Addition of Fiber To Solution of Fiber Reinforced Composites In Dental

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Abstract:
Along with the times, people's knowledge is increasing, to the awareness to do dental care. Dental care has now become a community need, starting from technical advancements in the installation of stirrups to the installation of dentures. Associated with dental care in the installation of dentures, there are several complaints of dentures that are easily soluble so that they are easily removed.Fiber reinforced compositesis a composite resin with added fiber reinforcement. FRC consists of composite, fiber and silane. Silane in the composite functions ascoupling agent. This is because the composite and fiber cannot bond well, so that between the two requires a coupling agent, namely silane. The use of silane in FRC composites is to improve the bond and help the bond between the composite and the fiber. One of the factors that affect the performance of the silane is the time it takes to dry the silane adhesive. The process of adding fiber will reduce the solubility of the material and water absorption. The results of a review of several studies show that there are differences in the mean values of the two sample groups. The difference in the mean value of the two sample groups was analyzed using a review of previous research journals. The conclusion is that the addition of fiber to FRC with silane affects the solubility of fiber reinforced composites.

Keywords: *addition of fiber, solubility, fiber reinforced composites*

INTRODUCTION

Tooth decay due to caries, systemic conditions, trauma, and periodontal disease, can result in impaired mastication. Fixed Denture Restoration or GTC directly that uses a composite material with additional fiber is called Fiber Reinforced Composite (FRC) (Widyapramana, et al., 2013).

Fiber Reinforced Composite is a material that has at least 2 components, namely fiber surrounded by a resin matrix (Hasanah, et al., 2014). This was also conveyed byWibowo, et al. (2018) that fiber reinforced composite is composed of composite resin and fiber as reinforcement. Another FRC composition is a silane coupling agent which is useful for increasing the adhesion between the matrix and the fiber. The composite resin matrix in FRC consists of a hydrophobic filler and a polymer composed of polymerized dimethacrylate monomers. Faizah, et al. (2016) parameters that determine success as reinforced are oriented, compositional, volume and distributed.

The use of fiber in dental materials has several functions including increasing strength and stiffness, increasing the resistance of the material to fracture, and reducing shrinkage (Septommy, et al., 2014). Fibers commonly used in dentistry are polyethylene fiber and glass fiber. Glass fiber is most often used because it has good chemical resistance properties. More than 90% of e-glass type fiber is used more often than all other glass fiber types (Maulida, et al., 2019). Its advantages include good aesthetics and biocompatibility, compression strength, and safety for patients with nickel allergy.

The availability of dental glass fiber in Indonesia is still limited with quite expensive prices (Jaelani, et al., 2019). However, the use of glass fiber in general has been used in engineering which is usually used as a reinforcement in the manufacture of gypsum panels, sculptures, automotive components, the aircraft industry, and so on.

The role of fiber in reducing water absorption cannot be separated from the strong adhesion between the glass fiber and the polymer matrix resulting from the silane coupling agent. The addition of a hydrophobic silane coupling agent can increase water resistance (Maulida et al., 2019). However, the content of non-dental glass fiber, namely Na2O and K2O, did not affect the adhesion of Candida albicans because the volume of fiber used was too small.

As described above, the idea arises that the possibility of adding fiber can be used as an alternative in the construction of dental FRCs. This can affect the flexural strength of theFRC of solubility in water. Based on the description above, the purpose of this paper is to explain the effect of adding fiber to the solubility of FRC.

LITERATURE REVIEW

Fiber

Fiber or fiber is a type of material in the form of components that form a complete elongated network of long, thin and easily bent substances (Murdiyanto, 2017). Fiber can be described as a material having an elongated shape with a slight and balanced transverse diameter and thickness of less than 250 m. Fiber orientation, distribution, content, and ability to maintain these parameters are very important for reinforcement to get good results (Zhang & Matinlinna, 2011). Fiber can improve the mechanical properties of the composite resin and can reduce external stresses thereby reducing the possibility of fracture because the pressure received by the fiber will be transmitted to the surrounding tissue (Dhamayanti & Nugraheni, 2013).

