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# THE EFFECT OF FINISHING AND POLISHING PROCEDURES ON THE SURFACE ROUGHNESS OF COMPOSITE RESIN MATERIALS: AN IN-VITRO STUDY

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## ABSTRACT

*The present study was conducted to evaluate the effectiveness of various finishing and polishing procedures on the surface roughness of two different composite resin materials (nanofilled composite, microhybrid composite) and to evaluate the effect of the surface sealant application(prime and bond) on the surface roughness after finishing and polishing procedures of tested composites. A total of 60 composite discs of dimension 6 x 3 mm (6mm in diameter x 3mm in thickness) were made using a custom made stainless steel mould. Out of these sixty specimen, thirty were of nanofilled composite (Z-350 3M ESPE) and thirty were of microhybrid composite (Z-250 3M ESPE). These two groups were then again randomly divided into three subgroups for finishing and polishing by three different methods; Sof-Lex, Shofu and Mylar strip). The average surface roughness (Ra, µm) of all the specimen were measured with the profilometer. A surface sealant was then applied to all the treated specimens, according to manufacturer's instructions and the average roughness was measured again. Results were statistically analyzed using analysis of variance (ANOVA F) and the paired and unpaired't' tests. The results showed that irrespective of the finishing and polishing systems used nanofilled composite exhibited a smoother surface than microhybrid composite. As for the effectiveness of finishing and polishing systems on both the composites, 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.*

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**KEY WORDS**

*Microhybrid composite; Nanofilled composite; surface roughness; profilometer; surface sealant; finishing and polishing systems*

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## INTRODUCTION

The esthetic quality of a restoration may be as important to the mental health of the patient as the biological and technical qualities of the restoration are to his physical and dental health. Use of composites in restorative dentistry has markedly increased in recent years due to increased demand of aesthetics [1].The surface quality is an important factor in determining the success of composite restorations[2]. Surface roughness is one reason for discoloration of restorations, and it is closely related to the type of composite material and the finishing and polishing systems used. Adequate finishing and polishing for composites is a prerequisite for high quality esthetics and enhanced longevity of restorations [3]. The composite restorations should be smooth so as to reduce plaque retention, surface staining, and recurrent decay.

The newer composites (for example microhybrid and nanofilled) combine the properties of hybrid composites and micro-filled composites. These systems have improved mechanical properties, better translucency and smoother surface finish. A variety of instruments are used for finishing and polishing composites. They remove the oxygen inhibited layer of resin but leave the surface rougher [4]. It is important to understand which type of surface-finishing treatments would be effective for different composite restorations. The present study evaluated the effectiveness of three different finishing and polishing systems in producing smoother surface finish of two different composite and the effectiveness of surface sealant application after finishing and polishing procedure of these composites.

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# MATERIALS AND METHODS

## Specimen preparation

The resin composites used in this study were Z-350(nanofilled) and Z-250(microhybrid) of shade A3. The sealant used was "Prime and Bond" (Denstply). The three finishing and polishing system used in this study were "Shofu" finishing and polishing kit, "Sof-Lex "composite finishing and polishing kit (3M) and "Mylar Strips" (Unident). Sixty 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 to be tested was inserted in each cavity in a single increment using a resin packing plastic instrument. Excess flash of the material was removed. A Mylar Strip and glass slide was placed on the mould and the material was light cured from both the sides for 40 seconds using a Quartz-Tungsten-Halogen (QTH) light curing unit. The distance between the light source and the composite material in the mould was standardized. With this procedure, sixty composite discs (thirty of each composite; nanofilled and microhybrid) were obtained. All the specimens were then stored in distilled water at 37 $^{0}$C for 24 hours in an incubator (Incubator (DBK BOD, Model - DTC 96, Innovative Bacteriological Incubator).

