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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF SURFACE ROUGHNESS OF THREE DIFFERENT COMPOSITE RESINS AFTER POLISHING -AN IN VITRO STUDY

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ABSTRACT

Aim: To determine the surface roughness of three different direct composite resin after polishing. **Materials and Method:** All 30 specimen were divided into three groups. Group I: Microhybrid composite resin, **Group II:** Nanofilled composite resin, **Group III:** Bulkfilled composite resin. All the specimen were light cured and subjected to polishing protocol with sof-lex polishing kit. Specimen were then subjected to profilometric analysis to determine surfaces roughness measurement. **Result:** Group II showed minimum surface roughness followed by group III and group I. **Conclusion:** The surface roughness of a nanofilled composite resin after polishing with a multi-step technique is better than that of a bulkfilled and microhybrid composite resin.

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INTRODUCTION

The demand for esthetic restorative material has increased substantially in recent years. Achieving favorable esthetics in a tooth colored restoration is critical. Unpolished restorations increase the coefficient of friction and as a result may increase the rate of wear. Moreover rougher surfaces contribute to staining, plaque accumulation, gingival irritation, and recurrent caries (Rochna Rai *et al*., 2013) Different composite materials have different surface characteristics which affect the longevity of the restoration. Composites have revolutionized the concept of aesthetic dentistry. It is a heterogeneous material that is composed of three major components resin matrix, filler particles, and silane-coupling agent (Mohammed *et al*., 2016). Polished restoration should demonstrate enamel like surface structure and gloss. The organic matrix structure and characteristic of fillers exert a direct influence on the surface roughness and staining susceptibility of composite resin (Katia Gerhardt, 2013). Final finish of the composite restoration depends upon its particle size, degree of hardness, filler load, quality, and polishing material used. Resinous and filler components of composites respond differently to abrasive agents because of difference in hardness (Rashmi, 2016). Various types of composites with different filler load and size have been developed to provide smooth surface finish and improve composite strength.

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A composite resin surface produced a high surface roughness level after polymerization (Ugur Erdemir, 2013). Roughness is mainly influenced by the composite resin filler. The larger the size and load of filler particle in a resin product, the rougher the surface (Itanto, 2017). Surface roughness can cause problems such as an increased retention of plaque and microorganisms, which can further develop into secondary caries and restoration failure. A study showed that bacteria could adhere easily to a composite resin surface with a roughness level of 0.2 μm or more.(6) Furthermore, a rough composite resin surface could produce a dull, unnatural clinical appearance. This study was conducted to provide clinicians with a better understanding of the best composite resin restoration for daily practice, especially considering esthetics and strength of composite resin inside the oral cavity. The aim of the present study was to compare and evaluate surface roughness of three different composite resins after polishing.

MATERIALS AND METHODS

Composite resins were taken and placed in increments by plastic filling instrument in a plastic mould specially designed for the study with specific dimensions. 30 samples were prepared, diameter of which is approximately (6.0 ± 0.1) mm and (2.0 ± 0.1) mm thick. The composite material was filled in the plastic mould with a composite filling instrument. The mould was slightly overfilled and was then covered on both sides with matrix strip. Then the composite resin was sandwiched between two glass plates to extrude the excess material, and the excess material was removed. Samples were cured after covering the surface with mylar strip. All the specimens were subjected to curing with a LED light for 30 seconds. All the samples of were finished with a 12 fluted tungsten carbide bur then subjected to polishing. Care was taken to maintain the planar motion during the procedure. Specimens were polished using a multi-step technique in dry conditions with medium, fine, and superfine grit sizes from the Sof-Lex Extra Thin Contouring and Polishing System (3M ESPE, USA). Specimens were then immersed in distilled water and stored in 37oC for 24 hours.

All the specimen were divided into three groups:

Group I: Microhybrid composite resin (Filtek Z250, 3M ESPE, USA)

Group II: Nanofilled composite resin (Filtek Z350 XT, 3M ESPE, USA)

Group III: Bulkfilled composite resin. (3M ESPE Filtek)

Surface roughness was determined by Rtec non- contact profilometer. It was characterized by the height parameter, Ra (µm). The surface roughness (Ra) values of each sample were measures. The Ra value (µm) reading were recorded using a profilometer with 0.8 mm cutoff and 0.25 mm/s speed. Three measurements were made and an average were calculated. The results were tabulated and subjected to statistical analysis. Data were subjected to statistical analysis and analyzed using one-way anova analysis of variance using the SAS. Significant were considered at $p<0.05$. All the statistical analysis were performed.

