DOI: 10.7860/JCDR/2025/82215.22041

Original Article

Dentistry Section

Comparative Evaluation of Surface Roughness in CAD/CAM-milled, 3D-printed, and Conventional Polymethyl Methacrylate Denture Base Resin Materials: An In-vivo Study

SMRUTI REKHA NAYAK[1], SNEHA SHIVKUMAR MANTRI[2], SUMATHI K NITIN[3], PUSHKAR GUPTA[4], ABHILASHA BHASIN[5]

ABSTRACT

Introduction: The surface roughness of denture-base resins significantly affects biofilm accumulation, aesthetics, and patient comfort. With advances in digital dentistry, CAD/CAM-milled and 3D-printed resins offer new fabrication options; however, their surface properties require further validation under clinical conditions.

Aim: To compare and evaluate the surface roughness of CAD/CAM-milled, 3D-printed, and conventional heat-polymerised acrylic Denture Base Materials (DBMs) under in-vivo conditions.

Materials and Methods: A comparative clinical in-vivo study was conducted in the Department of Prosthodontics, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh, India, from August 2023 to February 2025 on 270 disc specimens fabricated and equally distributed among three groups (n=90): Group A-CAD/CAM-milled; Group B-3D-printed; Group C-conventional heat-polymerised resin. Denture-base samples (6×2 mm) were embedded in the flanges of the dentures. After three and six-months of clinical use, the samples were retrieved and surface roughness was assessed using a contact profilometer; mean roughness values (Ra) were recorded and subjected to statistical analysis.

Results: The CAD/CAM-milled resin consistently showed the lowest surface roughness at all time points, whereas 3D-printed resin exhibited the highest. Conventional PMMA resin showed an intermediate value. The interaction effect of material type and time was statistically significant (F=13271.91, $p<0.05$), confirming that CAD/CAM-milled resin maintained the smoothest surface, whereas 3D-printed resin demonstrated the greatest roughness progression over time. Differences among all three groups were statistically significant ($p<0.001$).

Conclusion: The CAD/CAM-milled denture-base resins demonstrated superior surface smoothness compared with 3D-printed and conventional materials. The smoother surface of milled resins may promote better hygiene, reduce plaque accumulation, and enhance patient comfort, supporting their use in long-term prosthodontic care.

Keywords: Biofilm, Computer-aided design and computer-aided manufacturing, Dental polishing, Microbial adhesion, Prosthodontics, Surface properties

INTRODUCTION

Tooth loss significantly affects oral function, aesthetics, and quality of life. Dentures, as removable prostheses, are widely used to restore mastication, speech, and facial contours. They remain a primary treatment modality, particularly for edentulous patients, by enhancing oral function and psychosocial well-being [1].

Denture bases are fabricated from Denture-based Materials (DBMs), which must perform optimally in the dynamic and humid oral environment. Ideal DBMs should exhibit excellent biological, mechanical, physical, and aesthetic properties [2]. Biologically, they must be biocompatible, non carcinogenic and non sensitising. Chemically, they should demonstrate minimal solubility and water absorption while ensuring compatibility with artificial teeth and denture liners. Mechanically, DBMs require adequate elastic modulus, fatigue resistance, and impact strength. Physically, desirable features include low specific gravity, thermal stability, radiopacity, and dimensional accuracy. Aesthetically, translucency and pigmentation ability are essential, along with ease of manipulation and repair [3].

No single material currently fulfills all these ideal criteria. Hence, ongoing research explores modifications in DBMs to improve their performance [4]. Polymethyl Methacrylate (PMMA), introduced by Walter Wright in 1937, remains the most commonly used DBM because of its low cost, convenient fabrication, and acceptable mechanical properties. However, its limitations include susceptibility to fracture and water absorption, compromising long-term durability [4].

Recent advances have introduced CAD/CAM technologies in denture fabrication, offering new processing options for PMMA through subtractive and additive methods [5]. Subtractive CAD/CAM techniques utilise prepolymerised PMMA pucks, fabricated under standardised conditions, ensuring reduced porosity, higher strength, and improved surface features [6]. Additive techniques like Digital Light Processing (DLP) create objects by sequentially adding material in layers, using photopolymerisable resins, allowing rapid prototyping with intricate designs [7]. These approaches have significantly improved dimensional accuracy, production speed, and prosthesis reproducibility [8].

