ORIGINAL RESEARCH

The Effect of Different Finishing and Polishing Systems on Surface Properties of New Flowable Bulk-fill Resin Composite

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Abstract

Aim: The purpose of this research was to explore how various finishing and polishing techniques affect the surface roughness (Ra) and gloss of flowable bulk-fill injectable resin composite utilized for posterior teeth restoration, following exposure to a range of food-simulating liquids (FSLs) over three months.

Materials and methods: This study comprised fifty-six disk specimens of G-aenial™ Bulk Injectable flowable resin composite which were created using a Teflon mold (10 × 4 mm). Two techniques of finishing and polishing (F/P) were employed: The two-step 3M™ Sof-Lex™ F/P spiral wheels system and the multiple-step 3M™ Sof-Lex™ XT finishing disks supplemented by the Ultradent Jiffy HiShine polisher cup system. The Ra and gloss of the prepared specimens were measured using an interference microscope system and Horiba gloss checker respectively, immediately post-finishing and polishing and then reassessed after three months in artificial saliva and Coca-Cola.

Results: The two-step system showed a statistically significant difference, exhibiting greater "surface roughness (Ra)" and lower "surface gloss (GU)" mean values compared to the multiple-step system under different storage conditions, particularly after 3 months of storage ($p = 0.001$).

Conclusion: The multiple-step polishing system improved the "Ra" and "GU" of resin composite, suggesting their suitability for posterior resin composite restorations. Acidic media had a deleterious impact on the "Ra" and "GU" of resin composite restoration.

Clinical significance: The quality of resin composite restorations can be significantly improved with the correct use of finishing and polishing systems, particularly in complex areas of posterior teeth restorations, leading to successful dental procedures.

Keywords: Food simulating liquids, Multiple-step polishing system, Surface gloss, Surface roughness and two-step polishing system.

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Introduction

The finishing and polishing play an important role in determining the clinical outcome of posterior resin composite restorations as the finishing step is to remove any flash or overhangs from the margin of the posterior restoration for class I or II to create an anatomical rim to facilitate interproximal oral hygiene measures and adjust and optimize occlusal scheme.[1,2] Restorations that are polished have a lower risk of extrinsic staining and plaque buildup, while also potentially influencing the restorations' wear resistance, mechanical properties, and marginal integrity.[3] The factors related to the success of posterior restorations not only involve choosing a restorative substance with appropriate esthetic and mechanically durable properties but also the careful selection of a finishing and polishing method.[4] Creating a rounded marginal ridge contour, which improves interdental cleaning and removal of marginal excess between resin and tooth structure creating a more ideal occlusal scheme.[5] Inadequately finished and polished surfaces are indeed more prone to wear and plaque accumulation, thus exposing the restored tooth to a higher risk of staining, secondary caries, and gingival irritation. Furthermore, it is well known that restorations with smooth surfaces are more comfortable and better accepted by patients. Surface gloss refers to the tendency of a surface for reflecting light.[6] The higher the final polish of a composite restoration, the larger the dispersion of light, and the gloss increase.[7] A variety of instruments are available used for finishing and polishing resin composite restorations including carbide burs, diamonds, abrasive-impregnated rubber cups and points, abrasive disks, abrasive strips, and polishing pastes.[2] It is important to determine which finishing and polishing system offers the best results for adhesive restorations. However, there is a lack of material and technique to provide the smoothest surfaces for resin composites (RCs), especially in complex areas in posterior teeth.[2] Spiral polishing wheels were selected in our study to get the advantage of aluminum-oxide abrasives and the shape of the wheel which allows them to polish all flat and contoured surfaces like the occlusal surface of posterior teeth.[8] An aluminum oxide

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Table 1: Materials and tools' specification, composition, manufacturer and LOT number

