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ORIGINAL ARTICLE

A COMPARATIVE EVALUATION OF COMPRESSIVE STRENGTH OF CONVENTIONAL GLASS IONOMER CEMENT AND A NEW HYBRID RESTORATIVE MATERIAL GIOMER

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ABSTRACT

The primary objective of this study was to investigate the effects of different beverages on the compressive strengths of 2 restorative materials; GIOMER and GIC. Although during mastication multiple forces act on the restoration materials i.e. compression, flexure strength, and tension, compression was chosen because it dominates them. Compressive strength has shown to be superior in predicting mechanical properties in stress-bearing situations.

The materials used were GIOMER (Beautifil II) and GIC. A total of 54 samples each of GIOMER and GIC were made. 18 controls each of GIOMER and GIC were made. The samples were divided into 3 groups and then immersed into one of three media (coffee, orange juice, and distilled water) for 24 hours. UTM was used to calculate the compressive strength of all the materials.

It was found that the compressive strength of Giomer was greater than GIC (61.1 Mpa vs 14.3 Mpa). Immersion in orange juice caused a noticable decrease in the compressive strengths of both GIOMER (61.1 Mpa vs 39.8 Mpa) and GIC samples (14.3 Mpa vs 10.3 Mpa).

Within the constraints of this study, it can be concluded that orange juice due to the presence of acetic acid, causes greater damage in the mechanical properties of both GIOMER and GIC. Other solutions used don't change compressive strength significantly in GIOMER samples. Due to post hardening mechanism, the compressive strength of GIC samples can be increased after immersion.

Keywords: *Compressive Strength, Giomer, Glass Ionomer Cement (GIC), Distilled Water, Coffee, Orange juice, Restorative Material.*

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INTRODUCTION

The primary aim of restorative materials is to restore the physiological, biochemical, and aesthetic characteristics of healthy tooth structure in the carious tooth.[1,2] There is continuous research going on to develop restorative materials that offer long-term benefits with better compressive strength, better biocompatibility, and better esthetic properties. [2, 3, 4] Giomers, Glass ionomer cement, composites, and Zirconomer are just a few of the posterior aesthetic restorative materials that have been developed as a consequence of recent research to address the demand for strong compressive strength with little leakage.[2] Especially for juvenile patients, whose risk of developing caries is significant due to poor dental hygiene and brushing techniques, choosing the right material is crucial.[5] One of the measurements used by clinicians and researchers to forecast how well a restorative material will work is the compressive strength test to withstand the stress of masticatory forces.[2] Although there are multiple forces

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including tension, compression, and flexure forces that act during mastication on the restoration material, but compression dominates them.[6] The compressive strength of a material has been defined as the stress necessary to distort or break a material. It is calculated by dividing the maximum load by the specimen's original cross-sectional area.[2]

The words "Glass Ionomer" and "Composite" were combined to create the moniker "Giomer".[7] The aim of Giomer's creation was to overcome the cons of other restorative materials with the added advantages like:

i. Antiplaque effect

ii. Resistance to acids

iii. Release of fluoride

iv. Remineralization of dentin

v. Better mechanical properties[8]

Giomer, the latest hybrid material, has been created by various modifications in GIC.[9]

It has hybrid qualities of glass ionomer cement (i.e. physical attributes and biocompatibility) and composite resin (i.e. Fl release and antiplaque effect). A type of GIOMER, Beautifil II, is created using pre-reacted glass filler technology, which incorporates fluorosilicate glass particles into the resin matrix to boost the strength of the material.[2,6,9]

This PRG technology is responsible for the superior mechanical properties of Giomer.[10]

The widely used restorative material, GIC, has numerous pros including the release of flouride, biocompatibility, and ability to bond with enamel as well as dentin but the cons of weak compressive strength and unappealing look have decreased its significance in clinical use.[11]

Clinically, chemical substances present in saliva, food, and drinks either intermittently or continually expose composite restorations.[13] Today, people frequently drink fruit juice and other healthful beverages. But consuming acidic meals, fruit juices, soft drinks, coffee, and other similar liquids can harm the surface of GIOMER and affect its hardness, aesthetic quality, and other properties.[12]

The goal of this study was to investigate how different beverages (distilled water, coffee, and orange juice) affect the compressive strength of GIOMER and GIC.

