DENTINO
JURNAL KEDOKTERAN GIGI
Vol VIII. No 1. March 2023

THE EFFECT OF GLYCERIN APPLICATION ON ROUGHNESS OF NANOHYBRID COMPOSITE RESIN IMMERSED IN ISOTONIC DRINK

Laila Rahma Milenia[1)] ,Surya Nelis[1)],Brigitta Natania Renata Purnomo[1)] ,Nadia Hardini[1)]
[1)]Department of Dentistry, Faculty of Medicine, Diponegoro University, Semarang, Central Java, Indonesia

ABSTRACT
Background: *Composite resin is the most commonly used restorative material. One type of composite resin based on the filler material is a nanohybrid composite resin which has the advantage of good strength and smooth surface to produce good improvements in terms of durability and aesthetics. The roughness of the resin can be affected by drinks with low pHs, such as isotonic drink. Glycerin can reduce the roughness of the composite resin by acting as a barrier so that an oxygen inhibition layer (OIL) is not formed.* ***Purpose:*** *This study is to determine the effect of glycerin application on the roughness of nanohybrid composite resin immersed in an isotonic drink.* ***Method:*** *A total of 32 samples of nanohybrid composite resin used in this study were made with a diameter of 5 mm and a thickness of 2 mm. The nanohybrid composite resin samples were divided into group I without glycerin application and group II with glycerin application before the light curing process. Both groups were then immersed in an isotonic drink for 18 hours in an incubator. The research continued with roughness testing using a surface roughness tester.* ***Result:*** *There was a significant difference in the roughness of the nanohybrid composite resin immersed in an isotonic drink with and without glycerin application. This is indicated by the p-value < 0.05 in the unpaired bivariate t-test, which means that there is a significant difference in the two sample groups.* ***Conclusion:*** *The application of glycerin can reduce the roughness of the nanohybrid composite resin immersed in isotonic drink.*

Keywords: G*lycerin application, Nanohybrid composite resin, Roughness.*
Correspondence: Surya Nelis; Dentistry Study Program, Diponegoro University, Jln. Prof Soedarto, S.H., Tembalang, Semarang, Central Java, Indonesia; E-mail: nelis.ipm@gmail.com

INTRODUCTION

Composite resin is the most commonly used restorative material.[1] Composite resin can be used to replace missing tooth structure in both anterior and posterior teeth because it has a good mechanism when it binds to dentin and enamel and has a high esthetic value.[2]

Composite resin is composed of three main ingredients, namely a matrix derived from polymeric organic materials, fillers, and coupling agents.[3] Composite resins can be classified based on the size of the filler. One example is nanohybrid composite resins which contain a combination of microfil-sized (0.4-5µm) fillers with nanometer-sized (1-100 nm) fillers.[4] Nanohybrid composite resins are often used because they have good strength and smooth surface so that produces restoration that are both durable and aesthetically-pleasing.[5]

Surface roughness is an important indicator in assessing the quality of restorative material. Surface roughness can be defined as an unexpected form of irregularity on a surface. This can be caused by several factors such as excessive use, the emergence of friction, scratches, fatigue, and chemicals. Rough restoration surfaces can lead to plaque buildup, discoloration of the fillings, and damage to teeth and their supporting tissues when used for a long time. [6]

Previous research conducted by Nugroho (2020) has proven that the application of glycerin before curing on composite resin restorations can reduce the oxygen inhibition layer and increase the hardness of the composite resin.[2] Oxygen inhibition layer (OIL) is a layer that forms on the surface of the composite resin when the polymerization process is induced by free radicals and binds to oxygen in the air.[7] Application of glycerin in composite resins has a role as a barrier so that free radicals do not bond with oxygen so that OIL is not formed which can increase the hardness of the composite resin.[8] The surface of the composite resin formed by OIL consists of a layer of residual monomer which has an uneven surface that causes roughness in the composite resin.[9]

Several studies have shown that acidic drinks can affect the surface roughness of composite resin.

One example of an acidic drink that is widely circulated in the community is an isotonic drink. The pH level of isotonic drink is between 2.4 - 4.5 which is included in the critical pH.[10] It is recorded that as many as 200 million liters per year are consumed in isotonic drinks in Indonesia.[11,25] Isotonic drinks are often referred to as sports drinks. fluids and body salt and provide energy in the form of carbohydrates when doing activities.[12] Isotonic drinks can prevent muscle damage and increase the stability of athletes by balancing fluids and electrolytes in the body.[13]

Based on the background description above, the authors wanted to know whether there was an effect of glycerin application on the roughness of the nanohybrid composite resin immersed in an isotonic drink.

