**COMPARATIVE EVALUATION OF SURFACE ROUGHNESS AND TEXTURE OF POLISHED NANOFILL AND NANOHYBRID COMPOSITES USING PROFILOMETER AND SCANNING ELECTRON MICROSCOPE – IN - VITRO STUDY.**

**ABSTRACT**

**Aim:** To determine the effectiveness of three polishing systems on three different composite materials by evaluating surface roughness using a Profilometer and Scanning electron microscope.

**Methodology:** A total of Sixty-three resin composite disks were prepared in rectangular acrylic mold of 8×2mm dimension, with 4mm thickness. Specimens were made of light activated resin composite Filtek Z-250-XT, Tetric-N-Ceram bulkfill, Ceram X Duo. The sixty-three samples were divided into three groups of twenty-one samples each i.e Group A (Filtek Z-250-XT), Group B (Tetric-N-Ceram bulkfill) and Group C (Ceram-X-Duo). Out of 21 samples of each of the material, 7 specimens were polished with multi enhance polishing agents, 7 specimens were polished with super snap polishing agents and 7 specimens were polished with sof-lexdiscs.Surface roughness of each sample after polishingwas evaluatedusing Profilometer and Scanning electron microscope.

**Results :** One-way anova and kruskal wallis test was used for statistical analysis. Ceram-X-Duo gave least roughness average value with Super snap polishing system when compared to multi enhance and sof-lex polishing system.

**Conclusion :** Super snap polishing system is a better polishing system than multi enhance and sof-lex and Ceram-X-Duo composite material offers better polishability compared to Filtek Z-250-XT and Tetric-N-Ceram bulk fill.

**INTRODUCTION**

Composite resins of today provide improved strength, resistance to wear, and better esthetics, compared to earlier generation composites.Composites materials have evolved with the science behind them solving many of the problems experienced with materials of the past.1Adequate finishing and polishing of resin composites is a prerequisite for high quality esthetics and enhanced longevity of resin based restorations.2Measurement and analysis of surface of composites provide an excellent diagnostic tool for comparing both proprietary composites and process that produces polished surface.3

Composites containing a high concentration of only nano-sized fillers have been introduced and are called ‘nanofills’. One of the advantages of particle size reduction is excellent surface finish that can be achieved. Manufacturers claim that these ‘new’ composites have the strength of hybrids and polish of a microfill.4 There is a desire to understand three dimensional surface structure of an observed material because of 3D nature of surface and its interactions in-vivo. Profilometry proved to be an excellent method to study the surface roughness.5, 6Scanning Electron Microscope has the capacity to detect the variations in surface morphology.7

The search for an ideal polishing agent for dental composite is ongoing. Several polishing tools have been used over the years ranging from multiple step system using fine and super fine diamond finishing burs, abrasive disks, diamond and silicon impregnated soft rubber cups to one step polishing system.5The need for this study is to compare the surface roughness of these three composite materials (Filtek Z-250-XT, Tetric-N-cerambulkfill and ceram-X-duo)which are polished by three different finishing and polishing systems namely, multi enhance, super snap and sof-lex polishing discs using Profilometer and Scanning electron microscope.

**Methodology**

**Specimen preparation**

Total of Sixty three resin composite specimens were prepared in rectangular acrylic mold of 8×2mm dimension, with 4mm thickness. Mylar strip was placed on a glass slide . Acrylic molds were placed on thismylar strip. The mold was bulk-filled to slight excess covered with another mylar strip, and pressed with another top glass slide and the excess flush was removed with a top glass slide. It was cured with Smart Lite PS 230V of Dentsply.It is a blue LED unit with a light intensity of 950mW/cm2for 20 seconds in a wiping mode, from front and back of the specimens. Light –cured resin composite specimens were pushed out of their molds and stored at ambient atmosphere for a maximum of 1 hour before initial surface roughness determination. Reverse side of the disk was abraded with 600-grit silicon carbide abrasive under running water. Sixty three samples were divided into three groups of twenty one samples each.

