

Original Article

INVESTIGATING THE INFLUENCE OF FINISHING SYSTEMS ON SURFACE ROUGHNESS AND GLOSS OF FULL-BODY BULK-FILL RESIN COMPOSITES

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ABSTRACT

Objectives: This study assesses the impact of different finishing systems on surface roughness and gloss of full body bulk fill resin composites.

Materials and Methods: Four types of bulk filling material were chosen and involved in the standard manufacturing and surface preparation procedures. Specimens were assigned to groups according to specific finishing and polishing methods, and roughness and gloss were measured.

Results: The material type and finishing/polishing system significantly influenced both the surface roughness and the gloss, with Astropol delivering the most smooth surfaces and SonicFill 2 presenting the maximum gloss values.

Conclusion: This study concluded that the proper selection of finishing systems to get a suitable surface for clinical conditions is of critical importance for durability and longevity of restoration. The astropol showed most effective polishing system for decreasing surface roughness and sonicFill 2 with most superior gloss. Both composite type and finishing system significantly affected the surface quality, highlighting the significance of choosing suitable protocols for ideal clinical results.

Key words: Surface roughness, surface gloss, bulk fill (resin composite), finishing and polishing system, composite polishability

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INTRODUCTION

Resin composites (RCs), commonly referred to as composite resins, are tooth-colored dental materials utilized in restorative dentistry for the restoration

of tooth structure lost due to caries, fractures, or other defects¹. They are composed of filler particles and a resin matrix that simulate natural tooth properties. Building on early macro- and microfilled resin composites, "hybrid" composites emerged in the 1980s, marking a significant step forward in dental materials. The hybrid composites met with fairly poor acceptance because of their lack of wear resistance and poor polishability². However, as a result of constant innovation, microhybrid and then nanohybrid RCs were created, effectively addressing these drawbacks. Nevertheless, the use of higher filler loading

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in these composites resulted in increased stress and rigidity, which made the use of specialized layering procedures necessary for the best outcomes. In recent years, novel composite formulations known as "bulk-fill" composite (BFC) materials were introduced to overcome these problems³.

Full-body BFC have drastically changed past practices in restorative dentistry by providing improved efficiency and outcomes in the restoration of dental cavities and defects for clinicians⁴. These materials have continued to capture greater interest for their unique composition and application methods and their solutions to certain long-standing challenges linked with contemporary composite resins. As a whole, bulk-fill materials are dental restorative materials meant to fill a cavitated tooth in one increment of up to 4-5 mm, minimizing the number of steps necessary for placement⁵. Full-body bulk-fill composites expedite the restorative process by facilitating bulk placement, which minimizes chair time and the possibility of errors associated with multiple layering processes⁶.

It is particularly important to remember that clinicians frequently use finishing and polishing protocols intended for traditional microhybrid RCs as there are no particular finishing and polishing techniques for this class of materials¹⁰. However, surface quality (roughness and gloss) critically impacts restoration longevity, aesthetics, and patient satisfaction, necessitating targeted research¹². Surface roughness, refers to the irregularities and micro textures present on the surface of a restoration¹³. In addition to surface roughness, the role of gloss in restorative dentistry is equally significant. The capacity of a surface to evenly reflect light, giving it a polished or shining look, is referred to as gloss¹⁴. A highly lustrous surface finish is not only visually pleasing but also facilitates cleaning and maintenance, as it resists staining and promotes self-cleaning properties through saliva and oral fluids¹⁵.

Overall, achieving an optimal surface finish is paramount in restorative dentistry in order to ensure the long-term success and satisfaction of dental restorations¹⁶. By addressing both surface roughness and gloss, clinicians can enhance the esthetics, durability, and biocompatibility of restorations while promoting oral health and patient well-being. This underscores the importance of meticulous attention to detail

and the use of appropriate finishing and polishing techniques as integral components of the restorative process¹⁷. Finishing systems are tools and techniques to refine restoration, which are vital for achieving ideal surface quality. They remove excess material, smooth edges, and align restorations with natural tooth structure¹⁸. Proper finishing reduces roughness, prevents plaque buildup, and enhances gloss, ensuring patient comfort and aesthetic integration¹⁹.

