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Compressive Strength of Composite Resins Immersed in Water with Different Temperatures

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Abstract

Composite resins are widely used in dentistry because they are aesthetically pleasing and have good mechanical properties. Composite resin in its use as a restoration material in dentistry cannot be separated from exposure to salivary fluid and food and beverages consumed. The temperature difference of the food and beverages consumed may affect the mechanical properties of the composite resin. This study aims to determine the difference in compressive strength of composite resins immersed in water with different temperatures. The molding of the samples was carried out on a Teflon mold with a hole of 4.5 mm in diameter and 3 mm in height. The composite resin in the mold was irradiated with visible light for 40 seconds. Each sample was measured with a caliper to get the right size. The samples were immersed in aquabidest with temperature variations of 5°C, 25°C, 37°C, and 55°C. The compressive strength was measured using Shimatsu Autograph Ag-10 TE. One-way Anova test obtained a value of P = 0.113 or greater than a = 0.05, which means that there is no significant difference in the compressive strength of composite resins immersed in water with different temperatures. The compressive strength of composite resins immersed in water with different temperatures is the same.

Keywords: Composite Resin, Compressive Strength, Temperatures

Introduction

Composite resin is a dental restoration material that is often used in dental practice [6]. Composite resins have better mechanical properties and physical properties when compared to other fillings, such as acrylic and silicate resins [9]. Composite resin restorations are widely used to restore anterior tooth decay in class III, IV, and V cavities [13], tooth decay in class I cavities of premolars, and aesthetic factors [7]. Apart from the aesthetic aspect, the use of composite resin in posterior teeth is increasing due to considerations regarding the toxic effects of mercury produced from amalgam [14].

The oral cavity is always exposed to fluids both from food and drinks consumed and from saliva that is always produced. Composite resins are subject to hydrolytic degradation due to their polar nature that absorbs water from the environment. Various foods and drinks consumed by humans can affect the properties of the prosthesis used [5]. When people drink at different temperatures, it will cause temperature changes in the oral cavity. Temperature changes can affect the mechanical properties, namely the flexural strength of composite resin fillings, but do not affect the fracture resistance of composite resins in the oral cavity [4]. The temperature difference of the food a person eats may affect the mechanical properties of the composite resin. The mechanical properties of composite resins in someone who often consumes hot food may be different from those who often consume cold food. Based on this background, the author wants to examine the difference in compressive strength of composite resins immersed in water with different temperatures.

Material and Methods

Material

Tools used included teflon plates with cylindrical holes, 4.5 mm inner diameter and 3 mm height, celluloid strips, glass slab, magnifying glass, vernier caliper, visible light apparatus (Litex), petridish, Shimatsu Autograph Ag-10 TE, incubator

(Memmert), Carbolite Range incubator, oven. The materials used in this study are visible light composite resin from Galcier brand no. A2 (SDI) and aquabidest.

Methods

Printing of composite resins is carried out on Teflon plates with holes 4.5 mm in diameter and 3 mm high which are placed on a glass slab after the base is given a cellloid strip. Composite resin is inserted layer by layer, then the sample is pressed with a 200 gram weigher to compact and flatten the sample for 15 seconds Each sample that has been covered with cellloid strips is irradiated with visible light for 40 seconds. The distance between the tip of the light tool with the sample surface is 2 mm and perpendicular to the sample surface, irradiation is carried out twice, namely layer by layer, each layer is approximately 1-1.5 mm.

Each sample was removed from the mold after irradiation was complete. The samples were measured again with a caliper to get a more precise size and then immersed in aquabidest at 37°C for 7 days to minimize the influence of polymerization. The petridish that had been filled with distilled water was put into an incubator with a set temperature (e.g. 5°C). The samples were put into the petridish after the water temperature reached 5°C and kept in the incubator at 5°C for 7 days. The same was done for samples soaked at 25°C, 37°C, and 55°C.

Result

From the results of testing the compressive strength of the sample using the Shimatzu Autograph Ag - 10 TE tool, the following results were obtained:

Table 1: Compressive Strength Value of Glacier Composite Resin after immersion in water with different temperatures (Mpa)

Number	Water temperature for soaking			
	5º C	25º C	37º C	55º C
1.	573, 23	441,14	509, 55	500, 12
2.	398, 68	603, 92	500, 12	419, 91
3.	483, 60	481, 25	603, 92	306, 68
4.	490, 68	455, 30	573, 23	330, 27
5.	608, 63	396, 32	460, 01	509, 55
6.	460, 01	585, 04	334, 98	396, 32
7.	622, 79	592, 12	514, 27	455, 30

From the results of measuring the compressive strength of these samples, the mean values and standard deviations are shown in Table 2.