The following are the three groups:

The sixty-three samples were divided into three groups of twenty-one samples each.. Group A (Filtek Z-250-XT) : 21 samples were prepared of Filtek –Z-250-XT, Group B (Tetric-N-Ceram bulkfill) : 21 samples were prepared of Tetric-N-ceram,Group C (Ceram-X-Duo): 21 samples were prepared of Ceram-X-Duo.Out of 21 samples of each of the material, seven specimens were polished with multi enhance polishing agents, seven specimens were polished with super snap polishing agents, seven specimens were polished with sof-lex discs.

**Polishing Procedure**

**Polishing of specimens cured under mylar strip :** For Group A1, Group B1, Group C1, specimens were polished with multi enhance polishing discs.For Group A2, Group B2 ,Group C2, specimens were polished with super snap discs .For Group A3, Group B3,Group C3, specimens were polished with sof-lex discs.

For the above mentioned groups, polishing with super snap and sof-lex discs were performed as follows:For the first round of polishing, the largest abrasive particle size was used. All polishing procedures were performed intermittently for 20 seconds at low speed. After the first round of polishing using the largest abrasive particle size of each polishing system, the surface roughness of the polished specimens was measured. Likewise , after the second round of polishing using a reduced abrasive particle size, surface roughness was measured again. Third round of polishing was done with fine grit discs and final round of polishing is done with superfine grit discs followed by surface roughness measurement.

**Polishing of specimens ground on 600grit SiC paper :** With the same specimens cured under the mylar strip, their reverse side were manually ground for 10 seconds on wet 600-grit Silicon Carbide paper under slight pressure and in varying directions. After rinsing and air drying ,the same polishing procedures and sequences as followed for mylar strip cured surfaces were performed on the pre-ground surfaces. To prevent operator variability , the same operator performed all the polishing procedures . Each polishing tool or disc was discarded after being used on three specimen surfaces only. After the specimens were polished , it was analyzed for surface roughness determination using a Profilometer and Scanning Electron Microscope at National Institute of Technology, Karnataka. Profilometer readings were made at the centre of each specimen, and the numerical average was determined for each group.

**Profilometer**

Surface roughness was measured using 2D Profilometer SJ 301. Each specimen was measured five times at different locations and in different directions near the centre of the specimen , and the average roughness Ra value was derived from these five readings. For each measurement, stylus was automatically moved forward and backward three times along the same path.

**Scanning Electron Microscope**

Both the surfaces of specimens were sputter coated with gold to a thickness of 10nm and then subjected to Scanning Electron Microscope. Photographs were taken at 1000× and 3000× magnification.

**RESULTS**

 Mean and standard deviations were estimated for each study group. Mean values were compared by using One-way ANOVA and KRUSKAL WALLIS test. Standard deviation and ‘P’ value for mylar strip side and reverse side were compared using Wilcoxon signed rank sum test.

Ra value in micrometer for Group A1, Group A2,Group A3showed average value of 0.98µm, 0.20 µm, 0.42 µm(mylar side) respectively and 1.25µm, 1.24 µm,1.89 µm(reverse side) respectively,

Ra value in micrometer for Group 1, Group B2Group B3showed maximum roughness average value of 1.19 µm,0.19 µm, 1.03µm (mylar side) respectively and 2.36 µm, 1.20 µm, 1.99 µm ( reverse side) respectively. Ra value in micrometer for Group C1, Group C2, Group C3showed maximum roughness average value of 0.69 µm , 0.15 µm, 0.42µm(mylar side), and 1.12 µm, 0.72 µm ,0.97 µm ( reverse side)respectively.The Mean Ra value on the reverse side is greater than the Mylar strip side with all the groups when polished with different polishing systems. Among the groups, the least mean surface roughness value is seen with super snap polishing systemi.e 0.347, 0.541 and 0.127 respectively. Least surface roughness average was shown by Ceram-X-Duo (0.127) when polished with super snap polishing system. Maximum surface roughness average value is seen with multi enhance with all the three Groups i.e 0.440, 0.850 and 0.391 respectively (Graph 1).

