Quantitative and qualitative surface analysis of three resin composites after polishing – An *in vitro* study

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**Abstract**

**Aim:** The study aims to measure the surface roughness (Ra) of three resin composites subsequent to polishing with diamond-impregnated polishing paste.

**Materials and Methods:** Sixty specimens (10 mm × 2 mm) were prepared in metal molds using three nanocomposites: GC Sculpt, Filtek Z350 XT, and Tetric N Ceram. Specimens were then subjected to baseline roughening with #600 grit sandpaper and were polished with DirectDia paste according to the manufacturer’s instructions. After polishing, the Ra of resin composites of all the specimens was measured using profilometer and the surfaces were seen under scanning electron microscope.

**Results:** Tetric N Ceram specimens were significantly smoother and had the least Ra value compared to other groups.

**Conclusion:** Among the three resin composites tested, Tetric N Ceram exhibited the least Ra value owing to the small size of inorganic filler particles.

**Keywords:** Composite resin; profilometer; surface roughness

**INTRODUCTION**

The paramount goal of using a dental restorative material is to restitute the biological, functional, and esthetic properties of a healthy tooth structure. Due to alarmingly progressive restorative esthetic demands of a patient and newer improvement and advancement materials, its clinical uses have vigorously grown over years, regardless of cavity type and location.

The efficiency of finishing and polishing procedures on composite resin surface is an important factor affecting long-term success of restoration.[1] In addition, the surface roughness (R) of a restoration has been recognized as a parameter of high clinical relevance for wear resistance, plaque accumulation, gingival inflammation, material discoloration (especially in class-V restoration), and surface gloss.[2] Conversely, surface smoothness adds to the patient comfort.[3]

In a more recent trend, one-step (diamond-impregnated - Urethane diamethacrylate [UDMA] bristles) and two-step (resin-impregnated or silicon-impregnated burs) and loose particulate abrasives (polishing pastes) have been advocated to optimally achieve the desired smoothness after finishing.[1]

DirectDia, a paste by Shofu, is 20% diamond polishing paste that uses synthetic diamond powder (particle size between 2 and 4 µm) as an abrasive grain.

Filtek Z350 XT universal restorative is a visible light-activated composite designed for use in anterior and posterior restoration, and Tetric N Ceram is a light-curing, radiopaque dental restorative which is based on nanohybrid composite technology.

GC Sculpt is a universal sculptable composite with advanced light scattering technology that merges GC innovative single dispersion nanofillers.

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Therefore, the aim of this study is to measure the surface $R_a$ of three resin composites after polishing with diamond-impregnated polishing paste.

**MATERIALS AND METHODS**

A total of three groups were made: Group I ($n = 20$) for Tetric N Ceram, Group II ($n = 20$) for Filtek Z350 XT, and Group III ($n = 20$) for GC Sculpt.

Sixty composite resin specimens were prepared, and each composite was prepared in standardized cylindrical stainless steel mold (10 mm × 2 mm). The mold was placed on the Mylar strip supported by glass slide of 1 mm thickness.

After complete loading of the mold, the material was covered with another transparent Mylar strip on the top of the filled mold. A glass slide was placed against the top surface of the transparent Mylar strip and was pressed with light pressure to expel excess material from the mold and obtain a flat surface.

The specimens were polymerized through the 1-mm thick glass slide with the activated light calibrated at ≥600 mW/cm², and the intensity was checked with an intensiometer before curing each specimen. The curing time was set at 40 s, and all the specimens were light cured from both the surfaces (top and bottom). After retrieval from the mold, all specimens were stored in a container at 37°C and 100% relative humidity for 24 h in an incubator.

After storage, specimens were subjected to a baseline roughening with #600 grit sandpaper underwater cooling. All the specimens then were polished with DirectDia diamond-impregnated polishing paste.

Surface $R_a$ was measured quantitatively with a digital surface profilometer. The readings were taken and the data obtained were tabulated and subjected to statistical analysis using SPSS statistical software 19.0 version (Statistical Package for Social Science Version 23 Chicago Inc). One-way analysis of variance (ANOVA) and post hoc Tukey’s test were applied.

**RESULTS**

ANOVA and post hoc Tukey’s test were applied to confirm intergroup comparison and the difference between the individual groups and the level of significance was set at 5%.

In our study, Tetric N Ceram showed the least mean $R_a$ values of 0.1126 µm which is closest to the acceptable limit.
of 0.1 μm as in the study by Gedik et al. in 2005,[4] whereas for GC Sculpt, it came 0.1605 μm, and for Filtek Z350, it was 0.1329 μm [Table 1].

The mean Ra values obtained for GC Sculpt, Tetric N Ceram, and Filtek Z350 were 0.1605 ± 0.017, 0.1126 ± 0.018, and 0.1329 ± 0.02. Ra value was least for Tetric N Ceram [Graph 1].

