10.5005/jp-journals-10051-0057

ORIGINAL ARTICLE

Profilometric Analysis of Nanohybrid Composite Surface Polished with Three Polishing Systems: An *in vitro* Study

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ABSTRACT

Aim: The aim of the article is to evaluate the effect of three polishing protocols on the surface roughness of direct esthetic restorative material.

Materials and methods: Specimens (n = 32) measuring 10 × 2 mm were fabricated in an acrylic mold using light-cured resin-based material (nanohybrid composite – Filtex Z 250XT). After photopolymerization, all specimens were finished and polished with one of three polishing protocols (Sof-Lex, Super Snap, and Sof-Lex Spiral polishing systems). The average surface roughness of each treated specimen was determined using three-dimensional (3D) optical profilometer.

Results: The data were analyzed using one-way analysis of variance (ANOVA) with *post hoc* analysis applied to check honestly significant difference (HSD) among various groups. Significant difference ($p < 0.05$) in surface roughness was observed.

Conclusion: Polishing systems can be used to produce a smooth surface on esthetic restorative materials. Sof-Lex Spiral polishing system gave the least surface roughness (Ra) value as compared with other polishing systems used in this study.

Keywords: Enhance polishing system, Finishing and polishing systems, Three-dimensional optical profilometer.

How to cite this article: Uppal M, Arora G, Kataria P. Profilometric Analysis of Nanohybrid Composite Surface Polished with Three Polishing Systems: An *in vitro* Study. Int J Oral Care Res 2016;4(4):255-258.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

The ongoing search for biologically and esthetically acceptable adhesive restorative materials has brought varieties of tooth-colored materials to the market. The longevity and esthetic appearance of these tooth-colored restoratives, particularly of the composite, is strongly influenced by the final surface polish.[1] A highly polished and smooth surface slows the rate of plaque and calculus build-up and reduces superficial discoloration.[2] It has been reported that plaque accumulates on composite samples with a surface roughness of 0.7 to 1.44 mm.[3]

The smoothest surface can be obtained after simply polymerizing the composite resin against a clear matrix during curing. In matrix finish, the surface layer of restoration is found to be rich in resin organic binder. Removal of the outermost surface layer by a finishing procedure would tend to produce a harder, more wear-resistant, and, hence, a more esthetically stable surface.[4]

Roughness can be measured in a number of ways, but the most commonly used one both in dentistry and engineering is the surface roughness (Ra) value. Mechanical profilometer, scanning electron microscopy, optical three-dimensional (3D) profilometer, etc., are some of the methods used for measuring the Ra value.[5]

Different finishing and polishing systems are available in today's market. There is no general agreement in the dental literature on the best method for finishing and polishing of composite restorative materials. New products are steadily entering the market, making a continuous appraisal of their effect necessary. Hence, the present *in vitro* study was undertaken to evaluate the effect of three polishing systems on the surface finish of a nanohybrid composite resin.

MATERIALS AND METHODS

Preparation of Samples

A total of 32 samples were prepared in nanohybrid composite resin – Filtex Z 250XT (Fig. 1). The samples were made by placing the composite resin material into a circular acrylic mold of 10 × 2 m. The molds were slightly overfilled with the material, covered on each side with matrix strip (unident), and placed between two glass slides. Each side of the two-sided sample was irradiated with a halogen light-curing unit for 30 seconds. After the initial two-way light-curing steps, the samples were irradiated for an additional 60 seconds from both sides without the matrices in place. Then, the samples were removed from the mold (Fig. 2).

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Fig. 1: Filtex Z250 XT

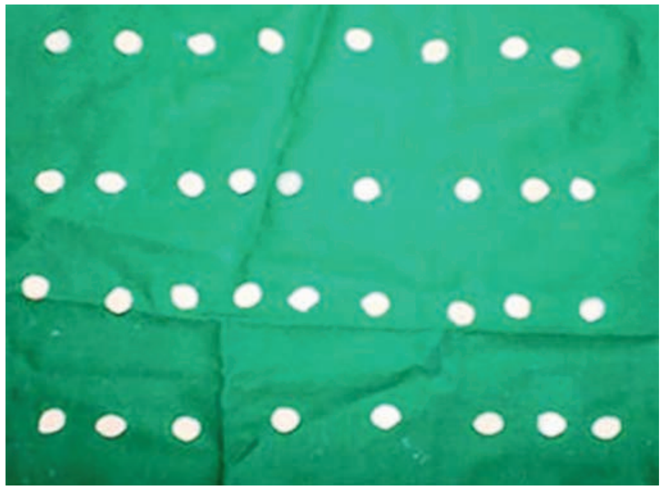


Fig. 2: Composite resin sample from circular acrylic mold

Grouping of Samples

Specimens were randomly divided into four groups: Group I – mylar strip, group II – Sof-Lex polishing system, group III – Super Snap polishing system, and group IV – Sof-Lex Spiral polishing system, and each of these groups had eight samples each.

Finishing of Samples

The samples in both groups, except subgroup A (baseline), were finished using 30 fluted tungsten carbide bur (S S White) for 3 seconds. The finishing procedure was carried out in one direction by one operator. Care was taken to maintain parallelism during preparation of samples.

Polishing of Samples

The four groups were polished according to their respective manufacturer's directions as follows:

- *Group I or Control group:* No further treatment was carried out after polymerization against the matrix strip (Fig. 3).
- *Group II:* Polishing was carried out using Sof-Lex polishing system (Fig. 4).
- *Group III:* Polishing was carried out using the Super Snap polishing system (Fig. 5).
- *Group IV:* Polishing was carried out using Sof-Lex Spiral polishing system (Fig. 6).