**DISCUSSION**

Surface quality of dental restorations is one of the important factors that determines the success of a restoration 8.As for the surface quality of resin composite restorations, it has been established that it is closely related to both the polishing procedure and inherent material characteristics such as size, hardness, amount of filler particles, and structure of the resin matrix.2

In this present study, all specimens in all the Groups i.e. Group A, Group B, and Group C showed least surface roughness on the mylar strip side compared to the reverse side which was abraded with SiC abrasive paper. This is in accordance with the study done by LS Turkun and M Turkun in the year 2004.Although Mylar strip produces lower surface roughness ,most of clinical situations requires removal of excess composite material in order to ultimately obtain a smooth glossy surface. Surface imperfections in the Mylar strip will be reproduced in the surface of the restoration. Hence contouring and finishing of composite restoration needs to determine the finishing tool that effectively produces smoothest surface36. Smooth surface that is obtained after simply polymerizing the material against a matrix strip consists of organic matrix that is less dense . Hence removal of superficial layer increases the resistance of the surface making it more dense and hard.9

Among the Groups, Group C i.eCeram-X-Duo has shown the least mean surface roughness value with all the three polishing systems when compared with other groups. This is in accordance with the study conducted earlier where Ceram-X-Duo has shown smoothest surface compared to other materials used in the study10.

Ceram –X-Duo is a nanofill composite having high loading of nanosized particles offering improved polishability and long term gloss.Filtek Z-250-XT and Tetric N –Ceram Bulkfillarenanohybrid composites which exhibit highest surface roughness as particles protrude from the surface during polishing procedure11. Physical properties of resin matrix can affect the degree of polishability of composite resin materials4.Reason for the difference in surface roughness between the three composites when polished with identical polishing system may be indicative of fillers in the system. Higher levels of surface roughness correlate to larger filler particle size. 12

In the present study, Filtek Z-250-XT has shown lesser surface roughness average than Tetric-N-ceramBulkfill. This coincides with the earlier study conducted by HAN and ZHANG et al. where both Filtek Z-250-XT andTetric-N-ceramBulkfill exhibited rough surface compared to other materials.13Filtek Z-250-XT is a nanohybrid composite with silica fillers which are large and irregular ranging from 0.2µ to 1µ.The nano portion of this nano Hybrid consists of nano silica paricles and nano zirconia/ silica clusters . Hence it is a unique hybridization of engineered nanoparticles.Tetric-N-ceramBulkfill is a unique nanohybrid composite developed specially for the fast, efficient ‘bulk placement’.

Nanotechnology represents a evolution on balance of esthetics and mechanical properties. However, it is not only the composition (resin matrix and inorganic fillers) and material type are responsible for maintaining the surface smoothness but also the finishing and polishing procedures. Sequential use of less abrasive instruments favoursmoothness compared to one step device14

In this study, Group A ( FiltekZ-250-XT),Group B (Tetric- N-Ceram Bulkfill) and Group C (Ceram –X–Duo)had shown maximum roughness average value with multi enhance polishing system and least roughness average value with super snap polishing system. This coincides with the previous study conducted by Stoddard and Johnson in 1991, and AUJ YAP in 1997 where super snap discs created a smoother surface than sof-lex discs15,16.

In this study, the surface characteristics of the finished and polished composites were determined qualitatively using SEM and 2Dprofilometry. 2D profile tracings provide quantitative recording of surface irregularities. Ra value is the arithmetic average value to assess the surface quality of polished resin composites. If the surface roughness (Ra) values were above 0.2µm, it exceeded the clinically acceptable threshold for composite resin restorations2.

Super snap discs showed Ra values below 0.2µm with all the three Groups. When there is increase in surface roughness above 0.2 µm, there is simultaneous increase in plaque accumulation and increase risk of caries and periodontal inflammation17.

Scanning Electron Microscope has the capacity to detect the variations in surface morphology7. SEM Photographs are used to compare the effects of polishing on the surfaces of composite resins18. Rough surfaces suggest particles pulled out creating nanopores. Smoother surface appearance suggests more effective bonding between the matrix and the filler19

In this study, Scanning Electron Microscope photographs have shown that Teric-N-Ceram bulkfillexhibited roughest surface when polished with all the three polishing systems which is in accordance with the earlier study conducted by Tatsuo and Wemer et.al Group A( Filtek Z-250-XT) and Group C (Ceram-X-Duo) exhibited smooth and uniformly abraded surface with super snap polishing system. 2

Correlation to clinical practice may be limited to situations where accessible relatively flat surfaces are finished. Further studies incorporating a spectrum of composite materials are needed to determine which polishing technique are best suited to clinical situations where access is limited and restoration surfaces are not flat.