RESULTS

- Among all the three categories, Group II (Nanofilled composite resin) has the lowest surface roughness and is significantly lower than the Group I & Group III.The p value is much less than 0.01%.
- Comparing across individual groups of GROUP I (Microhybrid Composite Resin) and GROUP II (Nanofilled Composite resin),the mean surface roughness of GROUP II (Nanofilled composite resin) is significantly lower than GROUP I (Microhybrid Composite Resin) at a p value of 0.0004%.
- Comparing across individual groups of GROUP II (Nanofilled Composite Resin),and GROUP III (Bulkfilled Composite Resin),the mean surface roughness of GROUP II(Nanofilled Composite Resin) is significantly lower than GROUP III(Bulkfilled Composite Resin)at a p value of 0.02%.
- Comparing across individual groups of GROUP III (Bulkfilled Composite Resin),and GROUP I (Microhybrid Composite Resin) the mean surface roghness of GROUP III(Bulkfilled Composite Resin)is significantly lower than GROUP I (Microhybrid Composite Resin) at a p value of 0.01%.
- In terms of quality of material, nanohybrid composite resin showed the best result followed by bulkfilled composite resin and microhybrid composite resin.
- The conclusion is statistically proved using the one way anova test.

Table 1.

Material	Mean	Standard deviation
Microhybrid	1.073	0.44
Nanofilled	0.294	0.14
Bulkfilled	0.569	0.34

Figure 1. Soflex Polishing Kit

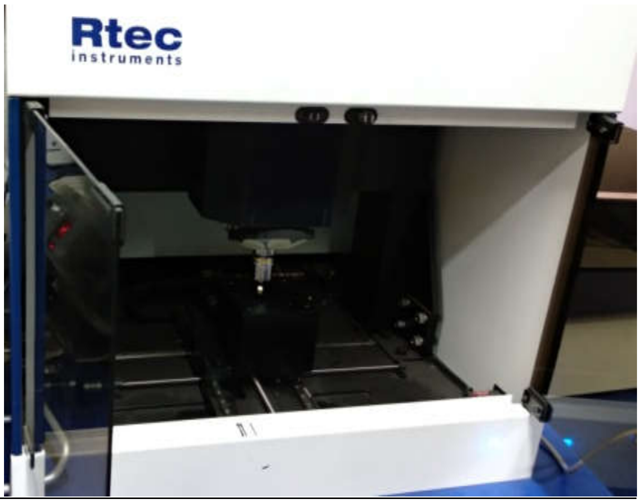

Figure 2. Rtec Surface Profilometer

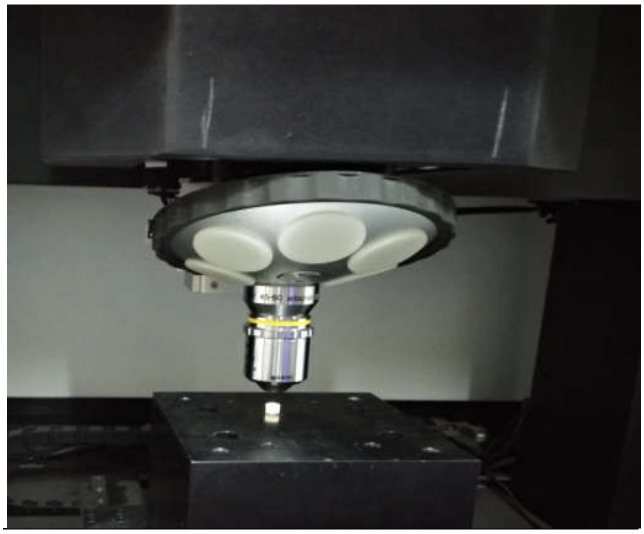

Figure 3. Measurement of surface roughness

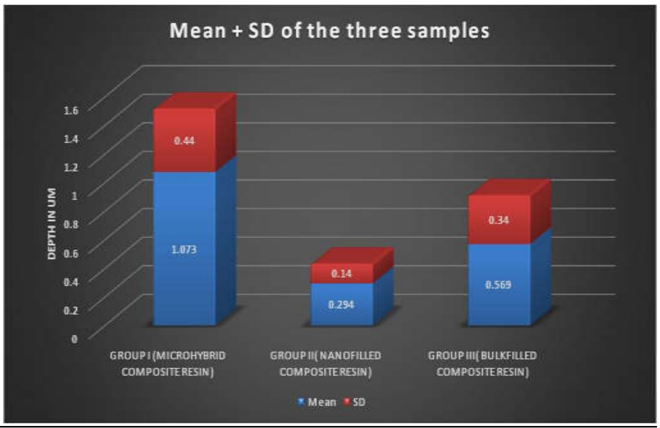

Figure 4. Graphical representation of surface roughness values of different materials

DISCUSSION

Composite resins used in this study were microhybrid, nanofilled and bulkfilled because all are readily available and are commonly used for tooth restoration. The finishing procedure was carried out using an aluminum oxide polishing instrument on dry conditions according to the manufacturer's instructions. The polishing procedure in this study was performed using a multi-step technique with particles of the same material varying from large to small. The polishing procedure was done immediately after finishing. Specimens were then immersed in distilled water to mimic the condition of the oral cavity. Finishing was necessary after curing based on standard operating procedure (Ugur Erdemir, 2013.)