There are two types of fiber, namely dental and non-dental fibers. Dental fiber is a fiber that is provided for treatment in the field of dentistry(Martha, et al., 2010). Types of dental fibers include carbon fiber, aramid fiber, nylon fiber, ultra high molecular weight polyethylene (UHMWPE), and glass fiber (Dhamayanti & Nugraheni, 2013). While non-dental fiber is a type of fiber used in the manufacture of gypsum, sculptures and automotive tools that are easily found on the market at affordable prices (Murdiyanto, 2017).

Composite

Composite is a material formed from a mixture of two or more materials and has a better quality than the constituent materials (Kosjoko, 2014). Composite resins are commonly used as tooth-colored fillings that can be used on both anterior and posterior teeth (Judge, 2013). The composite resin contained in the FRC serves to hold the fiber in place. Composite resins also have the function of transmitting pressure between the fibers and protecting the fibers from chemicals, mechanical trauma and moisture (Zhang & Matinlinna, 2011).

Composite resin is a material formed from two or more materials combined together, where the properties of the constituent materials vary. One material as a filler or matrix and the other as reinforcement or reinforcement. The matrix or filler is usually ductile, soft and binding when it reaches its freezing point. Reinforcers are usually more elastic and have good tensile strength but cannot be used at high temperatures(Astika, et al., 2013). The advantages of composite resins include good aesthetics, easy to manipulate, low heat conductor, durable for anterior dental fillings and not easily soluble in fluids in the oral cavity (Mukuan, et al., 2013).

Most modern composite resins today use aromatic or aliphatic diacrylate monomers. The most commonly used dimethacrylate composite resins in dentistry are bisphenol-A glycidyl methacrylate or bis-GMA, urethane diemethacrylate or UDMA and triethylene glycol diemethacrylate or TEGDMA (Wadudah, et al, 2013). Composite resins with bis-GMA have the advantages of good esthetics and easy application, but they have the disadvantage that when polymerization occurs, shrinkage usually occurs (Fu et al., 2014).

Polymerization

Polymerization is the process of changing the molecular structure of a restorative material (Pasril & Pratama, 2013). The polymerization process will determine the percentage change of monomer double bonds into polymer single bonds which is usually called the degree of conversion. The degree of conversion of the irradiated composite resin is generally 55-75%.

The mechanism of the polymerization process occurs through 3 stages. The first stage is the initiation stage where at this stage large molecules break down into free radicals due to the heat process. The second is the propagation stage where the activated monomers are bonded to each other so that a polymer with a certain number of monomers will be formed. The last stage is termination where the chain will form a stable bond (Anggi & Muttaqin, 2017).

The polymerization process is assisted by irradiation. The irradiation of the composite resin material is for at least 20 seconds. This is needed to get the maximum polymerization results. Insufficient irradiation will cause the material to harden on the outermost layer only and produce a soft layer on the bottom. Irradiation that is not carried out thoroughly on the material will result in shrinkage of the material. The intensity of the beam must also be considered, therefore the tip of the beam tool is placed as close as possible to the surface of the material without touching it (Sidiqa, et al., 2018). The hardness of the material is determined by the thickness of the material. Ideally, the light composite resin has a thickness of approximately 2-2.5 mm so that light can penetrate through to the most basic layer (Noviyani & Puspitasari, 2018).

Many factors can affect the polymerization of a composite resin with light. The factor of the material is the color and type of composite resin used. Factors of irradiation are the quality of the irradiation source, irradiation time, irradiation position, and the thickness of the composite resin layer (Pasril & Pratama, 2013).