Limited studies reported scientific data regarding the effects of orange juice, coffee, and distilled water on the compressive strength of GIOMER and GIC. The research will help clinicians choose better restorative material. It will also help the researchers develop restorative materials with better compressive strength in these media.

MATERIAL AND METHODS

This study was experimental and it was conducted in the Department of Science of Dental Material Department, Karachi Medical & Dental College from 1st July 2022 to 31st January 2023. The duration of the study was 8 months after the approval from the Ethical committee. The sample size calculated was 54 i.e. 18 per group with a confidence interval of 95% and 80% power of the test. The purposive sampling method was used for sampling. The material used was GIOMER (Beautifil II) and GIC. A total of 54 samples each of GIOMER and GIC were made. 18 controls of GIOMER and GIC were made. Samples and controls were made in KMDC Dental Material department and testing was carried out in PCSIR, Karachi.

After fabrication of the samples, specimens were placed into a compressive strength tester (Instron Universal Testing Machine at PCSIR, Karachi) one by one, before immersion, and were loaded (Cross-head speed 1.0 mm/min) till the sample fractured. The compressive strength for each specimen was calculated from:

Compressive strength= Load/ Area

$$CS = \frac{P}{\Pi \times r^2}$$

Where CS is Compressive Strength measured in N/mm^2, P is the load at which fracture occurs measured in Newton and r is the radius of the circular specimen in mm.

Immersion

50ml each of orange juice, distilled water, and coffee were taken in glass beakers. The samples were immersed in each solution for a period of 24 hours. The compressive strength of immersed samples was then tested using UTM.

Statistical analysis was done by using SPSS Version 21. Descriptive analysis was done for all variables i.e. distilled water, orange Juice, and coffee group to find out the statistical difference between the groups. One sample t-Test was also used to find the statistical difference within the group ($p < 0.05$).

Inclusion Criteria

- All specimens having a diameter of 10x2mm were included.
- All specimens having a smooth surface with no defects were included.

Exclusion Criteria

- Specimens having rough surfaces were not included in the study.
- All specimens which vary in dimension size 10x2 were not included.
- Distorted specimens were excluded.

