The Impact Of Different Types Of Polishing Bur On The Nanofiller Composite's Surface Roughness

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ABSTRACT

Background: *Composite resin is a filling material that is similar in color to tooth enamel and can be used widely for various cases, especially for the restoration of anterior teeth. Composite resins have been modified and improved to obtain maximum restoration results, one of which is nanofiller. Nanofiller composite is known to have a high level of smoothness, but polishing remains the key to success in the final filling process. There are many types of polishing on the market, this indicates that not all dentists use the same type of tools. This study aimed to determine the effect of various types of polishing bur on the surface roughness of nanofiller.*

Method: *The type of research conducted was an experimental laboratory. Cylindrical samples with a total of 40 samples measuring 10 mm x 2 mm were divided into 4 groups. Samples were soaked in distilled water and stored in an incubator for 24 hours at 37°C. The samples were polished using different types of bur except for the control group. Samples were tested for surface roughness using a surface roughness tester and scanning electron microscopy (SEM).*

Result: *This study shows differences in the surface roughness of the nanofiller composite after being polished using different types of polishing burs. The results of the one-way ANOVA test indicated that there was a significant difference from the average of the four sample groups.*

Conclusion: *Polishing burs can produce different surface roughness of nanofiller composite.*

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INTRODUCTION

The prevalence of caries in developing countries like Indonesia is increasing and requires attention.[1] The highest proportion of dental health problems in Indonesia in 2018 was cavities, which was 45.3% (Riskesdas, Ministry of Health RI, 2018), so the use of dental filling materials is still often used in dentistry. Composite resin is a filling material that is the same color as tooth enamel and can be used widely for various cases, especially for the restoration of anterior teeth.[2] Composite resin is an alternative material to amalgam because it can provide strength and aesthetics.[3] Currently, composite resin has been modified and improved to obtain maximum results by classifying it into four types based on the filler size: macrofiller, microfiller, hybrid and nanofiller.[4] Filler is an important factor, it affects the bond strength of the tooth structure, especially dentin.[5]

Nanofiller is a type of composite that is most often used in dentistry because it has a high degree of fineness with a particle filler in the form of silica of 1-100 nm.[6] Nanofiller have been known to have a high degree of fineness. Still, finishing and polishing is the key to a successful restoration. The surface roughness of the filling material will affect the quality and clinical performance of the filling material.[7] Restorations with great polishing results will provide advantages in terms of aesthetics and comfort.[8] Conversely, poor polishing will result in a less smooth surface, increase plaque and microorganism retention, which can result in restoration failure and secondary caries.[9] It can happen because polishing affect the marginal adhesion of the composite resin.[10]

The increasing incidence of restoration failure due to secondary caries also increases the prevalence of caries in Indonesia. That is the reason why the polishing process must be maximized. According to the previous research, an ideal restoration should not have an average surface roughness (Ra) value of more than 0.2 µm.[11] This limit is helpful so that the patient can feel comfortable because if it exceeds the limit, the patient can feel the roughness of the restoration using their tongue, which is an average value of 0.5 µm.[12]

There are many types of polishing tools available in the market such as carbide bur, diamond point, abrasive disc, abrasive finishing strips and polishing pastes.[13] This indicates that not all dentists use the same type of tool. Various types of polishing tools have variations in shape, quality and price. The same goes with polishing bur materials which there are a lot of varieties of them.

METHOD

This type of research is a laboratory experimental design Posttest Only Control Group Design. The sample used is a nanofiller composite which is put in a mold measuring 10 mm x 2 mm, then flattened and compacted, covered with mylar strip and object glass by giving pressure so that the sample's surface becomes flat. The composite was irradiated for 20 seconds using a light curing unit at a distance of at least 1 mm perpendicular to the surface of the composite resin until it hardened. The light intensity was measured using a digital light meter and the intensity used is 675 mW/cm^2. The samples were divided into four groups consisting of 10 samples in each group. The total samples are 40 samples. Samples were stored in distilled water at 37°C in an incubator for 24 hours.

