Surface Roughness of Packable Composite Resins Polished with Various Systems

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ABSTRACT

Purpose: The aim of this study was to evaluate the surface roughness of four packable composite resins, SureFil™ (Dentsply, Petrópolis, Rio de Janeiro, Brazil), Prodigy Condensable™ (Kerr Co., Orange, CA, USA), Filtek P60™ (3M do Brasil, São Paulo, Brazil), and ALERT® (Jeneric/Pentron, Inc., Wallingford, CT, USA) and one microhybrid composite resin (Filtek Z250™, 3M do Brasil) after polishing with four finishing systems.

Materials and Methods: Twenty specimens were made of each material (5 mm in diameter and 4 mm high) and were analyzed with a profilometer (Perthometer® S8P, Perthen, Mahr, Germany) to measure the mean surface roughness (Ra). The specimens were then divided into four groups according to the polishing system: group 1—Sof-Lex™ (3M do Brasil), group 2—Enhance™ (Dentsply), group 3—Composite Finishing Kit (KG Sorensen, Barueri, São Paulo, Brazil), and group 4—Jiffy Polisher Cups® (Ultradent Products, Inc., South Jordan, UT, USA). The specimens were polished and then evaluated for Ra, and the data were subjected to analysis of variance, analysis of covariance, and Tukey's test ($p = .05$).

Results: The mean Ra of SureFil polished with Sof-Lex was significantly lower than that of KG points. Prodigy Condensable polished with Enhance showed a significantly less rough surface than when polished with Sof-Lex. Filtek P60 did not exhibit a significant difference with the various polishing systems. For ALERT the lowest mean Ra was obtained with Sof-Lex and the highest mean Ra with KG points. Regarding Filtek Z250, polishing with KG and Jiffy points resulted in a significantly lower mean Ra than when polished with Enhance.

Conclusions: Packable composite resins display variable roughness depending on the polishing system used; the Sof-Lex disks and Jiffy points resulted in the best Ra values for the majority of the materials tested.

CLINICAL SIGNIFICANCE

The Sof-Lex disks and the Jiffy points produced the smoothest surfaces for the tested resin composites. As a result, they should be considered for clinical use as preferred polishing systems for these resin composites.

(*J Esthet Restor Dent* 16:42–48, 2004)

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The introduction of composite resins by Bowen in the 1960s was a landmark event in dentistry, leading to the development of cosmetic dentistry. Since that time these materials have been in continuous evolution, resulting in improvements in their composition.[1] Current composite resins present good mechanical properties such as wear and fracture resistance, making it possible to use them in posterior restorations.[2]

Compared with placing a Class II amalgam restoration, composite techniques are appreciably more demanding technically.[2] Because of manipulation differences, there is greater difficulty in reestablishing the contact and reproducing the proximal contour, as well as defining the restoration occlusal anatomy before light polymerization.[3] In light of these difficulties, researchers and manufacturers are working together to develop an esthetic material with amalgam-like characteristics that can be successfully used on posterior restorations.

Packable composite resins have recently been introduced. These materials generally have high filler loading, presenting a greater viscosity than previous composite resins, which allows matrix distention and is essential to the reestablishment of proximal contact.[4,5] Although the manufacturers have called these materials *condensable*, they should be called *packable* composite resins since there is no volume reduction, which would characterize a condensation, just a better adaptation to the cavity walls.[6] Packable composites have physical and mechanical properties that are similar to those of nonpackable posterior composites[7]; however, according to an article in *The Dental Advisor*,[8] these materials are more difficult to polish than are microhybrid composite resins. According to Cobb and colleagues, the packable resins present an increase in surface roughness when compared with hybrid composite resins.[9]

Finishing and polishing procedures are essential to periodontal integrity, marginal integrity, and wear reduction and contribute to the clinical longevity of restorations.[10,11] Plaque accumulation, surface discoloration, and esthetics are closely related to the surface roughness of both the teeth and the restoration.[12] Surface roughness, on the other hand, is directly related to both the material and polishing system used.

