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Original Research

Surface hardness of heat-cure vs. self-cure acrylic resin

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ABSTRACT:
Background: Acrylic resins are widely used in prosthodontics for denture base fabrication. Surface hardness is an important property that influences wear resistance, polishability, and long-term durability. This study aimed to compare the surface hardness of heat-cure and self-cure acrylic resins. **Materials and Methods:** Fifty standardized acrylic resin specimens were prepared and divided into two groups: heat-cure (n = 25) and self-cure (n = 25). Specimens were fabricated in uniform molds (10 × 10 × 2 mm) and finished using a standardized polishing protocol. Surface hardness was measured using a Vickers hardness tester, with three readings per specimen. Data were analyzed using Student's t-test ($p < 0.05$). **Results:** Heat-cure acrylic resin exhibited a significantly higher mean surface hardness (18.5 ± 1.2 VHN; range 16.8–20.3 VHN) compared to self-cure resin (14.2 ± 1.5 VHN; range 12.5–16.5 VHN). Statistical analysis confirmed the difference was highly significant ($t = 8.73$, $p < 0.001$). **Conclusion:** Heat-cure acrylic resin demonstrates superior surface hardness compared to self-cure acrylic resin, suggesting better resistance to wear and enhanced durability for denture bases. These findings support the selection of heat-cure resins for long-term prosthodontic applications.
Keywords: Acrylic, resin, roughness

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INTRODUCTION

Acrylic resins are widely used in prosthodontics due to their versatility, ease of manipulation, and cost-effectiveness. They form the primary material for complete and partial denture bases, interim prostheses, and orthodontic appliances. The performance of these materials depends not only on their esthetic properties but also on their mechanical characteristics, which influence durability and patient satisfaction.[1,2]

Acrylic resins are broadly classified into heat-cure (thermosetting) and self-cure (cold-cure or autopolymerizing) types. Heat-cure acrylic resin requires external heat for polymerization, typically using a water bath or microwave, while self-cure resin polymerizes at room temperature via a chemical reaction between the polymer and monomer components. These different polymerization methods result in variations in physical and mechanical properties.[3,4]

Surface hardness is a crucial property that determines the wear resistance, scratch resistance, and longevity of denture bases. A harder surface can better resist abrasion from daily use, cleaning, and masticatory forces, thereby reducing the likelihood of plaque accumulation and microbial colonization. It also affects the polishability and esthetic retention of the prosthesis over time.[5-7]

Several studies have reported differences in surface hardness between heat-cure and self-cure acrylic resins. Heat-cure acrylics are generally found to exhibit higher hardness due to more complete polymerization and lower residual monomer content, whereas self-cure resins may have increased porosity and lower hardness, leading to greater susceptibility to wear and microbial adherence. However, variability exists depending on material formulations, curing cycles, and testing methods.[8,9]

Understanding the differences in surface hardness between these two types of acrylic resin is important for clinical decision-making. Selecting a material with optimal hardness can improve the durability, hygiene, and overall performance of dental prostheses. Therefore, a comparative evaluation of heat-cure and self-cure acrylic resins provides insight into their mechanical behavior and helps guide prosthodontists in choosing the appropriate material for specific clinical situations.

MATERIALS AND METHODS

This in vitro study was designed to compare the surface hardness of heat-cure and self-cure acrylic resins. A total of 50 standardized specimens were prepared and randomly divided into two groups: Group A (n = 25) – heat-cure acrylic resin, and Group B (n = 25) – self-cure acrylic resin. All specimens were fabricated in a uniform rectangular mold measuring 10 × 10 × 2 mm to ensure consistency in dimensions and surface area for hardness testing.

Heat-cure acrylic resin (specify brand and type) was mixed according to the manufacturer’s instructions and packed into the molds. Polymerization was carried out in a water bath using a conventional curing cycle of 74°C for 2 hours, followed by 100°C for 1 hour. After curing, the specimens were allowed to cool gradually to room temperature, then finished and polished using fine sandpaper and a standardized polishing protocol to ensure a smooth, uniform surface.