Each group is labeled based on its group: Mylar Strip, Super-Snap Xtreme (12 mm and 8 mm with 3D shaped grits), Superfix (12,7 mm and 9,5 mm) and Sof-lex (extra thin 12,7 mm and 9,5 mm discs). Polishing was done in the dental unit by using a stopwatch to set the duration and the sample was placed on a digital scale to adjust the pressure except for the Mylar Strip group. The polishing process was done for 30 seconds

with a pressure of about 102 grams; the movements were carried out in the same direction with the speed of 30.000 rpm, then all samples were rinsed with water for 10 seconds and dried for 5 seconds.

The sample is placed on a flat surface and then the surface roughness test is carried out using Surface Roughness Tester. The test was done three times per sample and the average was taken in micrometer units (µm). The second test was done using Scanning Electron Microscopy (SEM) to determine the surface morphology of the sample.

RESULTS

This research was conducted to determine the effect of various types of polishing bur on the nanofiller composite's surface roughness. There were two test results in this study, the results of the surface roughness test can be seen in Table 1. According to the table, the group that was not polished, the control group Mylar Strip, has the highest surface roughness compared to the group that was polished with an average value of 1.19 + 0.10 µm. In the three polished groups, Superfix has a larger average than the other groups with an average value of 0.45 + 0.03 µm. The smallest roughness value was obtained in the Super-Snap Xtreme sample with a roughness value of 0.33 + 0.07 µm. If all of the following groups are sorted from the largest to the smallest roughness value, then the order is Mylar Strip, Superfix, Sof-lex and Super-Snap Xtreme.

One-Way ANOVA was conducted to prove the hypothesis of whether or not there is a significant difference between the four existing data. The test will prove that there is a substantial difference if the data shows a significance value of $p<0.05$. In Table 6, the resulting data has a significance value of $p = 0.001$, indicating that there is a significant difference between the four groups.

Scanning Electron Microscopy (SEM) was used to determine the surface morphology of the nanofiller composites. The selected samples were tested with 3500x and 5000x magnifications. The results of the surface morphology test with a magnification of 3500x can be seen in Figure 1. SEM test results in Mylar Strip or control group (Figure 1a) showed the roughest surface, this was determined by the lumps that were more clearly visible than the other groups. The results of the SEM test at 5000x magnification can be seen in Figure 2. At 5000x magnification, the results of the surface morphology of each sample can be seen more clearly. Mylar Strip or control group (Fig. 2a) still showed the roughest surface. There are visible streaks and lumps in the Super-Snap Xtreme sample (Figure 2b).

The Superfix sample (Figure 2c) shows that in some parts, there are quite clear lumps, although the lumps were less than the Sof-lex sample, the size of the lumps is quite large compared to the Sof-lex sample (Figure 2d).

Table 1. Comparison of Mean Surface Roughness and Standard Deviation

Sample	Type	N	Mean ± SD (µm)
A	*Mylar Strip*	10	1.19 ± 0.10
B	*Super-Snap Xtreme*	10	0.33 ± 0.07
C	*Superfix*	10	0.45 ± 0.03
D	*Sof-lex*	10	0.39 ± 0.05

Table 2. One-Way ANOVA Test Result of Nanofiller Composites

Variable	Sig.
Surface Roughness	.001

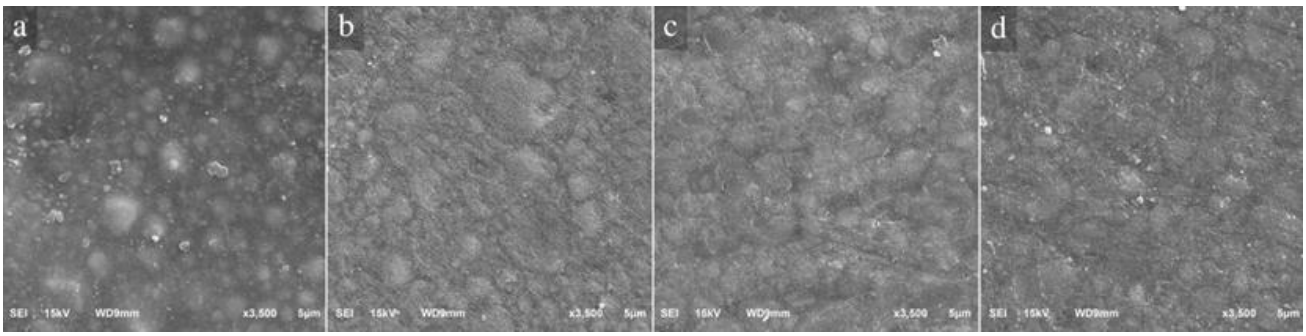

Figure 1. Scanning Electron Microscopy (SEM) image of nanofiller composite (magnification 3500x). (a) Mylar Strip, (b) Super-Snap Xtreme, (c) Superfix, (d) Sof-lex.

