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Literature Review

Benefit of Glycerine on Surface Hardness of Hybrid & Nanofill Resin Composite

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ABSTRACT

Background: *Composite resins restoration is a treatment for tooth structure loss due to pathological conditions. Longevity of composite resins restoration can be affected by surface hardness restoration. Glycerin can increase surface hardness restoration with inhibit bond oxygen and free radicals on polymerization composite resins.* ***Purpose:*** *Analyze the increase surface hardness composite resins restoration after glycerin application before light-curing composite resins.* ***Review:*** *Of the six journals included in this literature review, five journals reported significant differences because of the obstacles in the polymerization process of the composite resin when composite contact with light-curing will activate the photoinitiator to produce highly reactive free radicals, free radicals will break the double chain carbon bonds of monomers and form single bonds of free radicals with monomers. Bonding of free radicals with monomers will produce polymeric bonds (degree of conversion) which affects the level of surface hardness of the filling. While one journal noted no significant difference in the surface hardness of composite resin after glycerin application.* ***Conclusion:*** *The use of glycerin before light-curing can increase the surface hardness composite resin restorations.*

Keywords: *glycerin; surface hardness; oxygen inhibited layer; nanofill resin composite; hybrid resin composite*

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INTRODUCTION

One of many problems which often experience by Indonesian is cavity (dental caries). It can affect patients' quality of life. Dental caries prevalence in Indonesia is 45,3%.[1] The treatment done for dental caries is tooth filling or restoration by changing the loss of tooth anatomy structure.[2] The material used for tooth filling in dentistry is resin composite. Resin composite is chosen because it has several advantages such as having the same colour as the tooth itself and the ability to attach well with dental structure. [3]

The longevity of resin composite varies between 1-5 years.[4] The longevity of resin composite can be affected by secondary caries, occlusal wear and material fracture. Material fracture can occur because of the decrease of hard surface of restoration.[5] Surface hardness is the resistance to deformity from the applied pressure as a measuring tool for a filling material to determine the ability to withstand pressure during the chewing process.[6]

The surface hardness can be affected by the polymerization of the composite resin.[7] This happens due to polymerization process that will make sure the percentage of changing double carbon monomer bonds to be a single polymer called conversion degree. The residual monomer which cannot polymerize connected with conversion degree and surface hardness. The more residual monomer caused by unfinished polymerization process, the less hard it will be and it will make microleakage so that the failure of resin based composite will become bigger.[8]

REVIEW

The kind of resin composite used in tooth filling treatment or dental restoration to change the loss of tooth anatomy structure. This occurs because there is an advanced technology so that it can result in the new type resin composite to remove the lack of the previous type resin composite. These kinds of resin composite can be classified based on the size of its particle, the measurement of fillers, polymerization and viscosity.[9]

One of resin composite that is often used is hybrid resin composite and nanofiller resin composite. Hybrid resin composite is resin composite containing filler for 75%-80% with filler size starting from 0,6-2 μm.[10] Hybrid resin composite which has the same color as teeth structure and resistance to fracture. Meanwhile, hybrid resin composite has also good wear resistance and it can be used in posterior and anterior tooth filling.[11] Nanofiller resin composite has the particle size of 5-20 nm and contain filler of 79,5% so that it has good polishing characteristics, soft surface, and

shiny also high endurance towards abrasion. Nanofiller resin composite has very good mechanical and aesthetical characteristics. It can be used in posterior or anterior tooth filling.[5]

The difference size of filler in hybrid and nanofiller resin composite will influence the characteristics of resin composite itself. The bigger the filler, the weaker the attachment will be. It will cause abrasion when there are mechanical contacts which can make rough surface.[12] The difference container of the filler will influence the physical characteristics. The higher the filling the lower the resin composite until it can cause the polymerization is reduced, increase hardness of the surface and wear resistance.[10]

The cause of why resin composite faced a failure is because of secondary caries on rough tooth filling surface, occlusion resistance and material fractures. One of the causes of failure is that there is tooth filling fracture caused by the decrease of rough surface so that the characteristics must be paid attention to prevent tooth feeling fractures.[5] The hardness level of the subjects is used to evaluate resin composite towards the usage and to determine the degree of change of the materials on the load.[13] There are some methods that can be used to measure the hardness of resin composite by using Brinell, Knop, Rockwell, and Vickers.[7]