Despite these technological advancements, limited research [9] has compared the clinical performance of PMMA denture bases fabricated using subtractive and additive CAD/CAM methods versus conventional heat polymerisation. In particular, surface roughness, a critical determinant of microbial adhesion, patient comfort, and long-term prosthesis hygiene, has not been comprehensively evaluated across these fabrication techniques [10].

Surface roughness directly influences plaque accumulation and biofilm formation. Studies have shown that rougher surfaces promote *Candida albicans* colonisation, increasing the risk of denture stomatitis [10]. The clinically acceptable threshold for Surface roughness (Ra) is 0.2 µm; values above this limit significantly increase the risk of microbial retention and mucosal inflammation [11].

Although several studies [12,13] have examined the mechanical properties of CAD/CAM-fabricated PMMA, fewer have addressed their surface characteristics, particularly under intraoral conditions [14]. There is a gap in the literature concerning in-vivo comparisons of surface roughness among dentures produced using CAD/CAM milling, 3D printing, and conventional techniques. The study was designed to fill this gap by evaluating the surface roughness of denture-base resins processed by these three techniques after clinical use at baseline, three-months, and six-months.

The primary objective was to assess how different materials influence the surface characteristics of PMMA denture bases and explore their implications for prosthesis longevity and patient oral health.

MATERIALS AND METHODS

This was a comparative clinical in-vivo study conducted in the Department of Prosthodontics, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh, India from August 2023 to February 2025. Ethical clearance was obtained from the Institutional Ethics Committee (No. HDC&W20,23IL75/c). Written informed consent was obtained from all participants prior to the study.

Inclusion and Exclusion criteria: Patients in the age group of 40-70 years who were completely edentulous and required complete denture rehabilitation were included in the study. Patients were excluded if, they were smokers, betel quid or tobacco chewers, had systemic conditions such as Gastroesophageal Reflux Disease (GERD), presented with active oral infections such as candidiasis, or were unwilling to comply with the recommended instructions and follow-up protocol.

Sample size calculation: Based on the pilot study results (effect size/Cohen's d=0.80), with a two-sided 95% confidence interval and 80% study power, the minimum required sample size was calculated as 26 subjects per group per time interval. To account for an anticipated 10% loss to follow-up, the sample size was increased to 29 and rounded up to 30 subjects per group per time interval. Sample size determination was performed using G*Power software (version 3.1.9.7).

Study Procedure

A total of 270 disc-shaped specimens (n=90 per group) were fabricated using three different denture-base resin materials: Group A-CAD/CAM-milled PMMA resin; Group B-3D-printed PMMA resin; Group C-conventional heat-cured PMMA resin.

A total of 30 patients; each patient received a complete denture containing six disc placeholders (6×2 mm), into which two disc specimens from each group were inserted (maxillary right, maxillary left, and mandibular buccal flanges) [Table/Fig-1a]. Specimens were retrieved after three and six-months of clinical use for surface roughness analysis.

Materials: Materials used included CAD/CAM PMMA resin blanks (Ruthenium, India), 3D-printed PMMA resin (NextDent, Netherlands), and heat-cure PMMA (DPI, India).

a) **Conventional heat-cured PMMA discs:** A total of 90 discs were fabricated using the compression-molding technique. Stainless steel molds (6×2 mm) were invested in dental flasks with Type II and III gypsum. Heat-cured PMMA was packed during the dough stage and cured using a long curing cycle at 100°C for two hours. Finished and polished discs were then stored in distilled water at 37±1°C for 48 hours.

