The impact of non dental glass fiber addition against tensile strength pre-polymerized fiber reinforced composite

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Received 1 September 2023; 1st revision 15 October 2023; Accepted 20 September 2023; Published online 24 October 2023

Keywords:

Prepolymerized Resin Composite; Non Dental Glass Fiber; Fiber Reinforced Composite; tensile Strength

ABSTRACT

Background: *Composite resin is one of the most used materials in dentistry because of the simplicity and high aesthetic value. One of the varieties of composite resin is prepolymerized composite resin. Some research show that prepolymerized composite resin has relatively low mechanical strength. Therefore fiber needs to be added in repolymerized composite resin. The aim of this research is to find out the effect of adding non dental glass fiber into tensile strength fiber reinforced composite.*
Method: *This research used true experimental method with post test only control group design, there are two groups, the first one is prepolymerized composite resin with additional non dental glass fiber. The data has been tested with parametric independent T-test.*
Result: *The result showed the average flexural strength of prepolymerized composite resin without additional non dental glass fiber was 10.6625 Mpa, while the prepolymerized composite resin + non dental glass fiber was also 18.2263 Mpa. Independent T-test showed the p value = 0.000*
Conclusion: *The conclusion of this research is that prepolymerized resin + non dental glass fiber has higher tensile strength than composite resin without additional non dental glass fiber, thus it can be used as alternative choice applied in dentistry.*

doi: http://dx.doi.org/10.30659/odj.10.0.1-6
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Odonto : Dental Journal accredited as Sinta 2 Journal (https://sinta.kemdikbud.go.id/journals/profile/3200)
How to Cite: Hadianto *et al*. The impact of non dental glass fiber addition against tensile strength pre-polymerized fiber reinforced composite. Odonto: Dental Journal, v.10, special issue1, n.0, p.1-6, October 2023.

INTRODUCTION

The composite resin isa restoration material with resin basic material developed from the previous material namely silicate cement and acrylic cement[1]. The composite resin is one of the dentistry materials that is frequently used, because its application procedure is easy and only needs simple maintenance as well as has good aesthetic value[2]. The weakness of composite resin is the less good cavity edge adaptation, porosity, wear resistance and mechanically not chemically bonded with the email[3]. The composite resin consists of three main components namely matrix, filler, and coupling agent[1].

The development of science and technology, in dentistry field has progressed such as new type dental restoration material namely prepolymerized composite resin. The prepolymerized composite resin is composite resin with filler prepolymerized content, where filler prepolymerized is formed through the mixture between resin monomer and inorganic filler (pure silica)[1].

The prepolymerized composite resin has advantages such as has a good aesthetic value and polishing, able to add composite resin strength with increased filler composition, reduce the shrinkage at the time of polymerization, and easy in application[3]. The most important mechanical character to be evaluated in composite resin restoration includes the endurance against the fracture, and wear and tear[4].

The addition of fiber in composite resin can be called as Fiber reinforced Composite (FRC)[5]. FRC is a composite material made of polymer matrix, and is reinforced by fiber, which has tensile strength as well as high flexural strength[6]. The benefit of FRC is the minimum intervention, aesthetic compared to the metal dan can be done in one visit[7]. The addition of fiber as reinforcing material in composite resin has several benefits such as improving the strength and stiffness, durable against the fracture, able to lower the shrinkage[8].

One of the FRC compositions is Fiber. Fiber is a material made of long filament with an average diameter of 10 μm. The function of fiber is as reinforcer and gives stability and stiffness[9]. One of the fiber types is non-dental glass fiber, non-dental glass fiber has composition of SiO2 (56.88%), K2O (0.56%) and Na2O (12.91%).

The mechanical character of human dental structure which have been varied, the dentin tensile strength is 50 Mpa, compared to the email as 10 Mpa[2]. It shows that the tensile test can become the correct testing, and there is standard developed for other materisl[6].