The surface hardness is affected by various factors such as light curing distance, the thickness of the resin composite filling, type of filler, degree of conversion and polymerization process.[7] The higher the distance between the light source and the surface of resin filler and the large thickness of the material will cause a decrease in the intensity of light exposed in the resin composite. This results in the light for not being focused and spreading so that only a few initiators experience the initiation reaction and less free radicals are formed so the degree of polymerization decreases will decrease.[14,15]

The type of filler can affect the surface hardness of the resin composite, for example the combination of nanoparticle and nanocluster filler types will cause a decrease in the amount of interstitial space between the filler particles so that it can cause an increase in physical properties such as the surface hardness of the resin composite. The degree of conversion is the percentage of carbon double bonds that change into single bond. Forming polymer of resin composite where the higher the degree of conversion, the hardness of surface properties will increase.[16] In addition, pH in the cavity can affect the hardness of surface because it can result in matrix degradation.[17]

One of the factors affecting the hardness of surface of resin composite such as polymerization on resin composite. If polymerization is disturbed, it can cause the decrease of the surface hardness of tooth filling. There are factors that affect polymerization process such as light intensity activation, the long exposure, the length of light waves, the thickness of resin composite, tip distance of light curing unit on resin composite, the colour of resin composite and also resin composite.[18] Besides, there is oxygen in the atmosphere which available in the patient's oral cavity. It can make the disruption in the polymerization process.[19]

The polymerization process is a chain reaction process inducted by free radical.[20] Resin composite contains photoinitiator if it is exposed by light cured with the wave length of 486 nm. It will stimulate photoinisiator to become active and form free radical which will initiate polymerization process. Polymerization reaction consists of 3 stages such as initiation, propagation, and termination.[9]

In the initiation stage of polymerization resin composite, the free radical is formed. Free radical is an unmatched electron so that it will become reactive and interact with molecular electron in its surroundings.[10] The content of Bis-GMA in resin based composite is monomer dimethacrylate which has double bond carbon (C=C). The double bond carbon will be broken down so that one of the bond will attach to each other forming single bond and resulting in other free radicals. These free radicals will react with other resin composite monomer. That way, it will lengthen polymer chain reaction.[21] The change in monomer and polymer will affect mechanical characteristics and the hardness of the resin composite.[22] The forming of long polymer bond which causes the decreasing distance between monomer and increasing the solidity of resin composite.[21]

Oxygen is the strong inhibitor in slowing down or stopping the polymerization of resin composite.[23] Oxygen will cause free radicals which is supposed to bond with monomer and oxygen itself. Oxygen bonding and free radicals are marked by the forming of stable peroxide radical and not being reactive. The stable bond makes the free radicals bond causes non formation of the remains of monomer on the surface of resin composite. The remains of the surface filling can be called by oxygen inhibited layer (OIL).[20]

Oxygen inhibited layer (OIL) is the layer formed because of oxygen reaction with free radicals. OIL is the layer contains the residual monomer due to the decrease of conversion can inherit mechanically, physically, the hardness of the surface and increase the hardness of the surface of resin composite. The more OIL formed, the less decreasing of the hardness of surface [23]. There is some opinions of the researchers about the effect of OIL.[24] The positive effect of OIL causes the photoinitiator diffusion to overlaying until there is an increase of bond strength.[25] Other than that there is an opinion who said that the hardness of surface will cause plaque, secondary caries, increasing micro leakage, discoloration, and causing the failure of composite filling because the filling is more fragile.[23]

There are several ways to reduce the formation of OIL, namely finishing and polishing after light curing and using barriers such as Mylar strips or glycerine before light curing. Mylar strip and glycerine can block the contact with oxygen on the composite surface so that the formation of OUL can be prevented.[26] Mylar strip can be used in the proximal and bucolic cavities while for the use of glycerine applications can be more effective for complex cavities in the occlusal and restricted areas.[23]

Glycerine is a polyhydric alcohol compound (polyol) with 3 hydroxyl groups in one molecule or we can call it trivalent alcohol. Glycerine has the molecular formula $C_3H_8O_3$.[20] Glycerine is produced from the reaction of oil and grease with water and then purified for a high quality product.[27] Glycerine is a colourless or clear, odourless, viscous, liquid. Glycerine has a sweet taste and is a non-toxic liquid.[28]

The application of glycerine before light curing aims to prevent the bond between free radicals and oxygen on the surface of the resin composite. Glycerine can be used as a protective gel in polymerization of resin based composite as glycerine is a stable solution than oxygen.[28] The absence of free radicals bonds with oxygen due to the glycerine provision before light curing unit will cause no stable bond to form until the free radicals are fully attached to the monomer resin composite. The maximum capacity of free radicals and monomer bonds can show no residual monomer on the surface of the resin composite filling (oxygen with inhibited layer) which can be called the maximum polymerization process. It will form polymer attachment resulting in reduced monomer distance loss and increased resin based composite in density.[21]

