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# PRICE DISPARITIES IN GICs, DOES IT INFLUENCE THE SURFACE CHARACTERIZATION?

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***ABSTRACT***
***Background:*** *Glass ionomer cement (GICs) has become a common restorative material in dental practice. Therefore, there are so many GIC's brands can be found in the market with tremendous price disparities GIC brands can be found in the market with huge price disparity; Price of one brand can be up to tenfold than the others. For the cost-efficiency reason, many clinicians prefer the more economical. Therefore, questions arise from the clinician, does it influence the clinical performance.* ***Method:*** *Six cylindrical specimens (10mm x 2mm) from four GIC brands (Fuji IX, FXUltra, GlassyCem and Sangchi) were made based on the respective factory instructions and stored for 24 hours until the final setting reached. Micro Vickers hardness tester (Shimadzu) and Surface roughness tester were used as surface characterizations measurement. Collected data were analyzed statistically.* ***Results:*** *Kruskal-Wallis and Mann-Whitney analysis showed that Fuji IX and FXUltra significantly ($p<0.05$) higher surface hardness (68.47 and 63.29 VHN respectively) compared to GlassyCem and Sangchi (38.53 and 36.70 VHN). While for surface roughness measurement, Fuji IX has the highest surface roughness, 7.22 µm ($p<0.05$). GIC's clinical performance is affected by composition and powder-liquid ratio. Strontium in Fuji IX could increase surface hardness. The high powder-liquid ratio in Fuji IX and FXUltra improve its clinical performance compared to the other group.* ***Conclusion:*** *The more expensive GIC (Fuji IX and FX ultra) had better surface hardness with a slight difference in surface roughness. Therefore, clinicians should choose GIC based on cost-efficiency without ignoring clinical performance.*

***Keywords :*** *Glass ionomer cement, price disparity, surface hardness, surface roughness*
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## INTRODUCTION

Glass Ionomer Cement (GIC) is a group of materials known as acid-based cement. This material contains three essential ingredients: polymeric water-soluble acid, ion-leachable glass, and water.[1] Setting reaction occurs when the acidic liquid is mixed with the glass powder. Glass particles attacked by the acid, thus releasing calcium, aluminum and fluoride ions. The fluoride ions incorporated into the matrix. The acid-based setting reaction of GIC is hydrolytically unstable in its early stage. In its initial setting phase, GIC is sensitive to water loss and water uptake. Dehydration could also occur if it is left exposed to air. [2]

GIC initially introduced by Wilson and Kent in 1972 as a "new translucent dental filling material". GIC became popular with many advantages, including chemical adhesion to dentin and enamel, similar coefficient of thermal expansion to the tooth structure, fluoride release, less polymerization shrinkage compared to resin-based materials, and release no free monomer.[3] GIC is a versatile material with many potential clinical usages and classified into three groups. Type I as luting cement, type II as restorative materials and type III as liners and basis.

Type II GIC indicated for a variety of clinical usage, mainly in low stress-bearing areas. This includes class III and class V restoration in adult, posterior restoration in primary dentition, abrasive/erosive lesions, occlusal pit and fissure sealing, and minimal cavity preparations.[2] A wide variety of clinical usage made GIC become a popular material for clinicians.

Currently, several GIC products from different companies are available in the market. Clinicians free to choose from the less expensive product to the more expensive one. In the Indonesian market, there are several GIC products with tremendous price disparities;. GIC Fuji 2 is a popular product in Indonesia. Based on our survey in the market, we observed the price from several GIC products. In the same packaging content (10 mg powder), we found that FX ultra (Shofu. Inc, Japan) is the most expensive one (IDR 600,000≈40 USD), followed by Fuji IX (GC Corporation, Japan), which is 10% cheaper. Next is GlassyCem (Tehnodent, Rusia), which is 40% cheaper. And the last one is Shangchi GIC (Changshu Shangchi Dental Material, China) which cost less than 8USD. Clinicians are facing significant price disparities when choosing GIC from the market. The price to clinical performance from GIC as restorative materials is still questionable.

Surface properties from the materials already become an enormous parameter in determining the success or failure of material in dentistry, thus signifying the considerable importance of and the need for adequate characterization of the surfaces.[4] The surface hardness of a material is defined as resistance from indentation. Surface hardness is related to the resistance of the surface from abrasions.[5] On the other hand, the surface roughness of material often associated with sites for bacterial colonization, which could increase the risks of oral diseases. [6]

This study aimed to compare surface characterization (surface hardness and surface roughness) from four GIC products in the Indonesian market, which has significant price disparities.