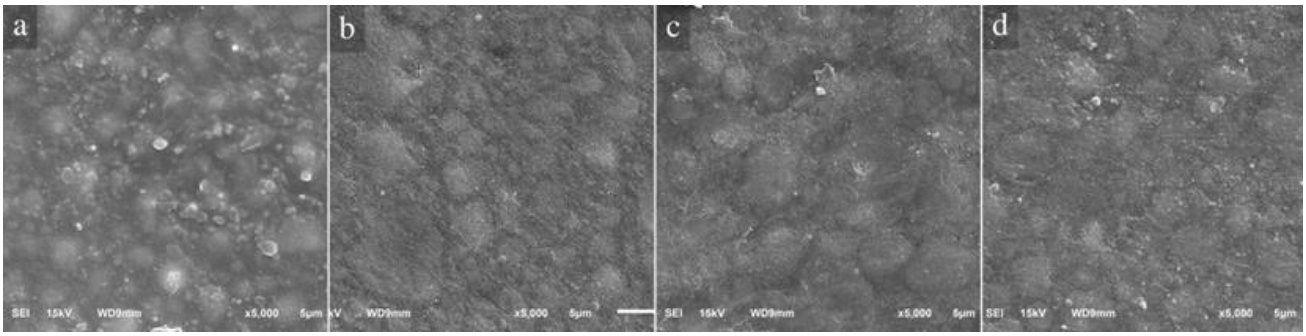

Figure 2. Scanning Electron Microscopy (SEM) image of nanofiller composite (magnification 5000x). (a) Mylar Strip, (b) Super-Snap Xtreme, (c) Superfix, (d) Sof-lex.

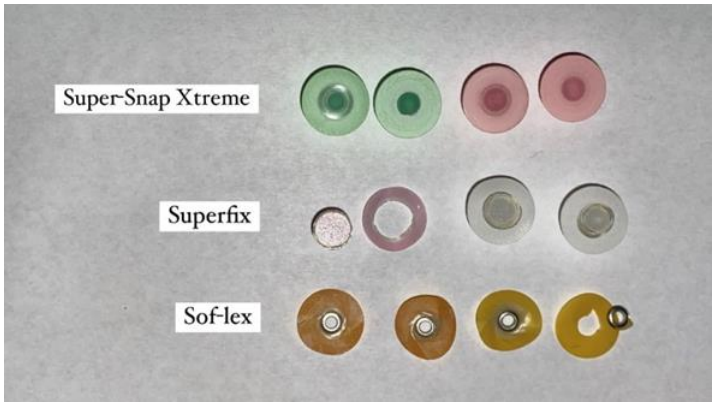

Figure 3. A comparison image of polishing burs after being used

DISCUSSION

This research was conducted by polishing nanofiller composites using three different types of polishing burs. The polishing stage has been proven to be an essential stage to produce maximum restoration. Research conducted by Haifa et al. (2014) explains that polishing can increase the resistance to staining of composites.[14]

Composites are known to be more susceptible to staining due to the nature of the composite which absorbs water.[15] Research by Parvin et al. (2013) showed that the polishing process was effective in reducing the occurrence of microleakage in the enamel margins of composite restorations.[16]

In this study, the treatment of the sample was carried out by controlling several things. Several previous studies showed that composites that were light-cured using Mylar Strips produced better surface roughness, therefore in this study all samples were light-cured using Mylar Strips.[17] Light cure was carried out using a light curing unit with a light intensity of 675 mW/cm^2 for 20 seconds with a distance of 1 mm perpendicular to the sample's surface. Polishing was carried out for 30 seconds, then rinsed with water for 10 seconds and dried using an air spray for 5 seconds to remove debris from the sample's surface. The pressure of polishing was carried out by weighing around 102 grams. This was determined according to the research results of Anna et al. (2021) which demonstrated that a pressure of 1 N (102 grams) is preferable because the higher the pressure applied, the higher surface roughness will be made.[18] Polishing was done from left to right, the number of movements is not determined because polishing was done without using tools that can maintain the pressure at 102 grams, so polishing refers only to its duration.

