

Original Article

Effect of finishing/polishing techniques and time on surface roughness of esthetic restorative materials

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ABSTRACT

Background: Surface roughness associated with improper finishing/polishing of restorations can result in plaque accumulation, gingival irritation, surface staining, and poor esthetic of restored teeth. The study aimed to evaluate the efficiency of various finishing and polishing systems and time using various procedures on surface roughness of some esthetic restorative materials.

Materials and Methods: In this *in vitro* study, samples of two composite materials, compomer and glass ionomer cement (GIC) materials, were fabricated. Finishing and polishing were done immediately ($n = 40$) and after 1 week ($n = 40$) using four systems (diamond bur + soflex discs; diamond bur + Astropol polishing brush; tungsten carbide bur + soflex discs; tungsten carbide bur + Astropol polishing brush). Surface roughness was measured using surface profilometer. Data were statistically analyzed by *t*-test (for each material and time period) and one-way analysis of variance followed by Tukey's *post hoc* (for finishing and polishing systems) at a significant level of $P < 0.05$.

Results: Analysis of time period, irrespective of finishing and polishing system showed that Ra values were greater ($P < 0.05$) in delayed polishing in GIC > Z100 > Filtek P90 > Dyract AP, suggesting immediate polishing is better. Among the materials, Filtek P90 had the least Ra values indicating the smoothest surface among all materials, followed by Z100, Dyract AP, and GIC. Comparison of polishing and finishing systems irrespective of materials showed that Ra values were lower ($P > 0.05$) in diamond + Astropol combination whereas diamond + soflex had the greatest Ra values.

Conclusion: It might be concluded that: (i) Filtek P90 showed least Ra values followed by < Z100 < Dyract < GIC; (ii) immediate (24 h) finishing/polishing of materials is better than delayed; and (iii) among all these polishing systems, diamond bur–Astropol and Astrobrush showed good surface finish.

Key Words: Artglass dental composites, dental esthetic, material, dental finishing, dental polishing

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INTRODUCTION

One of the desirable features for a satisfactory restoration is smooth surface finish.^[1,2] High-quality finishing and polishing of dental restorations are

important aspects of critical clinical restorative procedures that enhance both esthetics and longevity of restored teeth.^[3-5] Surface roughness due to improper

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finishing/polishing of dental restorations can result in excessive plaque accumulation, gingival irritation, increased surface staining, and poor esthetics of restored teeth that could potentially lead to demineralization of enamel, possible recurrent caries, and periodontal problems.^[6-9] Furthermore, patient consciousness of restorations with possible irritations to tongue, lips, and cheeks is matter of concern. Therefore, smoothness of restorations is of utmost importance for its success.

Among the wide variety of finishing and polishing devices that are available in the market to the clinician, silicon carbide-coated or aluminum oxide-coated abrasive discs, impregnated rubber or silicone discs and wheels, multifluted tungsten carbide finishing burs, and hard bonded-surface coated ceramic diamond rotary instruments are most commonly used to finish and polish dental restoratives.^[1,5,10,11] Each of these instruments or devices leaves the surface of various restorative materials with varying degrees of surface roughness.

The effectiveness of finishing/polishing procedures on restorative surfaces is an important consideration in restorative processes. As finishing/polishing procedures are usually conducted immediately postpolymerization, this prematurity can make the restorative material more susceptible to effects of heat generation. Delayed finishing/polishing may make the restorative material less susceptible to negative effects of heat generation.^[12-14] Thus, it becomes important to determine which finishing/polishing system and finishing/polishing time offer best results for esthetic restorative materials in clinical practice.

The study aimed to evaluate the efficacy of various finishing and polishing systems using various procedures on surface roughness of esthetic restorative materials and also to evaluate the effect of immediate or delayed finishing/polishing procedures on surface roughness of esthetic restorative materials.

A well-finished restoration with less adhesive properties contributes not only to better esthetics but also reduces the development of secondary caries and periodontal disease. Thus, we must remain cognizant of the right polishing system and timing for each material to obtain optimum results.

