

DENTINO
JURNAL KEDOKTERAN GIGI
Vol VI. No 1. Maret 2021

EFFECT OF WATER-SETTABLE GIC IMMERSION IN RIVER WATER AND PDAM WATER ON DIAMETRAL TENSILE STRENGTH

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ABSTRACT

Background: Dental and oral health problems according to Riskesdas (2018) in Indonesia is 57.6% and South Borneo is almost 60%. High level of damage in South Borneo is caused by the people still consumption of river water as a source of clean water. Caries can be treated by restoration of tooth, one of them is water settable GIC..

Objective: Knowing the effect of water settable GIC immersion in river water and PDAM water to diametric tensile strength. **Method:** This study used a true experimental laboratory research method with a post test only design with a control group design on 27 samples which were divided into 3 groups immersion. **Result:** This research shows that the mean of diametric tensile strength in group 1 (7.15 MPa), group 2 (8.42 MPa), and group 3 (10.54 MPa). The One Way Anova statistical test shows the value of ($P < 0.05$) which means that there is a significant difference in the value of the diametric tensile strength of each treatment group. **Conclusion:** There is an effect on the decrease in the value of the diametric tensile strength after immersion of water settable GIC in river water and PDAM water.

Keyword: Diametral Tensile Strength, GIC Immersion, River Water.

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INTRODUCTION

Oral and dental health is an integral part of human body which condition may affect the well-being. The most notable oral and dental disease occurred in Indonesian population is dental caries.¹ Dental caries or tooth cavity is an abnormality of dental hard tissue which is manifested by the demolition of email and dentin caused by demineralization as the result of interaction between microorganism, saliva, debris and host.² Based on Riskesdas 2018, Indonesian population shows an average of oral and dental diseases as much as 57.6% and it almost reached 60% in South Kalimantan.³ The high incident of dental caries in South Kalimantan is caused by environmental factor that is the utilization of river water.⁴

River water is fed by water that comes from wetlands, such as peatlands and swamps from the environment around the river. Wetlands are areas whose environment is saturated with water, such as swamps and peat, both permanent and temporary.⁵ The large amount of swamp water flowing into rivers causes the water to be acidic. River water in Kal-Sel is flowed by various rivers, so that it uses river water for daily needs such as rinsing and brushing teeth.³

Based on the average chemical parameter content of river water and PDAM water, it is known that the average value of the pH content of river water is more acidic than that of PDAM water, the pH of river water is 3-5 and the pH of PDAM water is 6.5-8.5. In terms of quantity, it has the potential to be used as a water source that can be used by humans for daily needs, but in terms of health quality and aesthetics, river water is not suitable for human activities, because it does not meet clean water standards according to PP 82 of 2001. PDAM can be an alternative as a suitable source of clean water because the PDAM water has been filtered and coagulated to neutralize the pH of the water, so as to prevent caries.³

Caries can be managed by removal of carious tissue removal and restoration of the tooth. One of the restoration materials developed and used by dentists is water-settable GIC. Water-settable GIC can be directly mixed with sterile water, making it easier for dentists because of its simple application. The acid solution in the liquid is freeze dried and then combined directly into the powder so that it can be mixed with sterile water. When the powder is mixed with water, the acid solution

combined with the powder dissolves followed by an acid-base reaction. The viscosity level of water-settable GIC is lower at the beginning of mixture than conventional GIC, making it easier to apply. Water-settable GIC contains less acid concentration than conventional GIC, which is 30-35% so it does not cause excessive irritation, formation of new carious lesions and high resistance to abrasion.⁸

The high abrasion resistance of the restorative material is related to the diametral tensile strength. If the diametral tensile strength is high, the hardness and resistance of the material to abrasion is high. Diametral tensile strength is a mechanical property of water settable GIC.⁹ Mechanical properties of water settable GIC can change by various factors, one of which is when exposed to water with low pH or acidic water, causing water settable GIC to degrade.

Based on this background, the researcher wants to know the effect of immersion in water settable GIC in river water and PDAM water on the diametric tensile strength.

MATERIALS AND METHODS

This research has obtained a research permit and ethical suitability issued by the Health Research Ethics Commission of the Faculty of Dentistry, University of Lambung Mangkurat No. 109 / KEPKG-FKGULM / EC / IV / 2020. This study used a true experimental laboratory research method with a post-test only and a control group design on 27 samples that were divided into 3 groups. Group 1 was the water settable GIC sample group immersed in river water, group 2 was the water settable GIC sample group immersed in PDAM water, group 3 was the conventional GIC sample group immersed in distilled water with 9 samples each with sample size diameter 5mm and thickness 2mm. The tools and materials used in this study were sample molds with a diameter of 5mm and a thickness of 2mm, sliding caliper, paper pad, celluloid strip, plastic filling instrument, agate spatula, scalpel, beaker, pH meter, tweezers, erlenmeyer, beaker glass, measuring cup, incubator, Universal Testing Machine, water settable GIC type II (restorative material) chromoglass brand from Lascod, Italy, conventional GIC type II brand GC Gold Label 9 Extra, Japan. vaseline, river water, PDAM water, and artificial saliva.

