MPa. Group 1 (DLP Before) had a slightly higher mean Impact strength (0.841 kJ/m²) compared to Group 3 (SLA Before) (0.742 kJ/m²), but this difference was not statistically significant. Group 4 (SLA After) had a significantly higher mean Impact strength (1.003 kJ/m²), indicating a significant difference between the two groups. As shown in Table 3.

DISCUSSION

The ability of denture base resin used in the construction of removable partial dentures to maintain its mechanical performance in the oral environment is a crucial factor in their clinical effectiveness. The imperative to assess the mechanical integrity and performance of 3D-printed denture base resins in conditions that mimic prolonged intraoral use is increasing as additive manufacturing methods like stereolithography (SLA) and digital light processing (DLP) become more prominent in prosthodontics. Flexural strength and Impact strength are the essential characteristics affecting the performance and durability of these materials.

Flexural strength is a crucial determinant affecting the longevity of dental materials. Flexural strength

of Group 1(DLP Before) was highly statistically significant, with $p < 0.001$ compared to Group 3 (SLA Before). This finding aligns with other research suggesting that the mechanical and biological properties of printed denture base resin can be affected by the 3D printing method.¹³ According to previous research, DLP printing enhances mechanical properties due to the distinct nature of its photopolymerization process and improved layer bonding.¹⁴ With the use of a digital light projector, DLP technology projects the entire image of one layer at once, which causes uniform polymerization and a strong bonding of the layer with its layer underneath.¹⁵ On the contrary, SLA printing utilizes a regional curing technique initiated by ultraviolet (UV) light occurring in a bath of liquid monomers, oligomers, and photo-initiators, resulting in a weak bond between layers.¹⁶ The improved performance of DLP-printed denture base resins may be related to optimized resin formulations. Studies have shown that dental restorative resins with higher polymer conversion levels provide superior mechanical properties.¹⁷ The mix of photopolymer resin significantly influences the mechanical properties of dental structures fabricated using DLP.¹⁸ By customizing resin formula for certain printing methods, manufacturers may enhance the performance of 3D-printed denture bases and perhaps augment their longevity and clinical outcomes. Higher Flexural strength is a desirable property for a removable dental prosthesis as it indicates better resistance to functional stresses during eating and handling by the patient. As a result, the demonstrated higher Flexural

strength of DLP printed denture base resin in this investigation emphasizes that it has benefits in the fabrication of more durable and dependable denture base prosthesis.

Group 1 (DLP Before) had a slightly higher Impact strength compared to Group 3 (SLA Before), although this difference was not statistically significant, $p = 0.349$. This result may be due to several factors, for example, the composition of denture base resin of DLP resembles that of SLA, the same printing parameter (wavelength), and post-processing. Although both method of printing utilizes different techniques of polymerization from each other.¹⁹ The challenge in establishing definitive findings on the influence of different printing technologies on the Impact strength of removable partial denture stems from the limited number of studies available in the literature, underscoring the need for more research in this area.

Thermocycling is a laboratory procedure aimed at replicating the heat variations experienced in the oral cavity, imitating prolonged intraoral application of biomaterials. Consequently, it aids in identifying the characteristics of denture base materials when exposed to temperature fluctuations.²⁰ The results of this study showed that groups 2 and 4 both showed reductions in their Flexural strength, consistent with the documented impacts of thermal aging. Thermocycling resulted in a statistically significant reduction in Flexural strength in the DLP group ($p < 0.001$), whereas the reduction observed in the SLA group was not statistically significant. This highlights that the effect of Thermocycling depends on the printing technology and material characteristics.