Materials and tools	*Specification*	*Composition*	*Manufacturer*	*LOT no.*
G-aenial bulk injectable resin composite (A2)	Nanofilled light-cured, high-strength injectable composite for bulk-fill restorations	Monomers: Ethoxylated bisphenol A, dimethacrylate bismethacrylate Filler: Ultra-fine particles with silane coubling agent. Silicon dioxide, barium glass, strontium glass, pigment and photoinitiator Filler size: 150 nm Filler content: (vol/wt 69%)	GC Corp, Tokyo, Japan www.gcdental.com	1901281
Ultradent diamond polish mint paste	1.2 mL Syringe mint-flavored polishing paste	Diamond polishing paste contain micro fine diamond particles (0.5 μm) in a water-soluble gel	(Ultradent Products. INC., South Jordan, UT, USA www.ultradent.com	090518
Sof-Lex spiral wheels two-step finishing and polishing system	Two-step diamond impregnated spiral rubber wheel	Finishing wheels - Fine (beige) - Aluminum oxide (25–29 μm) - Polishing wheels - Superfine (pink) - diamond particles	3M ESPE (USA) www.3m.com	NA34020
Sof-Lex disks multiple-step finishing and polishing system	Four-step rubber polishing disks	Color coded Al_2O_3 flexible disks: Coarse (black): 60 μm. Medium (dark blue): 29 μm Fine (medium blue): 14 μm Extra fine (light blue): 5 μm	3M ESPE (USA) www.3m.com	NC48146
Ultradent Jiffy HiShine polisher cups	Fine white cups	White abrasive silicon carbide particles and aluminum oxide particles impregnated rubber cups (1 μm)	(Ultradent products. INC., South Jordan, UT, USA www.ultradent.com	51149

course grit, medium-sized finishing disk can be used over the mesial and distal marginal ridges and cuspal inclines.[6] However, multiple-step finishing/polishing systems have been demonstrated to produce smoother surfaces for tested resin composite materials than simplified systems and diamond-containing systems.[9,10] Another study concluded that Ra changed for flowable and injectable RCs following finishing and polishing, and the Sof-Lex F/P disks method yielded lower Ra values compared to other systems.[11] Extrinsic factors including the polishing technique, light-curing method, and type of food and beverages consumed are also influential.[4,10] Various studies have explored the impact of different food-simulating liquids like Coca-Cola, artificial saliva, orange juice, tea, and coffee on RCs' surface properties, finding a significant increase in roughness over time (T).[5] Coca-Cola is a popular soft drink with a pH of (2.7). It has been reported that a low pH in acidic food and drink induces erosive wear in materials. High acidity might have a greater softening effect on the resin matrix, thus promoting the dislodgement and leaching out of filler particles and thereby increasing the Ra of composite resin.[12] When polymer materials absorb water, coupling agents cause hydrolysis and loss of chemical bonds between filler particles and the resin matrix. Filler particles dislodge from the outer surface of the material causing surface roughness. Artificial saliva with a pH of (7.2) simulates the liquids that usually exist in the mouth and that constantly interact with teeth and restorations to mimic the natural human saliva and that may influence the diffusion process through resin composite material.[5] In this *in-vitro* study would explore how different finishing and polishing methods impacted the "Ra" and "GU" of a flowable bulk-fill injectable resin composite employed in posterior teeth restorations after exposure to various food-simulating liquids to identify the technique that produces the smoothest surface possible and to identify which procedure increases the gloss values. The null hypotheses for this research would be that no changes in (a) the roughness of the surface of the tested material and (b) the GU would be observed after applying different finishing and polishing techniques to the bulk-fill injectable resin composite.

Materials and Methods

Tested Materials

The materials and tools used as well as their descriptions, principal components, and manufacturers are listed in Table 1.

Study Design

An *in-vitro* study was done in the Conservative Dentistry Department, Faculty of Dentistry, October 6 University, Egypt, and carried out from October, 2022 till January 2023. The disk-shaped specimens were randomly divided into four groups in a 1:1 allocation using a computer-generated randomization tool (www.random.org). The protocol of this study was approved by the Council of Conservative Dentistry Department – Faculty of Dentistry – October 6 University and the ethical issues were reviewed and revised by the Research Ethics Committee – Faculty of Dentistry – October 6 University on January 5, 2022 (Approval No. RECO6U/7-2022).