The research procedure was initiated with samples production using sample molds with a diameter of 5mm and a thickness of 2mm. The finished mold was covered with celluloid strips that were placed on the surface of the lab glass and then applied with vaseline. The conventional GIC and water-settable GIC restoration materials were stirred

according to the factory rules and put in the mold then covered and flattened with a celluloid strip. After the sample was stiffened, the sample was removed and trimmed with a scalpel. The sample was then stored in a measuring cup containing 100 ml of artificial saliva and placed in an incubator at 37oC for 24 hours so that the perfect setting reaction occurred. Furthermore, the samples were immersed for 55 hours in each group. After 55 hours, the samples were dried and then the values for the diametrical tensile strength of the samples were measured using a universal testing machine. Samples were measured with a crosshead speed of 0.5mm / min and a load cell of 250kgF until cracks or fractures were formed in the specimen.

Data analysis was using the Shapiro-Wilk normality test and Levene's homogeneity test. Data that were normally distributed and homogeneous were then analyzed using the One Way Anova parametric test to assess the hypothesis which was subsequently followed by the Bonferonni Post Hoc test to see the significant differences. Data processing was then performed using SPSS computer software.

RESULTS

This research was conducted in June 2020 in the wet laboratory of the Faculty of Dentistry ULM for the production of 27 samples and at the UGM Faculty of Engineering laboratory for sample measurement using a universal testing machine. After the measurement, the average value is obtained as follows.

Table 1. Result of Mean Value and Deviation Standard of GIC Water Settable Immersion Effect on Diametral Tensile Strength

Treatm ent Group	Diametral Tensile Strength (MPa) Mean Value ± Deviation Standard
Group 1	7,15 ± 2,18
Group 2	8,42 ± 2,20
Group 3	10,54 ± 2,90

Based on table 1, it can be seen that the average value of the highest diametral tensile strength is in the conventional GIC sample group immersed in aquadest, while the average value of the lowest diametral tensile strength is in the water settable GIC sample group immersed in river water. If the three groups are compared, the mean value of the diametral tensile strength in the water settable GIC sample group immersed in PDAM water is lower than the conventional GIC sample group

immersed in distilled water and the mean value of the diametral tensile strength in the water settable GIC sample group immersed in PDAM water higher than the GIC water settable sample group immersed in river water. When viewed as a whole, the mean value of the diametral tensile strength is around 7.1-10.5 MPa.

Data obtained from the test results of the value of diametral tensile strength, then performed statistical analysis using SPSS 26.0. At this stage, the data normality test was carried out using the Shapiro-Wilk Test, then the data homogeneity test was carried out with the Levene's Test. The results of the data normality test for the value of diametral tensile strength, namely the value of $P = 0.070$ in group 1, $P = 0.260$ in group 2, and $P = 0.219$ in group 3. The data shows a P value > 0.05 , which means the data is normally distributed. The results of the data homogeneity test were $P = 0.184$ ($P > 0.05$) indicating a homogeneous data variant. The test results obtained that all data were normally distributed and homogeneous, so that it was continued with One Way Anova parametric analysis.

Table 2. *One Anova* Test Statistical Deviation Result of GIC Water Settable Immersion Effect on Diametral Tensile Strength

Speciment	<i>One Way Anova</i> Test (P-Value)
Group 1	
Group 2	*P=0,038
Group 3	

Based on table 2, the results of the One Way Anova statistical test show the P value = 0.038 ($P < 0.05$), which means that there is a significant difference in the value of the diametral tensile strength in each treatment group. The One Way Anova test was significant and the variants were the same, then the Post Hoc Bonferroni follow-up test was continued to find out which groups had significant differences.

Table 3. *Post Hoc Bonferoni* Test Result of GIC Water Settable Immersion Effect on Diametral Tensile Strength

Speciment	<i>Post Hoc Bonferoni</i> Test (P-Value)
Group 1 on Group 2	*P=0,861
Group 1 on Group 3	*P=0,036
Group 2 on Group 3	*P=0,347

Based on table 3, the results of the Post Hoc Bonferoni test showed that there was a significant difference ($P < 0.05$) between the water settable GIC

sample groups immersed in river water compared to the conventional GIC sample groups immersed in aquadest. The water settable GIC sample group immersed in river water was compared with the water settable GIC sample group immersed in PDAM water and the water settable GIC sample group immersed in PDAM water was compared to the conventional GIC sample group immersed in aquadest which showed no significant difference.