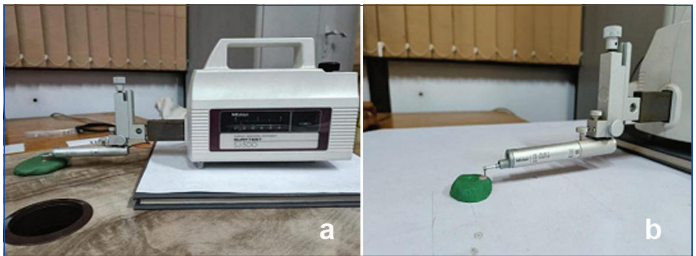
b) **3D-printed PMMA discs:** Discs were designed using ExoCAD software and printed using the DLP technique, at a build orientation of 45° and a layer thickness of 100 µm. Post-processing included isopropyl alcohol rinsing and UV-light curing for 15 minutes. Specimens were polished using 400-grit silicon carbide paper, pumice and rouge [15].

c) **CAD/CAM-milled PMMA discs:** Discs were designed in ExoCAD and milled from prepolymerised PMMA blanks using a 5-axis milling machine. Milling burs (1 mm and 2.5 mm) were used under wet conditions. The finished discs were polished similarly to the other groups and stored in distilled water [15].

[Table/Fig-1]: a) Disc place holders; b) Intraoral image.

Denture fabrication and insertion: Maxillary and mandibular complete dentures were fabricated using conventional techniques. Six disc specimens (two from each group) were incorporated into buccal flanges. Post-processing, dentures were finished, polished, and delivered to patients [Table/Fig-1b].

Patients were instructed to maintain oral hygiene with a soft-bristled brush. Disc specimens were retrieved at baseline (pre-insertion), after three-months, and after six-months using a 7 mm tissue punch. Additional discs made of heat-cured resin, of the same dimensions (6×2 mm), were fabricated and inserted into the dentures to fill and seal the spaces left by the retrieved specimens.



[Table/Fig-2a,b]: Surface roughness (Ra) was evaluated using a contact profilometer (Mitutoyo SJ-500).

Surface roughness evaluation: Surface roughness (Ra) was evaluated using a contact profilometer (Mitutoyo SJ-500). A diamond stylus traversed the specimen surface in the lateral and vertical directions. For each disc, three readings were recorded and averaged for analysis [Table/Fig-2a,b].

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel 2016 for Windows. Descriptive statistics, including frequencies, percentages, means, Standard Deviations (SD), and the minimum and maximum values of the variables, were calculated. The Shapiro-Wilk test indicated that the surface roughness values across the three denture-base resin groups (CAD/CAM-milled, 3D-printed, and conventional PMMA) at different time intervals (baseline, 3-months, and 6-months) followed a normal distribution. Therefore, a parametric test, specifically the two-way mixed-factorial analysis of variance {2-way (Analysis of Variance (ANOVA)}, was employed for further analysis. When the 2-way ANOVA revealed statistically significant differences between groups, the Least Significant Difference (LSD) post hoc test was used for pair-wise comparisons. A p-value of less than 0.05 was considered statistically significant. Data analysis was performed using Statistical Paackages of Social Sciences (SPSS) version 23.0 (IBM Corp., Armonk, NY, USA).

Denture base resin materials' groups	Surface roughness (μm) at different time intervals						p-value
	Baseline		After 3-months		After 6-months		
	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	
CAD/CAM-milled	0.17±0.02	0.14-0.20	0.21±0.02	0.18-0.24	0.24±0.02	0.19-0.28	<0.001
3D-printed	0.26±0.04	0.20-0.41	0.84±0.06	0.74-0.92	1.92±0.05	1.84-1.99	<0.001
Conventional (PMMA)	0.22±0.03	0.18-0.38	0.65±0.06	0.55-0.75	1.09±0.06	0.97-1.20	<0.001
2-way ANOVA {Interaction Effect (Groups, Time intervals)}	F=13271.91, p=<0.001						

[Table/Fig-3]: Comparison of surface roughness in three denture base resin materials' groups at different time interval.

RESULTS

Surface roughness analysis: Mean surface roughness (Ra) values, SDs, and ranges for each group at the three time points are summarised in [Table/Fig-3]. CAD/CAM-milled specimens exhibited the lowest surface roughness at all intervals, followed by conventional PMMA and 3D-printed specimens. At baseline, CAD/CAM specimens showed the lowest mean Ra (0.17±0.02 μm), while 3D-printed specimens exhibited the highest (0.26±0.04 μm). After 3 and 6-months, surface roughness increased in all groups, with the 3D-printed group showing the most pronounced change (0.84±0.06 μm at 3-months; 1.92±0.05 μm at 6-months). CAD/CAM specimens exhibited the least increase over time.

A two-way mixed-factorial ANOVA revealed a statistically significant interaction between the type of denture-base resin and time interval on surface roughness (F=13271.91, p<0.001).