The purpose of this research is to find out the impact of glass fiber non-dental addition against the prepolymerized tensile strength of pre- prepolymerized fiber reinforced composite. The benefit of this research is to give the data though contribution in dentistry filed as well as can be used as one of the options for dentistry practitioner in applying the dentistry material. The hypothesis of this research is that there is tensile strength impact against the tensile strength pre- prepolymerized fiber reinforced composite.

RESEARCH METHOD

This research is true experimental research, with the Post Test Control Group Design, which is conducted in December 2020. The amount of sample is 8 pieces, calculated using the Steel & Torrie formula. Then the sample is divided into 2 groups namely prepolymerized composite resin group + non-dental glass fiber and prepolymerized composite resin without non-dental glass fiber. The tool and material used in this research are: prepolymerized composite resin, non-dental glass fiber, Universal Testing Machine.

Non-dental glass fiber is taken one by one with tweezers to get the threads shape. Then non-dental glass fiber is scaled and cut to meet the criteria of fiber concentration. The sample creation of composite resin is by putting to the mold. Sample with non-dental glass fiber addition is added with silane. Non-dental glass fiber that has been moistened by silane horizontally then put the composite resin until filling the mold. Then, light curing process is done to the sample for 20 seconds. Then, incubation is conducted with aquades in the incubator with the temperature of 37^{o} for 34 hours. After that, can be done the tensile strength test to determine the tensile strength of the sample with Universal Testing Machine.

RESULTS

The result of this research regarding the tensile strength test in composite resin without non-dental glass fiber and the composite resin + non-dental glass fiber shows average score as shown on the table below:

Table. 4.1 The average score and deviation standard of tensile strength between the composite resin without non-dental glass fiber and composite resin prepolymerized + Non-dental glass fiber

No	Group	Average	±Deviation Standard
1	Prepolymerized CR without Non-Dental Glass Fiber	10.6625	1.15936
2	Prepolymerized CR + Non-Dental Glass Fiber	18.2263	0.40383

Table 4.1 shows that there is difference of tensile strength average score from both treatment groups. The tensile strength of prepolymerized composite resin + non-dental glass fiber (18.2263 MPa ± 0.4) is higher than the tensile strength group of prepolymerized composite resin (10.6625 Mpa ± 1.15).

The data from the obtained research results is tested by normality and homogeneity tests. The normality test used the Sapiro-Wilk. The data of normality test result to both groups is as follows:

Table 4.2 Results of Shapiro-Wilk Normality Test

Group	Sig	Description
Prepolymerized CR without Non-Dental Glass Fiber	0.536	Normal Data
Prepolymerized CR + Non-Dental Glass Fiber	0.951	Normal Data

The result of normality test using the Shapiro-Wilk in all groups obtain a p value > 0.05, it shows that all data in each group are distributed normally. Then, continue with homogeneity test using the Levene test, with the results as follows:

Table 4.3 Results of Levene Test Homogeneity Test

Levene Test	p	Description
3.661	0.076	Homogenic Data

Table 4.3 shows that the result of Levene test the data of all groups is bigger than 0.05, so that the group data variant is homogenic. After the data is tested by normality and homogeneity tests, can be done the statistic test by using the Independent T-test with the purpose to see whether there is significant difference between the specimen groups. From the statistics data analysis test the tensile strength of prepolymerized composite resin with tensile strength of prepolymerized composite resin + non-dental glass fiber shows the data as follows:

Table 4.4 Analysis of Independent T Test Parametric Test Results.

Group	N	p
Without Non-Dental Glass Fiber	8	0.000
Non-Dental Glass Fiber	8	

Statistic test of Independent T-Test with the meaning p<0,05

Table 4.4 from the statistics data analysis result of tensile strength between Prepolymerized composite resin and prepolymerized composite resin + Non-Dental Glass Fiber it is obtained that the research meaning value is less than 0.05. It shows that there is significant difference between the composite resin without fiber and prepolymerized composite resin + Non-Dental Glass Fiber.

