



The difference between glycerin coating and without glycerin coating before curing process on nanohybrid composite resin against porosity of the restoration surface

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Abstract

Background: The polymerization process occurs when monomers bind to each other to form polymers and if there is a bond between oxygen molecules and free radicals, the polymerization can be inhibited by oxygen diffusion and form an oxygen inhibited layer (OIL) on the surface of the composite resin. Glycerin applied to the surface of the composite resin before the curing process was able to reduce the formation of OIL, thereby increasing the hardness and decreasing the surface roughness. The surface roughness of the composite resin is related to changes in the microstructure such as porosity. The use of glycerin on the surface porosity of composite resins has not been fully explained, so it needs further research.

Purpose: To Prove porosity of the nanohybrid composite resin filled with and without glycerin coating before curing.

Methods: This research is an experimental laboratory conducted using a post-test only control group design which includes two treatment groups, namely nanohybrid composite resin without glycerin and nanohybrid composite resin treated with glycerin. This research was conducted to examine the surface porosity of the nanohybrid composite resin using a Scanning Electron Microscope (SEM).

Results: There was a significant difference ($p < 0.05$) in the porosity of the nanohybrid composite resin without glycerin and with glycerin analysis.

Conclusion: There are differences in the amount of porosity in the composite resin with coating and without glycerin coating on nanohybrid composite resin fillings.

Keywords: nanohybrid composite resin, glycerin, porosity, dental material

Introduction

Composite resin is used as the first choice for anterior and posterior teeth restoration^[1]. Fillers are used in composite resins to enhance monomer and initiator systems¹. Based on its filler size, composite resins are classified into macrofilled, microfilled, hybrid, and nano-composite. Nano-composite has two types, namely nanofiller and nanohybrid composite^[2].

The nanohybrid composite resin consists of matrix materials, such as Bis-GMA, UDMA, and dicarbamate. Nanohybrid composite resin filler particles consist of milled glass fillers and nanoparticles with 40-50 nm in size³. The advantages of nanohybrid composite resins are durable, low shrinkage, good polishing results, easy to apply, and have aesthetic properties^[2,3]. The durability of composite resins ranges from 1-5 years and generally it can last for 2-3 years^[4]. Systematic reviews show that composite resin restorations have good clinical performance with failure rates varying from 1% to 4%⁵. The most common restoration failure is due to secondary caries and tooth fracture^[6].

Composite resin polymerization occurs when monomers are bonded to each other to form polymers^[7]. In the initiation phase, polymerization will produce free radicals to activate monomers by opening the C=C bond so that other monomers can bind to carbon atoms and form polymers^[8]. According to Aromaa and Vallitu (2018), if the bond between free radicals and oxygen is greater than with the monomers, the polymerization reaction can be inhibited by oxygen diffusion from the surrounding and form an oxygen inhibited layer (OIL) on the surface of the composite resin^[9].

The thickness of the OIL layer can damage the composite resin homogeneity and mechanical strength. To minimize the formation of OIL, the surface of composite resin is given a material that can block the contact between oxygen and free radicals, such as mylar strip and glycerine^[10]. According to Zakiyah *et al.*, (2019), the use of glycerin before the curing process can increase the hardness and decrease the surface roughness of the nanofiller composite resin^[11].

The surface roughness of the composite resin is related to the composition and microstructural changes, such as porosity^[12]. Increasing the amount of porosity in the composite resin can reduce compressive strength, flexural strength, and cause fracture^[13]. The porosity of the composite resin may cause abrasion, discoloration, and initiate plaque accumulation on the composite resin surface which can increase the risk of secondary caries^[14].

Based on the research conducted by Rodrigues *et al.*, (2015) [15], they found a slight porosity in the nanohybrid composite resin. This is probably due to the manufacturing process that occurs during the material manipulation technique [15]. The results of composite resin fillings without porosity are difficult to achieve, regardless of the application technique and materials used [16]. Based on the explanation above, it shows that the use of glycerin towards the severity levels of the composite resin porosity has not been fully explained. Due to this gap of knowledge, the difference between glycerin coating and without glycerin coating before curing process on nanohybrid composite resin against porosity of the restoration surface needs to be investigated.