## Finishing and polishing procedure, Sealant application and measurement of surface roughness

The thirty samples of each composite resin were then randomly subdivided into 3 subgroups (n= 10); to receive the finishing and polishing with Shofu, Sof-Lex and Mylar strip respectively. The specimens to be finished and polished with Shofu and Sof-Lex systems, for both the composites 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 Mylar Strip groups of both the composite materials received no finishing and polishing treatment after being cured. The specimens of the two composite resins were finished and polished with the Sof-Lex system and Shofu system as specified by the manufacturer. After finishing and polishing, the surface roughness (Ra) of all the specimens was measured using a profilometer.

Further to evaluate the effect of surface sealant on the surface texture of all the finished and polished specimens, the Prime and Bond sealant was applied on all the specimens and again the surface roughness was measured using the profilometer. All the values of surface roughness obtained were subjected to statistical analysis. The data was analyzed with ANOVA F; paired and unpaired "t" test.

# RESULTS

The results obtained from the statistical analysis indicate that the Mylar strip group showed smoothest surface texture for both the composites (nanofilled and microhybrid composite). Sof-Lex finishing and polishing system was better than the Shofu finishing and polishing system for both the composites. The surface texture for both the composites improved drastically after sealant application. Irrespective of the finishing and polishing system used, and whether or not the sealant was applied, the nanofilled composite showed lower surface values as compare to microhybrid composite (see **tables– 1, 2 and 3**).

**Table– 1and 2** show the mean and standard deviation of surface roughness (Ra) values of both the composites. The values indicate that, for both the composites, the Mylar strip group shows lowest Ra values while Sof-Lex group shows lower Ra values than the Shofu group. For all the groups, in both the composites, the Ra values are less after sealant application indicating that the sealant application improved the surface texture

**Table: 1. Comparison of surface roughness values for nanofilled composite treated with three systems before and after sealant application**

| | Z-350 | N | Mean | SD | Paired t | P |
|---|---|---|---|---|---|---|
| Shofu | Before | 10 | 0.8985 | 0.15621 | 2.619 | .028 Sig |
| | After | 10 | 0.8000 | 0.21546 | | |
| Sof-Lex | Before | 10 | 0.7960 | 0.42589 | 1.355 | 0.208 NS |
| | After | 10 | 0.6210 | 0.19564 | | |
| Mylar strip | Before | 10 | 0.5510 | 0.23965 | 0.981 | 0.352 NS |
| | After | 10 | 0.4890 | 0.17195 | | |



**Table: 2. Comparison of surface roughness values for microhybrid composite treated with three systems before and after sealant application**

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| | Z-250 | N | Mean | SD | Paired t | P |
|---|---|---|---|---|---|---|
| Shofu | Before | 10 | 0.9320 | 0.17775 | 2.104 | 0.065 NS |
| | After | 10 | 0.8610 | 0.12991 | | |
| Sof-Lex | Before | 10 | 0.8570 | 0.42820 | 0.4 | 0.698 NS |
| | After | 10 | 0.6210 | 0.19564 | | |
| Mylar strip | Before | 10 | 0.4940 | 0.21910 | 2.235 | 0.052 NS |
| | After | 10 | 0.4410 | 0.16763 | | |

**Table: 3. Comparison of Surface roughness between the materials**

| | Material | N | Mean | SD | Unpaired t | P |
|---|---|---|---|---|---|---|
| Before | Z-350 | 30 | .7485 | .32199 | 0.145 | 0.885 NS |
| | Z-250 | 30 | .7610 | .34562 | | |
| After | Z-350 | 30 | .6367 | .22861 | 1.113 | 0.270 NS |
| | Z-250 | 30 | .7100 | .27921 | | |

**Table– 3** compares the two resin materials, by the mean surface roughness values with their standard deviations, before and after sealant application. The values were analyzed by the unpaired 't' test. From this table it is observed that there is no statistically significant difference in the surface roughness values between the materials before and after sealant application. However, the mean Ra values for nanofilled composite (Z-350) are less than the microhybrid composite (Z-250) before and after sealant application.

## DISCUSSION

Composite resins have been widely used since their introduction as they possess excellent aesthetic properties. Currently, composite resins are one of the most widely used materials in restorative dentistry having the widest range of indications. 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 [5].

