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COMPARATIVE EVALUATION OF SURFACE ROUGHNESS OF VARIOUS NANOHYBRID COMPOSITES AFTER MULTI-STEP POLISHING SYSTEMS USING SCANNING ELECTRON MICROSCOPY AND SURFACE PROFILOMETRY: AN IN VITRO STUDY

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ABSTRACT

The finishing and polishing in composite resins can be accomplished with finishing burs (carbide & diamond), abrasive discs, abrasive strips and abrasive pastes etc. Surface roughness can be measured up to Nano scale by qualitative methods, such as scanning electron microscopy, or quantitative methods, such as profilometry. The purpose of our study was to evaluate the surface roughness of various Nano-hybrid composite after multi-step polishing systems using scanning electron microscope and profilometry. The nano-hybrid composites used in this study were Tetric Evo Ceram (TET) (Ivoclar Vivadent Schaan, Liechtenstein), Filtek Z250 XT (3M ESPE) and Beautifil II (shofu).The polishing system used were Super Snap (Shofu, Inc, Kyoto, Japan).Polishing procedure involved use of abrasive disk of all four grits in a dry condition, using a planar motion for 30 seconds, using micromotor handpiece speed not exceeding 30,000 rpm. After each polishing step, the specimens were thoroughly rinsed with water for 10s to remove debris, air-dried for 5 seconds, and then polished with another disc of lower grit for the same period of time until final polishing. The surface roughness values of each specimen were then measured by using a profilometer. The average roughness (Ra) of a surface is defined as the average value of the height of the surface profile above and below a centreline throughout a prescribed sampling length. All groups showed variable values of surface roughness after polishing. Variations in values were due to different fillers, sizes and different matrix of composites. Tetric evo ceram with least roughness and Beautifil II showed the maximum roughness. To conclude, all composites exhibit roughness after polishing, the filler technology in composites may show variable results after polishing

Keywords: Ivoclar Vivadent Schaan, Liechtenstein

Introduction

In aesthetic dentistry, resin composites are the most frequently used materials in direct rehabilitation of the anterior region of the oral cavity, as they meet all the requirements of preservation of the tooth, aesthetic characteristics, and durability in the medium and in the long-term.[1]Since its introduction from late 1950's to recent nano-composites, composite materials are constantly considered for research. Composition of dental composite resins comprises of the resin matrix (organic phase) bisphenol A glycidyl methacrylate (Bis-GMA) or urethane dimethacrylate (UDMA), and other resins added for the viscosity correction, such as triethylene glycol dimethacylate[2] filler matrix coupling agent (interface), filler particles (dispersed phase) consist of silica in the form of quartz, or silicates of various types2, and other minor additions including polymerization initiators, stabilizers and coloring agents. Increasing demand for esthetic dentistry has fueled a rapid development of new restorative resins.

Dental materials need to be biocompatible materials, with optimal physical, mechanical, chemical, and esthetic properties.[3] The very important properties of dental materials are their polish ability and polish retention, and the surface quality that do not cause undesirable biological interactions and the adhesion of the

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bacterial plaque on the reconstructive material.[4,5]The finishing and polishing in composite resins can be accomplished with finishing burs (Carbide & diamond), abrasive discs, abrasive strips and abrasive pastes etc. Surface roughness can be measured up to Nano scale by qualitative methods, such as scanning electron microscopy, or quantitative methods, such as profilometry.[6] In recent years, Scanning electron microscopy has been largely used in dentistry to study characteristics of different materials.[7,8,9.10] This technique has emerged as the most reliable in the evaluation of surface roughness.[7]The purpose of our study was to evaluate the surface roughness of various nano-hybrid composite after multi-step polishing systems using scanning electron microscope and profilometry.

Materials and methods

The nano-hybrid composites used in this study were Tetric Evo Ceram (TET) (Ivoclar,Vivadent Schaan, Liechtenstein), Filtek Z250 XT (3M ESPE) and Beautifil II (shofu). The polishing system used were Super Snap (Shofu,Inc,Kyoto,Japan). A total of 90 specimens were fabricated for test (n=30 for each test) using a Custom made rectangular acrylic mold having rectangular shaped holes of 8 mm in diameter & 2mm in depth. Each of the material was then inserted into a rectangular acrylic mould. To obtain a flat surface without any defects and to prevent air entrapment, specimens were pressed with a glass microscope slide (1 mm in thickness) on the mould, and a constant pressure were applied to extrude the excess material. All the restorative materials were polymerized according to the manufacturers' recommended polymerization times (40 s) with a light-curing unit .The guide of the light-curing unit were placed perpendicular to the specimen's surface at a distance of 1 mm. Polishing procedure involved use of abrasive disk of all four grits in a dry condition, using a planar motion for 30 seconds, using micro motor hand piece speed not exceeding 30,000 rpm. After each polishing step, the specimens were thoroughly rinsed with water for 10s to remove debris, air-dried for 5 seconds, and then polished with another disc of lower grit for the same period of time until final polishing. For each specimen, a new polishing disc was used and discarded after each use.