Intragroup comparisons: The LSD post-hoc analysis showed a significant increase in surface roughness within each group across all time intervals (p<0.001). In the CAD/CAM group, mean roughness increased from 0.17±0.02 μm at baseline to 0.21±0.03 μm at three-months and 0.24±0.03 μm at six-months. In the 3D-printed group, values rose sharply from 0.26±0.04 μm to 0.84±0.06 μm and 1.92±0.05 μm at three and six-months, respectively. Similarly, conventional PMMA showed increases from 0.22±0.03 μm to 0.65±0.07 μm and 1.09±0.08 μm [Table/Fig-4]. In each group, the differences in mean Ra values between baseline and three-months, baseline and six-months, and between three and six-months were statistically significant (p<0.001).

Comparison groups	Mean difference (μm)	p-value
In CAD/CAM-milled group:		
At baseline and after 3-months	-0.04	<0.001
At baseline and after 6-months	-0.07	<0.001
After 3-months and after 6-months	-0.03	<0.001
In 3D-printed group:		
At baseline and after 3-months	-0.58	<0.001
At baseline and after 6-months	-1.67	<0.001
After 3-months and after 6-months	-1.09	<0.001
In conventional (PMMA) group:		
At baseline and after 3-months	-0.43	<0.001
At baseline and after 6-months	-0.87	<0.001
After 3-months and after 6-months	-0.44	<0.001

[Table/Fig-4]: Intragroup comparison (mean difference) of surface roughness in three denture base resin materials' groups at different time intervals.

Intergroup comparisons: Pair-wise comparisons between the three material groups revealed significant differences at all time points. At baseline, CAD/CAM specimens exhibited significantly lower roughness than both 3D-printed (p<0.001) and conventional PMMA (p<0.001). Similar results were observed at three-months and six-months, with the CAD/CAM group consistently showing the lowest surface roughness and the 3D-printed group the highest (p<0.001 for all comparisons) [Table/Fig-5].

These findings suggest that CAD/CAM-milled denture-base resin exhibits superior surface characteristics with minimal roughness over time, while 3D-printed resins are more prone to increased surface roughness in clinical conditions.

Comparison groups	Mean difference (μm)	p-value
At baseline:		
CAD/CAM-milled and 3D-printed	-0.09	<0.001
CAD/CAM-milled and conventional (PMMA)	-0.05	<0.001
3D-printed and conventional (PMMA)	0.04	<0.001
After 3-months:		
CAD CAM-milled and 3D-printed	-0.63	<0.001
Comparison groups	Mean difference (μm)	p-value
CAD CAM-milled and conventional (PMMA)	-0.44	<0.001
3D-printed and conventional (PMMA)	0.18	<0.001
After 6-months:		
CAD CAM-milled and 3D-printed	-1.69	<0.001
CAD CAM-milled and conventional (PMMA)	-0.85	<0.001
3D-printed and conventional (PMMA)	0.84	<0.001

[Table/Fig-5]: Intergroup comparison (mean difference) of surface roughness in three denture base resin materials' groups at different time intervals.

DISCUSSION

Tooth loss significantly impacts mastication, speech, and facial aesthetics. Dentures, particularly those fabricated from PMMA, have long been the mainstay for complete and removable partial denture prostheses. However, inherent limitations such as polymerisation shrinkage and porosity compromise their long-term performance [16]. Recent advances have introduced CAD/CAM and 3D printing technologies, offering alternative fabrication methods with potentially superior surface and mechanical properties. CAD/CAM dentures are milled from pre-polymerised PMMA pucks, which undergo polymerisation under high temperature and pressure, resulting in increased density, reduced residual monomer content, and decreased porosity [16]. Conversely, 3D printing builds prostheses layer by layer using photo-polymerised resin, which can result in anisotropic structures, surface irregularities, and incomplete polymerisation [17].