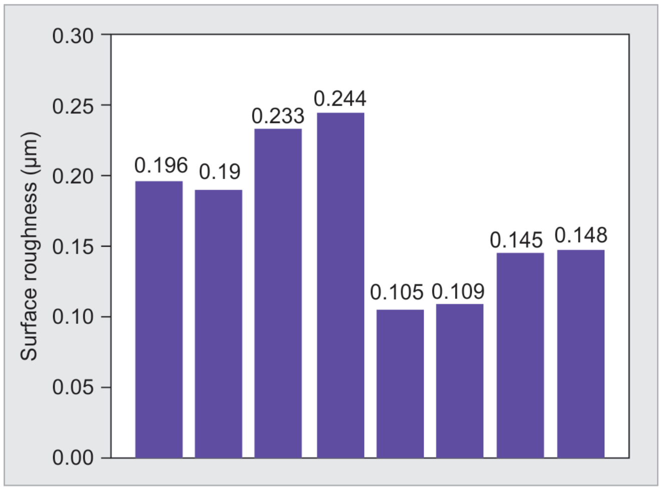


Fig. 1: Mean surface roughness with different interactions

Sample Size Calculation

A power analysis was performed to ensure sufficient statistical power for the assessment of a null hypothesis suggesting no variance in Ra and gloss across the groups. The sample size requirement was identified as a total of 56 samples based on an alpha level of 0.05, a beta of 0.2 (i.e., power = 80%), and an effect size (f) of 0.544 (grounded on Tosco et al., 2019 findings).[13] G*Power, version 3.1.9.7, was utilized for the calculation of sample size.

Eligibility Criteria

The top surfaces of the specimens were examined using a magnifying lens and 8 samples with surface voids or surface scratches were discarded. The bottom surface of each specimen was labeled with a small indentation, made with a small round bur.

Preparation of the Specimens

A total of fifty-six samples of G-aenial bulk-fill injectable resin composite, were fabricated using a split Teflon mold, which was 4 mm in thickness and 10 mm in diameter. This ensured a standard shape and size for each sample and provided a sufficient surface area for F/P.[14] The samples were then split into two equivalent groups, each containing 28 specimens, based on the type of finishing system (P); where P1 corresponds to Sof-Lex spiral wheels (SW) of the two-step system (comparator group) and P2 corresponds to Sof-Lex finishing disks and Ultradent Jiffy HiShine polisher cups of the multiple-step (intervention group). Every group was subsequently divided into four equivalent subgroups of fourteen specimens each ($n = 14$), based on the type of food-simulating liquid (F); where F1 corresponds to artificial saliva and F2 corresponds to Coca-Cola and the storage duration (T); where T1 is the baseline and T2 is after 3 months (Fig. 1).

The split Teflon mold was placed on a glass slide covered with a Mylar strip to remove excess material and eliminate the oxygen inhibition layer during polymerization on the outermost layer of the samples, resulting in a smooth, flat surface.[15] The mold was bulk filled with the tested composite material. To assure a smooth top surface, another Mylar strip was placed on top of the specimen's surface and covered with a second glass slide.

The samples were polymerized for twenty seconds using a Woodpecker light cure I LED (wavelength (385 nm 515 nm) with output light intensity (1000–1200 mW/cm^2), as per the manufacturer's guidelines. After curing, the sample was carefully extracted from the mold and stored in labeled airtight bottles with 20 mL distilled water at room temperature for 24 hours to simulate oral conditions on the day of restoration.[16]

The Specimens' Finishing and Polishing

Specimens F/P were obtained by mounting each polisher on a contra-angle handpiece (Marathon) in a micro-motor running at 15,000 rpm for 20 seconds. Each disk was polished using distilled water irrigation and a water syringe handled by an assistant at a flow rate of 20 cc/minute.[17] After polishing each sample, the aluminum oxide disk polishers were replaced after each sample, and the wheels and cups were replaced after three applications. Between each treatment phase, the specimens were completely rinsed for 10 seconds and dried by air for 5 seconds.[7]

- Two-step polishing system: Each specimen was finished with the Sof-Lex spiral finishing wheel (beige color), then polished with the Sof-Lex polishing wheel (pink color) with the application of diamond polishing paste.
- Multiple-steps polishing subgroups: Each specimen was finished with Sof-Lex contouring disks of size 13 mm (1/2 inch) to finish the top surface of each specimen starting with coarse then medium disks sequentially then white Ultradent Jiffy HiShine cups for polishing with the application of diamond polishing paste.[18]

Assessment of Surface Roughness

The measurement of Ra was conducted at baseline and after 3 months, utilizing a surface profilometer (The Interference Microscope System), which assessed Raat 10X Mirau objective at three distinct points on each specimen, with the average then calculated.