Specimen topography were evaluated by Scanning Electron Microscope at six different points, two points at the center, two points at the periphery and two points at mid distance from the periphery to center. The specimens were coated with silver in a vacuum evaporator. Photographs of representative areas of the polished surface were taken at 5000× magnifications.

Surface roughness measurement

The surface roughness values of each specimen were then measured by using a profilometer. The average roughness (Ra) of a surface is defined as the average value of the height of the surface profile above and below a centerline throughout a prescribed sampling length. A diamond stylus with a radius of 5 μm was used with a stylus speed 1 mm/s. For each specimen, five measurements at different locations, with a cut-off length of 25 μm and 2 mm tracing length, and the average values were recorded. The surface roughness values are shown in Table 1.There was no statistically significant difference among composite resins ($P > 0.05$).

Results

All groups showed variable values of surface roughness after polishing. Variations in values were due to different fillers, sizes and different matrix of composites.

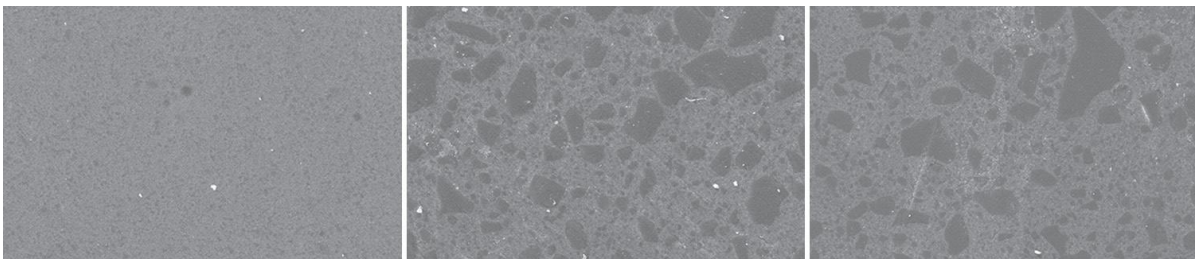

Figure 1: Representative SEM images of each group

Table 1: The surface roughness values

GROUP	Ra Arithmetical mean deviation of profile	Rp Maximum profile peak height	Rv Maximum profile valey depth
GROUP 1	2.917	1.12	4.02
GROUP 2	1.01	2.02	0.32
GROUP 3	0.29	0.93	0.04

Tetric evo ceram with least roughness and Beautifil II showed the maximum roughness.

Discussion

Scanning electron microscope and profilometry has become an important tool for imaging surfaces and analysis. The Scanning electron microscope offers quantitative data on surface morphology. This method has recently been proved as the most reliable method to measure surface roughness. In this study, Single polishing system with multi-step polishing system-Super Snap (Shofu, Inc., Kyoto, Japan), was used for standardizing the polishing protocol SEM was used to evaluate the surface roughness in this study. This method has recently been proved as the most reliable method to measure surface roughness.[7]Luca Giacomelli Giacomelli et al. in a similar study on different polishing systems and composites concluded all composites and polishing systems exhibited surface roughness.[10]Abdurazaq and Al-Khafaji in their study concluded Tetric evo Ceram exhibited intermediate roughness, which is similar to our study.[11] CanSay et al. evaluated the surface roughness of composites after polishing with two step polishing system. In their study, chemical force microscopy, showed high roughness Ra. This is in agreement to our study when compared to filtek Z 250 and Beautifil II values.[12]In this study, scanning electron microscopic analysis indicates that all the composites tested exhibited surface roughness after polishing. The results of this study showed the existence of some differences in surface roughness with multi-step polishing systems on all composites tested. The difference in (Ra) and (Rp-v) values may be attributed to the differences in composition among the materials.

Conclusion

To conclude, all composites exhibit roughness after polishing, the filler technology in composites may show variable results after polishing. Tetric Evo Ceram showed less surface roughness when compared to other composites.

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