The samples were rinsed in tap water and stored at 100% relative humidity at 37°C in a climate control chamber. Surface roughness of each sample in all the four groups was measured using a 3D optical profilometer (Figs 7 and 8).

RESULTS

The mean values were compared by one-way analysis of variance (ANOVA). *Post-hoc* analysis was used to identify significant differences among the groups. In the present study, $p < 0.05$ was considered as the level of significance. Statistical analysis revealed significant difference between various polishing systems ($p < 0.05$). Comparing mean surface roughness of all the groups, surface roughness was in the following order: Mylar strip < Sof-Lex Spiral

Fig. 3: No further treatment after polymerization against the matrixStrip (Group I)

Fig. 4: Polishing using Soflex polishing system (Group II)

Fig. 5: Polishing using Super Snap polishing system (Group III)

Fig. 6: Polishing using Sof-Lex Spiral polishing system (Group IV)

Fig. 7: Three-dimensional optical profilometer

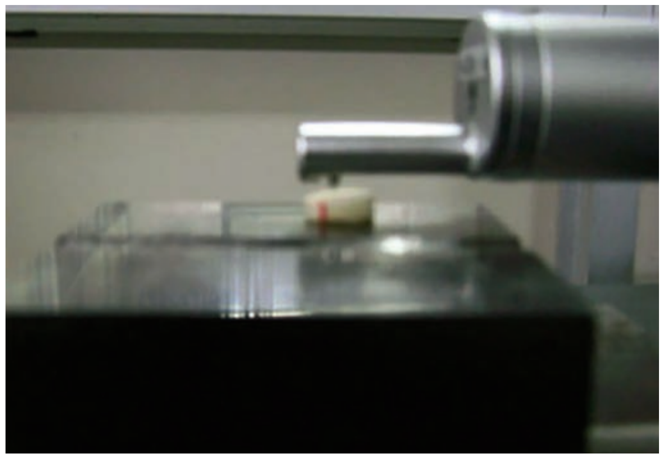


Fig. 8: Measuring of surface roughness of each sample using 3D optical profilometer

polishing system < Super Snap polishing system < Sof-Lex polishing system.

DISCUSSION

A highly smooth and polished surface finish is said to contribute to patient comfort, enhances the appearance of restorations, slows the rate of plaque retention, and reduces superficial surface discoloration.[2-11] Finishing refers to the gross contouring or reduction of the restoration to obtain the desired anatomy. Polishing refers to the reduction of the roughness and scratches created by the finishing instruments.[7-13]

In order to combine the desirable properties of polishability and strength and to be used as an anterior and posterior restoration, nanohybrid came into existence. Various studies have compared different composite resins of different manufacturers with different polishing systems in order to obtain surface roughness.[8-12] Nanohybrid composites provide excellent mechanical properties. Various finishing and polishing devices are available including silicon carbide-coated or aluminum oxide-coated abrasive disks and wheels, multifluted carbide finishing burs, fine diamond finishing burs, impregnated rubber or silicon disks and wheel, polishing pastes and abrasive embedded in resin polishing points, etc., that are commonly used to finish dental restoratives.[14]

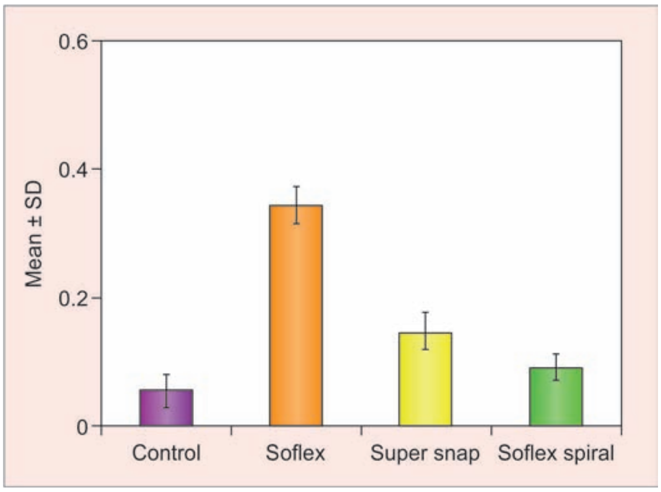
In this study, every effort was made to standardize the different aspects of the methodology. To avoid any procedural error, the study was carried out by a single operator.

The smoothest surface was produced when the material was allowed to cure against the cellophane matrix strip, due to the resin-rich layer on the top (Table 1, Graph 1).[15]

Table 1: Mean Ra values (µm) and Standard Deviation for the restorative material and various polishing systems evaluated

Groups	*n*	*Mean*	*SD*	*f-value*	*Sig.*
Control	8	0.05	0.02	187.9	0.001
Sof-Lex	8	0.34	0.01		
Super Snap	8	0.14	0.02		
Sof-Lex Spiral	8	0.09	0.11		

Highly significant at $p < 0.01$



Graph 1: Mean Ra values (µm) and Standard Deviation for the restorative material and various polishing systems

Among the experimental groups, the smoothest surface after finishing and polishing was obtained with Sof-Lex Spiral (Ra = 0.09) (Table 1, Graph 1); this may be due to geometry that conforms to the polishing surface, a variety of grit diameter, and radial bristle design. In addition, the application time with Sof-Lex spiral (two-step polishing system) is advantageous over other polishing systems used in the study.

Further series of studies have to be carried out utilizing different composite materials and polishing systems until we are able to pair a specific composite resin material with a matching polishing system in order to produce the smoothest surface, thereby reproducing a surface similar to a matrix strip that is considered a gold standard as far as the smoothest polish is concerned.

CONCLUSION

- Sof-Lex Spiral polishing system gave the least Ra value as compared with other polishing system used in this study.
- Three-dimensional profilometer has provided a very reliable quantitative measurement.

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