DISCUSSION

In the research of Park and Lee (2011), Strnad et al (2015) and Zakiyah er al (2018) on the hardness of filling surface on hybrid and nanofiller resin composite without polishing is divided into two groups with group 1 (without the layer of glycerine before the light curing) and group 2 (with the layer of glycerine before the light curing). The result of this research showed that there were differences on the hardness of surface significantly between result of group 1 and group 2. The difference of the hardness of surface is caused by the resistance of polymerization process of resin composite. This polymerization occured when light curing. Light curing will activate photoinitiator so that it resulted on free radicals which became extremely reactive. Free radicals will break the bond of double chain carbon monomer and form single form of free radicals with monomer. Free radicals with monomer will result in polymer bond (conversion degree) that affect the level of surface hardness filling. The hardness of surface in the tooth filling will decrease if the decrease of free radicals' bond occurs and monomer caused by the oxygen inside out mouth. The oxygen in our oral will hinder polymerization by bonding with free radicals. The bond of oxygen and free radicals will form the stable bond. The stable bond causes the form of free radicals with the remains of monomer on the surface of resin. The residual monomers on the surface of the filling is called oxygen inhibited layer (OIL). So that a lot of OIL is formed will cause the decrease of surface hardness. Free radicals bond and oxygen can be prevented by giving glycerine before light curing. Glycerine has stable characteristics towards oxygen so that it can hinder oxygen to stop bonding with free radicals. That is why, the increase of surface hardness of resin based composite affected by glycerine that is given before light curing.[23,26,20]

The difference of surface hardness was significantly proved by the research of Handayani et al (2019) and Kharisma (2020) about the surface hardness in resin based composite of nanofiller with polishing method. This significant different lies on polymerization process. In the group that glycerine wasn't applied, it affected by some factors like the conversion degree of polymerization (percentage of monomer bond and free radicals forming polymer chain) and the forming of OIL (from the bond of free radicals with oxygen). The result of oxygen due to polymerization will decrease excitability photoinisiator and stabilization of free radicals by forming OIL. If free radicals are bond with oxygen, they will decrease in numbers bonding with monomer so that the residual monomers can decrease their own surface hardness of resin composite. Meanwhile, in the group layered with glycerine, glycerine was given to prevent the bond between free radicals and oxygen so that it can increase the surface hardness of tooth filling. Therefore, the layer of glycerine has the purpose to prevent disturbance in polymerization by preventing oxygen to bond no more with free radicals.[29,30]

In this research done by Park and Lee (2011) and Strnad et al (2015) about the hardness of surface of tooth filling in hybrid resin composite with polishing is divided into two groups such as group 1 (without the layer of glycerine before light curing) and the second group (layered by glycerine before light curing). The result of the research showed that there was no difference between surface hardness significantly. The difference that was not significant happened because the polishing stage was done by reducing 0,2 mm. Polishing done by reducing 0,2 mm from the surface hardness of tooth filling was the same with removing OIL formed because the limited OIL with 0,2 mm deep. Apart from that, the deepness of surface was influenced by glycerine with 0,2 mm deep. So that, if polishing were done in group 2 (layered by glycerine before light curing) won't affect the surface hardness of tooth filling.[23,26]

However, Marigo's research (2019) said that there was no significant difference on surface hardness of the tooth filling by giving glycerine before light curing. In theory, glycerine can be used as physical barriers on the surface of tooth filling before light curing to reduce the forming of OIL. OIL can be formed if polymerization reaction contained oxygen that can hinder polymerization reaction. Oxygen will bond with reactive free radicals so that the hydro peroxides will be stable and has lots of monomer remains. The usage of glycerine is recommended to light treatment on the surface off posterior occlusal teeth.[31]

The reason of choosing glycerine because of the consistency. Glycerine won't harden while light curing happens and the light intensity of LED during polymerization.[29] Other than that, glycerine also has liquid consistency with low viscosity to reach the difficult part of the teeth.[30] That's why glycerine can be used to prevent the forming of oxygen inhibited layer due to free radicals' bond and oxygen. Therefore, glycerine is recommended to

be used in tooth filling on the surface of posterior occlusal teeth.[31]

CONCLUSION

There was an increase in the surface hardness of the resin composite with glycerin application before to light curing on hybrid resin composite and nanofiller resin composite without and with polishing.

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