Composite Fiber Resist

Fiber reinforced composites (FRC) is a material which is a combination of polymer matrix and reinforced fiber. Fiber is the main component in FRC which functions as reinforcement in composite restorations. Composites are materials that are formed from a combination of two or more constituent materials through inhomogeneous mixing and the mechanical properties of each of the constituent materials are different. Composites consist of a matrix that acts as an adhesive and a filler that protects from external damage and acts as a reinforcement (Sriwita & Astuti, 2014).

FRC is a mixture of polymer matrix and reinforced by fiber (Imam, et al., 2015). The main purpose of using FRC is to obtain high strength with a high modulus of elasticity. The use of FRC in dentistry is widely used for the manufacture of fixed dentures, post making, periodontal splinting, trauma splinting, orthodontic splinting, orthodontic retention, bridges, crowns, indirect restorations, and replacing metal-based restorations (Zhang & Matinlinna, 2011).

METHODS

This paper is a literature review review. Literature review is a scientific story on a particular problem. The literature review contains reviews, summaries, and the author's thoughts on several library sources (articles, books, slides, information from the internet, etc.) about the topics discussed.

RESULTS AND DISCUSSION

The review in this journal found that there were differences in the solubility of some of the composite resins tested. Research entitled "Sorption and Solubility of Composites Cured with Quartz-tunsten Halogen and Light Emitting Diode Light Curing Units". The study showed that there were differences in the solubility of the composite resin(Archegas, et al., 2008). The following table shows the differences in the solubility levels of each composite resin.

Table 1. Differences in Solubility of Composites

Composite	Storage Time	n	Sorption	Solubility
Herculite XRV	24 hours	20	7.64 (0.40) [a]	0.20 (0.20) [a,b,c]
	7 days	20	15.08 (0.33) [d]	0.10 (0.28) [a,b]
	28 days	20	16.44 (0.34) [e]	0.19 (0.27) [a,b,c]
Tetric Ceram	24 hours	20	8.45 (0.43) [b]	0.45 (0.22) [b,c,d]
	7 days	19	17.60 (0.53) [f]	0.40 (0.40) [b,c,d]
	28 days	20	18.86 (0.68) [g]	0.36 (0.51) [b,c,d]
Filtek Z250	24 hours	20	9.35 (0.47) [c]	0.72 (0.29) [d]
	7 days	20	22.61 (0.47) [h]	0.32 (0.40) [b,c]
	28 days	20	27.95 (0.29) [i]	-0.07 (0.21) [a]

Note: Groups with the same superscripted letters indicate they were not statistically significantly different ($p<0.01$).

The three composite [resins] showed the lowest solubility level of -0.07 and the highest 0.72, where all the solubility levels did not have a significant difference.

Another study entitled "The effect of the composition of some non-dental glass fibers on the solubility of fiber reinforced composites components". Based on the results of statistical tests, it can be concluded that the composition of glass fiber affects the solubility of components (Faizah et al., 2016). The following is a complete table of 1-way ANOVA test results.

Table2. Summary of Statistical Results of ANOVA 1 Pathway Solubility of FRC Components with Variable Fiber Composition and Volume

Kelompok	Kelarutan komponen	
	F	P
Komposisi	45,90	0,000

The results of the 1-way ANOVA test in the table above show a significance value ($p<0.05$). Based on the results of statistical tests, it can be concluded that the composition of glass fiber affects the solubility of the components of fiber reinforced composites.

Fiber reinforced composites (FRC) is a mixture of polymer matrix and reinforced by fiber (Imam et al., 2015). The main purpose of using fiber reinforced composites is to obtain high strength with a high modulus of elasticity. The use of FRC in dentistry is widely used for the manufacture of fixed dentures, post making, periodontal splinting, trauma splinting, orthodontic splinting, orthodontic retention, bridges, crowns, indirect restorations, and replacing metal-based restorations (Zhang & Matinlinna, 2011).

