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Comparison of surface roughness of nanofill and nanohybrid composite resin polished by aluminum oxide and diamond particle paste

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ABSTRACT

Introduction: The adequate finishing and polishing procedures might occur the restoration longivity, the color retention, and the good integrating with the surrounding environment. **Methods:** This study was conducted to determine the surface roughness of the nanofill composite with the nanohybrid composite polished by the aluminum oxide pastes and diamond polishing paste. This study was a pure experimental-in vitro study. The results of polishing on the resin composite surfaces was observed using the optical microscope at 500x magnification and given the score. The Krusskal-Wallis test was conducted to depict the data analysis. **Result:** The results showed that the resin composite group of the nanohybrid polished by both aluminum oxide and diamond particle had smoother surface than the resin composite of the nanofill. **Conclusion:** The conclusions of this study depicted that there were differences of polishing results using the aluminium oxide and diamond particle paste between the nanofill and nanohybrid resin composite surface roughness.

Keywords: Polishing, nanofill, nanohybrid, aluminium oxide, diamond.

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INTRODUCTION

Resin composites are commonly used for restorations in posterior teeth as well as for esthetic purposes since it does not contain mercury, acts as an isolator and is resistant towards corrosion. They had been undergoing many changes since its first emergence. The most significant change was by the development of composite based on nano technology hence leading to the emergence of nanofill and nanohybrid composite. Nano composite has its own advantages such as low contraction during polymerization stage, high in mechanical and esthetic characteristics, good color stability and good retention after polishing.

A successful restoration can be achieved by producing a smooth surface through finishing and polishing process. The purpose of finishing and polishing a restoration considered not only the esthetic purposes but also the health of

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oral mucosa. According to a few researches, a restoration with a good polishing surface provided an advantage to the patient's esthetic and the convinience to maintain and clean the restoration if compared to a rough restoration. A restoration with a rough surface increased the biofilm retention, causing superficial coloring, gingival inflammation that leads to secondary caries and restoration failure.

A rough surface speeds up the accumulation of plaque and bacteria. The roughness of a restoration surface should be less than 0.2 µm. Wietnam dan Eames[8] mentioned in their research that accumulation of plaque occured in a composite surface with the roughness of 0.7-1.44 µm. Sen *et al.*[9] in his research showed that there was a presence of rough surface in bis-acrylate and methyl methacrylate based composite that exceeded 0.2 µm after polishing using a single step finishing.

The roughness of surface may influence the organic matrix structure and the characteristics of resin composite filler. Besides the effect on the composition, the quality of the resin composite surface was also being influenced by the finishing procedure and polishing towards the surface roughness. The final product of polishing was influenced by the size, type, and the filler loading of composite material. Nanofill composite has nanofiller particles or nanocluster, meanwhile nanohybrid has microfiller and nanofiller particles. Based on the size and type of filler, the after polishing result would be different.

Various techniques and types of instrument can be used for finishing and polishing composites including the usage of prophylaxis paste. Composite prophylaxis paste generally are made of ultra-fine aluminum oxide and diamond paste. Aluminium oxide prophylaxis paste and diamond particles are glyserin based. The distribution size for aluminium oxide particle is 1 µm or smaller, meanwhile the distribution size for diamond particle paste is bigger, ranging from 10 µm to even smaller than 1µm.[10]

According to Edwab[11], a good polishing material should have a smaller particle size than the composite that was to be polished. The ideal size of the polishing paste should be half the size of the filler particle of the material to be polished.

According to the research conducted by Sen *et al.*[9], regarding the effect of polishing on composite based on bis-acrylate which were polished using aluminum oxide paste and diamond particle, it showed that the polishing product using diamond particle produced a smoother surface compared to aluminum oxide paste.

The finishing and polishing procedure in order to create a very smooth surface of resin composite took a few factors in account which was the difference in the amount of filler particle, particle measurement and the difference between the toughness in filler particle and organic matrix on resin composite.[7] The type of polishing paste chosen influenced the smoothness of the resin composite material.

According to the above theory, a research regarding the difference between the surface roughness of resin composite nanofill and nanohybrid after polishing with aluminum oxide polishing paste and diamond particle was conducted.

METHODS

The type of research conducted was pure experimental research in vitro to determine the difference between surface roughness of nanofill and nanohybrid resin composite after polishing with aluminum oxide polishing paste and diamond particle.

