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Comparative Study of Micro-Leakage Between Glass Ionomer Cement Restoration Materials and Alkasites on Cavitas Class I (GV. Black)

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ABSTRACT. Microleakage is a gap that allow clinically undetectable passage of bacteria, fluids, chemical substances between the tooth and its restoration. Microleakage can occurs whether in a cavity restored with Glass Ionomer Cement or Alkasite. The objective of this study is to compare the microleakage between GIC and Alkasite after 1 day, 7 days and 30 days polymerization. This study used 30 specimens divided into six groups. Group A is restored with GIC and Group B restored with Alkasite. Group A1 and B1 restored and conditioned in incubator for 1 day, group A2 and B2 for 7 days, group A3 and B3 for 30 days. The specimens isolated using varnish nail except the restored area and immersed in methylene blue 1% for 1 day, then all specimens were washed and cut longitudinally. The results were observed using a stereomicroscope. The observation results analyzed using nonparametric test Kruskal-Walis test, showed there's no significant difference in each material with different conditioning times ($p > 0.05$). Post hoc test using Mann-Whitney likewise, showed no significant difference between GIC and Alkasite with similar conditioning time. Descriptive statistics showed that all the mean of microleakage in GIC is bigger than Alkasite and microleakage mean score in both materials conditioned for 30 days in incubator is smaller than conditioned for 1 day and 7 days. This study concluded that microleakage in Alkasite is smaller than Glass Ionomer Cement

KEYWORDS: Microleakage, Glass Ionomer Cement, Alkasite, Class I

INTRODUCTION

Glass Ionomer Cement (GIC) is a restoration material that has often been used since its introduction by Kent and Wilson in 1972.[1] Glass Ionomer Cement is a water-based and self-adhesive material where contains fluoroaluminosilicate glass and a matrix in the form of polymers or copolymers of carboxylic acids.[2] Glass Ionomer Cement has several such advantages are relatively easy to manipulate and most importantly its nature that is able to release fluorine ions.[1] GIC material obtaining its attachment to the tooth structure is by forming a chemical bond between carboxylic acid in the polymer and calcium in the tooth structure. [3]

Glass Ionomer Cement has disadvantages, one of which is that it has a high viscosity level so that it can cause micro-leakage, George's research (2018) shows the average value of GIC micro-leaks after restoration for 1 day is 3.00. [1] In addition to micro-leakage GIC also has disadvantages, namely its opaque appearance is considered less aesthetic so that Alkasite is introduced, this material has the ability to release fluorine and has a more aesthetic clinical appearance. [4,5]

Alkasite is a dental material consisting of a liquid containing dimetharcrylate and an initiator and powder containing glass filler, initiator and pigment. Alkasite is a self-curing material and light curing as another option. [6]Alkasite has the ability to release fluorine and calcium hydroxide ions which function as anti-cariogenics as well as prevent demineralization of tooth structures. [7] This material also contains filler which has the ability to minimize the occurrence of shrinkage during polymerization so as to reduce micro-leaks that occur, but research by Burgess (2015) shows that micro-leaks can also occur in alkasite with an

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average value of micro leakage in Alkasite after restoration for 1 day, which is 0.5. [4] Micro-leakage will be the entry point of oral fluids, ions and bacteria that cause post-restoration sensitivity, pulp inflammation and secondary caries. [8]

Several studies have been conducted to see the average comparison of micro-leakage values between GIC and alkasite after soaking for 1 day. Research by Samanta et al (2017) states that the average micro-leakage value in the V GIC class cavity is greater (1,280) than alkasite (0.283). [6] Research by George et al (2018) also states the same thing that the average micro-leakage value in class II GIC cavitas is greater (3.00) than Alkasite (0.10).

Based on the research above, it turns out that there is still a difference in the average micro-leakage value in the two restoration materials and no research has been found on the comparison of micro-leaks between GIC restoration and Alkasite restoration after 7 days and 30 days of polymerization. GIC bonding to enamel due to interaction with the mineral hydroxyapatite will increase within a few days and will continue for several months which issuspected to decrease the micro-leakage value. [9,10,11] Alkasite material contains PEG-400 DMA in its liquid which plays a role in increasing the binding strength of this material and research by Tran et al (2020) shows that alkasite can form hydroxyapatite and the percentage of *hydroxyapatite-forming* components increases over time, this is thought to reduce the value of micro-leakage. [4.12 13]

Therefore, researchers are interested in re-examining the comparison of micro-leakage of Glass Ionomer Cement and Alkasite restoration materials as restoration materials in class I cavitas of premolar teeth after 1 day, 7 days and 30 days of polymerization.