MATERIALS AND METHODS

Materials used in the study

In this experimental *in vitro* study, silorane-based composite, methacrylate-based composite, compomer,

and glass ionomer cement were evaluated for surface roughness [Table 1].

The samples were represented as follows:

- Silorane-based composites (SBC)
- Methacrylate-based composites (MBC)
- Glass ionomer cement (GIC)
- Dyract AP Compomer (DAP)

Specimen preparation

All specimen preparation was done by a single operator, to reduce variability. Specimens were prepared using Brass molds (10 mm diameter × 2 mm thickness). The mold was sandwiched between transparent matrix strips. The uncured composites were inserted into the mold and intentionally overfilled. Light pressure was applied to expel excess material from the mold. Each specimen was light cured (CICADA dental LED curing light radiometer, Foshan CICADA Dental Instruments Co, Ltd, China) through the top and bottom for the duration recommended by the manufacturers. The intensity (200–400 mW/cm²) of the light-curing unit was checked before each sample run using a radiometer. The set cylindrical specimens were separated from the mold. The specimens were stored at 100% relative humidity at 37°C for 24 h.

Experimental design

Eighty specimens of each restorative material were fabricated ($n = 10$). The matrix strip formed surface was used as a baseline for all tests. Twenty specimens were finished and polished immediately using four finishing and polishing procedures and the remaining twenty specimens were finished and polished after a week [Figure 1]. Specimens were examined for obvious voids, labeled on the bottom and randomly separated into four treatment groups.

Finishing and polishing procedures

- Method I: Extra-fine finishing diamond bur followed by soflex discs (Al₂O₃-coated, abrasive disc system, fine grit, and extra-fine grit) (3M ESPE, St Paul, USA) was employed with a

Table 1: Materials used in the study

Product name	Type of material	Manufacturer
Filtek P90	Silorane-based microhybrid composite	3M/ESPE, St. Paul, MN, USA
Z100	Methacrylate-based hybrid composite	3M/ESPE, St. Paul, MN, USA
GC Gold Label Light Cured Universal Restorative	Resin-modified GIC	GC America
Dyract AP	Compomer	Dentsply India

GIC: Glass ionomer cement

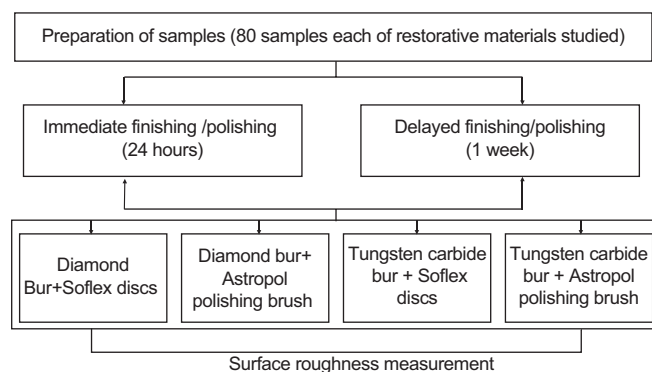


Figure 1: Experimental design

high-speed turbine with water-spray-coolant, and an air-dried slow hand-piece, respectively

- Method II: Extra-fine finishing diamond bur followed by the Astropol and Astrobrush polishing system (silicon-based abrasive polisher point and polisher brush) (Ivoclar Vivadent, Liechtenstein) was employed with a high-speed turbine with water-spray coolant, and a low-speed handpiece with water spray, respectively
- Method III: Thirty-fluted tungsten carbide bur followed by the soflex discs (Al_2O_3 -coated, abrasive disc system, fine grit and extra-fine grit) was employed with a high-speed turbine with water-spray coolant, and an air-dried slow handpiece, respectively
- Method IV: Thirty-fluted tungsten carbide bur followed by the Astropol and Astrobrush polishing system was employed with a high-speed turbine with water-spray coolant, and a low-speed handpiece with water spray, respectively.

Each step of the finishing–polishing was applied for 30 s. Each bur was applied using light pressure in multiple directions. The soflex discs were changed after the polishing of each sample and each silicon-based polisher point was discarded after use while the diamond burs and carbide burs (Mani, Inc., Japan) were changed every three samples.

