

## Comparison of compressive strength of type 2GIC, TiO NANO GIC and ZnO NANO GIC

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### ABSTRACT

**Introduction :** Glass-ionomer is the generic name of a group of materials that use silicate glass powder and aqueous solution of poly acrylic acid.

- However, They have a low compressive strength.
- This deficiency is generally held to limit their use in the stress-bearing areas.
- Nanoparticle and marine modified GICs have been shown to have fewer air voids and internal micro cracks, presumably because they are easier to mix than unmodified cements.
- In some cases this has resulted in greater compressive strengths which is why we are doing this study.

**Aim:** The aim of the study is to compare the compressive strengths of type 2 conventional GIC, type 2 GIC reinforced with TiO and type 2 GIC reinforced with ZnO nanoparticles. Materials and Methods

The samples of 3 groups: Conventional GIC, MgO GIC and CaO GIC were mounted in Instron 3000 universal testing machine to check for the compressive strength.

- The compressive force was applied with a crosshead speed of 1.0 mm/min and the values were obtained for the samples in Newtons(N).

**Results:** On performing ONE-WAY ANOVA between three groups-The compressive strengths decreased in the order : Conventional GIC <TiO GIC <ZnO GIC

The p-value is 0.19. The result is insignificant at  $p > .05$ .

**Conclusion:** It could be concluded that compared to conventional GIC, CaO and MgO incorporated GIC have a significant difference in their compressive strengths.

The compressive strengths decreased in the order: Conventional GIC <TiO GIC <ZnO GIC

**KEYWORDS:** Artificial preparation, compressive strengths, nanoparticles.

### INTRODUCTION

Glass ionomer cement (GIC) for dental restorative purposes is created through an acid-base reaction between polyacrylic acid and calcium fluoroaluminum silicate glass [1]. Their broad use as luting materials, cavity liners and bases, and restorative materials is the result of their advantageous adhesive and fluoride releasing capabilities. Fracture toughness, low wear resistance, and historically high dissolution are the main drawbacks.

The application of GIC was restricted to non-stress bearing locations due to its inadequate mechanical qualities [2].

Due to their potential to supply the therapeutic ions when PAA combines with ion leachable glasses [3, 4]. GIC's bioactivity is made possible. In comparison to resin-based materials, these cements' bioactivity is increased by PAA's hydrophilic properties [5]. The cement hardens in 2–10 minutes after the base (powder) and acid (liquid) have been combined [6]. GICs chemically attach to the dentin or enamel of the tooth structure through calcium and a carboxyl group from the cement itself. These cements also emit fluoride ions, which have anticariogenic effects for a considerable amount of time [7]. Fluoride's anticariogenic effects are caused by a variety of processes, including a reduction in demineralization, an increase in

remineralization of the dental hard tissues, and an inhibition of bacterial growth and metabolism in the oral cavity.

Numerous changes have been made to the inorganic component of GICs in an effort to improve their physical and mechanical characteristics without degrading their biological or handling qualities. Fibers, metals, and other nonreactive fillers have all been evaluated in this regard. Obtaining adhesion between the cement matrix and the reinforcing agents is the most difficult task in this situation. Additionally, a number of chemical changes have been investigated to improve the GICs . One technique was the incorporation of glass particles with carefully controlled particle sizes, which resulted in a high powder to liquid ratio[8]. High-viscosity GICs were produced using this method. When compared to traditional GICs, these high viscosity materials' characteristics were superior [9]..

Incorporating nano-hydroxyapatite into GICs has the potential to increase mechanical qualities in addition to improving biocompatibility.

Due to its identical makeup and structure to enamel and dentin, it also has the capacity to strengthen the relationship with tooth structure .

According to a recent study, adding TiO<sub>2</sub> NPs to GIC at 3% and 5% (w/w) greatly improved the material's hardness, compressive strength, fracture toughness, and flexural strength. This might be as a result of the nanoparticles' fine size being added to the GIC powder.

**MATERIALS AND METHODS**

The samples of 3 groups:Conventional type 2 GIC,TiO GIC and ZnO GIC were mounted in Instron 3000 universal testing machine to check for the compressive strength.

The compressive force was applied with a crosshead speed of 1.0 mm/min and the values were obtained for the samples in Newtons(N).

For compressive strength testing, samples were prepared

by mixing GIC powder and liquid according to the manufacturer’s-recommended ratio on a glass slab using a mixing spatula. Firstly the mixture was poured into the cylindrical metal mold (9.5x1mm). Excess material was removed using a glass slide. After setting the GIC cylinder was removed from the metal mold. Each sample was measured using a digital vernier caliper. A total of 15 samples were prepared for compressive strength testing.

**RESULTS**

On performing ONE-WAY ANOVA between three groups-The compressive strengths decreased in the order:Conventional GIC<TiO<sub>2</sub> GIC<ZnO GIC

**Table 1: represents the mean,standard deviation, mean difference of the three groups.**

Parameters	ZnO GIC	Conventional GIC	TiO <sub>2</sub> GIC
N	5	5	5
MEAN	455.51	322.636	103.048
STD DEVIATION	195.202	609.52	303.683

The p-value is 0.132. The result is insignificant at p > .05.