MATERIALS AND METHODS

This type of research is Experimental Laboratory with Post-Test Only Design method, to see a comparison of micro leakage images in Alkasite restoration and *Glass Ionomer Cement* on cavitas class I premolars using a stereomicroscope.

The specimens in this study are premolars of the upper jaw which have no caries, no restoration, the crown is intact and there is no fracture and has been cleaned with alcohol and then stored in *saline* solution. The cleaned teeth will then be prepared in the form of class I cavitation with details of a mesiodistal length of 4 mm, a buccal-palatal width of 2 mm and a depth of 4 mm.

The number of specimens used in this study amounted to 30 specimens which were divided into six groups, namely Group A1 (restoration with GIC which was carried out storage of specimens in humid conditions in the incubator for 1 day), Group B1 (*Alkasite* restoration carried out which was carried out storage of specimens in humid conditions in the incubator for 1 day), Group A2 (restoration with GIC which is carried out storage of specimens in humid conditions in the incubator for 7 days), Group B2 (*Alkasite* restoration which is carried out storage of specimens in humid conditions in the incubator for 7 days), Group A3 (restoration with GIC which is carried out storage of specimens in humid conditions in the incubator for 30 days), Group B3 (restoration *Alkasite* storage is carried out in a damp in the incubator for 30 days).

Teeth that do not have caries, fractures or restorations will be prepared with a mesiodistal width of 4 mm, a buccal-palatal width of 2 mm and a depth of 4 mm. Specimens that will be restored with GIC will be prepared which begins with using spherical bur to obtain the depth of cavitation then widened cavities with using cylindrical bur. Specimens that will be restored with *Alkasite* will be prepared which begins with using spherical bur to obtain the depth of the cavity then the cavitation is widened using cylindrical bur and makes a bevel of the edge of the restoration with bur *fissure*.

Cavity depth was measured using periodontal probs and ensured the smoothness of the prepared walls with sonde *half moon*. The teeth are then divided into 6 groups with 5 teeth in each group.

Prepared teeth that are included in group A1, group A2 and group A3 will be prepared which begins with applying *dentin conditioner,* with a *microapplicator* for 20 seconds. After that, it is rinsed using water sprayed with a *syringe* and then dried using *a cotton moplet* until the cavity is moist.

After that, prepare GIC with a ratio of powder and liquid is 1: 1, namely one measuring spoonful for powder and one drop for the liquid on the *paper pad* above the *mixing slab.* Then the powder is divided into two equal parts with a plastic spatula. Then the powder is mixed and stirred with the liquid for 10 seconds with a pressing and folding motion then put the remaining powder into the mortar and mix the whole material and collected within 20 seconds, so that the total stirring is 30 seconds until the material is homogeneous, then collect it at the end of the spatula and take the

material with a *plastic filling instrument* then put into the cavity. GIC hardening will occur for 7 minutes from the start of stirring the material and then applied with *cocoa butter* to isolate the material.

Prepared teeth that are included in group B1, group B2 and group B3 will be restored with *Alkasite* which begins with applying adhesive materials by rubbing using a *microapplicator* then thinning with a *chip blower* and a *light curing* procedure for 20 seconds.

After the *light curing* procedure is complete, proceed with preparing the powder and liquid in a ratio of 1: 1, namely one measuring spoonful for the powder and one drop for the liquid on the *paper pad* above the *mixing slab*. The powder and liquid are mixed with a small portion of the powder to the liquid and mixed and stirred the whole powder slowly within 45 to 60 seconds and then put into the cavity with a *plastic filling instrument* and will be hardened in 4 minutes.

After each specimen group was restored with GIC and *Alkasite*, the six specimen groups were placed in plastic vials on cotton wool that had been moistened with aquabides solution and stored in an incubator for 1 day, 7 days and 30 days at 37° C. Moisture can be maintained by maintaining the state of cotton wool to keep it wet. [14] After the storage of the specimen in the incubator is completed, the specimen is coated with two layers of *varnish nail* on the tooth surface except on the 2 mm tooth surface from the restoration edge. After that, the six groups of specimens will be put into a plastic vial containing 1% *methylene blue* for 1 day.