MATERIAL AND METHODS

This research was conducted at the Dental Preclinical Laboratory, Biomedical Laboratory, and the Mechanical Engineering Laboratory at Diponegoro University, Semarang (Ethics No. 112/EC/H/FK-UNDIP/XI/2021). This research is an experimental laboratory with Post-Test Only Control Group Design. This study used 32 samples of nanohybrid composite resin where each group consisted of 16 samples control group (group I) and 16 samples treatment group (group II).

The nanohybrid composite resin samples were fabricated using an acrylic mold with a diameter of 5 mm and a thickness of 2 mm and then compacted using a 500-gram weight for 30 seconds. The compacted sample was then divided into two treatment groups. Group, I without glycerin application and light-cured (LED B Woodpecker, China) for 20 seconds, while in group II with glycerin application and light-cured for 20 seconds. All samples were finished with a fine soflex bur and polished using a superfine soflex bur so that a sample with a smooth surface was obtained. The sample is removed from the mold and placed in a container that has been labeled with each treatment. The sample was divided into two groups by simple random sampling technique.

Two groups of samples were immersed in isotonic drink. Before immersing the samples in an isotonic drink, the acidity level was measured using a pH meter. The samples were inserted one by one into the glass beaker according to the treatment group using tweezers. The glass beaker was covered with aluminum foil which was then placed in an incubator at 37ºC for 18 hours.

Samples were measured surface roughness using a surface roughness tester and expressed in units of micrometers (µm). For each sample used, 3 measurement points were made. The sample is placed on a flat surface. The stylus is positioned at the first point of the sample surface. The tool is turned on, the stylus moves along a straight vertical line on the surface of the previously created sample. Measurements on each sample were carried out 3 times on each different line. The results obtained are then averaged with the following formula:

$$Ra = \frac{Ra1 + Ra2 + Ra3}{3}$$

Formula description:
Ra: Roughness value
Ra1: First roughness value
Ra2: Second roughness value
Ra3: Third roughness value

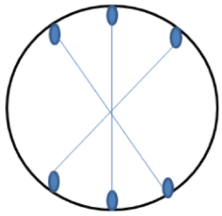

Figure 1. Schematic of the area to be measured on the sample.

RESULT

The data on the roughness of the nanohybrid composite resin were analyzed using a statistical program (IBM SPSS, v. 25, USA). The results, mean and standard deviation of the roughness test (µm) obtained the following results:

Table 1. Results, mean and standard deviation of the roughness test (µm)

Sample Groups	Amount of The Group	Mean (µm) ± SD
Group I (without glycerin application)	16	0,265 ± 0,0328
Group II (with glycerin application)	16	0,163 ± 0,0224

Table 2. Normality test

Sample Groups	p-value
Group I (without glycerin application)	0,208
Group II (with glycerin application)	0,074

Table 3. Homogeneity test

Homogeneity Test	p-value
Levene's test	0,053

The research data were tabulated, and tested for the normality distribution with the Shapiro-Wilk test and continued with the homogeneity test using Levene's test. Based on the Shapiro-Wilk test, it was obtained that the data were normally distributed ($p > 0.05$) and the Levene's test showed homogeneous data with a significance value of 0.053 ($p > 0.05$). Based on the results of the unpaired t-test on the effect of glycerin application on the roughness of the nanohybrid composite resin immersed in isotonic drink, the test results obtained with a value of $p = 0.001$ ($p < 0.05$) which means that there is a significant difference in the roughness of the nanohybrid composite resin immersed in isotonic drink with and without the application of glycerin.

DISCUSSION

Surface roughness is an important indicator in assessing the quality of restorative materials. Restorative materials that have a rough surface result in easier attachment of plaque and bacteria.[14] The roughness of the nanohybrid composite resin is influenced by several things, including the composite resin filler component, acid pH, polymerization process, and finishing and polishing procedures.[15] The application of glycerin is one of the materials considered to reduce the surface roughness of the composite resin.[8] In this study, the sample used was nanohybrid composite resin immersed in isotonic drink and then divided into 2 groups, namely group I and group II. Group, I was the group where glycerin was not applied to the sample surface, while in group II glycerin was applied before irradiation. The two groups were immersed in an isotonic drink for 18 hours in an incubator. The roughness test on the composite resin sample was carried out using a surface roughness tester.

