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# An *in vitro* comparative evaluation of mechanical properties of Cention N, FujiCEM 2 with a conventional glass ionomer cement

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**Abstract**
To evaluate and compare the diametral tensile strength and shear bond strength of Cention N, FujiCEM 2 with a conventional glass ionomer cement. A total of thirty samples were used for the evaluation and comparison of diametral tensile strength. Ten samples of each of the restorative material were prepared with the help of metallic moulds and stored in distilled for 24hrs, following which they were tested on the Universal Testing Machine at crosshead speed of 5.5 mm/min. A total of thirty-three premolars were used to evaluate the shear bond strength with eleven premolars in each group. The premolars were then grinded perpendicular to the long axis of the tooth, restored with the respective cements following the manufacturer's instructions and stored in distilled water at room temperature for 7-10 days, later they were subjected to thermocycling. After 24 hours, the specimens were tested in the Universal Testing Machine at a crosshead speed of 0.5 mm/min. The obtained data was statistically analyzed. There was statistical difference in diametral tensile strength values of Cention N when compared to FujiCEM 2 and Fuji IX (p value= 0.00). The shear bond strength of Cention N was significantly higher than that of FujiCEM 2 and Fuji IX (p=0.005 and p=0.008 respectively). The results of our study concluded that Cention N performed better in terms of mechanical properties than FujiCEM 2 and Fuji IX.

**Keywords:** Cention N, FujiCEM 2, Fuji IX, diametral tensile strength, shear bond strength

## Introduction

The human tooth has a very definite capacity for regeneration, thus, when it is lost because of caries, trauma or any other reasons, it requires a replacement. This replacement is provided in the form of a restorative material that preserves the tooth structure and maintains the form, function and esthetics of the tooth [1].

Among the several new materials that have been developed over the years, dental amalgam has served as an excellent material for many years. However, its main drawbacks such as the unavoidable use of mercury and esthetics have led to the search of newer materials [1]. To overcome these drawbacks, glass ionomer cement (GIC) was developed by Wilson and Kent in 1972 and was reported to form chemical adhesive bonds with the tooth structure. The use of GICs has grown ever since due to their various advantages namely improved esthetics, fluoride release, radiopacity, biocompatibility, chemical bonding with tooth structure and remineralization of adjacent dentin [1, 2].

However, conventional GIC has several disadvantages such as prolonged setting time, moisture sensitivity during initial hardening, low fracture toughness and poor wear resistance [1, 2] These properties reduced their use in the areas which are constantly subjected to masticatory forces [1].

Many restorative materials are quite brittle in nature and highly susceptible to crack propagation when subjected to tensile stress, resulting in a clinical failure. Therefore, measurement of tensile strength will determine the ability of the restorative material to resist these stresses before a crack develops [2].

In the oral cavity, dental materials undergo different forces specially while chewing, brushing or in case of an oral habit such as bruxism or clenching.

The chewing action is related to shearing phenomenon; hence, the interfacial strength is represented by the shear bond strength. Shear bond strength is the ability of the material to withstand these forces before being debonded or undergoing fracture [3].

Several modifications were tried to enhance the mechanical properties of GICs with the development of advanced restorative materials like resin modified glass ionomer (RMGI), ceramic reinforced glass ionomer and compomers.

GC Fuji IX was introduced in the late 1990s especially for Geriatric and Paediatric patients. It is also known as condensable or packable GIC and is said to have high strength, high viscosity and better esthetics. This improvement was due to the reduction in the size of glass particles in the matrix [1].

Cention N (Ivoclar Vivadent, Schaan) was introduced as a radiopaque, alkasite which is considered as a subgroup of composite materials. Cention N is a urethane dimethacrylate (UDMA)-based, self-curing restorative material with an optional light curing. It is suggested to have increased bond strength and reduced shrinkage stresses [3]. It displays a high degree of polymerization over the complete depth of the restoration and thus can be used as a bulk-filling material [4].

A resin modified glass ionomer cement named FujiCEM 2 with increased strength and high fluoride release was introduced. FujiCEM 2 claims to have increased strength, high fluoride release, low film thickness, and exceptional marginal integrity [5].