DISCUSSION

The results of the research shows that the addition of non-dental glass fiber to the prepolymerized composite resin causes average score of tensile strength is higher than the prepolymerized composite resin without fiber. It is affected by several factors namely, fiber content, fiber sticking, fiber position, volumetric fraction, fiber orientation direction, and fiber length.

Non-dental glass fiber has several contents, such as SiO2, Al2O3, MgO, and CaO. The SiO2 content is the main oxide as the glass fiber frame maker and can be bound well with the matrix. The Al2O3 content modifies the structure of SiO2 so that can improve the mechanical strength. The other contents such as MgO functions as stabilizer that can improve the chemical strength and elasticity modulus. While the CaO content can improve the durability[11].

The sticking between the matrix and non-dental glass fiber are formed because of the addition of silane coupling agent. The silane functions to form good bond between the matrix and fiber so that can improve the durability against the humidity. The silane characteristic is useful to improve the adhesion[8]. Chemically, the approach of fiber to the matrix occurs because of the bond between silica in the non-dental glass fiber and

prepolymerized composite resin matrix. Non-dental glass fiber has oxide metal content in certain concentration that can affect the FRC mechanical character[11]. The SiO2 content with estimation concentration od 55.86% as main oxide is able to form the hydrogen bond. The O element contained in the bis-GMA will be bond with the H in the non-dental glass fiber[11].

The position of fiber in fiber reinforced composite can have an effect on the tensile strength improvement. There are 3 types of fiber position which are commonly used in Fiber Reinforced Composite namely tension position, neutral, and compression. In this research the fiber position is located in neutral position. According to the research of Mosharraf, in 2011 that the neutral position is bale to improve the mechanical strength of FRC because it has a quite big shear force. The fiber position placement can affect the cracking of a material. In compression position, the tensile is not directly moved to the fiber, the tensile will be distributed in the composite resin first. The fiber can distribute is located in the weak area, such as in neutral side. In the given tensile strength will distribute the shear force in the fiber so that directly cause the fraction[12].

The volumetric fraction of the fiber can affect the tensile strength of prepolymerized fiber reinforced composite if the addition of fiber in the optimum limit, but if the addition of fiber is more than the optimum value than can affect the mechamic strength, because the resin cannot closely connect with the fiber so that the absorb energy value decreases. In this research the non-dental glass fiber used as amount as 1% of specimen volume namely 0.0406 gr. It is in line with the research of Syifa in 2018 stating that the addition of 1% fiber to the FRC is able to improve the mechanic strength optimally.

The orientation direction of fiber is divided into three, namely unidirectional, bidirectional and random. In this research I use the unidirectional thread direction arranged parallelly or one direction between one fiber with other fiber, the fiber orientation direction in unidirectional has bigger strength and stiffness than the bidirectional fiber direction based on krenchel factor. The strength and stiffness of fiber orientation direction in unidirectional will improve if the given load is parallel with the fiber direction, however if the given load is perpendicular with the fiber direction can reduce the strength and stiffness[5]. In the research of Ahmad, 2014 the FRC mechanic strength with bidirectional orientation direction is lower than the unidirectional direction. It is related to the Krenchel Factor value 1 a fiber with unidirectional direction can give the maximum reinforcement level in the tensile distribution.

The fiber composite thread type is divided into two, namely long thread (continuous) and short thread (discontinuous). This research uses the continuous type. The continuous fiber type has the advantage namely easily oriented, if compared to the discontinuous. The continuous fiber also can distribute the tensile in the composite resin, so that the mechanic strength will increase.

CONCLUSION

The tensile strength in prepolymerized composite resin with the addition of non-dental glass fiber has a higher tensile strength value than the composite resin without addition of non-dental glass fiber. It is caused, the addition of non-dental glass fiber is able to distribute the tensile evenly in all non-dental glass fiber layers.

ACKNOWLEDGE

The researcher would like to thank all parties who participated in this research, especially to the

institution of the researcher namely Faculty of Dentistry Sultan Agung Islamic University.

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