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Comparison of Surface Roughness between Nano Hybrid and Nanocomposite Composites

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ABSTRACT

Composite is usually a mixture of two phases. The composites used in dentistry have high durability. The individual properties of each phase are important to increase the mechanical property of the composite. This study aimed to determine the surface roughness changes of two composite resin restorative materials after thermocycling. Two of the commercially available composites were chosen (Nanocomposite 3M Z350 and Nanohybrid composite 3M Z250). The composite disks of dimension 10mm diameter and 3mm height were prepared using silicone molds, and every increment was light cured for 30s. A stylus profilometer was used to assess the surface roughness pre thermocycling, and then, the disks were subjected to an integrated thermocycler (T.S-4.4) for 1000 cycles. The post surface roughness was obtained after the thermocycling process using the same stylus profilometer. The surface parameter values before and after thermocycling of the 3M Z350 sample is less than that of 3M Z250. There was a significant difference between the Rz and Rq values of the two different commercially available composite materials. Thus, the present study concludes that thermocycling influenced the surface roughness of composite resin and increased the surface roughness of both the 3M Z250 & Z350 composites.

Key words: Composite resin, Innovative measurement, Surface roughness, Thermocycling.

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INTRODUCTION

Nanohybrid composite resin is made up of micro-sized (diameter of 0.3-1 μm) and nano-sized (diameter 0.02-0.05 μm) fillers & offers durability, low polymerization shrinkage, high polish ability, easy handling and superior aesthetic properties. In dentistry, composite is an esthetic filling material so that it is used efficiently in endodontic specialties and restorative dentistry [1]. Composite materials are actively and successfully used in restorative dentistry because they are highly durable and biocompatible. Composite materials are similar in their role, which are used to restore the structure of an injured or broken tooth in restorative dentistry. The composite materials are mostly used in filling the injured posterior teeth in recent times [2].

Composite is usually a mixture of two phases; the most commonly used composite is resin composite which is composed of resin polymer and glass fillers. As the composite used in dentistry is a hybrid of two constituents, the composites used have high durability. However, there are failures of composite materials noted in few studies [3, 4]. Stating the degradation of the composite materials due to abrasion, wear of the composite material, and enzymatic and hydrolytic action. Degradation of composite materials is a process that leads to microleakage of the teeth that are restructured. The mixture of different substances results in the formation of different composite materials; the individual properties of each material are important to increase the mechanical property of the composite [5-7].

Surface roughness is the value of the texture on the surface of a material. Surface roughness is crucial in restorative dentistry as it attracts the plaque formation, discoloration, and mechanical wear

of the composite materials [8]. Thermocycling is a method that exposes the required material to a wide range of temperatures to determine the compatibility and strength of composite materials [9]. Surface roughness is determined by the calculation of Ra, Rz, and Rq values. Ra value in surface roughness determines the vertical deviations from the initial sample. Hence, the surface roughness is crucial in determining the durability of the composite material. Thus, the composite materials are substances with good physical and elastic properties, but their durability also depends on the environment of the oral cavity [10].

MATERIALS & METHODS

Nanohybrid (3M Z250) & Nanocomposite (3M Z350) are the two composites used for the in vitro testing. Five samples were prepared from each composite material, as shown in Figure 1 and table 1. The sample size was examined and reviewed by the institutional review board [11]. A round mold with 10mm diameter and 3mm height was prepared, and using a Teflon instrument, the composite materials were filled into the mold carefully. The filled mold was then light-cured for 30s in two intervals. The composite disks were removed from the mold and polished using a micro motor, and the composites' disk dimensions were measured using a digital caliper for uniformity of the sample [12].

The surface roughness before thermocycling of the prepared composite disks was determined using a stylus profilometer SJ310 Mitutoyo with the diamond-tipped stylus (tip size 2mm), as shown in Figure 2 and table 2. After obtaining the pre-surface roughness, the composite disks were thermocycler at 10°C (cold) and at 60°C (hot) in an integrated thermocycler, TC-4 SD Mechatronik for 1000 cycles which equated for months [13]. The dwell time was set to be 30 s and the drain time to be 10 s in every cycle. The post surface roughness was obtained after the thermocycling process using the same stylus profilometer. The surface roughness of the composite materials before and after the thermocycling process was obtained and tabulated. SPSS software version 21.0 (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.) was used to analyze the results using independent sample tests and was graphically represented [14-16].