The average surface roughness produced by each sample group after being polished was measured using a surface roughness tester in micrometers (µm). The control group or Mylar Strip produces the highest average compared to the other groups, at 1.19 $\pm$ 0.10 µm. This happened because the control group was not polished, hence why this group had the roughest surface.

Super-snap Xtreme is an improvement from the previous generation, called Super-Snap. In this latest generation, Shofu added a 3D coating that can produce a smoother surface compared to the previous generation. When polishing was done, these burs could polish the surface quite well. As seen in Figure 3, compared to the other two types, Super-snap Xtreme was not easily damaged even though they are designed for one-time use only. These burs are stiffer than the other ones, even a bur could polish two samples without any damage. Super-Snap Xtreme produces the smallest average surface roughness among the other groups, at 0.33 $\pm$ 0.07 µm. This is also supported by research conducted by Aparna (2017) which shows Super-Snap Xtreme produces the smallest average surface roughness among the other groups.[19]

Superfix has two burs that were used for polishing in light pink (fine) and white (superfine). These burs have superior flexibility compared to other types. This can make it easier at polishing the interproximal of the teeth. However, in this study, Superfix is the most easily damaged bur as can be seen in Figure 3. This happens because it could not be given too much pressure. Superfix has an average surface roughness of 0.45 $\pm$ 0.03 µm, which is the highest level of roughness compared to Super-Snap Xtreme and Sof-lex. In a study conducted by Junior et al. (2015), Superfix has the second highest level of roughness of the other four groups.[20] But there are still not many studies using this type of bur to be compared with other types.

Sof-lex consists of two burs used for polishing in light orange and yellow. Sof-lex has an extra thin layer, which might be why this type of bur also got damaged, as can be seen in Figure 3. Sof-lex burs end up with wavy shapes and some of them have come off completely. Sof-lex indicates an average surface roughness higher than Super-Snap Xtreme and smaller than Superfix at 0.39 $\pm$ 0.05 µm. Previous research shows that Sof-lex resulted in a higher average surface roughness than the other groups.[21] Other research shows Sof-lex has a low average surface roughness but not too significant because there are several other types of burs that have a lower average.[22]

After all the samples are polished, it can be concluded that not all types of burs can be given the same pressure. This research sets the pressure on ±102 grams, however this indicates some type of bur is damaged hence why some samples need to be polished using two burs. Samples that have been polished was tested for surface roughness using a surface roughness tester then a statistical test was carried out. Research conducted by Bollen et al. showed that an ideal restoration should not have an average surface roughness (Ra) value of more than 0.2 µm to prevent the discomfort that can be felt by the patient using their tongue.[9,10] If you look at the average roughness results obtained in Table 1, the closest to the ideal average is the Super-Snap Xtreme. However, because none of the four groups had an average surface roughness of less than 0.2 µm, no group was able to achieve an ideal average roughness in this study.

The data that can be seen in Table 2 shows that there are significant differences in the four groups, the various types of polishing bur used in this study has an influence on the surface roughness of the nanofiller composite.

SEM test results can be seen in Figure 1 for 3500x magnification and Figure 2 for 5000x magnification. The group that was polished looks smoother than the Mylar Strip which did not get polished. This is determined by the shape of the lumps that are more subtle in the group that was polished.

On a comparison of the results of the three groups that were polished, it can be seen that the Super-Snap Xtreme has the smoothest surface compared to the other groups. This is determined by the lack of visible lumps in the Super-Snap Xtreme. This statement is also in accordance with the surface roughness test results that have been carried out in the previous stage. Super-Snap Xtreme proved to have the lowest average value of the other groups at 0.33 ± 0.07 µm.

The results of the surface morphology test on the Superfix and Sof-lex do not have much difference, because both of them have some lumps that are clearly visible. The visible difference between the two groups is the lump in the Superfix looks bigger than the Sof-lex. This may result in differences in the results of the surface roughness test. The flexibility of the bur may also matter due to the results. When everything was done, both of these types of bur experienced damage which could affect the morphology of the sample surface so that it looked rougher.

CONCLUSION

The results showed that the various types of polishing bur produce a significant difference on the nanofiller composite's surface roughness.

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