## MATERIALS AND METHOD

Four GIC products obtained from the Indonesian market were included in this study (table 1): FX Ultra (Shofu. Inc, Japan), Fuji IX (GC Corporation, Japan), GlassyCem (Tehnodent, Rusia), and Shangchi GIC (Changshu Shangchi Dental Material, China). Six cylindrical specimens (10mm x 2mm) from four GIC brands (Fuji IX, FXUltra, GlassyCem and Shangchi) were made based on the respective factory instruction and powder/liquid ratio. Samples were obtained by condensing each material in the metal ring placed above a glass slide. After materials were mixed and placed inside the mould, a second glass slide placed above the mould and materials condensed, all samples were stored for 24 hours to reach the final setting.

In order to identify surface characterization, Surface hardness and surface roughness measurement were carried out respectively. Surface characterization was done on the top surface. For surface hardness measurement, a digital Micro Vickers Hardness Tester (Shimadzu) was used in the experiment. Samples microhardness were measured with a 50 g load applied through a Vickers indenter. Three indentations in three different areas were recorded for the measurement. Vickers hardness was calculated as a mean of the three recordings.

Surface Roughness Tester measurements were done using Fowler Surfcorder SE 1700. Samples were placed below the surface roughness tester stylus. All samples were measured under parameters: M speed: 0.5 mm/s, cut off 0.8 mm, length 4 mm. Measurements were recorded from three areas. Surface hardness was calculated as a mean of the three recordings. Measurement data were analyzed using IBM SPSS v23 for Windows.

## RESULT

The mean surface hardness and surface roughness in the study group are presented in table 1. The mean of surface hardness from FX ultra and Fuji IX groups were higher than the other two groups. Fuji IX had slightly higher surface hardness (68.47 ± 4.46 VHN) compared to FX ultra (63.29 ± 12.67 VHN), while Shangchi group showed the lowest surface hardness (36.70 ± 6.27 VHN). Interestingly, Fuji IX had the highest surface roughness result 7.22 ± 2.08 µm compared to other three groups.

**Table 1.** Test results

| Group | Surface hardness | Surface roughness |
|---|---|---|
| FX Ultra | 63.29 ± 12.67 VHN | 5.58 ± 1.14 µm |
| Fuji IX | 68.47 ± 4.46 VHN | 7.22 ± 2.08 µm |
| GlassyCem | 38.53 ± 4.53 VHN | 3.88 ± 1.36 µm |
| Shangchi | 36.70 ± 6.27 VHN | 5.03 ± 0.74 µm |

Before the comparative test was done, the Shapiro-Wilk test was done first to determine the data normality. Result of the Shapiro-Wilk test showed in table 2. Based on the Shapiro-Wilk test result, surface hardness data were analyzed using the Kruskall-Wallis test, while surface roughness data were analyzed using one-way ANOVA. Both comparative test results are presented in Table 3.

**Table 2.** Shapiro-wilk test results

| Group | Surface hardness | Surface roughness |
|---|---|---|
| FX Ultra | 0.768 | 0.735 |
| Fuji IX | 0.206 | 0.322 |
| GlassyCem | 0.045 | 0.466 |
| Shangchi | 0.950 | 0.217 |

**Table 3.** Comparative test results

| Group | Kruskal-Wallis test for Surface hardness | One-way ANOVA for Surface roughness |
|---|---|---|
| Significance | .000 | .005 |

Table 3 showed that there were significant differences both in surface hardness and surface roughness in the test groups ($p<0.05$). The significance level of the Kruskal-Wallis for surface hardness was .000, while the significance level of the one-way ANOVA for surface roughness was 0.005. In order to get a clear comparison between the test group, a post-hoc test using Mann-Whitney U (Table 4) was used for surface hardness and LSD (Table 5) for surface roughness.