Surface roughness (Ra) is a critical parameter influencing biofilm accumulation, staining, and overall oral hygiene maintenance. Ra values exceeding the 0.2 μm threshold significantly increase microbial adherence and plaque formation [18]. Thus, smoother surfaces are preferable for clinical longevity and patient comfort. In the present in-vivo study, the CAD/CAM-milled group consistently demonstrated significantly lower surface roughness at all time intervals (baseline, 3-months, and 6-months) compared with conventional PMMA and 3D-printed PMMA (p<0.05). At baseline, the CAD/CAM group had the smoothest surface, attributed to subtractive manufacturing and the high degree of polymerisation of milled PMMA blocks [19]. This is consistent with the findings of Helal MA et al., who reported significantly smoother surfaces in CAD/CAM materials compared with 3D-printed and flexible resins [20]. The 3D-printed group exhibited the highest initial surface roughness, likely due to the presence of residual monomers and interlayer voids [21]. Dimitrova M et al., similarly reported increased roughness in 3D-printed denture bases compared with conventional PMMA, especially after brushing and storage simulations [22]. Surface degradation over time was observed in all groups, with statistically significant increases in Ra values from baseline to three and six-months ($p<0.05$). However, the CAD/CAM group maintained the lowest roughness even after prolonged intraoral exposure. These findings corroborate those of Zeidan AA et al., and Fiore A et al., who demonstrated that CAD/CAM dentures resist wear and biofilm accumulation better than their conventionally processed or additively manufactured counterparts [15,23]. Interestingly, Alouthah H et al., found that the application of nano-filled glaze coatings can mitigate the surface irregularities of 3D-printed dentures, suggesting potential for future enhancements in additive manufacturing [24]. Like-wise, Tasn R et al., and Demirkol D et al., emphasised that surface roughness varies depending on both fabrication method and post-processing technique [25,26].

After six-months, intergroup comparisons revealed that CAD/CAM dentures still exhibited the lowest surface roughness, followed by conventional PMMA, with 3D-printed dentures showing the highest roughness ($p<0.05$). This corresponds with observations by Al-Dulaijan YA et al., who reported increased roughness in 3D-printed materials after simulated aging and thermal cycling [27].

While some authors, such as Gad MM et al., and Al-Dwairi ZN et al., have suggested that proper polishing can bring 3D-printed materials to comparable surface quality, clinical observations indicate persistent roughness even with standard finishing [28,29]. These variations highlight the need to optimise printing protocols and post-processing procedures.

The present study also aligns with Freitas RF et al., who observed that CAD/CAM materials exhibit superior mechanical and anti-biofilm properties compared with conventional and 3D-printed resins [30]. A smoother surface may also improve oral hygiene, decrease *Candida albicans* adhesion, and contribute to the prevention of denture stomatitis. The findings emphasise the importance of selecting DBMs based on long-term performance. While 3D-printed dentures offer benefits in fabrication speed and cost, their inferior surface characteristics may predispose patients to microbial colonisation and require more frequent replacement or additional surface treatments. CAD/CAM-milled resins, despite higher initial costs, may provide better long-term outcomes in terms of hygiene, durability, and patient satisfaction.

Limitation(s)

The study was limited by its relatively short follow-up duration (6-months) and the influence of patient-specific intraoral factors that were not controlled. Only one type of each fabrication technique was evaluated. Further longitudinal studies with larger cohorts, inclusion of various additive manufacturing systems, and comparative evaluation of post-processing techniques (e.g., Ultraviolet curing, nano-coating, and multistep polishing) are necessary to validate and optimise the performance of modern DBMs under in-vivo conditions.

CONCLUSION(S)

The present in-vivo study demonstrated that CAD/CAM-milled denture base resins consistently exhibited the lowest surface roughness values over six-months, indicating superior surface stability and clinical performance. Conventional heat-cured PMMA showed intermediate surface roughness, while 3D-printed resins had the highest values at all time points. All groups exhibited a progressive increase in roughness over time. The smoother surface of CAD/CAM-milled resins may contribute to reduced plaque accumulation, improved oral hygiene, and enhanced patient comfort, making them a preferable choice for long-term prosthodontic rehabilitation.

REFERENCES

[1] Couto Martins AM, Campos CH, Frotté Silva CS, Tavares MLC, Antunes LS, Antunes LAA. Impact of new complete dentures on oral health-related quality of life: A 12-month follow-up. Int J Prosthodont. 2022;35(3):287-93.

[2] Alqutaibi AY, Baik A, Almuzaini SA, Farghal AE, Alnazzawi AA, Borzangy S, et al. Polymeric denture base materials: A review. Polymers (Basel). 2023;15(15):3258.

