An in-vitro evaluation of effect of three finishing and polishing systems on the surface of nanofilled composite resin

Sarita Singh[1,*], Jyoti Mandlik[2], Kalpana Kanyal[3], Abhijit Jadhav[4], Aishwarya Handa[5]

[1,2]Associate Professor, [3,4]Assistant Professor, Dept. of Conservative Dentistry &Endodontics, BharatiVidyapeeth Deemed University Dental College & Hospital, Pune, Maharashtra

***Corresponding Author:**
Email: drsaritavsingh@gmail.com

Abstract

Background: The aims of this study were to evaluate the effectiveness of three finishing and polishing systems on the surface of nanofilled composite, and to evaluate the effect of the surface sealant application (prime & bond) on the surface roughness after finishing and polishing procedures of tested composite.

Material and Method: A total of 30 composite discs of dimension 6 x 3 mm (6mm in diameter x 3mm in thickness) were made using a custom made stainless steel mould and then randomly divided into 3 subgroups for finishing and polishing by three different methods; Sof-Lex, Shofu and Mylar strip. The average surface roughness (Ra, µm) of all specimens was measured with aprofilometer. A surface sealant was then applied to all the treated specimens, according to manufacturer's instructions and the average roughness was measured again.

Result: Statistically significant difference was observed in surface roughness values before and after sealant application when finished and polished with shofu system. The lowest roughness values, before and after sealant application, was obtained when cured under a Mylar strip and the highest values were obtained when treated with Shofu.

Conclusion: The Mylar strips gave lowest Ra values followed by Sof-Lex followed by Shofu and the surface sealant improved the surface texture of tested specimens drastically.

Keywords: Nanofilled composite; Mylar strips; Sof-Lex and Shofu finishing and polishing system.

Introduction

Introduction of composite restorative materials in the 1960s marked the beginning of modern cosmetic dentistry by combining the principles of esthetics and tooth conservation. Smooth, highly polished restorations are more esthetically appealing and less susceptible to plaque accumulation and extrinsic discoloration and they also exhibit improved mechanical properties.[1]

Early studies have shown that the smoothest surface of a resin restoration is attained when the resin is polymerized against an appropriate matrix strip. When a matrix is not used, polymerization of outer layer is inhibited, resulting in a surface layer rich in organic binder with stick and soft consistency. In either case, removal of that outermost resin by trimming and finishing procedures would lead to producing a harder, more wear resistant, and, hence, a more aesthetically stable surface.[2]

The primary goal of finishing is to obtain a restoration with good contour, occlusion, healthy embrasure forms and a smooth surface. Tight margins of the restorations should blend aesthetically into the tooth's natural contours.[2]

The resin matrix and the filler particles of composite resins do not abrade to the same degree due to different hardnesses. For instance, craters are often formed around hard quartz particles of conventional composite resins after polishing. As consequence, irregularities appear on the surface of the restorations. The filler content of the composite resin also affects roughness, as microfilled composite resins show smoother surfaces than hybrid composite resins. Similarly, the resin matrix composition may also play a role in the final smoothness of the restoration.[3]The finishing and polishing procedure involves some fundamental principles that allow us to better understand its application in dentistry.[4]

A variety of instruments are commonly used for finishing and polishing tooth-colored restorative materials including; carbide and diamond finishing burs, abrasive impregnated rigid points, impregnated rubber cups and points, aluminium oxide coated abrasive discs, abrasive strips, and polishing pastes.[5] Each of these instruments or devices remove the oxygen inhibited layer of resin but leave the surface of restorative materials with varying degrees of surface roughness. Thus it is important to understand which type of surface-finishing treatments would significantly affect the surface irregularities of different composite resin restorations.

The present study evaluated the effect of various finishing and polishing procedures on the surface roughness of nanofilled composite and the effectiveness of surface sealant application after finishing and polishing procedure of tested composite.

Material and Method

The resin composites used in this study were Z-350(nanofilled) of shade A3, as listed in **Table 1**. Thirty Cylindrical blocks of light-cured resin composite, 6mm in diameter and 3mm in depth, were prepared in a stainless steel mould. The stainless steel mould was placed on a glass slab and the composite was inserted in each cavity in a single increment using a resin packing plastic instrument. Flash was removed and material was finished flush with the top of the mold surface. A Mylar Strip & glass slide was placed on the mould and the specimen discs were light cured from both the sides for 40seconds as instructed using a Quartz-Tungsten-Halogen (QTH) unit. The tip of the curing light was placed on the glass slide perpendicular to the specimen surface to standardize the distance between the light source and the specimen. All specimens were stored in distilled water at 37^0C for 24 hours in an incubator (Incubator (DBK BOD, Model - DTC 96, Innovative Bacteriological Incubator). The 30 samples of composite resin were then randomly divided into 3 subgroups, as listed in **Table 2**. A Mylar Strip group of 10 specimens of both the materials received no polishing treatment after being cured. The remaining 20 specimens were surfaced with a Diamond finishing bur in a rotary motion, for 15 seconds with water coolant, to simulate initial finishing of the restorative material.