The aim of this study was to evaluate the surface roughness of four packable composite and one microhybrid composite resin after being finished with four different polishing systems.

MATERIALS AND METHODS

The composite resins and polishing systems used in this study are shown in Tables 1 and 2, respectively.

A polytef mold was used to prepare 20 cylindric specimens, each 5 mm in diameter and 4 mm in height, of each material. The resins were compacted inside the matrix with an amalgam condenser, covered on each side with a polyester strip (Odahcam, São Paulo, Brazil), and pressed between two glass plates. The specimens were light cured for 40 seconds against the polyester strip and glass plates and for another 40 seconds without the glass plates. All specimens were light cured with the same unit (Optilight 600®, Gnatus LTDA, Ribeirão Preto, São Paulo, Brazil). The specimens were stored in a saline solution at 37°C ± 5°C for 24 hours and then analyzed with a profilometer to measure the mean surface roughness (Ra). Five measurements were made for each specimen at different locations and then averaged.

After the initial Ra measurement, the specimens were stored again in saline solution at 37°C for 1 week[11,13]; then they were divided into four groups of each composite resin per group (one for each polishing system used; see Table 2), with five specimens of each composite resin per group (one for each type of composite resin; see Table 1). The polishing procedures were performed by a single operator to prevent operator variability. The points or disks were applied intermittently for 15 seconds each at a low speed.

The specimens were analyzed again with a profilometer to obtain the Ra after the polishing procedures. Data were subjected to a statistical analysis of variance (ANOVA),

TABLE 1. COMPOSITE RESINS USED IN THIS STUDY.

Composite Resin	Manufacturer	Average Size of Particles (μm)	Batch No.
SureFil™	Dentsply, Petrópolis, Rio de Janeiro, Brazil	0.8	990820
Prodigy Condensable™	Kerr Co., Orange, CA, USA	0.6	906443
Filtek P60™	3M do Brasil, São Paulo, Brazil	0.6	9AT
ALERT®	Jeneric/Pentron, Wallingford, CT, USA	0.7	MS10246930019
Filtek Z250™	3M do Brasil	0.6	9CT

analysis of covariance (ANCOVA), and Tukey's test ($p = .05$).

RESULTS

Data for Ra and SD for the three materials analyzed before and after polishing are shown in Table 3.

The data obtained before polishing were submitted to a two-way ANOVA ($p = .05$) and showed that the ALERT resin presented a significantly higher mean Ra than did the other resins. The data obtained after polishing were subjected to a two-way ANOVA ($p = .05$) and showed significant differences for the three materials analyzed, that is, material, polishing, and interaction material times polishing. The values obtained after polishing were used as dependent variables. A two-way ANCOVA test was applied ($p = .05$), and it also showed significant differences for the three factors analyzed when the variable *before* was analyzed as a covariance value.

To locate these differences, the Tukey post hoc test ($p = .05$) was computed and significant differences were observed for some experimental conditions. When the factors *material* and *polishing* were observed separately, ALERT presented a mean Ra significantly higher than did the other resins; Sof-Lex disks and Jiffy points provided a smoother surface than did abrasive and Enhance points. The interaction material versus polishing, however, must also be evaluated because of its individual variation between the factors.

The results of the Tukey test for the interaction material versus polishing are presented in Table 3. It was observed that the SureFil resin polished with the abrasive silicone points presented average Ra values that were significantly higher than did the Sof-Lex disks. The Prodigy Condensable specimens polished with Sof-Lex disks resulted in a significantly rougher surface than with the Enhance points. No statistically significant difference was found for the Filtek P60 resin for the four polishing conditions. The ALERT

TABLE 2. POLISHING SYSTEMS WITH SEQUENCE STEPS AND MANUFACTURERS.