Materials and Methods

The type of this research is experimental laboratory. This research was conducted using post-test only control group design. The samples used were 32 nanohybrid composite resins (Filtek Z250XT, 3M ESPE, USA) in the form of disc molds with a diameter of 5 mm and a thickness of 3 mm. The samples were divided into two groups consisting of 16 samples for group 1 (composite resin without glycerin coating) and 16 samples for group 2 (composite resin with glycerin coating).

Sample Making

Divide the sample of the nanohybrid composite resin into each group. Each group consists of 16 samples, namely:

Group 1: composite resin without glycerin coating – light cure for 20 seconds

Group 2: composite resin with glycerin coating – light cure for 20 seconds

The composite resin is placed on the disc mold and covered by a glass over the mold. The composite resin was irradiated perpendicularly using light cure with a distance of 1 mm with the provisions of the working procedures for each treatment.

Sample Storage Process

Each group of composite resin samples was labeled according to the group and immersed in distilled water in petridish. Then, stored in an incubator at 37°C for 24 hours.

Composite Resin Surface Porosity Observation and Measurement

The porosity of the composite resin can be observed using a Scanning Electron Microscope (SEM). The composite resin is removed from the mold, then the coating is applied. The sample was inserted into the SEM device and irradiated with a 10Kv electron beam. After that, observations were made on all surfaces and took photos of them. The results of photos of SEM porosity readings were measured using Image J software.

Data analysis

Data analysis used in this reasearch are Shapiro-Wilk Tes for normality test and Independent T-Tes to determine the differences between groups.

Result

Based on this research, it was reported the differences between glycerin coating and without glycerin coating before curing process on nanohybrid composite resin against porosity of the restoration surface.

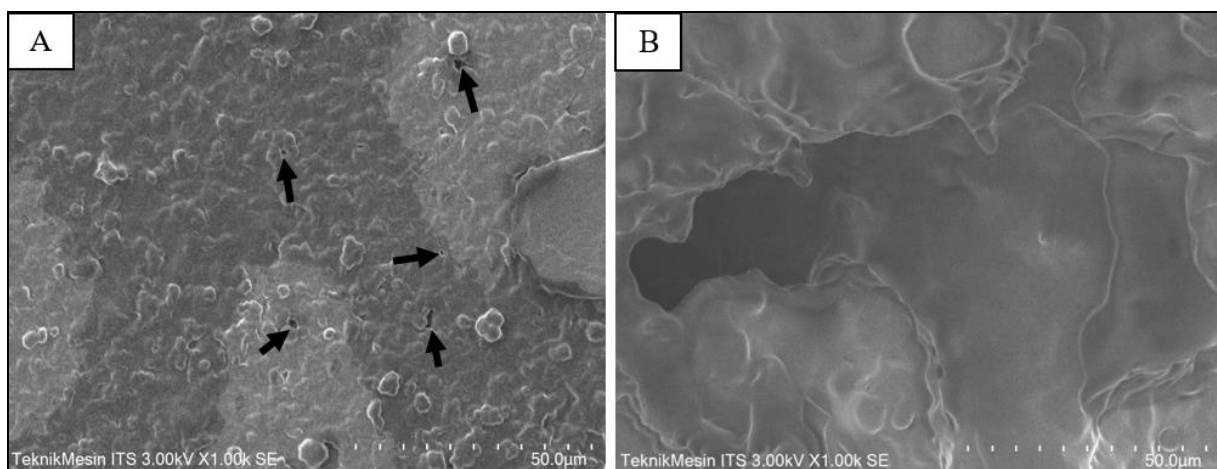


Fig 1: The Scanning Electron Microscope (SEM) results towards the porosity on the composite resin sample using 1000x magnification. (A) Composite resin without glycerin coating and its porosity indicated by black arrows, (B) Composite resin with glycerin coating and no visible porosity.

Table 1: Average value and standard deviation of composite resin porosity.