The three finishing and polishing system used in this study were Shofu finishing and polishing kit, Sof-Lex composite finishing and polishing kit (3M), Mylar Strips (Unident). **Table 3** shows the complete description of these systems. 10 samples of each of the two composite resins were finished and polished with the **Sof-Lex system** and **Shofu polishing system** as specified by the manufacturer. To measure the surface roughness of the specimens a profilometer was used. Three measurements in different directions were recorded for the ten specimens in each group, the mean Ra value was determined for each specimen, and mean Ra for each group then was determined. Then surface sealant (prime & bond) was applied to all treated specimens and the average roughness **(Ra)** was measured. The results were analyzed statistically by ANOVA F, paired and unpaired 't' test.

Table 1: Description of Restorative Materials used in the study

Material	Category	Composition	Manufacturer
Z 350	Nanofilled composite	Bis-GMA, UDMA, TEGDMA, Bis-EMA RESINS The fillers are a combination of aggregated Zirconia/silica cluster filler with an average cluster particle size of 0.6-1.4 microns with primary particle size of 5-20 nm and non-agglomerated/non-aggregated 20nm silica filler.	3M ESPE
Sealant		Di-and trimethacrylate resins functionalized amorphous silica, PENTA (dipentaerythritolpenta acrylate monophosphate), Photoinitiators, Stabilisers, Cetylaminehydrofluoride, Acetone	Prime & Bond (Denstply)

Table 2: Description of groups

Groups (n=10 for each group)	Composite	Finishing and polishing system
1-A	Z-350	Shofu
1-B	Z-350	Sof-Lex
1-C	Z-350	Mylar Strip

Table 3: Description of finishing/ polishing systems

System	Description	Manufacturer
Shofu finishing and polishing kit	2 Dura-Green and 2 Dura-White stones for finishing. 6 Composite for prepolishing and polishing. 2 Composite fine (white band) polishers for superpolishing	Shofu Dental Corporation
Sof-Lex finishing and polishing kit	Coarse disc aluminium oxide (50µ) Medium disc aluminium oxide (40µ) fine disc aluminium oxide (24µ) Extra fine disc aluminium oxide (8µ)	3M ESPE
Mylar strip		UNIDENT

Result

The surface roughness values of the tested composite finished and polished with three different systems before and after sealant application have been mentioned in Table 4. Statistically significant difference was observed in surface roughness values before and after sealant application when finished and polished with Shofu system. The lowest roughness values, before and after sealant application, was obtained when cured under a Mylar strip and the highest values were obtained when treated with Shofu.

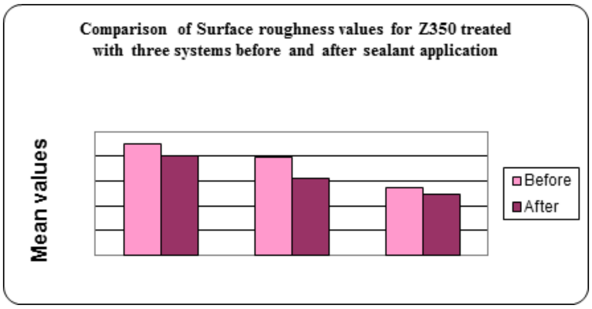
Table 4: Comparison of Surface roughness between different groups using Z-350 (before sealant application)

Z-350 Before	N	Mean	Std. Deviation	ANOVA F	P
Shofu	10	.8985	.15621	3.63	0.04 Sig
Soflex	10	.7960	.42589		
Mylar strip	10	.5510	.23965		

Table 5: Comparison of Surface roughness between different groups using Z-350 (after sealant application)

Z-350 After	N	Mean	Std. Deviation	ANOVA F	P
Shofu	10	.8000	.21546	6.40	0.005 Sig
Sof-Lex	10	.6210	.19564		
Mylar strip	10	.4890	.17195		

Table 4 and 5 shows the statistical analysis done with ANOVA F, comparing Ra values with different finishing and polishing systems for Z350. The difference is statistically significant before (p value 0.04) and even after (p value 0.005) sealant application.