Measurement of surface roughness

The surface was evaluated using Surtronic 3+ (Taylor Hobson Limited, England) coupled to a computer with Talyprofile software surface analyzer with a cut off length of 0.80 mm and a crosshead speed of 0.25 mm/s to obtain average surface roughness (represented by unit Ra, μm) and a surface profile tracing. Each sample was rotated 120°C , relative to the center, for each of three readings and averaged to generate average roughness value.

Statistical analysis

The data were expressed as mean \pm standard deviation (SD). The significance of differences ($P = 0.05$) among the groups was assessed using one-way analysis of variance (ANOVA) test followed by Tukey's test.

RESULTS

Data were statistically analyzed by *t*-test (for each material and time period) and one-way ANOVA followed by Tukey's *post hoc* (for finishing and polishing agents). The data were expressed as mean \pm SD $P < 0.05$ was considered as significant.

Analysis of time period irrespective of finishing and polishing system showed that Ra values were greater ($P < 0.05$) in delayed polishing in $\text{GIC} > \text{MBC} > \text{SBC} > \text{DAP}$, suggesting immediate polishing is better. Within the materials, when immediate and delayed polishing was compared to baseline readings, polishing was better (less Ra value) in $\text{DAP} < \text{SBC} < \text{MBC} < \text{GIC}$ in immediate; whereas in delayed polishing, the order was $\text{SBC} < \text{MBC} < \text{DAP} < \text{GIC}$. Among the materials, SBC had the least Ra values indicating the smoothest surface among all materials, followed by MBC, DAP, and GIC [Figures 2 and 3]. Comparison of polishing and finishing systems irrespective of materials showed that Ra values were lower ($P > 0.05$) in diamond + Astropol combination followed by tungsten + soflex, tungsten + Astropol whereas as diamond + soflex had the greatest Ra values indicating that diamond and soflex combinations should be least used during the finishing and polishing of composites [Figures 2 and 4].

DISCUSSION

The finishing and polishing techniques employed for the tooth-colored dental restorative materials improves its longevity and aesthetic appearance of the material.^[15] Polishing is complicated by the heterogeneous nature of these dental materials, i.e., hard filler particles embedded in a relatively soft matrix. Some other factors affecting the polishability of resin restorations are filler content, particle size, polishing medium, and polishing technique.^[16,17] In this study, Surtronic 3 + was used to evaluate the surface roughness values (Ra) and the results were statistically analyzed using one-way ANOVA with Tukey's *post hoc*.

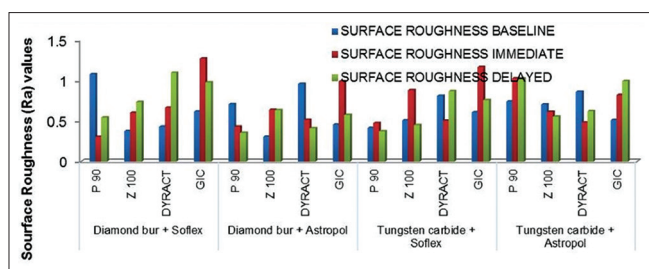


Figure 2: Comparison of roughness with materials and finishing/polishing systems (μm).

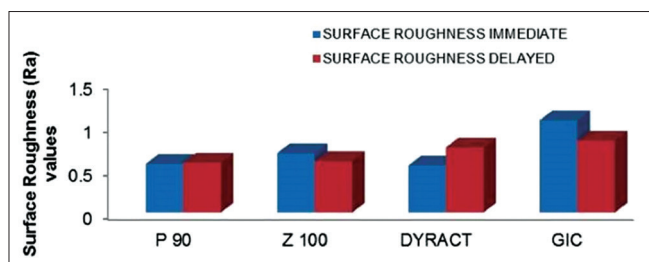


Figure 3: Comparison of roughness in all materials (μm).