Assessment of Surface Gloss

Gloss assessments were conducted at baseline and after 3 months, using a small-area gloss meter (Horiba Gloss Checker, IG-331, Japan) with an oval-shaped measuring area of 3 mm × 6 mm for a 60° angle. Three measurements were taken for each specimen at a 60° incidence angle.[19]

Following the evaluations, the specimens were stored in two distinct mediums: artificial saliva and Coca-Cola, each in 20 mL solutions in a graduated plastic container for a duration of three months at room temperature.[5] The liquids were replenished and prepared daily using the same quantity for standardization. After the 3-month storage period, the specimens were removed from their respective mediums, lightly rinsed with distilled water, and gently dried with absorbent paper, for the re-evaluation of Raand gloss retention as per the previous steps.[12]

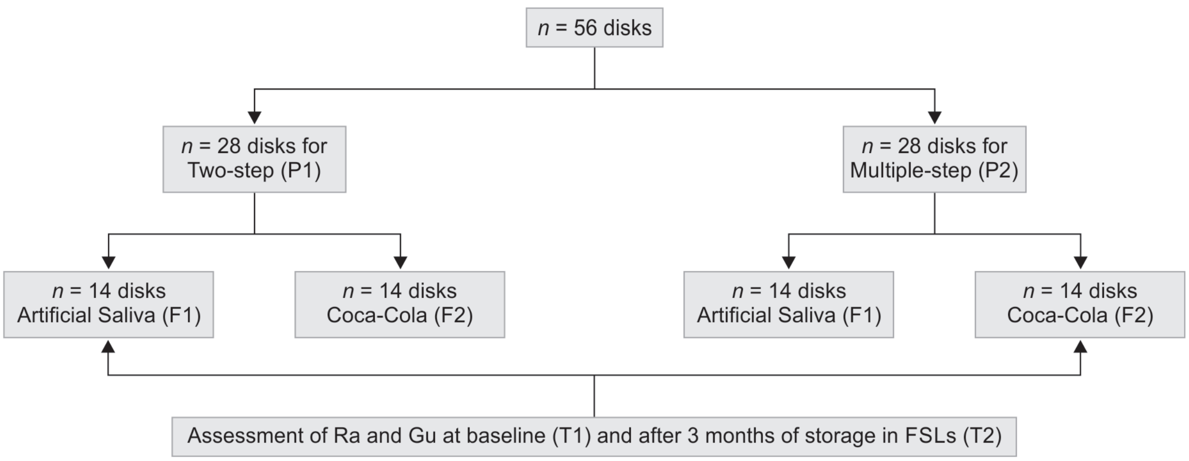
Statistical Analysis

A three-way mixed MANOVA was used to investigate the impact of varying finishing and polishing procedures, food-simulating liquids, and T on Ra and gloss. *Post hoc* Bonferroni multiple-comparison was used for pairwise comparisons, and the significance threshold for all statistical tests was set at $p < 0.05$. All statistical tests were conducted on Windows using the Statistical Program for Social Studies (SPSS) version 25 (IBM SPSS, Chicago, IL, USA).

Table 2: Comparison of surface roughness between two-step and multiple-step systems

	Finishing and polishing systems				
	Two-step system	*Multiple-step system*			
Surface roughness (μm)	*Mean ± SD*	*Mean ± SD*	*MD*	*p-value*	*Sig*
Baseline					
Artificial saliva	0.196 ± 0.015	0.105 ± 0.008	0.091	0.001	S
Coca-Cola	0.190 ± 0.010	0.109 ± 0.011	0.081	0.001	S
After 3 months					
Artificial saliva	0.233 ± 0.006	0.145 ± 0.007	0.088	0.001	S
Coca-Cola	0.244 ± 0.005	0.148 ± 0.007	0.096	0.001	S