DISCUSSION

The results of "The Effect of Water-Settable GIC Immersion in River Water and PDAM Water on Diametral Tensile Strength" study shows that there are variations in the value of water settable GIC's diametral tensile strength after its immersion in river water and municipal water as well as conventional GIC immersion in distilled water. The results of this study showed that group 1, group 2, and group 3 experienced a decrease in the value of the diametral tensile strength. This is because each immersion solution shows different conditions, one of which is the degree of acidity (pH). The low degree of acidity (pH) causes the water settable GIC to easily degrade, so that the diametral tensile strength decreases.

Water-settable GIC consists of aluminosilicate glass and polyacrylic acid, but what distinguishes water settable GIC from conventional GIC is that it can be mixed with sterile water.¹¹ This is because the powder in water settable GIC has been combined with polyacrylic acid which has been compacted in freeze-dried form. One of the advantages of water settable GIC is its high resistance to abrasion, so it has a higher mechanical strength than conventional GIC.⁷

In this study, the value of the diametral tensile strength in the water settable GIC sample group immersed in river water had the lowest mean value of 7.15 MPa due to the acidic nature of river water. This is in accordance with the research of Farahdillah et al (2017) which states that materials exposed to solutions with low pH experience degradation so that they have a lower diametral tensile strength value.¹²

When the acid is presence in the water, hydrogen ions (H^+) coming from the acid solution enter and then the H^+ ions will react with the outer surface of the glass particles which are still smooth. This causes cations on the glass surface such as Ca^{2+} , Na^+ , and Al^{3+} which previously bind to polyacrylic acid to be released and leaked, causing degradation in the water settable GIC. This is supported by the research of Francisconi et al (2008), which shows that there is a decrease in mechanical properties after immersion in an acidic

solution due to the release of cations from the water settable GIC.¹³

Another factor that affects the value of the diametral tensile strength of the water settable GIC is the immersion time. The longer a material is immersed in acidic water, the higher the decrease in the mechanical properties of the material. Andina's research (2011) states that prolonged contact between restoration materials and an acidic environment (low pH) can cause degradation of the restoration material.¹³

The value of the diametral tensile strength in the conventional GIC sample group immersed in distilled water had the highest mean value, namely 10.54 MPa. This is in accordance with the research of Permatasari et al (2016) which states that the restoration material immersed in sterile distilled water does not experience significant changes in mechanical properties.¹⁴

The results of research by Feng et al (2018) stated in their research that the restoration material by immersing in sterile water for six months did not show significant changes in mechanical properties. In Fitriyana's (2014) study, it was stated that GIC suffered more morphological damage when it was in the oral cavity which had an acidic pH compared to those that only had contact with saliva.¹⁴

The value of the diametrical tensile strength in the water settable GIC sample group immersed in PDAM water has a higher average value than the water settable GIC sample group immersed in river water and has a lower average value than the conventional GIC sample group immersed in aquadest which is equal to 8.42MPa. This is consistent with the research of Nadia et al, which states that PDAM water is not acidic, because filtration and coagulation has been carried out to neutralize the pH of the water.³

In this study, there was a significant difference between the water settable GIC sample group immersed in river water and the conventional GIC sample group immersed in aquadest, due to the low pH of river water. This is in accordance with the research of Permatasari et al (2016) which states that restoration after immersion in river water experiences a higher degradation than sterile aquadest.¹⁴

Research by Cender (2018) reveals that the degradation of restorative materials is due to exposure to acidic solutions, while restorative materials exposed to sterile water do not change significantly in mechanical properties.¹⁴ This is supported by research by Singh et al (2012) which states that the restorative materials exposed to acid solutions experience a significant reduction in

mechanical properties compared to restorations exposed to distilled water.¹¹

In this study, there was no significant difference between the water settable GIC sample group immersed in PDAM water and the conventional GIC sample group immersed in distilled water because the pH of the PDAM water was close to neutral so it did not experience a significant decrease. This is supported by research by Nadia et al (2018) which states that the pH of PDAM water is close to neutral so it does not cause degradation.³

The results showed that the pH of each solution was 2.9 for river water, 7.5 for PDAM water, and 7 for sterile distilled water. This is in accordance with the theory of Fitriyana et al (2014) which states that materials exposed to an acidic pH will experience a higher decrease in mechanical properties, thus causing the value of the diametral tensile strength of the water settable GIC sample group immersed in river water to have the lowest value compared to with other sample groups.¹⁴ Based on this research, it can be concluded that there is an effect of immersion in water settable GIC in river water and PDAM water on diametric tensile strength.

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