[3] Zafar MS. Prosthodontic applications of polymethyl methacrylate (PMMA): An update. Polymers (Basel). 2020;12(10):2299.

[4] Khan AA, Fareed MA, Alshehri AH, Aldegheishem A, Alharthi R, Saadaldin SA, et al. Mechanical properties of modified denture base materials and polymerization methods: A systematic review. Int J Mol Sci. 2022;23(10):5737.

[5] Al-Dwairi ZN, Tahboub KY, Baba NZ, Goodacre CJ. Comparison of flexural and impact strengths and flexural modulus of CAD/CAM and conventional heat-cured polymethyl methacrylate (PMMA). J Prosthodont. 2020;29(4):341-49.

[6] Al-Dwairi ZN, Tahboub KY, Baba NZ, Goodacre CJ, Özcan M. Comparison of surface properties of CAD/CAM and conventional polymethyl methacrylate (PMMA). J Prosthodont. 2020;28(4):452-57.

[7] El Samahy MM, Abdelhamid AM, El Shabrawy SM, Hanno KI. Evaluation of physicomechanical properties of milled versus 3D-printed denture base resins: A comparative in vitro study. J Prosthet Dent. 2023;129(5):797.e1-7.

[8] Srinivasan M, Kamnoedboon P, McKenna G, Angst L, Schimmel M, Özcan M, et al. CAD-CAM removable complete dentures: A systematic review and meta-analysis of trueness of fit, biocompatibility, mechanical properties, surface characteristics, color stability, time-cost analysis, clinical and patient-reported outcomes. J Dent. 2021;113:103777.

[9] Fouda MM, Rabie AM, Abdel-Rahman AK, Mahmoud MM, Yousif MA, Ghoneim AH. Physical, mechanical, and anti-biofilm formation properties of CAD/CAM-milled or 3D-printed denture base resins: In vitro analysis. J Prosthodont. 2022;32(S1):38-44.

[10] Othman RB, Klein G, Farah B, Kareem RA, Abdel-Aleem N. Influence of fabrication technique on adhesion and biofilm formation of Candida albicans to conventional, milled, and 3D-printed denture base resin materials: A comparative in vitro study. Polymers (Basel). 2023;15(8):1836.

[11] Aguirre BC, Chen JH, Kontogiorgos ED, Murchison DF, Nagy WW. Flexural strength of denture base acrylic resins processed by conventional and CAD-CAM methods. J Prosthet Dent. 2020;123(4):641-46.

[12] De Oliveira Limirio JPJ, Gomes JML, Alves Rezende MCR, Lemos CAA, Rosa CDDRD, Pellizzer EP. Mechanical properties of polymethyl methacrylate as denture base material: Conventional versus CAD-CAM resin A systematic review and meta-analysis of in vitro studies. J Prosthet Dent. 2022;128(6):1221-29.

[13] Arslan M, Murat S, Alp G, Zaimoglu A. Comparison of the flexural strength of printed and milled denture base materials. BMC Oral Health. 2024;24:929.

[14] Tonuk E, Kaya E, Demirel O. Surface hardness and wear resistance of prefabricated and CAD/CAM-milled artificial teeth: A cross-over clinical study. J Prosthodont. 2023;32(5):520-28.

[15] Zeidan AA, Abd Elrahim RA, Abd El Hakim AF, Harby NM, Helal MA. Evaluation of surface properties and elastic modulus of CAD/CAM-milled, 3D-printed, and compression moulded denture base resins: An in vitro study. J Int Soc Prev Community Dent. 2022;12(6):630-37.

[16] Ameer Y, Ali J. Comparison of denture base adaptation and some mechanical properties among conventional, CAD-CAM, and 3D-printed denture base materials. J Res Med Dent Sci. 2022;10(7):26-30.

[17] Baba NZ, Goodacre BJ, Goodacre CJ. CAD/CAM complete denture systems and physical properties: A review of the literature. J Prosthodont. 2021;30(2):113-24.

[18] Sharmista S, Siva Kumar G, Ravisankar Y, Srinivas K, Hari Krishna MVS, Satyendra Kumar T. Surface roughness of acrylic denture base resins polished with different abrasive agents: An in vitro study. Int J Dent Mater. 2020;2(3):91-97.