The universal hybrid composites provide the best general blend of good material properties and clinical performance for routine anterior and posterior restorations. Microhybrid and nanofilled composite resins exhibit low polymerization shrinkage, optimal handling properties and a durable polish. The average particle size of inorganic fillers in microhybrid dental composites has been reduced to around 1 µm or less so that the polished restoration can achieve adequate gloss and during long-term service, the wear of the restoration does not create a rough surface [5].

Nanofilled composite have been produced with nanofilled technology and formulated with nanomer and nanocluster filler particles. Nanomer are discrete nanoagglomerated particles of 20-75nm in size, and nanocluster are loosely bound agglomerates of nanosized particles. The combination of nanomer-sized particles and nanocluster formulations reduces the interstitial spacing of filler particles and, therefore, provides increased filler loading, better physical properties and superior polish and gloss retention [5].

Surface roughness is one reason for external discoloration, and it is closely related to the type of composite material and the finishing and polishing systems used. Hence adequate finishing and polishing for resin composite is a prerequisite for high quality esthetics and enhanced longevity of resin- based restorations [3]. The longevity and esthetics of a restoration greatly depends on the quality of finishing polishing techniques [6].

The finishing and polishing devices fall into one of three categories as coated abrasive, bonded abrasive or loose abrasives. 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 [6].

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The present study compared the effectiveness of three finishing and polishing systems; Mylar strip, Shofu and Sof-Lex; on surface texture of two different composites, i.e., Microhybrid and Nanofilled composites. We also studied the influence of a sealant on the surface texture, applied after finishing and polishing procedure.

The results of this study show that the specimens polished with planar motion (Sof-Lex disks) gave lower surface roughness values than the specimens polished with rotary motion (Shofu) in both the composites. This is attributed to the Aluminium Oxide as an abrasive in Sof-Lex system. LS Turkun and M Turkun stated that the large particles embedded in Sof-Lex disks tend to rip through the surface of resin composite , when used with certain hybrid composites, tend to cut abrade filler particles resin matrix equally, resulting in a smooth surface [3]. 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, generally, higher than most filler materials used in composite formulations [7]. 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 this study Mylar strips formed the smoothest surface in both the composite groups. 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 esthetically stable surface [8]. 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 [4, 9].

The quantity and size of the fillers in composite resin greatly influences the surface characteristics of the final restoration. In composite resins in which fillers are markedly harder than the resin matrix the resin may suffer a preferential loss during finishing and polishing leaving the filler phase in positive relief. In several studies it was also reported that larger filler particle size resulted in greater roughness values. Use of composite resins with higher amount of small-sized filler particle content has increased in recent years due to difficulties in producing smooth surfaces such as enamel with composite resins which have larger particles. An increase in the amount of filler content results in smoother surface because of decreased particle size and better distribution within the resin matrix [10].

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.

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 an adhesive agent or fissure sealant [11]. Rebonding of composite restoration with unfilled resin has been recommended for penetration of the sub-surface micro-cracks and interfacial gaps generated during finishing and polishing procedures [12]. In our study, surface sealing with Prime and Bond (Dentsply), had a positive effect on surface texture. The results of this study are in accordance with the results of studies by CYG Takuchi, EHG Lara, 2003 [11] and Nuray Attar 2007 [5].

## CONCLUSIONS

Within the constraints of this in-vitro study, from the results obtained, we conclude that, though the surface roughness values of both the composite materials did not show statistically significant difference with all three finishing and polishing systems, the Mylar strips exhibited smoothest surface followed by Sof-Lex system. The Shofu system showed the highest surface roughness values for both the composite. As for the comparison between the Microhybrid and Nanofilled composites, the Nanofilled composite resin showed better surface texture with all the three finishing and polishing systems. Furthermore, the surface texture for both the composites improved drastically when sealant was applied after finishing and polishing procedures.

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## CONFLICT OF INTEREST

Authors declare no conflict of interest.

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