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THE EFFECT OF GLYCERIN APPLICATION ON SURFACE HARDNESS OF NANOHYBRID COMPOSITE RESIN IMMERSED IN ALCOHOLIC MOUTHWASH

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ABSTRACT
Background: *Composite resin is the most commonly used restorative material. One of properties composite resins is surface hardness can change due to exposure of the restorative material to oral fluids such as alcoholic mouthwash. The degradation that occurs due to alcoholic mouthwash is able to reduce the surface hardness of the nanohybrid composite resin. Glycerin is able to increase the hardness of the composite resin by perfecting the polymerization that occurs in the restorative material when exposed to light cured light.* ***Objectives****: This study aims to determine the effect of glycerin application on the hardness of nanohybrid composite resins after immersion in alcoholic mouthwash.* ***Methods:*** *A total of 32 samples of nanohobride composite resin in this study were made in the form of a cylinder with a diameter of 5 mm and a thickness of 2 mm. The nanohybrid composite resin samples were divided into control and treatment group by applying glycerin on the sample surface before light curing. The study was continued by immersing the sample into artificial saliva for 24 hours and alcoholic mouthwash for 6 hours. The research continued with surface hardness test using the Vickers Hardness Tester.* ***Result*** *: Paired bivariate T test showed a significant difference between the two groups ($p<0.005$). The conclusions of this study indicate that the application of glycerin has an effect on the hardness of the nanohybrid composite resin after immersion with alcoholic mouthwash.* ***Conclusion:*** *The application of glycerin affects the hardness of the nanohybrid composite resin after immersion with alcoholic mouthwash.*

Key words*: Glycerin application, Hardness, Nanohybrid composite resin*
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INTRODUCTION

Composite resin is the most commonly used dental restorative material due to its good ability to form bonds with enamel and dentin, is resistant to fracture and has a color similar to natural teeth.[1] The use of composite resins has increased every year.[1,2]

Nanohybrid composite resin is the latest version of composite resin with nano technology and developments from microhybrid composite resins.[3] Nanohybrid composite resins have the advantage that the volume of the filler is large and the size of the filler is small, this makes the strength between the particles tighter. Nanohybrid composite resins are categorized as the first universal composite resins that have relatively easy handling and polishing capabilities, so they are widely used as restorations on anterior teeth and can also be used as restorations on posterior teeth.[3,4]

Mouthwash is starting to become a general need that is almost used by many people. Types of mouthwash commercially circulating in the community consist of alcoholic mouthwash and non-alcoholic mouthwash. Public knowledge about the benefits and drawbacks of this type of mouthwash is still lacking, especially mouthwashes that contain alcohol which can cause side effects in the form of dry mouth or xerostomia, burning sensation, tooth structure damage and damage to composite resin restorations.[6]

The alcohol contained in mouthwash has been shown to cause surface degradation by opening the polymer chain of the composite resin. Polymers that are often degraded are monomers, oligomers and unreacted linear polymers.[6] The OH- group in ethanol adds more water absorption, which then causes the swelling of the composite resin and increases the risk of resin deforming or fracture.[7-9] Fractures in composite resins usually also occurs. This is caused by water absorption because the Bis-GMA component in the nanohybrid type composite resin is hydrophilic. This is a deficiency of nanohybrid type composite resin which can cause the restoration material to decrease in hardness.[6]

The alcohol content in mouthwash can cause surface degradation of the restorative material and water molecules can easily enter the composite resin so that the composite resin hardness decreases. An additional material is needed that can increase the hardness of the composite resin. One of the materials that can be used is glycerin.[8]

Glycerin is a surface coating material containing polyhydric alcohol compounds which have a structure of three hydroxyl groups in one molecule or commonly called trivalent alcohol in liquid or gel form. This material can be used as a barrier for composite resin fillings which serves to reduce the formation of an Oxygen Inhibition Layer (OIL) layer on the restoration surface.

MATERIAL AND METHODS

This research was conducted at the Preclinical Laboratory of Dentistry, Diponegoro University, Biochemistry Laboratory, Faculty of Medicine, Diponegoro University and UPT Integrated Laboratory, Diponegoro University, Semarang. This type of research is a laboratory experimental study with a Post-Test Control Group design. This research uses 32 samples of nanohybrid composite resin molded in a cylindrical shape with a diameter of 5 mm and a thickness of 2 mm and compacted using weights weighing 500 mg for 30 seconds. The nanohybrid composite resin samples were divided into a control group and a treatment group by applying glycerin on the sample surface before light curing. The light curing process was carried out for 20 seconds as close to the sample surface as possible. All samples were polished using a Soflex bur to obtain a sample with a smooth surface.

The study was continued by immersing the sample into artificial saliva for 24 hours and alcoholic mouthwash for 6 hours. The sample was soaked by inserting the sample into an incubator with a temperature of 37^{o} C. The surface hardness test was then carried out using a Vickers Hardness Tester using a load of 100 gF for 15 seconds. .