At the same time, the DLP group maintains higher Flexural strength than that printed by the SLA printers, with $p < 0.001$. According to the other research, the main strength of the DLP printers is due to their unique ability to combine various material groupings. It specifically enables the integration of both organic and inorganic substances into the photocurable resin matrix, which adds to its strength.²¹ In contrast to this research, Alharbi, Osman²² explain the features of incremental layers in additive manufacturing technology that may trigger fracture propagation, leading to structural failure of the printed material. The adhesion between the layers is inferior to that inside the layer itself. This phenomenon is attributed to the accumulation of residual strains and porosities during UV polymerization and material contraction. The

Flexural strength of Group 2 (DLP After) significantly decreased after Thermocycling. This reduction was statistically significant with a $p < 0.001$. The decline in Flexural strength of DLP-printed specimens may be ascribed to water absorption, which modifies the material's properties by inducing internal stresses detrimental to the resin's long-term efficacy. Minimizing water absorption helps avert fractures and fissures, hence prolonging the durability of dental restorations. Furthermore, residual monomers in the resin are associated with the dimensional instability of restorations and may negatively impact oral tissues.²³ In contrast, Group 4 (SLA After) also showed a decrease in mean Flexural strength, but this change was not statistically significant $p = 0.099$. This may be linked to its stratification method, accelerated polymerization rate, polymerization depth, and conversion degree.²³

Group 4 (SLA After) showed higher Impact strength than Group 2 (DLP After). The statistical analysis revealed that this difference was highly significant ($p = 0.001$). The increase in Impact strength observed in the SLA group after Thermocycling may be attributed to a potential post-curing effect caused by exposure to elevated temperatures (up to 55°C). This thermal exposure may enhance polymer chain mobility and increase the degree of conversion in some resin systems. However, this effect is material-dependent and should not be generalized to all SLA-printed resins. This aligns with past research on composite resin, which indicated that storing specimens in water without heat cycling did not significantly impact the degree of conversion (DC). Consequently, it may be inferred that elevated temperatures during thermal cycling may expedite monomer dilution by enhancing monomer diffusion. This result aligns with research done previously after Thermocycling, the mechanical properties of SLA samples increased, whereas those of DLP samples decreased.²³

The findings demonstrate a significant decrease in Impact strength for the DLP group. This may relate to the existence of flaws, including microcracks and fissures, inside the 3D-printed resin. Previous research has shown that defects as little as $16\ \mu\text{m}$ may considerably diminish the Impact strength of PMMA denture base resins. The imperfections in the denture base resin samples function as stress concentration locations, which may readily serve as sites for fracture initiation

during impact testing, possibly resulting in a substantial reduction in Impact strength.²⁴ This reduction may be associated with the material's improved water absorption capacity. Water molecules infiltrated the minuscule pores of the 3D-printed base resin, resulting in damage to the network structure. Moreover, it hydrolyzed the silane coupling agent, compromising the chemical link between the coupling agent and the resin matrix or filler, thereby diminishing the Flexural strength of the resin base.²⁵

The mechanisms proposed to explain the changes in mechanical properties, such as water uptake, microdefects, and degree of polymer conversion, should be interpreted with caution. These explanations remain hypothetical, as no direct material characterization tests were conducted in the present study. Future investigations are recommended to include techniques such as Fourier-transform infrared spectroscopy (FTIR) for evaluating the degree of conversion, water sorption and solubility tests, and scanning electron microscopy (SEM) fractography to better understand the structural and chemical changes occurring in the materials. Only one build orientation (0°) and one layer thickness (0.05 mm) were used during specimen fabrication. These parameters are known to influence the anisotropy and mechanical performance of 3D-printed materials. Therefore, future studies should investigate different build orientations and layer thicknesses to provide a more comprehensive understanding of their effects on mechanical properties.

CONCLUSION

Within the limitations of this study, DLP-printed samples demonstrated superior Flexural strength compared to SLA-printed samples both before and after Thermocycling. Thermocycling had a material-dependent effect on Flexural strength, causing a statistically significant reduction in the DLP group ($p < 0.001$), while the reduction observed in the SLA group was not statistically significant. Regarding Impact strength, Thermocycling significantly decreased the values in the DLP group, whereas it significantly increased the values in the SLA group. These findings indicate that the effect of Thermocycling on mechanical properties varies depending on the printing technology and material characteristics.

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Conflict of Interest

The authors declare no conflicts of interest.

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