Qualitative assessment of scanning electron microscopic (SEM) photomicrograph accorded well with quantitative results. SEM analysis with diamond polishing paste revealed GC Sculpt had heterogenous surface with some matrix imperfections, Filtek Z350 showed heterogeneous surface texture with some voids where as Tetric N Ceram revealed smooth surface [Figure 1].

Ten point average roughness - average values of the height of five highest peaks and depths of the five lowest values over the measuring length, Tetric N Ceram, and Filtek Z350 were 2.1914 ± 0.189, 1.5330 ± 0.188, and 1.8236 ± 0.252. Rz value was least for Tetric N Ceram.

GC Sculpt revealed heterogeneous surface with some matrix imperfections.

Filtek Z350 showed small heterogeneous surface texture with some voids and dislodgment.

Tetric N Ceram revealed that smooth surface and no particle dislodging were observed.

**DISCUSSION**

Upsurge in esthetic demand has been forcing the manufacturers and dental professionals to identify new approaches for improving restorative materials and handling techniques. To enhance the color stability, to minimize wear of the restoration, and to achieve an acceptable smooth surface, multiple composites and polishing agents have been cited in the literature and are considered to be ongoing research.[3] Esthetic dentistry demands duplicity of the natural tooth as well as imperceptibility to the naked eye, for which the polished restoration should simulate enamel-like surface texture and gloss.[3]

Various factors affecting the surface R of composite resins are composition of resin matrix, particle size and shape, filler size, and different polishing systems used. In our study, surface R of three composite systems with single polishing agent was evaluated using Ra value, which is the arithmetic average height of R component irregularities from the mean line measured within the sampling length.

One gloss is a one-step aluminum oxide-impregnated silicon polisher which is designed with idea to save time and to serve either for finishing or polishing. Pressure of approximately 1 N with intermittent water is used for finishing and pressure of 0.3 N is used for polishing. Saves time as polishing and finishing can be achieved with a single instrument. DirectDia paste is 20% diamond polishing paste that uses synthetic diamond powder as abrasive grain. DirectDia diamond-impregnated polishing paste removes both the phases of the composite homogeneously. Another advantage of the paste is that it does not require a dry surface and always stays on the tooth during polishing yet washes off easily. It has a palatable lime flavor for maximum patient comfort. It was used at a speed of 8000 rpm for 1 min with the paste and intermittent water spray. One gloss coated with diamond-impregnated paste can reduce clinical chair time and produce acceptable surface topography. The paste can also be used for interproximal area with super snap buff.

The DirectDia paste should be avoided using with oxidizing materials and should be stored within the range of <30°C and can cause acute oral toxicity if used in excess.

Tetric N Ceram showed the least mean R values of 0.1126 μm which is closest to the acceptable limit of 0.1 μm as in the study by Gedik et al. in 2005, whereas for GC Sculpt, it came 0.1605 μm, and for Filtek Z350, it was 0.1329 μm.

The mean difference Ra values obtained for GC Sculpt versus Filtek Z350 was 0.027 ± 0.00614, which was statistically significant.

The mean Ra values obtained for GC Sculpt, Tetric N Ceram, and Filtek Z350 were 0.1605 ± 0.017, 0.1126 ± 0.018, and 0.1329 ± 0.02. Rz values obtained for GC Sculpt, Tetric N Ceram, and Filtek Z350 were 2.1914 ± 0.189, 1.5330 ± 0.188, and 1.8236 ± 0.252. Ra and Rz values were least for Tetric N Ceram as compared to other two composite systems, which might be attributed to the high filler loading of Tetric N Ceram comparatively as reported by Patel et al. in 2019.[4] Different mean values for all the three composite system might be due to the size, hardness, and amount of filler resins that use distinctively in the different composite systems. When the mean value of all the composite systems were compared, the smoothest surface obtained was of Tetric N Ceram, which might be due to the small size of inorganic filler particles because of which this composite system provides the best polished surface and lowest surface R average.

Our results are in accordance to Ismail et al. in 2011,[7] who reported similar results when compared the surface R of Tetric N Ceram and Ivoclar Vivadent composite systems with Sof-Lex polishing agent. The study concluded that Tetric N Ceram exhibited the least R values. The results of this study are also in favor of diamond abrasives as a polishing agent as reported by Lainovic and Kardis in 2013[7] and Filho and Robert in 2003[8,9] they reported that...
diamond paste and abrasives reduce the surface hardness of the restoration due to its high wearing capacity.

However, due to different composite systems, in our study, the Ra and Rz values observed were comparable and further studies should be carried out in future to get more significant results.

**CONCLUSION**

From the results of this study, it can be concluded that DirectDia is an effective polishing agent for minimizing the surface defects and providing a lustrous surface finish for all the composite systems used in the study. However, Tetric N Ceram specimens were smoother than GC Sculpt and Filtek Z350 due to the least surface Rₐ values of the former which further supports the best surface finish.

Hence, it can be said that due to the good surface finish, the longevity and esthetics of the restoration are enhanced and so are the patient comfort.

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**Conflicts of interest**

There are no conflicts of interest.

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