Table 2: Mean values and standard deviations of the compressive strength of Glacier composite resins immersed in water of different temperatures

Number	Water Temperature for Soaking	N	$\bar{X}$	SD
1.	5º C	7	519, 66	83, 42
2.	25º C	7	507, 87	84, 31
3.	37º C	7	499, 44	86, 88
4.	55º C	7	416, 88	78, 60

To determine the significance of the compressive strength of composite resins immersed in water with different temperatures, a one-way ANOVA test was conducted, the results of which are shown in the table.

Table 3: One-way ANOVA Test

	Sum of Squares	Free Degree	Mean Square	F	F
Between groups within the total group	45989, 733 166763, 55 212753, 28	3 24 27	15329, 911 6948, 481	2, 206	.133

After conducting a one-way Anova test, the P value = 0.113 or greater than a = 0.05, which means that there is no significant difference in the compressive strength of composite resins immersed in water with different temperatures because the results of the Anova test are obtained greater than a = 0.05, so it is not continued with the HSD test.

Discussion

This study uses measurement validity which includes 3 elements, namely: Measuring instruments, measuring methods, and measurers (authors). It is intended to get valid, reliable, and precise research results. Homogeneous samples were obtained by controlling the research variables. The samples were obtained by paying attention to controlled variables which include how to make the sample, the shape, thickness and diameter of the sample, how to irradiate, how to immerse the sample in water, immersion time, and how to measure compressive strength. Controlling the research variables was also carried out by using a fixed measuring instrument to test the compressive strength of the composite resin, namely the Shimatzu Autograph Ag-10 TE.

A hybrid type light-cured composite resin with A2 color was used in this study. The selection is because hybrid type composite resin has been widely used in dental practice and can be used in areas that have high pressure so that it can be used as a posterior tooth filling material [10]. The choice of A2 color is due to aesthetic considerations because it is the same color as the teeth and the light intensity becomes more adequate so that the hardness is quite good.

The samples in this study were soaked in water before the compressive strength test was carried out in order to get conditions or conditions that are almost the same as the conditions of the oral cavity which are never free from liquids. Composite resins soaked in water for 7 days showed higher Kc than Kc composite resins soaked for 1 and 6 months [11]. Composite resins soaked after 2 weeks show an increase in Kc value, then it will stabilize until week 6 [2].

Water molecules can induce degradation through two mechanisms. First, the water content diffuses and occupies the free volume between the polymer bond chains, causing the resin matrix to expand and undergo expansion, thus initiating monomer chain breaks. Another mechanism is that water can degrade the bond between the silica surface and the coupling agent through hydrolysis reactions resulting in the release of filler particles from the resin matrix. This condition causes a reduction in mechanical properties, one of which is fracture of the composite resin [8].

Compressive strength is important to know in materials used for dental restorations because this property affects the chewing process. In the chewing process there are many compressive forces, especially on the posterior teeth [1]

Oral tissues can accept temperatures with a lower limit of 4°C and an upper limit of 60°C [3]. This study used

temperatures of 5°C, 25°C, 37°C and 55°C. The temperature of 5°C is assumed to be the lower limit of the temperature that can be accepted by oral tissues, 55°C as the upper limit, and 37°C as the normal body temperature. 25°C is used as the standard room temperature.

Materials in compression or pressing also have properties that are affected by pressure. Plastic and elastic are properties that can be affected by pressure and these properties are usually independent of heat treatment. Based on the statistical analysis of the compressive strength test results, it was found that there was no significant difference in the compressive strength of the composite resin after immersion in water with temperatures of 5°C, 25°C, 37°C, and 55°C. This may be because after soaking for 14 days Kc will increase so that there is a stronger bond between the resin matrix and the filler material. The strength of the bond makes the mechanical strength of the composite resin higher and not easily destroyed by compression pressure [9].

Very high temperatures cause compressive strength to decrease [12]. The temperatures used in this study are 5°C, 25°C, 37°C and 55°C, where there is no difference in compressive strength because at that temperature there has been no change in the bond between atoms of the matrix contained in the composite resin.

A linear decrease in the strength of the composite resin occurs with increasing temperature although in this study there was no significant difference from the statistical test results. This decrease occurs because the matrix contained in the composite resin has thermoplastic properties when heated. Increasing temperature causes the matrix in the composite resin to become elastic and will reduce the bond between atoms. The effect of increasing temperature also causes the polymer in the composite resin to expand and will fill the gaps. If it continues to expand and there are no more gaps or spaces to compensate, the resin will break easily when compressed.

Conclusion

From the results of this study, it can be concluded that the compressive strength of composite resins immersed in water with different temperatures is the same.

Acknowledgment

Nil.

Conflict of Interest

The author declares no conflict of interest.

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