The population of this research was resin composite and types of polishing paste. The sample of this research was resin composite nanofill (Filtek Z350 XT, 3M ESPE), resin composite nanohybrid (Filtek Z250 XT, 3M ESPE), aluminum oxide with fine dan extra fine size (Prisma Gloss, Dentsply) polishing paste, and diamond particle with fine dan super fine size (Diamond Polishing Paste, Kerr Dental) polishing paste.

Data regarding the resin composite nanofill material used in this research were: Name: Filtek Z350 XT; brand: 3M ESPE; classification: composite nanofiller; shade: translusent; matrix: Bis-GMA,UDMA,TEGDMA,BIS-EMA; filler: (1) silika non-agglomerated/non-aggregated 20 nm, (2) Filler zirconia non-agglomerated/non-aggregated 4-11 nm, (3) Cluster filler aggregated zirconia/silica (consists of 20 nm silika and 4-11 nm particle zirconia) 0-20 micron; and filler loading: weight 72.5% and volume 55.6%.

Data regarding the resin composite nanohybrid material used in this research: Name: Filtek Z250 XT; brand: 3M ESPE; classification: composite nanohybrid; shade: A2; matrix: BIS-GMA, UDMA, BIS-EMA, PEGDMA and TEGDMA; filler: (1) surface-modified zirconia/silica with average particle size 3 micron or smaller, (2) Surface-modified particle silica non-agglomerated/non-aggregated 20 nm; and filler loading: 82% of weight, 68% of volume.

Data regarding aluminum oxide polishing paste used in this research: Name: Prisma Gloss; brand: Dentsply; abrasive material: aluminum oxide; Number of grit: 2; Size of grit: Fine 1 μm, extra fine 0,1 μm; colour: fine and extra fine white.

Data regarding diamond particle polishing paste used in this research: Name: polishing paste diamond; type: Kerr Dental; abrasive material: diamond; number of grit: 2; size of grit: Fine and super fine, undetected; Colour: Fine, light blue and Super fine, grey.

The instrument used in this research was Optic Microscope Olympus BX51, micromotor and straight handpiece, instrument used to measure pressure while polishing, 6 pieces of microscope slide with the size of 7.5x2.5 cm and 1 mm thick, glass with the size of 3x5 cm and 3 mm thick with 5 mm hole as mold, light cure (SmartLite Focus, Dentsply), rubber cup, tweezers, and cement spatula.

Research procedures are as follow: Sample preparation, A microscope slide was used as a cover for the sample preparation and another microscope slide was used as an instrument to compress the sample making. The glass with the holes in was used as the mold of the sample nanofill and nanohybrid composite was respectively withdrawn for 5 mm from the tube and was administered to the glass mold and was placed in between two microscope slide. Resin composite was then being light cured for 20's with the distance of 0 mm.

Sample polishing procedure, sample was divided into 4 groups: Group A, resin composite nanofill polished using aluminum oxide polishing paste; Group B, resin composite nanofill polished using diamond particle; Group C, resin composite nanohybrid polished using aluminum oxide. polishing paste; Group D: resin composite nanohybrid polished using diamond particle polishing paste. Each group was then polished using rubber cup with respective polishing paste for 60's and continued with the speed of 20.000 rpm with the pressure of 0.20-0.30 gram. One rubber cup was used to polish one sample, samples which had already been polished was then cleaned using ultrasonic cleaner for 30 minutes to clean up the sample from the excessive polishing paste. This procedure was repeated twice.

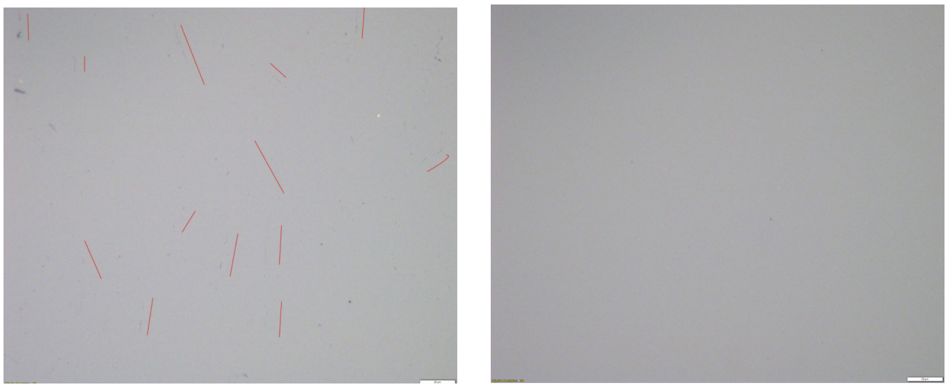
Surface roughness of each group was measured using optical microscope with the enlargement of 500x. The assessment of surface roughness was conducted using scoring system with the following criteria: score 1, there was a scratch on the surface and score 2, there was no scratch on the surface. The score for the surface roughness was tabulated was measured for the difference in surface toughness between Group 1, 2, 3, and 4. Statistical test used for this research was Kruskal -Wallis test.