After all six groups soaked for 1 day the teeth were rinsed with aquabides and dried with *a blower chip*. Then, the tooth is split into two parts longitudinally from the buccal - palatal direction using a micromotor and *carborandum disc*. After that, each specimen was observed for micro-leaks that occurred in class I cavitation using a stereomicroscope.

After the specimens were immersed in a plastic vial containing *methylene blue* solution for 1 day, the teeth in these six groups were washed thoroughly under running water and then cut in half, then observed using a stereomicroscope with a magnification of 20x.

Micro-leakage measurements can be performed by providing the following critiqued score:[15]

1. Score 0 : No dye penetration
2. Score 1 : Penetration up to half of cavity
3. Score 2 :Penetration exceeds. Half the depth of cavity
4. Score 3 : Penetration reach walls of the pulp

The results of micro-leakage observations between *Glass Ionomer Cement* and *Alkasite* in class I cavitation viewed with stereomicroscopes were analyzed withthe Kruskal-Wallis non-parametric test followed by *post hoc* tests with Mann-Whitney.

RESULTS

The results showed that the specimen with the highest micro-leakage score occurred in group A1 with a score of 3. Group A2 had a score of 1 on five specimens. In group A3 there was only one specimen that did not have a micro-leakage and the other four specimens had a microleakage with a score of 1. In group B1 had a score of 1 on five specimens. In group B2 there was only one specimen that did not have a micro-leak and the other four specimens had a micro-leak with a score of 1. Group B3 had 2 specimens that did not have micro-leaks and only had micro-leaks with a score of 1 in the other three specimens.

The results of statistical tests with the Kruskal-Wallis test conducted to determine the comparison of micro-leaks between treatments with durations of 1 day, 7 days and 30 days on each material that the *p* value obtained is greater than 0.05 can be concluded that there is no significant difference.

The average micro-leak score in GIC and *Alkasite* that was stored in the incubator for 30 days was smaller than the average value of the micro-leakage score that occurred in each of the restored materials for 7 days and 1 day.

The results of the *post hoc* test with the Mann-Whitney test conducted to determine the comparison of micro-leaks between each group also showed that the entire *p* value > 0.05. It can be concluded that there is no significant difference in the micro-leakage that occurs between *Glass Ionomer Cement* and *Alkasite* with storage time in the same incubator

DISCUSSION

Micro-leakage is a gap that allows the entry of bacteria, liquids, molecules and ions between the walls of the cavity and clinically invisible restoration material which is considered to be the main factor

affecting the length the age of a restoration. [16] The results of micro-leak observations using a stereomicroscope show that micro-leaks can still occur in *Glass Ionomer Cement* and *Alkasite*. Based on the results of statistical analysis, it was found that the average value of micro-leakage in each specimen treated with storage in the incubator for 30 days was smaller than specimens with storage in the incubator for 1 day and 7 days, but the results of the Kruskal-Wallis nonparametric test showed that the difference that occurred was not significant.

The average value of micro-leakage in GIC specimens with storage in the incubator for 1 day is most likely due to the maturation process that is still ongoing even though the material has been *clinically set up*. Nicholson (2018) said that the state of GIC after maturation for 1 day is still the same as it was 1 hour after restoration, so this is suspected to be the cause of micro-leaks that occur in GIC with the highest storage duration of 1 day. In the maturation process, there is an ion exchange between GIC and the tooth structure which will continue to increase so that over time it produces a bond between GIC and a better tooth structure so that the average value of micro-leakage in specimens with storage for 7 days and 30 days is smaller. However, the GIC maturation process is a slow-running process so it is suspected to be the thing that causes the difference in micro-leakage in GIC material between storage durations of 1 day, 7 days and 30 days is insignificant. [10]