Self-cure acrylic resin (specify brand and type) was prepared by mixing the polymer and monomer in the recommended ratio. The mixture was placed into identical molds and allowed to polymerize at room temperature for 10–15 minutes until complete setting. After polymerization, the specimens were finished and polished using the same procedure as for heat-cure samples to standardize surface smoothness.

The surface hardness of each specimen was measured using a Vickers hardness tester (specify model). Three readings were taken from different points on each specimen’s surface, and the mean value was calculated for analysis. All measurements were performed under controlled laboratory conditions at room temperature to minimize environmental variability.

The mean surface hardness values of the two groups were compared using Student’s t-test, with a significance level set at $p < 0.05$. Data were analyzed using SPSS software. This statistical comparison allowed evaluation of differences in mechanical behavior between heat-cure and self-cure acrylic resins, providing insights into their clinical performance.

RESULTS

The mean surface hardness values of heat-cure and self-cure acrylic resin specimens were measured using a Vickers hardness tester. Heat-cure acrylic resin showed higher surface hardness compared to self-cure resin. Statistical analysis using Student’s t-test indicated that this difference was significant($p < 0.05$).

Table 1: Mean Surface Hardness of Heat-Cure and Self-Cure Acrylic Resin

Group	Sample Size (n)	Mean Surface Hardness (VHN)	Standard Deviation (SD)	Range (VHN)
Heat-Cure Acrylic Resin	25	18.5	1.2	16.8-20.3
Self-Cure Acrylic Resin	25	14.2	1.5	12.5-16.5

Table 2: Statistical Comparison Between Heat-Cure and Self-Cure Resin

Comparison	t-value	p-value	Significance
Heat-Cure vs Self-Cure	8.73	< 0.001	Significant

DISCUSSION

Acrylic resins are widely used in prosthodontics for fabricating denture bases due to their ease of manipulation, esthetic appeal, and cost-effectiveness. These materials are available in two primary types: heat-cure and self-cure. Heat-cure acrylic resin requires external heat for polymerization, whereas self-cure resin sets at room temperature via a chemical reaction. Among the key properties influencing clinical performance, surface hardness plays a critical role as it affects wear resistance, polishability, and susceptibility to microbial colonization. Therefore, comparing the surface hardness of heat-cure and self-cure acrylic resins provides valuable insights into their mechanical durability and long-term suitability for dental prostheses.[10]

In the present study, heat-cure acrylic resin demonstrated a significantly higher mean surface hardness (18.5 ± 1.2 VHN) compared to self-cure acrylic resin (14.2 ± 1.5 VHN), with ranges of 16.8–20.3 VHN and 12.5–16.5 VHN, respectively. Statistical analysis using Student’s t-test yielded a t-value of 8.73 and a p-value of <0.001, indicating that the difference between the two groups was highly significant. These findings suggest that heat-cure acrylic resin may provide superior resistance to wear and abrasion compared to self-cure resin, making it a preferable option for long-term denture use.

Supporting these results, Carbajal Córdova SP et al. evaluated 80 acrylic discs (40 heat-cured, 40 self-cured) over various storage periods and found consistently higher microhardness values for heat-cured specimens across all time points, with statistically significant differences (P<0.001). Conversely, Bahrani F et al. reported no significant difference in hardness or surface roughness between heat-cured Meliodent and self-cured FuturaGen resins, indicating that certain self-cure materials may perform comparably under specific conditions.[11,12]

Additionally, Elnailia S et al. examined the surface roughness of multiple denture base materials, including heat-cure and chemical-cure resins, and found that surface texture varied according to resin type and polishing protocol. High-impact heat-cure resins exhibited the highest roughness, while finer polishing significantly reduced surface irregularities, highlighting the influence of both material composition and finishing technique on surface properties.[13]

Overall, these studies collectively emphasize that heat-cure acrylic resins generally exhibit superior surface hardness, contributing to better mechanical performance and durability. However, certain self-cure resins with optimized formulations can achieve comparable hardness and smoothness, underscoring the importance of material selection, fabrication technique, and finishing protocol in ensuring long-lasting and clinically effective denture bases.

CONCLUSION

Heat-cure acrylic resin demonstrates superior surface hardness compared to self-cure acrylic resin, suggesting better resistance to wear and enhanced durability for denture bases. These findings support the selection of heat-cure resins for long-term prosthodontic applications.

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