**Table 4**. Post-hoc test results using Mann-Whitney U test for surface hardness

| | FX Ultra | Fuji IX | GlassyCem | Shangchi |
|---|---|---|---|---|
| FX Ultra | | 0.173 | 0.004 | 0.004 |
| Fuji IX | 0.173 | | 0.004 | 0.004 |
| GlassyCem | 0.004 | 0.004 | | 0.521 |
| Shangchi | 0.004 | 0.004 | 0.521 | |

**Table 5**. Post-hoc test results using LSD test for surface roughness

| | FX Ultra | Fuji IX | GlassyCem | Shangchi |
|---|---|---|---|---|
| FX Ultra | | 0.349 | 0.305 | 1.000 |
| Fuji IX | 0.349 | | 0.003 | 0.086 |
| GlassyCem | 0.305 | 0.003 | | 1.000 |
| Shangchi | 1.000 | 0.086 | 1.000 | |

Statistical analysis in table 4 represents there were two subgroups when comparing the surface hardness. FX ultra and Fuji IX showed no significant differences in surface hardness, but this subgroup exhibited a significant difference compared to the other subgroup (GlassyCem and Shangchi). This means that GICs with the higher price were significantly higher in surface hardness. Interestingly, the result from table 5 represents almost no significant surface roughness differences between all test groups, except between Fuji IX and GlassyCem.

**DISCUSSION**

GIC formed from the reaction between silicate glass powder and polyalkenoic acid. GIC type 2 indicated as direct restoration, mainly in low stress-bearing areas, such as in class V and III cavities, primary dentition, and cervical area. GIC is also indicated for patients with high carious risk due to its ability to release fluoride.[6] The surface hardness of a material is related to material survival ability to survive from abrasion and increase the longevity of restoration in the oral cavity.[7] Inside the oral cavity, abrasion occurs on the restoration surface. If the material has a low surface hardness, it is prone to abrasion. As more abrasion occurs, more particles are released, and it will deteriorate the physical and mechanical properties of the materials[8].

Xie et al.; reported that there were many factors that influence the surface hardness of GIC, including glass particle size and shapes, tightly packed glass particles in the matrix that might be related to powder/water ratio[9]. Table 6 summarized technical detail of GIC used in the study. Unfortunately, due to a lack of information, we could not find detailed information about powder and liquid composition of Shangchi GIC.

**Table 6**. GIC technical comparison

| | Powder composition | Liquid composition | Powder/liquid ratio | Setting time |
|---|---|---|---|---|
| FXUltra[10] | Fluoroaluminosilicate glass and pigments | Acrylic acid tricarboxylic acid co-polymer solution and Tartaric acid | 2.7 g : 1.0 g | 2’ 30” |
| Fuji IX[11] | Strontium based glass, Fluoroaluminosilicate glass and pigments | Poliacrylic acid and tartaric acid | 3.4 g :1.0 g | 2’ 20” |
| GlassCem[12] | micronized fluorinated modified X-ray contrast glass | polyacrylic acid, modifiers and regulator additives | 2,6 g : 1.0 g | 4-5’ |
| Shangchi[13] | ? | ? | 1 g : 0.4 g | 6’ |

Strontium in Fuji IX powder composition could also positively impact the physical and mechanical properties of restoration. Khaghani reported that strontium in GIC could improve mechanical properties, clinical performance and biological characterization in the restoration.[14] Strontium will mimic calcium in the formation of strontium hydroxyapatite and strontium fluoroapatite to affect internal remineralization within the tooth structure.[11] Another factor that affects the surface hardness of GIC is the powder: liquid ratio. Table 6 showed that Fuji IX has the highest powder: liquid ratio (3.4 g :1.0 g) compared to other GIC. High powder: liquid ratio makes GIC become more viscous, shorten setting time duration and more condensed materials.[15]

Surface roughness is the topography of the restoration surface. The lower surface roughness means the surface becomes smoother. Several things are affecting the surface roughness of the material, including surface erosion, a non-homogenous mixture between powder and liquid, porosities, and material placement inside the cavity.[16] Rios et al. reported that the surface roughness of GIC could increase when there is a non-homogenous mixture between powder and liquid in GIC. Air bubbles trapped in the mixture and result in porosities formation. [17]

In this research, samples were not polished. Surface roughness and surface hardness measured consecutively after samples reach their final setting. The purpose of this method was to measure the surface roughness of the sample as it is. Conventional GIC needs 24 hours to reach its final setting; therefore, polishing should be postponed after the final setting reached. In contrast, RMGIC showed no significant difference in surface characterization and microleakage between immediate polishing and delayed polishing, as reported by Ezoji et al.[18]

With the limitation of the study, it is concluded that the GIC groups with the higher price resulting in higher performance, especially in surface hardness. As we know that surface hardness could determine the physical, mechanical and longevity of the restoration inside the oral cavity. Therefore, clinicians should choose GIC based on cost-efficiency without ignoring clinical performance.

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