Numerous research studies in the field of restorative dentistry investigated resin composite finishing techniques²⁰. Many aspects of finishing techniques are covered by the insights gathered from these studies; however, there remains a significant research gap that relates specifically to full-body BFC materials. Earlier investigations have predominantly focused on testing more traditional nanohybrid resin composites in regard to surface roughness, gloss retention, and polishing effectiveness. There is very little information dealing with the finishing requirements and results of full-body bulk-fill materials. The composition and, handling manner of these newer materials are completely different, and this creates an urgent need to evaluate their finishing and polishing protocols²¹. It is imperative to understand how the type, size, and distribution of fillers affect polishability since it might lead to the development of optimized finishing systems specifically for these materials. Evaluating how different finishing techniques can affect surface properties and subsequently the long-term clinical performance will add value to our endeavor of producing durable yet aesthetic restorations. Optimizing finishing protocols for these materials requires analyzing how filler properties influence polishability. Such efforts will improve clinical guidelines and restoration quality²².

This study evaluates how different finishing systems affect surface roughness and gloss of full-body bulk-fill composites. By addressing existing research gaps, it aims to establish tailored protocols to enhance restoration durability, aesthetics, and clinical practices.

MATERIALS AND METHODS

This study evaluated four bulk-fill restorative materials selected for occlusal surface applications. Filtek Bulk Fill Posterior Restorative (FB), shade A2, was sourced from 3M-ESPE (St. Paul, MN, USA). Ivoclar Tetric EvoCeram bulk-fill (EC), shade IVA,

originated from Ivoclar Vivadent (Schaan, Liechtenstein). SonicFill2²⁴, shade A2, was supplied by Kerr (Orange, CA, USA). Fill-Up! (FU), universal shade, was provided by Coltène/Whaledent (Altstätten, Switzerland). The clinical relevance for occlusal load-bearing surfaces led to the selection of these materials.

Specimen Fabrication

60 meticulously crafted specimens, that were disc shaped and having dimensions of 7mm diameter and 2mm thickness, were placed into specially made PTFE molds sandwiched between two glass slides and cured for 40 seconds using an LED curing light (Valo, Ultradent, South Jordan, UT, USA) with an output of 1000 mW/cm². To facilitate composite post-cure, the specimens prior to use were placed in incubator at a constant temperature of 37°C and 100% humidity for 24 hours²³.

Surface Preparation

Specimen surfaces were standardized for initial roughness using a #1982M Sof-Lex medium-grit disc (3M ESPE, St. Paul, MN, USA). Each surface was treated for 20 seconds to mimic clinical red diamond bur roughness. Prior to testing, a single operator (EM) was trained with a precision scale to apply consistent 40 g force, defined as light clinical pressure. This operator performed all manual finishing and polishing steps. Calibration was verified every 10 specimens through periodic scale measurements²⁴.

Finishing and Polishing Procedures

Each resin composite (RC) material had 15 randomly assigned specimens allocated to one of four groups for testing finishing and polishing techniques. Group 1 (SW) used Sof-Lex Spiral Wheels by 3M ESPE. Group 2 (HL) applied for the HiLusterPLUS Polishing System from Kerr. Group 3 (AP) employed Astropol by Ivoclar Vivadent. Group 4 (OS) tested OptiStep, also by Kerr. Each method was done with a low-speed dental air water turbinetool, using circular motions and constant water cooling (50 mL/min). Groups 1, 2, and 4 followed a 20-second process per step, while Group 3 (AP) used a shorter 15-second step. After treatment, samples were rinsed carefully with distilled water²⁵.

Measurement of Surface Roughness

Before analysis all samples were cleaned

with 95% ethanol ultrasonically, for 3 minutes to eliminate residual debris. Surface roughness (Ra) measurements were obtained using a Mitutoyo SJ-201P profilometer (Kanagawa, Japan). The device was set to a 0.8 mm cutoff, 0.5 mm/s stylus speed, and 5.0 mm tracking length, following standardized methods²⁶. A custom-fabricated mold ensured consistent alignment between the instrument handpiece and specimens during measurements. Three Ra readings per specimen were averaged to determine final roughness values (μm), minimizing positional variability.