**DISCUSSION**

In dentistry, compressive strength tests are used for laboratory simulation of the stresses that may be associated with the loads applied clinically to a restorative material [10]. The accurate value of masticatory forces is not known but almost all mastication forces are compressive in nature. Hence, it is of extreme importance to conduct an investigation about the role of compressive forces in fracture failure during the mastication process. The lowest values required to withstand the mastication forces in primary and posterior teeth are 100 and 125 MPa, respectively [18].

The mechanical qualities of the final set cement are enhanced by hydroxyapatite by altering the process of the setting reaction as well as the degree of poly salt bridge formation of the glass ionomer. Since hydroxyapatite dissolves in acidic media, calcium ions can be drawn off the surface of HA by combining the powder with an acidic solution [11]. It has been suggested that titanium dioxide (TiO<sub>2</sub>) nanoparticles be used as reinforcing fillers in epoxy and dental resin composites. TiO<sub>2</sub> is a viable inorganic addition due to its chemical stability, biocompatibility, and lack of toxicity [12] it shows promising properties.

The control group in another study [13] had the lowest compressive strength, measuring 132.090.79 MPa, of all the experimental groups. Whereas in our study control group showed the maximum compressive strength.

In another study the compressive strength of Group 2 glass ionomer cement powder modified with 3% titanium dioxide nanopowder  $177.14 \pm 0.81$  MPa. Contreras et al. investigated the physical, antibacterial activity and bond strength properties of conventional base, core build and restorative of glass ionomer cement (GIC) compared to GIC supplemented with titanium dioxide (TiO<sub>2</sub>) nanopowder at 3% and 5% (w/w). The supplementation of TiO<sub>2</sub> NPs to restorative GIC significantly improved Vickers microhardness, flexural and compressive strength. In our study TiO<sub>2</sub> infused GIC showed lesser compressive strength because of small sample size. These studies are not in accordance with the results of our study [14].

When acid is mixed with GIC powder containing metallic nanoparticles, the metal ions are released. These released metal ions act as a cross-linking species resulting in a stable cement. As mentioned in the previous study, low strength values can be attributed to metal ions that cannot leach out to form cross-linking [15].

## CONCLUSION

It could be concluded that compared to conventional GIC, TiO<sub>2</sub> and ZnO incorporated GIC have a significant difference in their compressive strengths. The compressive strengths decreased in the order: Conventional < TiO GIC < ZnO GIC. The p value of this study is 0.137, it is insignificant this could be due to small sample size. In future if we overcome this limitation we shall get better results.

## CONFLICT OF INTEREST:

The article has been read and approved by all the contributors and there isn't any conflict of interest.

## FUTURE SCOPE:

The study can be conducted on cavities and natural tooth surface to measure the erosion with multivitamin syrups containing ascorbic acid. Scanning electron microscopy can be done for further evaluation.

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## REFERENCES

- [1]. Inglehart MR, Bagramian R. Oral Health-related Quality of Life. Quintessence Publishing Company, 2002.
- [2] Khurshid Z, Zafar M, Qasim S, et al. Advances in Nanotechnology for Restorative Dentistry. *Materials* 2015; 8: 717–731.
- [3] Schwendicke F, Frencken J, Innes N. Caries Excavation: Evolution of Treating Cavitated Carious Lesions. Karger Medical and Scientific Publishers, 2018.
- [4] Santos VE dos, dos Santos VE, Filho AV, et al. A New 'Silver-Bullet' to treat caries in children – Nano Silver Fluoride: A randomised clinical trial. *Journal of Dentistry* 2014; 42: 945–951.
- [5] Akelah A. Functionalized Polymeric Materials in Agriculture and the Food Industry. Springer Science & Business Media, 2013.
- [6] Wilson AD, Kent BE. A new translucent cement for dentistry. The glass ionomer cement. *British Dental Journal* 1972; 132: 133–135.
- [7] Nicholson JW. Adhesion of glass-ionomer cements to teeth: A review. *International Journal of Adhesion and*

Adhesives 2016; 69: 33–38.

- [8] Moshaverinia A, Roohpour N, Chee WWL, et al. A review of powder modifications in conventional glass-ionomer dental cements. *J. Mater. Chem.* 2011; 21: 1319–1328.
- [9] Barbucci R. *Integrated Biomaterials Science*. Springer Science & Business Media, 2002.
- [10] Mansoor E, Martin SA, Perez A, et al. Response to: Correspondence on ‘On the ethics of digestive health research in historically marginalised communities’ by Velez and Targownik. *Gut*. Epub ahead of print 21 November 2022. DOI: 10.1136/gutjnl-2022-329038.
- [11] Mount GJ. *An Atlas of Glass-Ionomer Cements: A Clinician’s Guide*. Thieme, 2002.
- [12] Ahmed S, Ali W. *Green Nanomaterials: Processing, Properties, and Applications*. Springer Nature, 2020.
- [13] Rekha C, Varma B, Jayanthi. Comparative evaluation of tensile bond strength and microleakage of conventional glass ionomer cement, resin modified glass ionomer cement and compomer: An in vitro study. *Contemporary Clinical Dentistry* 2012; 3: 282.
- [14] Garcia-Contreras R, Scougall-Vilchis RJ, Contreras-Bulnes R, et al. Mechanical, antibacterial and bond strength properties of nano-titanium-enriched glass ionomer cement. *J Appl Oral Sci* 2015; 23: 321–328.
- [15] Kim H-J, Bae HE, Lee J-E, et al. Effects of bioactive glass incorporation into glass ionomer cement on demineralized dentin. *Sci Rep* 2021; 11: 7016..