Flowchart 1: A flow diagram for the study groups



Results

Regarding Surface Roughness

The intragroup comparison within both groups showed that there was a statistically significant difference with an increase in Ra after 3 months of the two-step system with Coca-Cola compared with that of artificial saliva ($p = 0.001$) while there was no significant difference in Ra after 3 months of the multiple-step system between artificial saliva and Coca-Cola ($p = 0.204$). On the other hand, intergroup comparison showed that, there was a statistically significant difference with an increase in Ra at baseline and after 3 months with artificial saliva and Coca-Cola of the two-step system compared with that of the multiple-step system ($p = 0.001$) as the mean ± SD Ra of the two-step system with Coca-Cola after 3 months showed the highest value of 0.244 ± 0.005 μm and that of the multiple-step system with artificial saliva at baseline showed the lowest value of 0.105 ± 0.008 μm (Table 2, Fig. 1 and Flowchart 1).

Regarding Surface Gloss

The intragroup comparison within both groups showed that there was no significant difference in GU values at the baseline of the two-step system ($p = 0.252$) and the multiple-step system ($p = 0.751$) between artificial saliva and Coca-Cola. After 3 months there was no significant difference in GU values of the two-step system between artificial saliva and Coca-Cola ($p = 0.230$). There was a statistically significant difference with high GU values after 3 months of the multiple-step system of artificial saliva compared with that of Coca-Cola ($p = 0.004$). On the other hand, the intergroup comparison showed that there was a statistically significant difference with high GU values at baseline and after 3 months with artificial saliva and Coca-Cola of the multiple-step system compared with that of the two-step system ($p = 0.001$). as the mean ± SD GU of the multiple-step system with artificial saliva at baseline showed the highest value of 82.929 ± 6.17 and that of the two-step system with artificial saliva after 3 months showed the lowest value of 45.929 ± 6.719 (Table 3 and Fig. 2).

Over a period of 3 months, the multiple-step finishing and polishing system provided better values regarding the surface smoothness and gloss of posterior resin composite restoration than the two-step system ($p = 0.001$). There was no significant main effect of food-simulating liquids on Ra ($p = 0.35$) and GU ($p = 0.78$).

Discussion

This *in-vitro* study used the multiple-step Sof-Lex finishing disks and Jiffy HiShine polishing cup and the two-step Sof-Lex spiral wheels to explore which system achieves lower Ra and higher gloss values of flowable bulk-fill injectable resin composite utilized for posterior teeth restoration, following exposure to food-simulating liquids over three months. The seamless exterior of resin composite restorations contributes to its long-lasting clinical performance and fosters excellent esthetic harmony with the surrounding tooth structure, thereby inhibiting discoloration and staining.[18]

The roughness of the surface (Ra), based on the international standard (ISO 4287:1997, 2015), is one of several various parameters utilized to define a surface's departure from its ideal state due to more delicate flaws that result in the changes of the surface's smoothness which is influenced via the materials or the

Table 3: Comparison of surface gloss between two-step and multiple-step systems

	Finishing and polishing systems				
	Two-step system	*Multiple-step system*			
Surface gloss (GU)	*Mean ± SD*	*Mean ± SD*	*MD*	*p-value*	*Sig*
Baseline					
Artificial saliva	68.286 ± 8.071	82.929 ± 6.17	–14.643	0.001	S
Coca-Cola	71.143 ± 4.074	82.143 ± 7.113	–11	0.001	S
After 3 months					
Artificial saliva	45.929 ± 6.719	66.714 ± 4.480	–20.785	0.001	S
Coca-Cola	48.286 ± 3.173	60.857 ± 5.503	–12.571	0.001	S

MD, mean difference; NS, non-significant; *p*-value, probability value; S, significant; SD, standard deviation