RESULTS

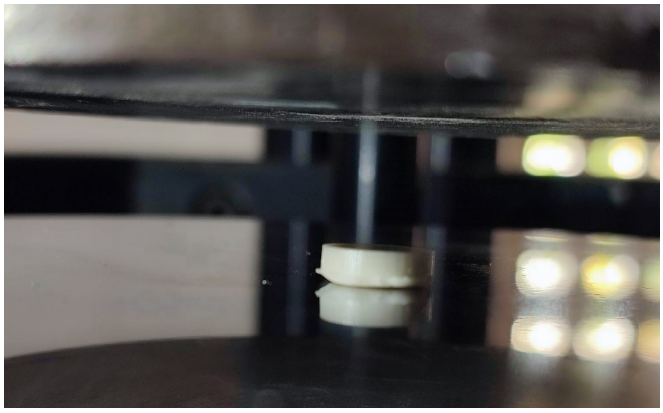

Fig 1: Giomer testing Machine

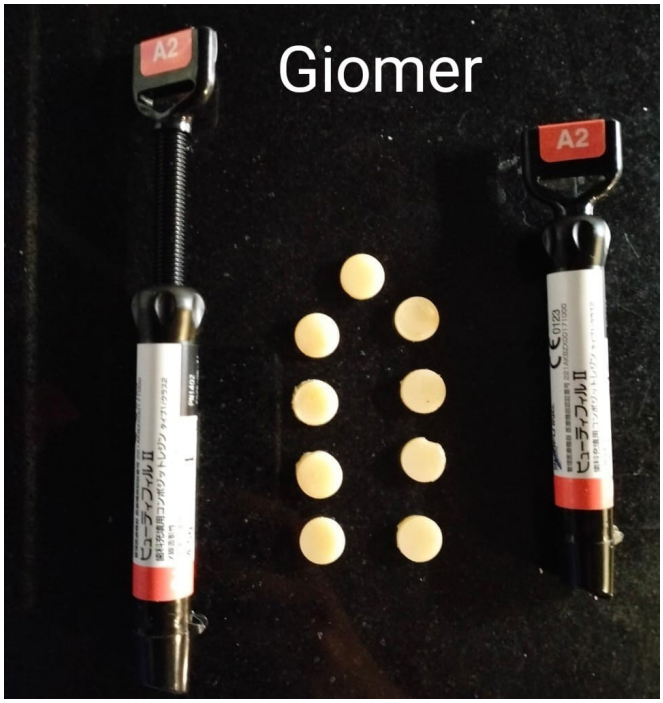

Fig 2: Giomer used in this study

Fig 3: Universal Testing machine

Fig 4: GIC sample after fracture

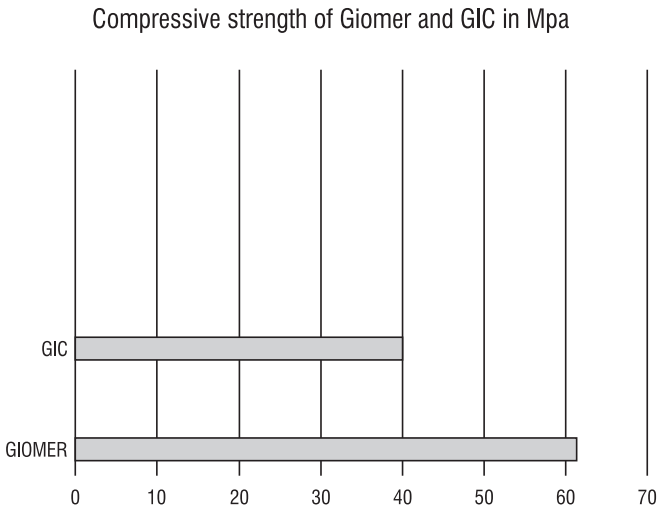

Fig 5: Compressive strength of GIOMER and GIC in Mpa

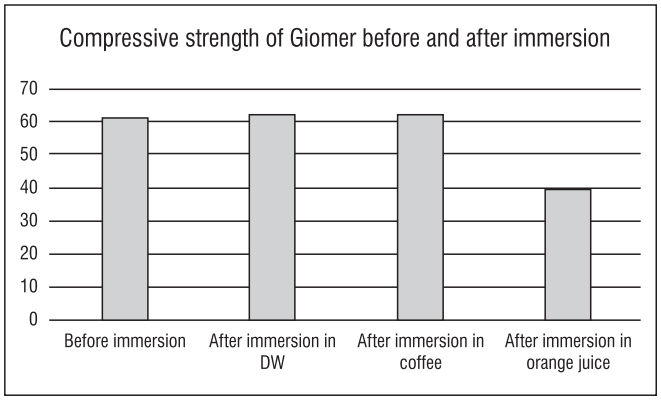

Fig 6: Compressive strength of Giomer before and after immersion

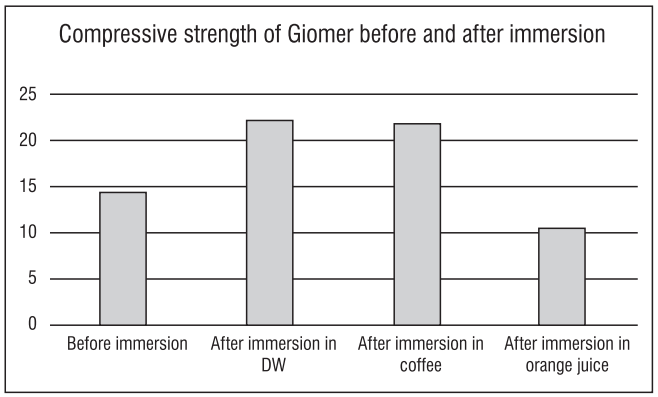

Fig 7: Compressive strength of GIC before and after immersion

DISCUSSION

This study compared the compressive strengths of GIOMER and GIC, both before and after immersion in 3 media (distilled water, coffee, and orange).