FRC has the advantages of good aesthetics, non-toxic and highly biocompatible. The effectiveness of FRC depends on several factors such as the composite resin used, the content of the composite resin contained in the productfiber, the attachment between the matrix and fiber, quantity fiber in the resin matrix, form fiber, long fiber and direction fiber (Yanti, et al., 2011).The composition of FRC includes fiber and matrix resin which functions as reinforcement and provides stability and rigidity. Protective part matrix resin, producing strength and workability of the material/ material (Sharafeddin, et al., 2013).

Dental materials that come into contact with fluids in the mouth such as saliva will cause the solubility of the material. The release of components in the mouth will result in a cytotoxic reaction. Cytotoxic reactions will be dangerous if allowed to continue. This release occurs in two ways, namely by breaking the bond between fiber and the matrix or by softening the matrix by water (Faizah et al., 2016).

The water-soluble components of FRC cannot be equated with the large amount of water that enters the FRC. This is because the rate of diffusion of water and the dissolution of a component in water is not directly proportional. This means that the absorption of water will occur faster than the dissolution of the components of the material. The solubility of the components of a material can be reduced by the use of fiber (Alagga & Gupta, 2020).

Solubility is a state of a compound either gas, solid or liquid that can be dissolved in a gas, solid or liquid to form a homogeneous solution.(Pramudhita & Hendriani, 2016). Water absorption and solubility are important properties and have an influence on the strength, color stability of composite resins, and resistance to abrasion. Absorption of water can also result in swelling, weight gain, and solubility. In composite resins, water absorption and high solubility can reduce the mechanical ability which will affect the long-term durability of the FRC material (Yudith, et al., 2013).

There are many factors that affect the water absorption and solubility of materials. The use of a matrix can affect water absorption and solubility if the matrix used is more than the filler will cause more water absorption. Inadequate irradiation intensity can lead to inadequate polymerization as well as to facilitate water absorption and FRC solubility (Yudith, et al., 2013).

Dental materials that come into contact with water molecules in the mouth will cause the material to dissolve. The release of fiber components that occur in the mouth will result in a cytotoxic reaction. This process can occur in two ways. The first is by breaking the fiber bond with the matrix, so that water will enter the composite component and is followed by the release of oxides and alkali oxides. The second is through the process of softening the matrix by water (Schmalz & Bindslev, 2009).

Solubility test of FRC composite was carried out in order to determine the hardness of the composite resin as a dental material. This is in line with Kafalia, et al. (2017) that solubility and water absorption can affect the surface hardness of composite resins. Factors that affect the surface hardness of composite resins include physical and chemical properties. Physical properties of composite resins that affect the hardness of composite resins are solubility and water absorption, while chemical properties are polymerization of the material, thickness of composite resin, irradiation distance, and irradiation time. A material immersed in water will experience two different mechanisms. First, the absorption of water, which causes swelling and an increase in mass and second, the solubility of the material in water, the release of components from the unreacted monomer which causes a decrease in mass (Archegas et al., 2008).

The amount of water-soluble components of FRC cannot be equated with the amount of water that enters the FRC. This is because the rate of diffusion of water and the dissolution of a component in water are not directly proportional. Water absorption occurs faster than the dissolution of the component until it approaches saturation (Zhang & Matinlinna, 2011). Bonding with the addition of a good silane coupling agent between the matrix and fiber will cause less water absorption to occur, thereby reducing the solubility of the FRC components (Schmalz & Bindslev, 2009).

CONCLUSION

Fiber reinforced composites (FRC) is a material consisting of a matrix (composite) with fiber reinforcement. The composition of FRC is matrix (composite), fiber and silane coupling agent. The matrix functions to protect and maintainfiberto stay in place, while fiber has a function as a reinforcement inFRC. The addition of fiber to FRC can affect the solubility of FRC.

Solubility is an important property and has an influence on the strength, color stability of composite resins, and resistance to abrasion. Absorption of water can also result in swelling, weight gain, and solubility. In composite resins, water absorption and high solubility can reduce the mechanical ability which will affect the long-term durability of the FRC material.

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