**Conclusion :** On the basis of this study it can be concluded that Super snap polishing system is a better polishing system than multi enhance and sof-lex and. Ceram-X-Duo composite material offers better polishability compared to Filtek Z-250-XT and Tetric-N-Ceram bulk fill.

**BIBLIOGRAPHY**

1. Lesage B. Finishing and polishing criteria for minimally invasive composite restorations. Academy of general dentistry 2011;vol 4:p. 422-428.
2. Endo T, Finger WJ, Kanehira M, Utterodt A, Komatsu M. Surface texture and roughness of polished nanofill and nanohybrid resin composites. Dental Materials Journal 2010;vol 29(2): p. 213-223
3. Sakrana AAE, Abouelatta OB, Matsumura H, Koizumi H, Tanoue N. Surface roughness evaluation of polished composites using three dimensional profilometry. Int China J Dent2004;vol 4:p. 85-91.
4. Costa JD,Ferracane J, Paravina RD,Mazur RF, Roeder L. The Effect of different polishing systems on surface roughness and gloss of various resin composites. J EsthetRestor Dent 2007;19:214-226
5. Yap AUJ, Yap SH, Teo CK, Ng JJ.Comparison of surface finish of new Aesthetic Restorative materials. J Operat Dent 2004; 29(1): 100-104.
6. Joniot SB, Gregoire GL, Auther AM, Roques YM .Three Dimensional Optical Profilometry Analysis of Surface States obtained after finishing sequences for Three composite resins. Operative Dentistry , 2000; 25: 311-315
7. Marigo L, Rizzi M, Torre GL, Rumi G . 3-D Surface Profile Analysis: Different finishing methods for resin composites. J operat Dent 2001; 26: 562-568
8. LU H, Roeder LB, Powers JM . Effect of Polishing systems on the surface roughness of microhybrid composites. J EsthetRestor Dent 2003; 15: 297- 304.
9. Turkun LS, Turkun M. The Effect of One-step polishing system on the surface roughness of three esthetic resin composite materials.Operat Dent 2004; 29(2): 203-211.
10. Jung M, Sehr K, Klimek J. Surface Texture of Four Nanofilled and one Hybrid Composite after finishing. J operat dentistry 2007; 32(1):45-52.
11. Erdemir U, Sancakli H, Yildiz E. The effect of one-step and multi- step polishing systems on the surface roughness and microhardness of novel resin composites. Eur J Dent 2012; 6(2):198-205.
12. Senawongse P,Pongprueksha P. Surface Roughness of Nanofill and Nanohybrid Resin composites after Polishing and Brushing. J EsthetRestor Dent 2007;19: 265-275.
13. Han JM, Zhang H, Choe HS, Lin H et.al. Abrasive wear and surface roughness of contemporary dental composite resin . Dental Material Journal 2014;May 14: p.1-7.
14. Schmitt VL, Rontani RM, Naufel FS et al. Effect of polishing procedures on color stability and surface roughness of composite resins. ISRN Dent 2011; July 11.
15. Stoddard JW, Johnson GH. Evaluation of polishing agents for composite resins. J Prosthet Dent 1991 Apr; vol 65(4): p. 491-495.
16. Yap AUJ, Lye KW, Sau CW. Surface characteristics of Tooth –colored restoratives polished utilizing Different Polishing systems. Operative Dentistry ,1997; 22: 260-265.
17. Yap A, Yap SH, Teo CK, Ng JJ. Finishing / Polishing of Composite and Compomer Restoratives: Effectiveness of One-Step Systems. J Operat Dent 2004; 29(3): 275-279.
18. Serio FG, Strassler HE, Litkowski LJ, Moffitt WC, Krupa CM. The effect of polishing pastes on composite resin surfaces. A SEM Study. J Periodontal 1988;59(12): 837-40.
19. Luo J, Lannutti JJ, Robert RS. Effect of filler porosity on the abrasion resistance of nanoporous silica gel/polymer composites. Dent Mater 1998; 14: 29-36.

 **GROUP A GROUP B GROUP C**

 **(FILTEK Z-250 –XT) (TETRIC- N -CERAM BULK FILL) (CERAM –X-DUO)**

**Graph 1: Comparison of mean average with three polishing systems among the three groups of materials.**