Although a number of laboratory methods are available to measure the mechanical properties in the laboratory, the compressive or flexure strength tests have been shown to be superior for determining the mechanical properties appropriate for stress-bearing situations clinically.[3,7,14,15,16]

This study found that compressive strength of Giomer was far superior to that of GIC. Various other studies have demonstrated higher efficacy of GIOMER in terms of compressive strength when compared to other filling materials.[2, 5, 17, 18]

After immersion in distilled water and coffee, the compressive strength of GIOMER did not show any statistically significant change. On the contrary, once GIOMER samples were immersed in orange juice for 1 day, the compressive strength declined steeply. (61.1 vs. 39.5 N/mm) This drastic change was probably due to the presence of acetic acid in orange juice. Citric acid or orange juice affects Giomers mechanical strength negatively as well. Citric acid and ethanol were discovered by Kooi and others to have the greatest influence on the hardness of giomers. Giomer restoratives become significantly more abrasive due to the presence of citric acid.[11] Fukazawa and colleagues also reported that due to the acid anions' capacity to chelate, restorative materials submerged in citric acid deteriorated more quickly and badly.[19]

However, the GICs exhibited an increase in compressive strength when exposed to distilled water for 24 hours. This is consistent with the research by Lohbauer and colleagues that examined how various dental filling materials responded to submersion in water. After being submerged in water, they discovered that GIC had enhanced mechanical performance over time, in part because of a post-hardening mechanism. [(20)] After immersion in coffee for 24 hours, similar results were obtained as of water. These were probably due to post hardening mechanism. But, after immersion in orange juice for 24 hours we found that the compressive strength of GIC was significantly reduced (from 14.3 to 10.2 N/mm). This is in accordance with Xiaoyan, that the GIC's mechanical characteristics are extremely acid-sensitive. [(21)]

TABLE 1: DETAILS OF THE MATERIALS UNDER INVESTIGATION

Material	Manufacturer	Ingredients	The (LOT) numbers
Giomer Beautifill II	Shofu Inc. Japan	S-PRG filler based on fluoroboroaluminosilicate glass, pigments, Bis-GMA, TEGDMA, polymerization initiator	062295
GIC	GC corporation Tokyo, Japan	10g powder, 7g liquid	2203101

TABLE 2: MEAN STRENGTH OF GIC AND GIOMER BEFORE IMMERSION

Mean Strength of GIOMER before immersion	Mean Strength of GIC before immersion
61.1 Mpa	39.9 Mpa

TABLE 3: COMPRESSIVE STRENGTH OF GIOMER BEFORE AND AFTER IMMERSION

Distilled Water			
S.No.	**Mean Strength of GIOMER Before immersion In Distilled Water Mpa**	**Mean Strength After Immersion In Distilled Water Mpa**	**P value**
1	61.1	62.4	0.012
	Coffee		
	Mean Strength of GIOMER Before immersion In Coffee Mpa	Mean Strength After Immersion In coffee Mpa	
2	61.1	62.4	0.05
	Orange Juice		
	Mean Strength of GIOMER Before immersion In Orange Juice Mpa	Mean Strength After Immersion In Orange Juice Mpa	
3	61.1	39.5	0.839

TABLE 4: COMPRESSIVE STRENGTH OF GIC BEFORE AND AFTER IMMERSSION

Distilled Water			
S.No.	**Mean Strength of GIC Before immersion In Distilled Water Mpa**	**Mean Strength After Immersion In Distilled Water Mpa**	**P value**
1	14.3	22.2	0.001
	Coffee		
	Mean Strength of GIC Before immersion In Coffee Mpa	Mean Strength After Immersion In coffee Mpa	
2	14.3	21.6	0.01
	Orange Juice		
	Mean Strength of GIC Before immersion In Orange Juice Mpa	Mean Strength After Immersion In Orange Juice Mpa	
3	14.3	10.3	0.539

CONCLUSION

- The following conclusions can be drawn considering limitations of the study:
- The compressive strength of Giomer was found to be superior to GIC.
- A significant reduction in compressive strength was observed in both GIC and GIOMER samples after immersion in orange juice, probably due to the presence of acetic acid.

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3 Affan Ahmad:	Data collection, Literature review.
4 Danish Muzaffar:	Introduction, Data collection.
5 Nadeem Hafeez Khokhar:	Literature review.
6 Syed Junaid Mehmood:	Data collection, Literature review.
7 Saima Imad:	Data collection, Literature review.
8 Sofia Alvi:	Data collection, Literature review.