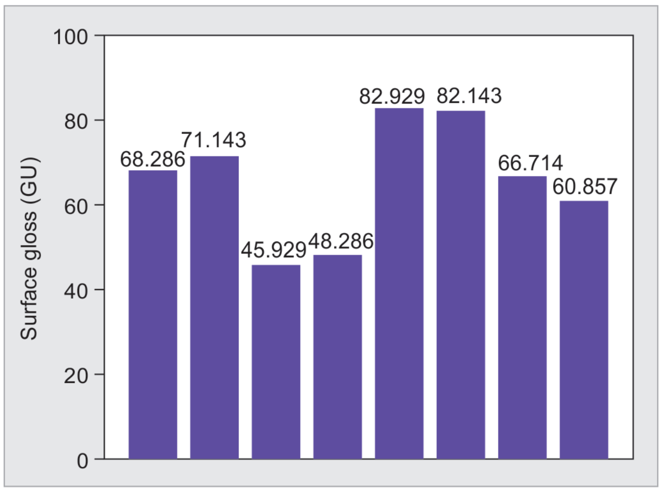


Fig. 2: Mean surface gloss with different interaction

process of manufacturing. Patients can only detect Ra when it surpasses 0.5 µm, which has been determined to be the critical threshold value.[17,20]

Surface shine can be measured using a crucial feature called surface gloss (GU). A small area gloss meter is used to measure GU, and gloss units (GU) are used to express the results.[21] The American Dental Association (ADA) defines an appropriate gloss surface as 40–60 GU (ADA Professional Product Review, 2010), while Cook and Thomas[22] observed acceptable gloss levels ranging from 60 to 80 GU.[2,23,24] A 20° angle provides for more differentiation than a 60° angle because it is close to the average person's observation angle of the surface and also agreed with the guidelines stated in the technical report of (ISO 2813-201428).[25,26]

Finishing and polishing processes are essential steps in restoring the morphological form of the tooth and improving its visual attributes. Finishing involves contouring the restoration to achieve flawless anatomy and creating a smooth surface that may be utilized to remove any substance with a particle size greater than 25 µm. The polishing process lessens the roughness and scratches left over from finishing, gives the restoration an enamel-like luster, and lowers surface energy by removing particles smaller than 25 µm.[27]

To solve concerns like a restricted curing depth in deep cavities, lengthy operations, and other polymerization shrinkage issues, a bulk-fill composite was introduced due to its composition, related to filler size, which allows for a 4 mm thickness increment application in a straightforward process.[10] Surface roughness can be evaluated up to the nanoscale using qualitative methods such as scanning electron microscopes or quantitative methods like a surface profilometer.[9] In this study, the Ra was assessed using a non-contact profilometer.[12]

The Sof-Lex aluminum oxide disks had been used in the current research since the majority of studies have found that the disks with aluminum oxide particles are considered an efficient instrument for achieving a smooth composite surface because they have minimal roughness.[18,28] The benefit of the wheel's design, which enables them to polish all flat and contoured surfaces like the occlusal surface of posterior teeth, was the reasons spiral polishing wheels were chosen for our investigation.[2] At the end of the restorative therapy, some dental polishing techniques use polishing paste containing aluminum dioxide or diamond particles. This was done by using a diamond Ultradent polishing mint paste with polishing cups and wheels. Food and drug administration (FDA, 1976, USA) recommendations were utilized to choose the food-simulating liquids employed for the preservation of the polished resin composite samples. The resin composite samples in this investigation were subjected to storage liquids for three months, which is similar to daily intake for about 3 years, which is an appropriate duration to analyze the chemical breakdown of resin composite restoration that exists in the mouth.[5]

For years, laboratory investigations like the non-contact profilometer were employed in this study to quantify surface roughness. However, this measurement technique has limitations because it can only produce numerical or quantitative values.[12]

The statistical evaluation indicated a significant difference ($p = 0.001$) between the two finishing and polishing methods, with the two-step system displaying the greatest values and the multiple-step system exhibiting the lowest values. This study's findings indicated that the null hypothesis was rejected. The finishing Sof-Lex disks (SX/S/SLex) and ultrafine Jiffy-HiShine polishing cup provided the best smoothness of the examined material in the current study, resulting in Ra values below 0.2 µm.[4]

Results from the present study for both systems showed the roughness data that are clinically viable. However, statistically significant disparities between the materials became apparent. This study is comparable to, which compared several polishing and finishing methods in one group and discovered that the multiple-step method had the lowest Ra values.[13]