Measurement of Surface Gloss

A glossmeter (MG6-SA; KSJ, Quanzhou, China) with a 2×2 mm square measurement area was used for measuring gloss. Following ISO 2813 standards for ceramics²⁷ readings were taken at 60°. During testing, a black plastic mold was placed over each sample to ensure accuracy. This blocked external light and fixed the sample's position relative to the glossmeter's sensor, ensuring consistent readings.

Statistical Analysis

To test the first hypothesis, surface roughness was analyzed using a two-way ANOVA, with material type and polishing method as factors. Before analysis, roughness data was tested for normality (Shapiro–Wilk test) and homogenous group variances (Levene test). Post hoc Tukey tests were applied when needed. For the second hypothesis, gloss data underwent the same steps (two-way ANOVA, Tukey tests) after confirming normality and equal variances. The relationship between roughness and gloss was tested using Pearson's correlation. All analyses used a significance threshold of $p < 0.05$ and were conducted in SigmaPlot 11.0 (Systat Software Inc., USA).

RESULT

The results of surface roughness data (Ra, μm) are summarized in Table 1. Statistical analysis confirmed that both the type of material ($p < 0.001$) and polishing method used ($p < 0.001$) significantly affected surface smoothness. Fill-Up showed the roughest surfaces compared to other materials ($p < 0.05$) irrespective of the finishing/polishing procedure. Among polishing systems, regardless of the type of material used Astropol produced the smoothest results overall ($p < 0.05$). SonicFill 2 also

performed better, yielding smoother surfaces than HiLuster and Opti1 Step ($p < 0.05$).

Surface gloss measurements are detailed in Table 2. Statistical analysis showed that both factors including the type of material ($p < 0.001$), and polishing method used ($p < 0.001$) significantly influenced gloss levels. Among materials, SonicFill 2 had the highest gloss, outperforming Fill-Up ($p < 0.05$). Filtek Bulk and Evo Ceram also showed a notably higher gloss than Fill-Up. When evaluating polishing systems alone, all differed significantly ($p < 0.05$). The maximum gloss was achieved by Sof-Lex Spiral Wheels, and the lowest by Opti1 Step. These results highlight how material choice and polishing technique jointly shape the final gloss of bulk-fill composites. A moderately negative correlation (a Pearson correlation coefficient of $r = -0.534$) between roughness and gloss was observed using Pearson correlation analysis. This correlation was found to be statistically significant ($p < 0.001$).

DISCUSSION

Researchers have studied various finishing and polishing methods for resin composites extensively. While their effects on surface texture and shine in traditional hybrid and nanohybrid composites are well documented, their impact on bulk-fill materials

remains unclear. Bulk-fill composites often show 2–7 times higher surface roughness than nano-filled composites. This study tested how the roughness and gloss of full-body bulk-fill composites is influenced by different finishing and polishing techniques. According to the results, the type of material and the polishing methods had a substantial impact on surface quality.

Roughness and relative gloss are two clinically relevant parameters associated with structural restoration material. Roughness is a measure using Ra, a roughness average, identifies surface wrinkles, and determined the average root-mean-square of the total mean absolute value within a fixed distance²⁸. Gloss, meanwhile, is a measure of the incidence of bending that refers to how much the surface is glare. This quality is utilized in terms of function enhancing and provides a shiny surface to the material. It is measured in terms of gloss units which are influenced by the light and other materials' refractive index of the resin matrix and filler^{29,30}. The size of the filler and the homogeneity between matrix-filler also affect the gloss. The less homogeneous filler size composition has a lower light reflectivity. The study's results validated the preliminary findings by demonstrating an indirect linear association between gloss and roughness³¹.

Table 1: Surface roughness (Ra, μm) was analyzed using descriptive statistics. Lowercase letters indicate there are considerable changes between finishing techniques within each restorative material, while the uppercase letters indicate significant differences between four materials within each treatment ($p < 0.05$).