RESULT

Table Result, mean hardness (HV)

Treatment group	Number of samples(n)	Mean(HV)
Control group (Without glycerin)	16	120.66
Treatment group (with glycerin)	16	135.10

In this study, there was a difference in hardness between the composite resin samples of the control group and the group treatment. The results of measurements and data collection showed that the hardness of the nanohybrid composite resin with glycerin application showed a higher hardness value than the nanohybrid composite resin sample without glycerin application with an average hardness value of 120.66 HV in the control group while 135.10 HV in the control group treatment group.

Data analysis table

Test T pair

	mean	t	Df	p value
Differences between groups	-14,434	12,251	15	0.040*

* Significant ($p < 0.05$); Paired T test

The research data were tested for normality using Shapiro-Wilk because the number of samples <50 and homogeneity test using Levene's test. The research data obtained were normally distributed and homogeneous and continued with paired T-test. In the paired T test results on the effect of glycerin application on the hardness of nanohybrid composite resins after immersion with alcoholic mouthwash, a significance value of $p < 0.05$ was obtained, so it can be concluded that there is a difference in the hardness of the nanohybrid composite resin without the application of glycerin and with the application of glycerin after soaking with alcoholic mouthwash.

DISCUSSION

Nanohybrid composite resins can experience changes in hardness which are influenced by several factors including less than optimal polymerization, restoration thickness, pH, water absorption and contact with fluids in the oral cavity such as alcoholic mouthwash. Composite resins require materials that can increase their hardness, such as the use of glycerin to last longer in the oral cavity.[1,2]

The results of statistical analysis with test T pair obtained p value = 0.0040 ($p < 0.05$) namely there is an effect of glycerin application on the hardness of the nanohybrid composite resin after immersion with alcoholic mouthwash. The application of glycerin on the surface of the composite resin before the light curing process is able to increase the formation of a more perfect polymer by reducing the formation of an oxygen inhibition layer (OIL) so that the hardness of the composite resin can increase.[10]

Glycerin is a surface coating material containing a polyhydric alcohol compound $C_2H_4(OH)$ which has a structure of three -OH hydroxyl groups in one molecule or commonly called a trivalent alcohol in liquid or gel form. This material can be used as a barrier for composite resins to polymerize properly. This material can increase

the hardness of the resin by blocking the contact mechanism between oxygen and free radicals produced by composite resin when exposed to light cured light which can form an oxygen inhibition layer (OIL). The free radicals that are formed during the polymerization process are unpaired electrons, will bind with oxygen in the air to form R-O=O (stable radical) bonds which then diffuse to produce peroxide radicals that can reduce the reaction of composite resin monomers to form an uncured monomer (OIL) layer which has a lower hardness.[11] Therefore, to prevent the formation of oxygen inhibition layer, a barrier such as the application of glycerin is needed to increase the hardness of the composite resin.[12,13]

Increasing the hardness of composite resin is necessary to prevent further damage such as easy occurrence of edge leaks, fractures and failure of restorations which result in composite resin fillings not being durable in the oral cavity due to decreased hardness.[15] One of the things that can cause a decrease in composite resin hardness is the use mouthwash containing alcohol. In a study by de Moraes (2014) stated that the alcohol contained in mouthwash can cause softening of the composite resin surface by removing monomers from the polymer structure and opening the polymer composite resin structure. The number of H+ ions in alcoholic mouthwash is greater because the pH is more acidic. These H^+ ions can be easily absorbed by the composite resin bonds reacting by catalyzing the ester groups of dimethacrylate monomers (Bis-GMA, UDMA, TEGDMA). Then the monomer that binds to H+ ions will be cut off from the composite resin polymer chain. This can induce a hydrolysis or diffusion reaction of water contained in the mouthwash resulting in polymer chain expansion, especially in the bond between the matrix and the composite resin filler, then the resin matrix slowly dissolves and results in increasingly severe damage, especially in decreasing its hardness.[16] Meanwhile, according to Jose PL (2017) the ethanol content in alcoholic mouthwash penetrates and diffuses in the polymer bonds causing expansion in the polymer composite resin structure. The Si-O-Si that bind the particles will be broken, due to the expansion that occurs so that the bond between the filler material and resin matrix will degraded.[17]

The content of water and alcohol are the main cause in reducing the hardness of the composite resin. The alcohol content can soften the surface of the composite resin by degrading its surface structure through breaking the silane bond with the matrix.[16] The resulting surface degradation due to alcohol is able to provide gaps for water molecules to easily enter into the composite resin structure and too much water absorption can increase the pressure inside the composite resin around the composite resin filler so that the bond between the resin matrix and the composite resin filler is broken.[9,17,18]

Increasing the hardness of the composite resin is needed to provide composite resin properties that are more resistant to liquids such as alcoholic mouthwash. The difference in the hardness of the nanohybrid composite resin in the control group and the treatment group was due to the reduction in the formation of oxygen inhibition layer so that the polymerization of the composite resin could run perfectly and the hardness of the composite resin could increase. The use of glycerin is recommended because it is a clear, colorless, odorless solution and has good stability to oxygen in the atmosphere.[18,19] The application of glycerin affects the hardness of the nanohybrid composite resin after immersion with alcoholic mouthwash. It is recommended that further research be conducted on the effect of glycerin application on other types and properties of nanohybrid composite resins.

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