All the groups showed a surface roughness beyond the composite resin roughness tolerance of 0.2 µm. This could be caused by the use of a very abrasive aluminum oxide instrument with a particle size of 50-90 µm. (Brijesh Patel, 2016). This indicated the necessity of the polishing procedure. The continuous development of esthetically acceptable adhesive restorative material has made a variety of tooth colored materials available for clinical use (Rishi D Yadav, 2016). The average particle size of primary filler in nanocomposite and microhybrid is in nanometer and micrometer range, respectively. Due to this small size of filler particles the wear of the restoration does not create a rough surface (Rochna Rai, 2013). These results are supported by Lu *et al*. who also reported better surface smoothness of nanocomposites. The literature also reveals that all the type of restorative material as well as the finishing and polishing protocol influence the surface geometry of esthetic restorations (Nashaat Mohammed Magdy, 2017). Composite resin consists of hard filler component and soft resin matrix. After polishing of restoration, filler particle are left protruding while resin matrix remains shorter. This results into surface roughness (Tamayo Watanabe, 2005). This can be reduced with use of an effective polishing system. The use of finishing and polishing technique is essential to improve the mechanical properties of composite resin surface (Polyana Moura Ferreira, 2015). Fruits have reported that three types of motion may be critical to the development of optimal surface smoothness rotary motion (circular), planar motion, or reciprocating motion kusum bashetty It was found that for all the materials and abrasive grits, the planer motion achieved the lowest Ra values. In the current study, a planar motion was used for polishing (Jinzhong Wu, 2015)

Vyavahare *et al.* in their study reported that rough surface on restoration can promote accumulation of dental plaque and bacterial adhesion, which can be prevented by polishing the composite surface after restoration (Maria, 2015). Schmitt *et al*. observed better surface result with use of sof‑lex polishing system. Sof‑lex products are flexible, color coded (dark‑to‑light shade from coarse‑to‑fine grits) discs made up of aluminum oxide coated with polyurethane (Rashmi G Chour, 2016). They are available as medium (40 µm), fine (24 µm) and ultrafine (8 µm) grit sequence. Sof‑lex is multistep finishing and polishing system used in dry field for finishing and polishing under light pressure (Schmit, ?). In the present study, surface profilometer was used to check surface roughness. It has vertical resolution at nm level, high speed, reliability, and cannot be damaged easily on use. It helps to obtain two‑dimensional as well as three dimensional images of the specimens (Richard Koh, 2008). Different polishing techniques give different surface Ra values. The Ra value of a specimen was defined as the arithmetic average height of roughness component irregularities from the mean line measured within the sampling length (Ergucu, 2007) The surface roughness of the restoration will appear optically smooth when their surface Ra value is smaller than 0.1µ. (Mohammed S Abzal, 2016). The present study compared the surface roughness of different composite resin restorative materials; microhybrid, nanofilled and Bulk-fill composite resin after finishing/polishing with Sof-lex polishing system.

These restorative materials were selected because they have different filler load. Profilometers have been used for years to measure surface roughness in laboratory investigations. For a composite finishing system to be effective, the abrasive particles must be relatively harder than the filler materials (Nashaat Mohammed Magdy, 2017). If not, the polishing agent will only remove the soft resin matrix and leave the filler particles protruding from the surface. Even though the effects of previous finishing instruments on the surface roughness of resin composites have been well studied, the results are controversial (Richard Koh, 2008). This difference is partly attributed to the size, hardness, and amount of filler of the resins used to restore the teeth. When surface roughness is evaluated, another contributing variable is the resin composite system (Nashaat Mohammed Magdy, 2017). During polishing, these particles can be worn away, rather than plucking out the large second particle from the resin itself. Eventually, the surfaces have smaller defects and better polish retention (Ergucu, 2007).

Limitations of the Study: The present study is an *in vitro* test and there could be changes in clinical situations. In this study only three types of composite resin were evauated. The recent development in composite resin in terms of resin matrix or fillers have not been concluded nor the article has taken into consideration the recent developments. Further research is needed with other types of composite resin also. In this study, sample size was less and only one polishing system was taken. There is a need of further research to check other polishing systems with larger sample sizes and also in in clinical situations.

Conclusion

Within the limitations of this study, it has been found that there is a difference in surface roughness between microhybrid, nanofilled and bulkfilled composite resins after polishing using a multi-step technique. The nanofilled composite resin's surface roughness was lower compared to the bulkfilled and microhybrid composite resin after polishing with sof-lex polishing system. It is suggested that clinicians use nanofilled composite resins for anterior fillings for their lower surface roughness and to increase esthetics. Further studies are needed to compare the surface roughness of nanofilled, microhybrid and bulkfilled composite resins using a different polishing technique.

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