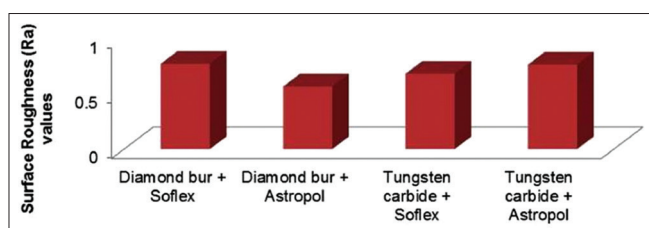


Figure 4: Comparison of roughness in finishing and polishing systems (μm).

The time for finishing and polishing is an important factor to be considered because it has an effect on the surface roughness of esthetic restorative materials. In this study, irrespective of polishing system used, both GIC and MBC showed increased roughness values at both the immediate (24 h) and delayed (1 week) period as compared to the baseline value. Among the polishing materials, DAP and SBC demonstrated least Ra values within 24 h (immediate) followed by MBC and GIC while the Ra values after a 1 week (delayed) showed SBC and MBC created the least surface roughness followed by DAP and GIC.

Therefore, based on the results of this study, the surface roughness of the materials when finished/polished was measured immediate (24 h) showed the least Ra values when compared to delayed (1 week). These results were supported by Venturini *et al.*^[14] that immediate polishing did not produce a negative impact on the surface roughness, hardness and microleakage of a microfilled (Filtek A110) and a hybrid (Filtek Z250)

resin composite compared to delayed polishing. Cenci *et al.*^[18] recommended immediate polishing since this procedure reduces the number of clinical sessions. Several other authors also have proposed a 24-h delay for finishing procedures,^[19,20] which supports the result obtained in this study, but most clinicians perform finishing/polishing procedures immediately after restoration placement.

However, the system used for finishing and polishing also should be taken into consideration. The types of finishing/polishing systems and abrasives might have an influence on the surface roughness of the materials. Despite carefully placing the matrixes during esthetic restoration, removal of excess material or recontouring of restorations is often clinically necessary. For proper contouring anatomically structured teeth, diamond and carbide burs are necessary.^[1] Finishing diamonds were best suited for gross removal and contouring because of their high cutting efficiency on composite surfaces while carbide finishing burs would be best suited for smoothing and finishing as a result of their low cutting efficiency.^[21,22]

In this study, extra-fine diamond burs and 30-fluted tungsten carbide burs were used to finish the surface of the restorations and following these procedures sofex discs (in Groups I and III) and Astropol and Astrobrush (in Groups II and IV) were used to polish the restorations. When different polishing systems were used irrespective of materials, the surface roughness (Ra) values varied from high to least in the order when diamond bur-sofex disc, tungsten carbide bur-Astropol and Astrobrush, tungsten carbide bur-sofex disc, and diamond bur-Astropol and Astrobrush.

According to the results obtained in this study, the surface finish was good when diamond bur-Astropol and Astrobrush was used. Other investigator have shown that Super-snap abrasive discs produced a smoother surface than Astropol and Astrobrush silicone polishers for all the materials,^[19] the results would be valid clinically for readily accessible and flat surfaces, i. e., not for all areas in the mouth. Therefore, silicone polishers are necessary for posterior areas and for concave and convex surfaces.^[19]

After finishing and polishing of esthetic materials with different techniques, the remaining roughness may be attributed to distinct patterns of particle size and their arrangement within the resin matrix. For a finishing system to be rendered effective, the cutting particles

should be harder than the filler particles; otherwise, the abrasive medium may abrade the softer matrix only. This may result in higher surface roughness. Therefore, the effectiveness of finishing and polishing procedures on restorative material surface may be more critical.^[23,24] Further research is required to assess the other mechanical properties of these esthetic restorative materials. Additional *in vivo* and *in vitro* studies are desirable to further substantiate the findings of this study.

CONCLUSION

Under the limitations of this *in vitro* study, it might be concluded that: (i) SBC showed least Ra values followed by < MBC < DAP < GIC, (ii) immediate (24 h) finishing/polishing of materials is better than delayed, and (iii) among all the polishing system used diamond bur–Astropol and Astrobrush showed good surface finish.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

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