The abrasive material used in the Sof-Lex diamond Polishing System has a degree of hardness of 10 Mohs and produces the most textured surface after polishing, whereas aluminum oxide has a hardness of 9 Mohs and may be the ideal hardness for evenly eliminating filler particles and resin matrix from the examined materials. Because diamond particles can inflict greater scratches on a finished composite, the tested material may be more abrasive.[8,29]

The multiple-step system used in this study that included the Sof-Lex finishing disks provided a smoother surface than the two-step system of the examined material, resulting in Ra values below 0.2 µm, confirmed the results of researchers who discovered that the multiple-step "Sof-Lex ST" finishing and polishing system with aluminum oxide decreases Ra more than the two-step diamond-particle finishing and polishing technique.[8,11,18,30] Aluminum oxide disks are effective smoothing tools because they are capable of eliminating the matrix and filler particles from the restoration surface evenly.

The manufacturer of the "Sof-Lex wheels" utilized in this investigation changed them by adding diamond particles to the final polisher instead of aluminum oxide, which would have likely changed how effective this technique was.[8] According to a recent study of, the SW did not considerably improve the surface smoothness of the three bulk filling materials.[31] The enhanced spiral flexibility of the Sof-lex spiral polishing technology may be responsible for its lower roughness levels.

According to the study of two-step polishing and P (diamond-containing) can provide Ra equal to multiple-step systems (aluminum oxide), but our results are in opposition to their findings.[32,33] In order to improve the smoothness of a nanohybrid composite's surface, reduced-step systems can be utilized after a prepolisher and are a viable option to multiple-step systems.

The use of the Ultradent Jiffy HiShine white polishing cup in the current study, a multiple-step system produced a surface with low Ra and high gloss levels. This might be attributable to the polishing paste that allows the used tool to move across the surface promoting even wear of the surface.[14]

The findings of who compared the "SX/S/SLex", Jiffy, and OptraPol polishing techniques, discovered that Jiffy polishing cups and SX/S/SLex were efficient for polishing nano-filling resin materials.[33] In those systems, the Ra values were less than 1 µm, which was regarded as clinically acceptable and those results are agreed with our investigation. However, The Jiffy HiShine Polishing System, which has a diamond particle with a hardness of 10 Mohs, was said to provide the roughest surface after polishing, according to, and those results are contrary to our assertion.[31]

The Ra values of the two-step system with Coca-Cola and artificial saliva were compared, and the results revealed that the degrading impact of the Coca-Cola as a result of its acidic pH levels which encourage matrix breakdown and induce erosion led to a significant increase in Ra on the outer surface of dental restorations after 3 months.[5] The findings are supported by their discovery that all evaluated restorative materials significantly increased their Ra after being stored in liquids that simulated food, and that methyl ethyl ketone had rougher surface values than aqueous ethanol.[34]

In contrast, discovered that the difference in the Ra values of the RCs that were tested after storage in various food-simulating liquids was not significantly different and that the greatest Ra value was found after storage in citric acid.[35]

Surface roughness did not vary statistically significantly between artificial saliva and Coca-Cola after three months. In the multiple-step system groups, despite the latter having higher Ra values, acidic solutions cause the resin matrix covering the resin composite's filler particles to dissolve, resulting in a projecting filler particle. The putative remineralization properties of artificial saliva might similarly affect Ra. These findings are consistent with those of researcher who discovered no statistically significant variations between distilled water, heptane, and ethanol on their impact on Ra changes for multiple-step F/P systems either on nano filler or micro hybrid resin composite due to the tested resin composite materials' polish retention-promoting structure.[19]

A study conducted on three bulk-filling restorations completed with Sof-Lex aluminum oxide disks discovered a significant statistical difference between various solutions "methyl ethyl ketone, ethanol, and artificial saliva" after storage.[36] This study's findings were in contrast to our results because methyl ethyl ketone has a high erosive impact on the material resin matrix in humid conditions, it was this compound that induced the highest surface alterations in bulk filling materials.