RESULT

The result of the research was collected by determining the roughness of the nanofill composite resin which was polished using aluminum oxide polishing paste (Group A), nanofill composite resin which was polished using diamond particle polishing paste (Group B), nanohybrid composite resin which was polished using aluminum oxide polishing paste (Group C), and nanohybrid composite resin which was polished using *diamond* particle polishing paste (Group D). The surface roughness of resin was determined through observing its morphological surface observed through optical microscope Olympus BX51 with the enlargement of 500x. The surface roughness was measured through the presence of scratch on the surface of observation. The description of the morphological surface toughness for each Group A, B, C,and D are shown in Figure 1.

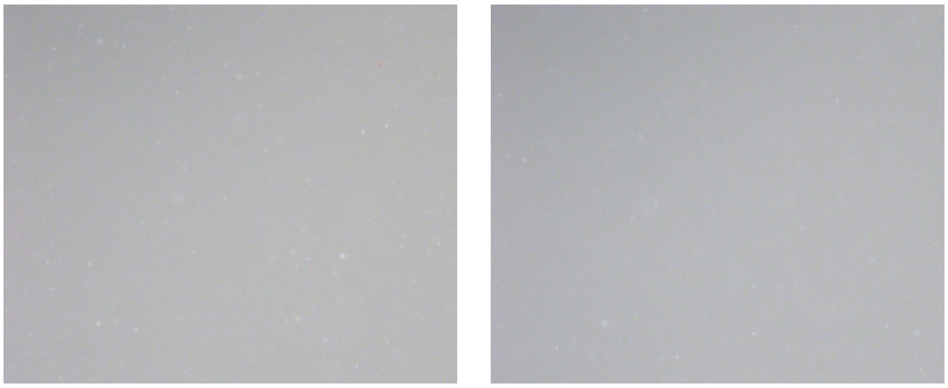
Table 1 showed the assessment result of score for the surface toughness resin composite nanofill and nanohybrid which was polished using aluminum oxide and diamond particle polishing paste. All 4 samples from Group A has the score of 1, meanwhile 1 out of the 4 sample from Group B has the score of 1 and the rest had the score of 0. Group C and D had the score of 0 on each of the 4 samples.

Statistical test using Kruskal-Wallis test



A B

Figure 1 A. Morphological surface roughness on nanofill resin which is polished using Aluminum oxide polishing paste with enlargement of 500x (Group A); B. Morphological surface roughness on nanofill resin which is polished using Diamond particle with enlargement 500x (Group B).



C D

Figure 2. A. Morphological surface roughness on nanohybrid resin which is polished using Aluminum oxide polishing paste with enlargement 500x (Group C); B. Morphological surface roughness on nanohybrid resin which is polished using diamond particle polishing paste with enlargement 500x (Group D)

Table 1. Score asessment of surface roughness between resin nanofiller and nanohybrid after polished using aluminum oxide paste and diamond particle.

Sample	Nanofiller+aluminum oxide (Group A)	Nanofiller+diamond particle (Group B)	Nanohybrid+aluminum oxide (Group C)	Nanohybrid+diamond particle (Group D)
1	1	1	0	0
2	1	0	0	0
3	1	0	0	0
4	1	0	0	0

was conducted to determine whether each of the 4 groups had any difference in their surface toughness. Based on the statistical analysis with the accurate level of 95% (alpha=0.05) it was found that *p value* (0.00E+00)<alpha (0.05) showed significant difference statistically. Thus it showed that all 4 groups had different surface toughness. The result from the statistical analysis is shown in Table 4.

According to Table 4, results from the statistical analysis using *Kruskal Wallis* test showed that the higher the value of rank, the higher the surface toughness of composite resin on respective groups. Significantly, Group A was statistically different from Group B, as well as Group C and D. Meanwhile, Group B had a significant difference with Group C and D. Group C dan D had no significant difference.

DISCUSSION

In this research, the preparation for sample making was conducted with polymerization process of composite underneath microscope slide. The usage of microscope slide in this research was to control the initial condition of the nanofill and nanohybrid composite resin without the need to conduct different action of different polishing instrument on the surface of resin composite, until the influence from the polishing paste can be observed significantly on its surface.