Group	N	\bar{X}	SD
Composite Resin without Glycerin Coating	16	53.0263	10.37808
Composite Resin with Glycerin Coating	16	40.2656	17.80191

Based on table 1, it is known that the average porosity test value of composite resin on composite resin without glycerin coating is greater than the composite resin with glycerin coating.

Table 2: Independent T-Test

Treatment	<i>p-value</i>
Composite Resin without Glycerin Coating	0.019*
Composite Resin with Glycerin Coating	

*There is significant difference between groups ($p\text{-value} < 0.05$)

Based on the Independent T-test in table 2, it is known that the result is $p = 0.019$ ($p < 0.05$). The statistical analysis data showed that there was significant difference between the treatment groups.

Discussion

The porosity of the composite resin without glycerin coating was greater than the composite resin with glycerin coating. Porosity is one of the important parameters to characterize the microstructure which may contain liquid or air above the total volume of the material [14]. Composite resins containing porosity can affect material properties including absorption capacity and mechanical properties. Several factors that can cause porosity are polymerization and material viscosity [16].

The polymerization of the composite resin occurs through three stages, namely initiation, propagation, and termination. In the initiation stage, free radicals are induced to activate monomers and form polymer chains. Composite resin exposed to outside air allows Oxygen (O₂) to bind with free radicals so that it can reduce the photo-initiator system and stabilize free radicals by forming an oxygen inhibited layer (OIL). The OIL on the surface of the composite resin will bind to free radicals which then begins the propagation stage. In the propagation stage, monomer formation is added to the polymer chain which is being activated. However, due to the presence of OIL, the formation of monomers into polymers cannot be formed completely so that the polymerization process is inhibited [7, 8, 17].

The formation of OIL results in failure of polymerization so that it can increase roughness, decrease hardness, form a porous structure, and affect marginal adaptation [13].

Surface roughness is related to the composition and porosity of the composite resin material [12]. The roughness of the composite resin is affected by the filler materials, filler hardness, the degree conversion of resin matrix, the stability of the silane coupling agent, and the polishing procedure. The addition of nanofiller gives a lower roughness value because of the small filler size [18].

Glycerin is a liquid that is stable towards oxygen because it can balance water vapor in the surrounding atmosphere when exposed to air [17, 18]. In this study, glycerin was applied in a thin layer using a microbrush on the surface of the composite resin, then it was irradiated using a light cure. The consistency of glycerin does not harden during irradiation and has a transparent color that does not affect the irradiation distance and light intensity during polymerization [10].

Glycerin applied on the surface of the composite resin before the curing process can optimize the polymerization process by blocking the contact between oxygen and free radicals so that no oxygen is trapped in the composite resin [10, 11]. Optimal polymerization will form a polymeric bond which results in a reduction the amount of the lost monomers so that it can increase the density of the composite resin [13]. The porosity of the oxygen-containing composite resin has an impact on its biocompatibility because the monomer that is not polymerized and in contact with the porosity can potentially lead to the dislodge the composite resin due to solubility [14, 16].

Glycerin viscosity can also affect the amount of composite resin porosity. Glycerin is twice higher in viscosity than water. The high viscosity of glycerin is able to prevent the formation of porosity because the glycerin molecules can enter most of the nanopores [16]. In line with the research of Yassen and Haridy., (2015) stated that the viscosity of glycerin is 1.4/2 Pas which allows it to close the cavity or porosity. Due to the small molecular size, when subjected to high pressure the glycerin molecules are able to cover the porosity [19].

The amount of porosity and microstructure of the material affects the wear rate, compressive strength and surface roughness. Porosity in composite resins can form during the manufacturing process [15]. Porosity can also occur from the intrinsic porosity of the material which cannot be controlled or modified by the dentist so a strict clinical protocol is the best way to reduce porosity [16].

Conclusion

Glycerin coating before curing process can reduce the porosity of the composite resin restoration. Porosity in composite resins can be form through manufacturing process that will affects the wear rate, compressive strength and surface roughness. The used of strict clinical protocol can be the best effort to reduce porosity in composite resin restoration materials.

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