Alkasites also undergo ion exchange with tooth structures due to contains calcium *barium fluorosilicate* and *calcium fluoro silicate glass*. Todd (2016) said that the ion exchange that occurs produces a layer of minerals calcium *fluoride* and *calcium phosphate*, this mineral layer will continue to increase over time so that *alkasite* bonds with tooth structure will also become better. This is suspected to be the cause of the average value of micro-leakage in *Alkasite* specimens with a storage duration in the incubator for 30 days smaller than specimens with a storage duration in the incubator for 7 days and 1 day. However, the difference in micro-leakage that occurs is not significant, this is suspected to be because the alkasite ion exchange process and tooth structure run slowly. [4]

The entire average value of micro-leakage in *Glass Ionomer Cement* with a treatment duration of 1 day, 7 days and 30 days is greater than *alkasite* with a treatment duration of 1 day, 7 days and 30 days according to previous research conducted by George et al (2018), this is suspected to be due to the difference in viscosity between the two materials. In this study, Fuji IX was used, which is a GIC material that has adequate physical properties due to the influence of the high molecular weight of the polymer, but this high molecular weight produces a high viscosity, while *Alkasite* has a lower viscosity because it contains monomers with low viscosity, namely *Urethane dimethacrylate* (UDMA), DCP and *Aromatic aliphatic* -UDMA. Materials with high viscosity will be difficult to wet the entire surface of the teeth dengan baik sehingga can result in micro-leakage, on the contrary, materials with lower viscosity will be easier to wet the tooth surface so as to reduce the formation of micro-leakage between the restoration material and the tooth structure. [4.17]

In this study, specimens that were restored with GIC were given *dentin conditioner* first in the form of 10% polyacrylic acid for 20 seconds. The provision of dentin conditioner aims to lift the *smear layer* in the form of debris produced from enamel instrumentation, dentin and cementum or is dirt that can block the interaction of the material with the tooth structure, besides that *dentin conditioner* also plays a role in demineralizing part of the tooth structure and forming microporosity to obtain bonds through *mechanical mechanisms interlocking* and improve the chemical interaction of *polyalcenoic acid* with hydroxyapatite. *Dentin* conditioner can increase GIC bonding to tooth structure for the better, this is as mentioned by Wardani et al (2018) that the strength of GIC bonds given *dentin conditioner* is 7.7 MPa and in GIC materials that are not given *dentin conditioner* is 3.3 MPa. [2,18,19]

In specimens that were restored with *Alkasite*, adhesive materials were given first with a *one-step self-etch* technique and the adhesive material used in this study wasTetric N Bond Universal. Adhesive materials this contain. *methylaryloyxydyl dihydrogen phosphate* (MDP) so that it has the ability to perform mild demineralization of enamel and allows the formation of *a hybrid layer* on dentin then the monomer will enter into the microporosity formed and after polymerization a good bond will be formed between enamel and dentin with adhesive materials and *alkasites*, in addition MDP also has the ability to chemically trigger chemical bonding of restoration materials with calcium in enamel and dentin, as well as the ability to prevent degradation between the surfaces of adhesive materials. The bond strength produced after the administration of this adhesive material is 17 MPa so it is greater than the material given *dentin conditioner* this causes the average value of micro leakage that occurs in GIC to be greater than that of *Alkasite*. [8.21]

Although the entire average value of micro-leakage in GIC is greater than that of *Alkasite* in both

storage with a duration of 1 day 7 days and 30 days, the difference that occurs is not significant, this is thought to be due to the almost the same properties of these two materials in terms of continuously undergoing ion exchange with the tooth structure so that the bond strength produced by both continues to increase. In addition, this is suspected to be due to the small shrinkage that occurs in both materials, the acid-base reaction in the GIC setting process produces a small shrinkage. The setting reaction that occurs in *Alkasite* occurs with a reaction between *free radicals* that react with monomers so as to form many polymer bonds. Polymerization of *Alkasite* can cause shrinkage, but shrinkage due to this reaction is prevented by *isofillers* that act like springs that resist shrinkage during polymerization. These two materials both have a small shrinkage so it is suspected to be the thing that causes the difference in micro-leaks that occur is insignificant. [4,10,22,23]

CONCLUSION

Based on the results of research on class I cavitation visually using a stereomicroscope, *Alkasite* material experienced a smaller micro-leakage than *Glass Ionomer Cement* but statistical analysis showed no significant differences and micro-leakage in each material with a treatment duration of 30 days smaller than with a treatment duration of 1 day and 7 days.

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