Polishing process in this research was done directly after the polymerization process was complemented. The purpose was to prevent the influence from the storing process on the resin composite surface. Yazici *et al.*[12] stated that there was no significant difference towards the surface toughness and shining retention between finishing and polishing whether done directly or delayed.

Based on observation, it was shown that there was a significant difference between the polishing aftermath on nanofill and nanohybrid composite resin.The surface of nanofill composite resin which was polished using aluminum oxide polishing paste had a tougher surface compared to nanohybrid composite resin Besides that, 1 out of 4 of nanofill resin surface polished using diamond particle has a higher surface toughness.

The result of this research was different from the previous research which stated that the surface of nanofill composite resin had smoother surface compared to nanohybrid nor microhybrid composite resin.[3,5] Jung *et al.*[13] with Tetric EvoCeram (Ivoclar Vivadent), conducted a research on the surface toughness of 3 *nanofill* composites and one *nanohybrid* composite after polishing. The result from the research showed that there was one composite nanofill possessed a higher surface toughness compared to nanohybrid. Janus *et al.* stated that the relationship between filler measurement with the surface toughness of nano particle did not increase the quality of the surface.

The surface toughness is the microrelief which presented during finishing and polishing. A few matters influenced the result of polishing included the pressure between the polishing instrument and the resin composite surface. In this research, the pressure during polishing was managed using measuring balance in order to measure the amount of pressure received by the surface area. The highest pressure in this research was 0.20-0.30 gram. The amount of pressure was determined when the polishing instrument (*rubber cup*) touched the surface of the composite gently.

During the process of finishing and polishing, abrasion from matrix of the resin and filler particle due to the smoothness of the matrix which was due to the heat produced locally, produced defects and scratches on the surface due to the release of filler, and scratches produced by higher abrasive materials.[14] in this research, polishing was conducted without water and was done constantly in 1 location. This could lead to increase in heat on the surface of composite nanofill, producing scratches on the surface after polishing procedure was done.

Vickers hardness number (VHN) of nanofill (Filtek Z350XT) and nanohybrid (Filtek Z250XT) composite was different. According to research done by Nadhum and Al-Khafaji[15], Filtek Z350 XT had a lower VHN compared to Filtek Z250XT. Filtek Z350XT had VHN of ±68.71 meanwhile Filtek Z250XT had VHN of ±96.71. This was also stated in the research by Abuelenain *et al.*[16] stating that Z350XT had a lower VHN compared to Filtek Z250XT.

VHN was measured by the load given by composite divided with the surface area of the projection of indentation. VHN was measured in order to determine the hardness of the composite. The hardness of the composite was influenced by the filler fraction, chemical composition and the degree of polymerization of dental composite.[17] in this research the surface toughness of nanofill composite was higher because of the lower VHN due to the increase in temperature during polishing causing the matrix to become easier to be scratched and the filler particle to be released from matrix more easily.

Jung *et al.*[13] from Tetric EvoCeram (Ivoclar Vivadent), stated that the higher the surface thickness on composite nanofill (Ceram X Duo, Dentsply) was due to the low volume in filler loading and presence of porosity on the specimen. Similar result was also found in this study. Volume of filler loading of Z350XT composite was lower compared to Z250XT and porosity was found in a few specimen.

The hardness of polishing instrument

(abrasive) was measured using the Mohs' Scale of hardness. The scale used was 1-10 with 1 is the lowest and 10 is the highest. The higher the difference in hardness (Mohs' scale) of polishing instrument and the surface to be polished, the action of the polishing material became more effective.[18] Aluminum oxide had the highest surface hardness of 9 Mohs' meanwhile diamond was 10 Mohs'. Difference in the degree of hardness influenced the effectiveness or the action of polishing instrument.[5,9]

Sen *et al.*[9] in his research stated that bis-acryl composite had a smoother surface if polished using diamond paste compared to aluminum oxide. In this research, aluminum oxide had a lower effectivity compared to diamond particle for polishing composite nanofill. aluminum oxide had a lower hardness compared to diamond, thusthe effectiveness in polishing was low. Lainovic *et al.*[1] stated that the use of diamond paste produced smoother surface on nanofill composite.

Few obstacles found in this research was the presence of porosity on the specimen nanofill composite which influenced the quality of the surface of restoration. Pressure management during polishing was one of the obstacles found although the pressure was determined using a machine. The presence of wind factor during polishing process influenced the number in the weighing balance, therefore the pressure was difficult to be managed.

CONCLUSION

It can be concluded that there were differences of polishing results using the aluminium oxide and diamond particle paste between the nanofill and nanohybrid resin composite surface roughness.

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