Polishing System	Description/Procedure Systems	Manufacturer
Sof-Lex™	Aluminum oxide medium disk (40 μm), aluminum oxide fine disk (24 μm), aluminum oxide superfine disk (8 μm)	3M do Brasil, São Paulo, Brazil
Enhance™	Abrasive rubber cups (40 μm)	Dentsply, Petrópolis, Rio de Janeiro, Brazil
Composite Finishing Kit ("abrasive")	Green abrasive rubber cups,* gray abrasive rubber cups*	KG Sorensen, Barueri, São Paulo, Brazil
Jiffy Polisher Cups	Green abrasive rubber cups (2 μm), yellow abrasive rubber cups (1.5 μm), white abrasive rubber cups (1 μm)	Ultradent Products, Inc., South Jordan, UT, USA

*Abrasive particle size was not stated by the manufacturer.

TABLE 3. AVERAGE MEAN SURFACE ROUGHNESS AND SD FOR ANALYZED COMPOSITE RESINS.

Composite Resin	Time of Measurement*	Mean Surface Roughness in µm (SD)†			
		Sof-Lex	Enhance	Composite Kit	Jiffy Points
SureFil	Before	0.10 (0.03)	0.10 (0.03)	0.10 (0.03)	0.10 (0.03)
	After	0.63 (0.24)[a]	0.83 (0.29)[ab]	1.26 (0.21)[b]	0.85 (0.17)[ab]
Prodigy Condensable	Before	0.11 (0.03)	0.11 (0.02)	0.11 (0.02)	0.11 (0.03)
	After	1.14 (0.43)[b]	0.55 (0.12)[a]	0.60 (0.09)[ab]	0.73 (0.43)[ab]
Filtek P60	Before	0.12 (0.03)	0.12 (0.04)	0.12 (0.04)	0.12 (0.04)
	After	0.96 (0.23)[a]	0.75 (0.15)[a]	0.71 (0.19)[a]	0.63 (0.15)[a]
ALERT	Before	0.15 (0.03)	0.15 (0.02)	0.15 (0.02)	0.15 (0.03)
	After	0.41 (0.18)[a]	1.39 (0.15)[c]	2.02 (0.35)[c]	1.00 (0.26)[b]
Filtek Z250	Before	0.12 (0.01)	0.12 (0.01)	0.12 (0.01)	0.12 (0.01)
	After	0.78 (0.15)[ab]	1.31 (0.16)[b]	0.60 (0.07)[a]	0.62 (0.20)[a]

*Relative to polishing.
†The same lowercase letters in the same line were not significantly different at $p = .05$
There was a significant difference between the Sof-Lex group and the Enhance and Abrasive points groups, with the Jiffy points group in an intermediary position.

specimens polished with the abrasive points presented an average Ra that was significantly higher than for the specimens polished with Enhance or Jiffy points, which, in turn, resulted in a significantly rougher surface than did the specimens polished with Sof-Lex. Filtek Z250 specimens polished with Enhance points resulted in an average Ra that was significantly higher than with the abrasive or Jiffy points.

DISCUSSION

Packable composite resin has been subjected to a number of studies aimed at evaluating their laboratory and clinical applications because they are recent materials in dentistry. One of the difficulties presented by these materials is the quality of the polished surface, which is questionable, according to an article published in *The Dental Advisor* in 1999.[8] Polishing is considered important to the clinical performance of a restoration since it betters periodontal integrity, marginal integrity, and occlusal wear reduction.[10,11]

In our study we measured the surface roughness of all specimens prior to the polishing to homogenize the samples, as detailed by Roeder and colleagues.[14] It was observed that the average surface roughness of the light-cured specimens against the polyester matrix was lower than after polishing for the five materials analyzed. These results can also be observed in the studies of Roeder and colleagues, Hoelscher and colleagues, and Stanford and colleagues.[14–16] Mean Ra values after light curing against the matrix for SureFil, Prodigy Condensable, Filtek P60, and ALERT were 0.10, 0.11, 0.12, and 0.15 µm, respectively.

The values presented in *The Dental Advisor* article were 0.14, 0.12, 0.11, and 0.24 µm for the same packable resins, respectively.[8] The comparison of Ra values after light curing against a polyester band showed that only the ALERT packable resin presented a significantly rougher surface than did the 3M Filtek Z250 microhybrid resin.