Discussion

Many significant advances have been made since then with regards to improving the properties of earlier resin based restorative materials. These resin materials have progressed from macrofills to microfills and from hybrid to microhybrids, and new materials such as packable and nanofilled composites have been introduced to the dental market. Each type of composite resin has certain advantages and limitations.[6]

Nanofilled composite have been produced with nanofilled technology and formulated with nanomerand nanocluster filler particles. This combination reduces the interstitial spacing of filler particles and, therefore, provides increased filler loading, better physical properties and superior polish and gloss retention.[2]

The mechanism in mechanical finishing and polishing using abrasive particles are part of triobiology, the discipline associated with material science, physics, chemistry and surface engineering. Finishing in dentistry refers to the steps of gross contouring of the restoration to obtain desired anatomy while polishing refers to the reduction and smoothening of the surface roughness and scratches created by the finishing instruments in the process of gross reduction and initial polishing.[4]

Dentists have always been encouraged to take time and effort to adequately finish and polish restorations. The clinical and scientific reasons for careful finishing and polishing have been to remove excess flash and refine the margins of the restoration, to reduce the risk of fracture, since a rough surface may be more likely to fracture, to reduce surface imperfections, hence reducing surface area and thus reducing the risk of surface breakdown and corrosion. The other reasons are to produce a smooth surface less likely to retain plaque, to improve oral function of mastication since food slides more easily over polished tooth surfaces, to produce smooth surfaces that facilitate oral hygiene procedures with access to all surfaces, marginal areas and interproximal areas through normal tooth brushing and use of dental floss, to produce smooth restoration contacts leading to less wear on opposing and adjacent teeth and to produce a more aesthetic restoration for the patient.[4]

It has been reported that the colour measuring geometry influenced the colour measurement of composite resins with different surface roughness. If the surface configuration has a matte finish there would be an excessive amount of light reflected at the surface level and a reduction of light transmission through the material. Surface texture controls the degree or scattering or the reflection of the light striking on the natural tooth or restorative material. For this reason clinicians experience problems in establishing harmony of the shade, obtained with the original shade that was selected using a shade guide especially after finishing and polishing procedures.[3]

All abrasive finishing and polishing devices fall into one of three categories as coated abrasive, bonded abrasive or loose abrasives. A fourth classification includes cutting instruments such as fluted or multifluted tungsten carbide finishing burs. Coated abrasive are finishing devices usually in the form of a paper, Mylar strip or some other polymeric backing, wherein the abrasive particles are distributed on the surface of backing or some other symmetric matrix design. Aluminum oxide constitutes the most commonly used abrasives compound on coated abrasives discs with silicon carbide. Bonded abrasives are devices in which the abrasive particles or media are uniformly dispersed throughout the device matrix. The device is usually an elastomeric material such as rubber or silicone compound but can also be rigid or non-elastic in nature. The last groups classified under abrasive devices are loose abrasives. With respect to use in dentistry loose abrasive polishing pastes contain a fine particle size distribution of either aluminium oxide or diamond particles dispersed in a water soluble vehicle such as glycerine.[4]

Various motions may be critical to the development of optimal surface smoothness. A rotary motion, a planar motion and a reciprocating motion can be employed to polish the surface of resin based material. In rotary motion the axis of rotation is parallel to the surface being smoothened. The planar motion is a rotational movement with the axis of the rotation of the abrasive device perpendicular to the surface being smoothened. Reciprocating motion is employed when a finishing strip is pulled back and forth over a surface.

The results obtained by Fruit and others (1996) comparing different polishing motions showed that for all possible combination of the materials and abrasive grits, the planar motion achieved the lowest average roughness values.[7] In our study, the specimens polished with planar motion (Sof-Lex disks) gave lower surface roughness values than the specimens polished with rotary motion (Shofu).

Several studies stated that the large particles embedded in Sof-Lex disks tend to rip through the surface of resin composite and, when used with certain hybrid composites, tend to cut and abrade filler particles and resin matrix equally, resulting in a smooth surface.[7] For a composite finishing system to be effective the cutting particles (abrasive) must be relatively harder than the filler materials, otherwise the polishing agent will only remove a soft resin matrix and leave the filler particles protruding from the surface. The hardness of aluminium oxide is significantly higher than silicon dioxide, and generally, higher than most filler materials used in composite formulations.[5] The trend of Sof-Lex discs is to provide a slightly smoother surface with the aluminium oxide abrasive on rigid matrix as this has the ability to flatten the filler particles and abrade the softer resin matrix at an equal rate.