Based on statistical analysis using unpaired t-test, p-value = 0.001 ($p < 0.05$). The results show that the research hypothesis is accepted, which means that there is an effect of glycerin application on decreasing the roughness of nanohybrid composite resins immersed in isotonic drink. Previous research conducted by Zakiyah et al (2018) also stated that the application of glycerin on the surface of the composite resin before light-cured can reduce the roughness level of the composite resin.[8] This can occur due to the application of glycerin before light-cured can help reduce the formation of an oxygen inhibition layer consisting of from the residual monomer layer which has an irregular surface that causes the surface of the composite resin to become rough.[9]

The oxygen inhibition layer is a thin layer that forms on the surface of the composite resin when an imperfect polymerization process occurs. The polymerization process in composite resins is divided into four stages, namely activation, initiation, propagation, and termination. The activation stage begins when the blue light activator (light-cured) initiates camphorquine which is a photoinitiator in the composite resin so that it can form free radicals. The initiation stage occurs when the free radicals that have been formed in the activation stage break the monomer double bonds so that the monomer molecule is activated marked by the presence of free electrons at the end of the monomer. In the propagation stage, the activated monomer will break the double bonds of other monomers due to free radicals, resulting in a long chain. At the termination stage which is the last stage where there is no chain addition due to the free radicals at the end of the chain have joined to form a stable polymer chain.[16-18]

Disruption of polymerization can occur when free radicals which are unpaired electrons combine with oxygen in the air to form R-O=O bonds (stable radicals). This bond results in the formation of a peroxide radical which has the property of reducing the reactivity of the monomer.[19] The polymerization that occurs is inhibited due to the reduced reactivity of the double bond in the monomer and forms a layer known as the oxygen inhibited layer.[20] The layer consists of monomers that are not completely polymerized which appear on the surface of the composite resin after the polymerization process. This has an impact on increasing the surface roughness of the composite resin because the monomer layer that is not completely polymerized has an irregular layer.[21]

The surface roughness of the composite resin can be affected by drinks that have an acidic pH.[26] This study used an immersion solution in the form of an isotonic drink with the Pocari Sweat brand whose acidity level had previously been measured using a pH meter and obtained a pH value of 3.7. The citric acid content in isotonic drink has very erosive properties and makes the pH of the drink lower because it has excess H+ ions which have an impact on matrix degradation in the nanohybrid composite resin.[22] Matrix degradation begins when the water absorption process diffuses into the composite resin matrix against bond instability due to crosslinking bonds between the polymer matrix and H^+ ions. This causes the double bonds in the polymer matrix to break so that the matrix material becomes easily eroded. The matrix degradation also has an impact on the emergence of filler bulges which are the cause of surface roughness in the composite resin.[23]

Reducing surface roughness on nanohybrid composite resin restoration materials is needed, especially for composite resins that are often exposed to acidic pH drinks such as isotonic drink to reduce bacterial attachment and plaque accumulation that causes secondary caries and discoloration of the composite resin. One of the materials that can be used to reduce the surface roughness of nanohybrid composite resins is glycerin.[8] Glycerin can act as a barrier so that there is no bond between oxygen in the air and monomer free radicals in the composite resin where the bond will form an oxygen inhibition layer which can interfere polymerization process.[24] Glycerin can be applied to occlusal areas, especially deep pits and fissures where the oxygen inhibited layer is not completely removed by finishing and polishing processes.[2] Based on the research that has been done, it can be concluded that there is an effect of glycerin application in reducing the roughness of nanohybrid composite resins immersed in isotonic drink.