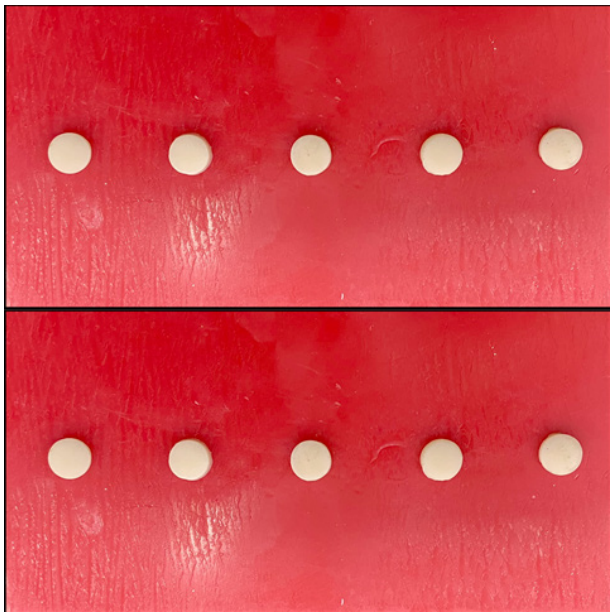

Figure 1: Nanohybrid (3M Z250) and Nanocomposite (3M Z350) samples.

Table 1: Surface roughness values for 5 samples of nanohybrid (3M Z250) composite.

Z250	Ra	Rq	Rz
1	0.325	0.481	3.096
2	0.743	1.002	4.897
3	0.734	1.142	6.805
4	0.25	0.384	2.337
5	0.166	0.454	4.337
Mean	2.085	3.096	18.01

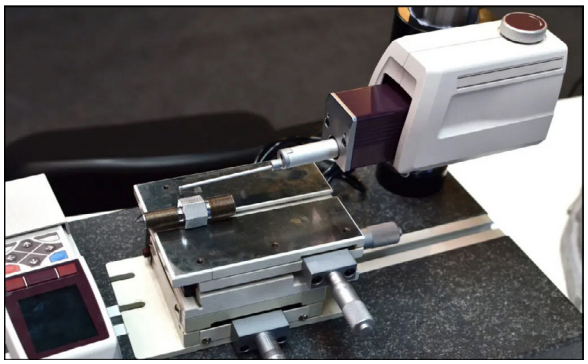

Figure 2: Surface roughness measured using stylus profilometer and the Ra, Rz and Rq values determined.

Table 2: Surface roughness values for 5 samples of Nanocomposite (3M Z350).

Z350	Ra	Rq	Rz
1	0.074	0.132	1.316
2	0.335	0.45	2.856
3	0.624	1.007	6.194
4	0.416	0.524	2.548
5	0.196	0.327	2.42
Mean	1.448	2.178	13.398

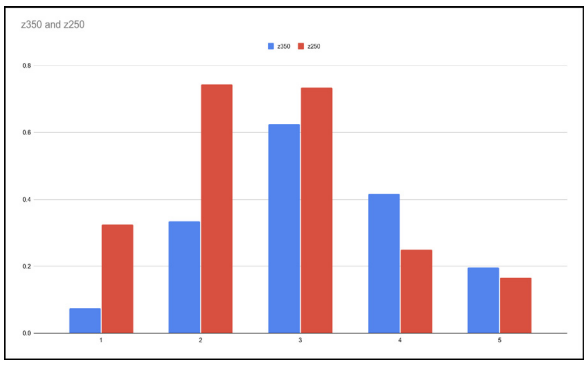

Figure 3: Nanocomposite (3M Z350) has lesser surface roughness than the Nanohybrid composite (3M Z250).

RESULTS

The Rq parameter before and after thermocycling was calculated and determined that the nanocomposite had less surface roughness when compared to nanohybrid composite (3M Z250) figure 3, so nanocomposite is a better composite even before the process of thermocycling.

DISCUSSION

In a study conducted, surface roughness of nano filled and nano hybrid resins were compared after polishing with a multi-step technique, which showed a statistical significance that nano filled composite was much better than nanohybrid composites. Another study, For the nanofill resin composites, there were no significant differences in surface roughness between the two polishing methods or among the unpolished surfaces. After brushing, the surfaces of all materials, except those made from Filtek Z350 and Filtek Supreme XT (dentin), had greater roughness than unpolished surfaces and surfaces polished with either abrasive disks or silicone devices.

Surface roughness of two different Glass ionomer cements was compared using brushing simulation. Surface roughness of D-Tech Colgate group GIC samples was increased after brushing simulation than the gold label group. Good commercially available composites should have good properties. The ideal properties include increased durability, high strength, good resistance to mechanical wear, low density and resistance to creep. Hence, the commercially available 3M Z350 composite may be a better choice than 3M Z250 because of the less surface roughness before and after the thermocycling process.

Both the composites show remarkable differences before thermocycling; thermocycling tends to increase the surface roughness of both the composite materials. Thermocycling increases the surface roughness because it causes the hydrolysis of the coupling agents influencing stress to the matrix filler, which is associated with a significant increase in the surface roughness. The study had a few limitations, including a small sample size and the possibility of including more than 2 composites to provide a better selection of commercially accessible composite materials. Only the surface roughness was discovered; the study may have included other variables. The thermocycling procedure was limited to 1000 cycles.

CONCLUSION

Z350 nanocomposite has lesser surface roughness than Z250 nanohybrid composite. Thus, it will lead to reduced plaque accumulation which in turn causes less gingival irritation & discoloration making it a superior restorative material between the two.

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