In the literature, the most common methods used to assess the effectiveness of finishing and polishing instruments include: Visual evaluation, Scanning electron microscopy and Profilometric analysis. We used Profilometric analysis to evaluate the surface finish of different composites with different polishing systems. There are two advantages with the mechanical profilometer method used in our study. First the profilometer gives a quantitative aspect through the calculation of (Ra) which cannot be obtained with SEM, and secondly, it enables the sample surface to be studied more precisely, as the stylus sweeps the sample surface detecting tiny variation.[3]

In this and other studies Mylar strips formed the smoothest surface in all the composite groups tested. The surface obtained with a Mylar strip is perfectly smooth and it is rich in resin organic binder. Therefore removal of outermost resin by finishing-polishing procedures would tend to produce a harder more wear resistant layer hence an aesthetically stable surface.[4] Despite careful placement of matrices, removal of excess material and recontouring of restorations is often clinically necessary. This requires some degree of finishing and polishing that will violate the smoothness obtained with a matrix.[1-5,8]

However even after accomplishing appropriate finishing and polishing technique the surface of all resin composites exhibit micro irregularities that inherently lead to material wear, deterioration and marginal infiltration resulting mainly from the abrasive processes to which the restoration is subjected in the oral environment. In an attempt to overcome this problem, using a thin layer of low viscosity resin over polymerized composite restoration has been investigated. This approach is assumed to provide a more uniform, regular surface, thereby, enhancing surface smoothness.

Although the properties of the latest resin composites have been optimized, indeed, there is still lack of study reporting whether or not the surface integrity of these materials may be enhanced by the use of low viscosity surface sealant. A sufficiently low-viscosity resin agent with proper characteristics and formulation, even though not specifically developed for such purpose, could be successfully used as a surface sealant. Various Studies have suggested coating polymerized resin composite with adhesive agent or fissure sealant.[9]Rebonding of composite restoration with unfilled resin has been recommended for penetration of the sub-surface microcracks and interfacial gaps generated during finishing and polishing procedures.[10] In our study surface sealing with Prime and Bond (Dentsply), had a positive effect on surface roughness. The results of this study are in accordance with the results of studies by CYG Takuchi, EHG Lara, 2003[9] and Nuray Attar 2007.[2]

Conclusion

1. For the nanocomposite resin tested in this study (Z350), Mylar strip provided the smoothest surfaces followed by Sof-Lex followed by Shofu.
2. The surface texture for the composite improves drastically when sealant is applied after finishing and polishing procedures.

References

1. Endo T, Finger WJ, Kanehira M, Utterodt A, Komatsu M. Surface texture and roughness of polished nanofilled and nanohybrid resin composites. Dent Mater J 2010 Mar;29(2):213-23.

2. Türkün LS, Türkün M. The effect of one-step polishing system on the surface roughness of three esthetic resin composite materials. Oper Dent 2004;29(2):203-11.
3. Sarac D, Sarac YS, Kulunk S, Ural C, Kulunk T. The effect of polishing techniques on the surface roughness and color change of composite resins. J Prosthet Dent 2006;96(1):33-40.
4. Jefferies SR. Abrasive finishing and polishing in restorative dentistry: a state-of-the-art review. Dent Clin North Am 2007;51(2):379-97.
5. Ruyter IE. Composites - characterization of composite filling materials: reactor response. Adv Dent Res 1988;2(1):122-9.
6. Attar N. The effect of finishing and polishing procedures on the surface roughness of composite resin materials. J Contemp Dent Pract 2007;8(1):27-35.
7. Lu H, Roeder LB, Powers JM. Effect of polishing systems on the surface roughness of microhybrid composites. J Esthet Restor Dent. 2003;15(5):297-303.
8. Uctasli MB, Arisu HD, Omurlu H, Eliguzeloglu E, Ozcan S, Ergun G. The effect of different finishing and polishing systems on the surface roughness of different composite restorative materials. J Contemp Dent Pract 2007;8(2):89-96.
9. Neme AL, Frazier KB, Roeder LB, Debner TL. AL Neme, KB Frazier, LB Roeder, TL Debner. Effect of prophylactic polishing protocols on the surface roughness of esthetic restorative materials. Oper Dent 2002;27(1):50-8.
10. Hoelscher DC, Neme AM, Pink FE, Hughes PJ. The effect of three finishing systems on four esthetic restorative materials. Operative Dentistry, 1998,23,36-42. Oper Dent 1998;23(1):36-42.

How to cite article:

Singh S, Mandlik J,Kanyal K, Jadhav A, Handa A. An in-vitro evaluation of effect of three finishing and polishing systems on the surface of nanofilled composite resin. Ind J Conserv Endod 2016;1(2):37-41.