In accordance with the investigation's findings, the "Ra" raised significantly of the two-step and multiple-step systems with artificial saliva and Coca-Cola after 3 months compared with that of baseline ($p = 0.001$) as Coca-Cola made the highest value of change in Ra followed by artificial saliva due to the low pH and the amount of immersion T in the used media significantly affect Ra changes.[6] These findings are in line with that of those who discovered that samples submerged in Coca-Cola revealed the degradation of the structure causes a rise in the "Ra" of the resin composite in various substances (such as juice, cola, and artificial saliva) over T.[5]

The GU value of the multiple-step system was higher than that of the two-step system at baseline, according to the statistical analysis of this study. According to, the aluminum flexible disks are considered an effective instrument for producing surface glossiness, while SX/S/SLex with a diamond paste produce optimum outcomes regarding an appropriate gloss value.[17] This is in agreement that of those who demonstrated the highest levels of gloss for the multiple-step approach.[28]

Additionally, other recent trials conducted by demonstrated that "SW" were effective in obtaining better GU values than "SX/S/SLex".[4] The "Sof-Lex Spiral Wheel" can adapt to practically any restoration surface because of its rubbery spiral design. However, because S/S/SLex are less flexible, polishing requires more pressure, which causes abrasive particles to penetrate the material more deeply and results in deeper scratches.[31]

After 3 months of storage, there had been no noticeable change in the GU of the two-step system between artificial saliva and Coca-Cola, but specimens stored in Coca-Cola showed a decrease in GU relative to artificial saliva. Because Coca-Cola contains acid, which affects light incidence and reflection and causes brightness to drop, it softens the organic matrix. These findings concur with that of those claimed that because Coca-Cola has a low buffering capacity compared to the citric acid in coffee and juice, submerged specimens in Coca-Cola and artificial saliva produced slight gloss alterations with no discernible variances.[37] Coca-Cola caused a decrease in gloss values after storage, whereas artificial saliva caused Water diffusion into the matrix causing a less hydrolytic breakdown of the substance, which may result in less GU changes.[38]

The difference in the impact of food-simulating liquids on the "GU" of two-step and multiple-step systems may be attributed to the abrasive particle content of (F/P) systems, the pressure used during finishing/polishing, as well as the shape of the abrasive tools. As a result, the finishing methods modify the "Ra" and "GU" of RCs.[13] The gloss instability of composites following acidic solution soaking might be attributed to the weakening of the organic matrix, which altered both the incidence and reflectivity of light causing a drop in brightness, and had less gloss alteration after immersion in artificial saliva.[39]

Those findings are consistent with the findings of those who conducted chemical challenges using low pH solutions and discovered a significant difference after chemical challenges, and all tested resin composite samples showed a decrease in GU values over time after artificial aging, resulting in surface abrasion of the examined RCs.[38,40]

While those findings contrast with the findings of those who discovered a non-statistically significant difference in the GU of multiple-step and two-step polished systems in both resin composite groups after three months of storage in different food stimulating solutions.[19] This could be due to both "SX/S/SLex" and "Sof-Lex spiral finishing wheel" are composed of aluminum-oxide particles, which may explain their similar gloss values on both tested RCs. Consequently, despite there being no statistically significant difference, the two systems can maintain a high degree of surface smoothness and glossiness.[19]

This study's limitations include the use of only one kind of resin composite and the examination of only two finishing and polishing techniques on a flat surface disk shape. So, future studies are recommended using other types of polishing systems utilizing different kinds of RCs, particularly for posterior restorations, which have a complex occlusal structure under various storage conditions and aging procedures such as thermocycling and toothbrushing.

The quality of resin composite restorations can be significantly improved with the correct use of finishing and polishing systems particularly in complex areas of posterior teeth restorations, leading to higher patient satisfaction and successful dental procedures. Using different systems as a protocol for finishing and polishing can be recommended to achieve an accepted Ra and gloss.

Conclusion

Within the framework of this *in vitro* study, it can be concluded that using the multiple-step finishing and polishing method for posterior resin composite restorations enhances the success of resin composite restorations, and creates a smooth surface comparable to natural enamel in the intricate areas of posterior teeth restorations. Exposing RCs to acidic conditions leads to significant degradation of surface properties.

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