REFERENCES

1. Shabrina N. Gambaran penggunaan bahan amalgam, resin komposit dan *glass ionomer cement* (GIC) di Rumah Sakit Gigi dan Mulut Unsyiah pada bulan Juli-Desember 2014. J Caninus Denstistry. 2016; 1 (11): 9–11.
2. Kharisma P, Nugroho R, Budirahardjo R. Effect of glycerin application on hardness of nanofiller composite with immersion of apple cider vinegar. 2020; 8 (2): 87-92.
3. Anusavice JK, Chiayi S, Rawls HR. Phillips' Science of Dental Materials. 12 th ed. China: Elsevier; 2013. p.277-285.
4. Tanthanuch S, Kukiattrakoon B, Siriporananon C, *et al*. The effect of different beverages on surface hardness of nanohybrid resin composite and giomer. J Conserv Dent. 2014; 17 (3): 261-265.
5. Mount GJ, Hume WR, Ngo HC, Wolff MS. Preservation and restoration of tooth structure. 3 rd ed. John Wiley & Sons; 2016. p.199–213.
6. Ansuj MDF, Santos ISD, Marquezan M, Durand LB, Pozzobon RT. Evaluation of the surface roughness of a nanofilled composite resin submitted to different smoothing and finishing techniques. Revista de Odontologia da UNESP. 2016; 45 (2): 110-114.
7. Handayani TM, Nugroho R, Hidayati L, Fatmawati DWA, Sumono A. Effects of glycerin application on the hardness of nanofilled composite immersed in tamarind soft drinks. Majalah Kedokteran Gigi. 2014; 52 (2): 95-99.
8. Zakiyah D, Effendy R, Prasetyo EA. The effect of glycerin on the surface hardness and roughness of nanofill composite. Conservative Dentistry Journal. 2018; 8 (2): 46-53.
9. Chour, RG, Moda A, Arora A, Arafath MY, Shetty VK, Rishal Y. Comparative evaluation of effect of different polishing systems on surface roughness of composite resin: an in vitro study. Journal of International Society of Preventive & Community Dentistry. 2016; 6 (2): 166.
10. Wasono NP, Assa YA, Anindita PS. Pelepasan ion nikel dan kromium bracket stainless stell yang direndam dalam minuman isotonik. Pharmacon. 2016; 5 (1): 158–63.
11. Susiani D. Pengaruh Perendaman resin komposit nano hybrid dalam minuman isotonik terhadap kekuatan tekan. J Wiyata. 2015; 2 (2): 176–80.
12. Budiman ST, Ray HRD. Perbandingan pengaruh air kelapa dan minuman isotonik terhadap tingkat hidrasi atlet cabang olahraga bola basket. J Ilmu Faal Olahraga Indonesia. 2019; 1 (2): 15
13. Colakoglu FF, Cayci B, Yaman M, Karacan S, Gonulateş S, Ipekoglu G, *et al*. The effects of the intake of an isotonic sports drink before orienteering competitions on skeletal muscle damage. J Phys Ther Sci. 2016; 28 (11): 3200–3204.
14. Chaisomboonphun P, Rodklai A. Surface roughness and erosion of nanohybrid and nanofilled resin composites after immersion in red and white wine. J Conserv Dent. 2016; 19 (1): 51.
15. Ozcan S, Yikilgan I, Uctasli MB, Bala O, Kurklu ZGB. Comparison of time-dependent changes in the surface hardness of different composite resins. European Journal of Dentistry. 2013; 7 (1): 20–25.
16. Sakaguchi RL, Powers JM. Craig's restorative dental materials. 14 th ed. Philadelphia: Elsevier; 2018. p.163-182.
17. Ritter AV, Boushell LW, Walter R. Sturdevant's art and science of operative dentistry. 7 th ed. St. Louis : Elsevier; 2019. p.106.
18. Rueggeberg FA, Giannini M, Arrais CAG, Price RBT. Light curing in dentistry and clinical implications: a literature review. Braz. Oral Res. 2017; 31 (1): 64-91.
19. Panchal AC, Asthana, G. Oxygen inhibition layer: a dilemma to be solved. Journal of Conservative Dentistry. 2020; 23 (3): 254.
20. Yamaji A, Tsujimoto A, Asaoka T, Matsuyoshi S, Tsuchiya K, Takamizawa T, *et al*. Effect of oxygen inhibition in two-step self-etch systems on surface free energy and dentin bond strength with a chemically cured resin composite. Journal of Oral Sciences. 2014; 56 (3): 201-207.
21. Donova BJ, Garoushi S, Lassila LV, Vallittu PK. Oxygen inhibition layer of composite resins: effects of layer thickness and surface layer treatment on the interlayer bond strength. European Journal of Oral Sciences. 2015; 123 (1): 53-60.
22. Dhurohmah, Mujayanto R, Chumaeroh S. Pengaruh waktu polishing dan asam sitrat tehadap microleakage pada tumpatan resin komposit nanofiller aktivasi light emiting diode

– in vitro. Odonto: Dental Journal. 2014; 1 (1): 11-15.
23. Nurmalasari A. Perbedaan kekasaran permukaan resin komposit nano pada perendaman teh hitam dan kopi. Jurnal Wiyata. 2015; 2 (1): 1-6.
24. Starnd G, Kvacs M, Andras E, Resescu L. Effect of curing, finishing and polishing techniques on microhardness of composite restorative materials. Procedia Technology. 2015; 19 (1): 233-238.
25. Afrianti N, Erlita I, Adhani R. Isotonic beverage effect on surface hardness of bulk-fill type composite resin. Dentino: Jurnal Kedokteran Gigi. 2019; 4 (2): 130-134.
26. Fadewi, FB, Erlita I, Saputera D. Surface roughness of bulk-fill resin-based composite restorative materials after immersion in probiotic milk. Dentino: Jurnal Kedokteran Gigi. 2019; 4 (2): 124-129.