[19] Rapone B, Pedone S, Carnevale A, Plantamura P, Scarano A, Demelio A, et al. Profilometer comparison of the surface roughness of four denture base resins: An in vitro study. Appl Sci. 2022;12(4):1837.

[20] Helal MA, Fadl-Alah A, Baraka YM, Gad MM, Emam AM. In vitro comparative evaluation of surface properties and impact strength of CAD/CAM milled, 3D-printed, and polyamide denture base resins. J Int Soc Prev Community Dent. 2022;12(1):126-31.

[21] Gad MM, Fouda SM, Abualsaud R, Alshahrani FA, Al-Thobity AM, Khan SQ, et al. Strength and surface properties of a 3D-printed denture base polymer. J Prosthodont. 2022;31(5):412-18.

[22] Dimitrova M, Corsalini M, Kazakova R, Vlahova A, Chuchulska B, Barile G, et al. Comparison between conventional PMMA and 3D-printed resins for denture bases: A narrative review. J Compos Sci. 2022;6(3):87.

[23] Di Fiore A, Meneghello R, Brun P, Rosso S, Gattazzo A, Stellini E, et al. Comparison of flexural and surface properties of milled, 3D-printed, and heat-polymerized PMMA resins for denture bases: An in vitro study. J Prosthodont Res. 2022;66(3):502-08.

[24] Alouthah H, Lippert F, Yang CC, Levon JA, Lin WS. Comparison of surface characteristics of denture base resin materials with two surface treatment protocols and simulated brushing. J Prosthodont. 2023;34(1):58-67.

[25] Tasın S, Ismatullaev A, Usumez A. Comparison of surface roughness and color stainability of 3D-printed interim prosthodontic material with conventionally fabricated and CAD/CAM-milled materials. J Prosthet Dent. 2021;128(5):e1-e8.

[26] Demirkol D, Tugut F. Comparison of the effect of the same polishing method on the surface roughness of conventional, CAD/CAM milled and 3D-printed denture base materials. Cumhuriyet Dent J. 2023;26(3):281-86.

[27] Al-Dulaijan YA, Alsulaimi L, Alotaibi R, Alboainain A, Alalawi H, Alshehri S, et al. Comparative evaluation of surface roughness and hardness of 3D-printed resins. Materials (Basel). 2022;15(19):6822.

[28] Gad MM, Fouda SM, Abualsaud R, Alshahrani FA, Al-Thobity AM, Khan SQ, et al. Strength and surface properties of a 3D-printed denture base polymer. J Prosthodont. 2021;31(5):412-18.

[29] Al-Dwairi ZN, Al Haj Ebrahim AA, Baba NZ. Comparison of surface and mechanical properties of 3D-printable denture-base resin material and conventional polymethyl methacrylate (PMMA). J Prosthodont. 2023;32(1):40-48.

[30] Freitas RF, Duarte S, Feitosa S, Dutra V, Lin WS, Panariello BH, et al. Physical, mechanical, and anti-biofilm formation properties of CAD/CAM-milled or 3D-printed denture base resins: In vitro analysis. J Prosthodont. 2023;32(S1):38-44.

PARTICULARS OF CONTRIBUTORS:

1. Postgraduate Student, Department of Prosthodontics, Crown and Bridge, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh, India.
2. Professor and Head, Department of Prosthodontics, Crown and Bridge, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh, India.
3. Reader, Department of Prosthodontics, Crown and Bridge, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh, India.
4. Professor, Department of Prosthodontics, Crown and Bridge, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh, India.
5. Professor, Department of Prosthodontics, Crown and Bridge, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Smruti Rekha Nayak,
Postgraduate Student, Department of Prosthodontics Crown and Bridge,
Hitkarini Dental College and Hospital, Jabalpur-482001, Madhya Pradesh, India.
E-mail: rekhanayaksmruti@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Aug 16, 2025
- Manual Googling: Sep 02, 2025
- iThenticate Software: Sep 08, 2025 (5%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Jul 25, 2025**
Date of Peer Review: **Aug 22, 2025**
Date of Acceptance: **Sep 10, 2025**
Date of Publishing: **Nov 01, 2025**