Roughness Ra (μm)												
Treatment	Sonic Fill 2			Filtek Bulk			Evo Ceram			Fill up		
	Mean	SD	Sig.	Mean	SD	Sig.	Mean	SD	Sig.	Mean	SD	Sig.
SW	0.15	0.025	c	0.16	0.015	c	0.18	0.017	c	0.47	0.015	b
HL	0.24	0.026	b	0.23	0.021	b	0.30	0.015	a	0.73	0.031	a
AP	0.12	0.020	b	0.20	0.019	b	0.14	0.011	d	0.32	0.021	c
OS	0.35	0.026	a	0.31	0.023	a	0.24	0.021	b	0.43	0.015	b

Table 2: Descriptive statistics of gloss (GU) analysis. The uppercase letters indicates a statistically significant difference among finishing systems independently, while lowercase letters indicate significant differences among finishing systems within each restorative material. Additionally, uppercase letters label significant differences among the four materials within each treatment ($p < 0.05$).

Gloss (GU)												
Treatment	SonicFill 2			Filtek Bulk			Evo Ceram			Fill up		
	Mean	SD	Sig.	Mean	SD	Sig.	Mean	SD	Sig.	Mean	SD	Sig.
SW	44.70	0.600	b	38.73	0.473	a	37.17	0.352	b	41.67	0.208	a
HL	38.73	0.473	c	35.20	0.300	c	41.22	0.302	a	8.40	0.300	d
AP	49.50	0.635	a	36.15	0.329	b	36.88	0.202	b	26.80	0.229	b
OS	34.15	0.231	d	28.64	0.127	d	35.38	0.019	c	15.31	0.096	c

A necessary goal of finishing and polishing is the creation of enamel-like surfaces. Accordingly, the roughness of the end composite must parallel that of enamel-to-enamel contact in occlusal territories (0.64 μm). Therefore, the range of 0.11 μm for the finest result to 0.69 μm for the roughest is deemed clinically acceptable. The finest results were achieved with Roth Plus, which did not significantly differ from the Ultradent or Schaan groups³². The Fill-Up! group had the highest Ra among the components in all comparisons, and its roughness was always considerably higher than that of other denture materials. This was likely linked to the filler's properties, such as the largest average filler size and the least amount of filler. Nevertheless, Fill-Up! was tested for the sake of completion as it can be applied on its own for specific repairs, meeting the conditions of a full-body material³³.

No substantial differences in roughness appeared between SonicFill 2, Filtek Bulk, and Evo Ceram, consistent with previous observations that material composition might affect roughness outcomes. Likewise, finishing/polishing techniques intending to provide an enamel-like gloss concluded with all systems attaining gloss values in the "poor" range as characterized by Cook and Thomas. While gloss measurement geometry lacks agreement in the literature, this study used a 60° measurement angle to conform to standard protocols. Sof-Lex™ Spiral Wheels with Filtek-bulk had the smoothest surface while; 3-step Astropol system produced the smoothest surface in all but one sample. Compared to the other treatments, Sof-Lex™ Spiral Wheels created a significantly higher gloss²³. This study's limitations include one initial finishing system, which may have caused initial roughness differences, and the stability of these results over time remains to be seen. Likewise, the need for standardization in gloss measurement protocols and the possible influence of filler-matrix composition is highlighted by all these factors.

CONCLUSION

The surface properties of full-body bulk-fill resin composites are greatly influenced by finishing techniques. This study found Astropol to be the most effective in reducing roughness, while SonicFill 2 excelled in enhancing gloss. Roughness and gloss showed a moderately negative association, indicating

their interdependency. These findings emphasize the need for clinicians to select appropriate finishing systems to ensure long-term success in dental restorations. Future research should explore the clinical implications of these surfaces to guide material selection for optimal patient outcomes.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design: BZB, RB, AK, KR, SAA, ME

Acquisition, Analysis or Interpretation of Data: BZB, RB, AK, KR, SAA, ME

Manuscript Writing & Approval: BZB, RB, AK, KR, SAA, ME

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.



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