Although surfaces light cured against a matrix band are generally smoother, in most cases finishing of the restoration is necessary to remove excess material and to recontour; this reduces the surface smoothness and necessitates restoration polishing.[11] Moreover, the polymerized surface against the matrix band is rich in resin matrix and is less resistant to abrasion and can contain bubbles.[17]

Comparing Ra values obtained with the different polishing systems, it can be observed that each material presented a different behavior pattern. For SureFil the smoother surface was obtained with Sof-Lex disks and the roughest with the abrasive points. For Prodigy Condensable the polishing with Enhance points resulted in a significantly smoother surface than did polishing with Sof-Lex disks. For Filtek P60 there was no difference among the different polishing conditions. For ALERT a significantly smoother surface was obtained from polishing with Sof-Lex, and a rougher surface resulted after polishing with the abrasive points. For Filtek Z250 polishing with the abrasive and Jiffy points resulted in a smoother surface when compared with the results with Enhance points.

These differences in results can be explained by the properties of the composite resin, namely, the filler type and size, amount of filler, and type of resin. The final surface obtained by polishing also depends on the flexibility of the backing materials in which the abrasive is embedded, the hardness of the abrasive, the geometry of the instruments, and the instruments employed.[18–20]

ALERT presented, in general, the greater Ra values, which could be explained by the size of the filler particles, ranging from 1.0 to 110 μm.[21] These results were also found in an earlier study comparing the polishing of various packable composites.[14] Nevertheless, Sof-Lex produced the smoothest composite surface with ALERT, suggesting its ability to cut the composite filler particle and matrix equally.[20]

Overall, the surface roughness was satisfying for all of the evaluated systems, except for the ALERT–abrasive points association (Ra = 2.02 μm), because, according to Weitman and Eames and Shintani and colleagues, there was no appreciable difference in plaque accumulation between surfaces polished by different methods that resulted in Ra values within a 0.7 to 1.4 μm range.[22,23] In addition, Kaplan and colleagues stated that Ra values < 10 μm are clinically undetectable.[24]

Generally, it was observed that the resins evaluated presented variable surface roughness depending on the polishing system used, except for the Filtek P60, which presented similar results regardless of the polishing system. Therefore, it is concluded that the polishing quality of the packable resin analyzed is variable and that, depending on the polishing system used, the surface can be rougher, similar, or less rough than that of Filtek Z250 microhybrid resin.

As some authors have shown in their research on other packable, hybrid, and microfilled resin composites, the Sof-Lex disks produce the best results.[14,17,25] In this study the Sof-Lex disks were able to polish four of the five composites tested to their smoothest level and are accepted clinically as the preferred polishing system. Nevertheless, owing to Sof-Lex geometric design limitation, one could also recommend the Jiffy points, which were also able to polish the majority of the composites tested to their smoothest level, since points may be used clinically in areas that are not readily accessible to disks. Furthermore, the packable resins are used in posterior restorations, where access and anatomic shape are generally more difficult and detailed. Therefore, the point shape is another factor that can contribute to the polishing quality. It is recommended that the manufacturers of these polishing systems create different shaped polishers to allow a greater variety of choices for each case.

CONCLUSIONS

According to the methodology used, the following can be concluded:

- The greatest Ra value was found with the ALERT–abrasive points association, and the smoothest surface was obtained with ALERT and Sof-Lex.

- The Sof-Lex disks and the Jiffy points were able to produce the smoothest surfaces for the majority of the composites evaluated.

DISCLOSURE AND ACKNOWLEDGMENTS

The authors thank Álvaro José Damião, Marcos Wander Ribeiro, and Luiz Carlos Magalhães Lavras from IEAv–CTA, São José dos Campos in São Paulo, for their assistance with sample measurement; Ivan Balducci for the statistical work; and the above-mentioned manufacturers for supplying the materials.

The authors have no financial interest in the companies whose products are mentioned in this article.

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