Since these three materials have not been compared in terms of their mechanical properties, hence, this study was aimed at evaluating the diametral tensile strength and shear bond strength of Cention N, FujiCEM 2 with a conventional glass ionomer cement.

## Materials and Methods

### Diametral Tensile Strength Testing

For evaluation and comparison of diametral tensile strength, thirty cylindrical specimens were prepared in customized metal moulds (6mm diameter x 4mm height) that were coated with petroleum jelly. Ten specimens of each material were prepared according to manufacturer's instructions (Figure 1) and stored in distilled water at room temperature for 24 hours. Following this the diametral tensile strength was tested on a Universal Testing Machine at a crosshead speed of 5mm/min. Samples were placed with the flat ends perpendicular to the platens of the apparatus and the load was applied to the diameter of the specimens until visible or audible evidence of fracture was observed. The Diametral Tensile strength (DTS) was calculated in Mega Pascals (Mpa) using the formula: $T=2P/\pi DL$, where P is the maximum load applied (N), D is the measured mean diameter of the sample (mm), and L is the measured length of the sample (mm).

**Table 1:** The Restorative materials used in this study

| Group | Material | Manufacturer |
|---|---|---|
| Group A | Cention N | Ivoclar – Vivadent, Schaan, Liechtenstein |
| Group B | GC FujiCEM 2 | GC Corp, America |
| Group C | GC Fuji IX | GC Corp, Tokyo, Japan |

### Shear Bond Strength Testing

Thirty three premolars free from any pathology were cleaned off any debris, sterilized by autoclaving before use and stored in distilled water. The teeth were then randomly divided into three groups of 11 samples each. The root portion of each tooth was embedded in acrylic resin block with the occlusal surface of tooth parallel to the base. Then the tooth was sectioned with a fine diamond disc by a flat cut perpendicular to the long axis of the tooth until dentin is exposed. A Teflon mould (3 mm diameter x 2 mm height) was placed on the prepared occlusal surface and the respective materials were packed and restored according to the manufacturer's instructions (Figure 2). Following this, the specimens were stored in distilled water at room temperature for 7-10 days to simulate oral conditions. Subsequently, these were subjected to thermocycling in water baths for 500 times between the temperatures of 5° and 55 °C for a dwell time of 15s and a transfer time of 10s (Figure 3). After 24 hours, the specimens were tested on a Universal Testing Machine at a crosshead speed of 0.5 mm/min until visible or audible evidence of fracture is observed.


**Fig 1:** Groups for Diametral Tensile Strength


**Fig 2:** Groups for Shear Bond Strength

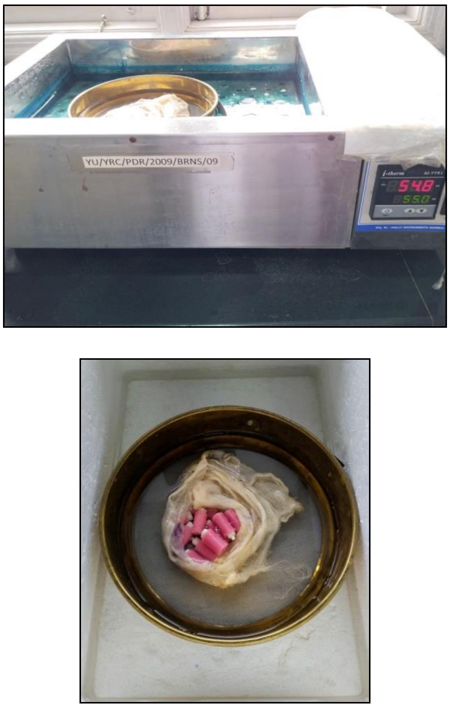

**Fig 3:** Thermocycling Procedure

## Statistical Analysis

The data was analyzed using Statistical Package of Social Sciences (SPSS version 23, Chicago Inc., USA) and subjected to One-way ANOVA followed by post hoc analysis for the comparison of diametral tensile strength and shear bond strength between groups. A value of $p$ <0.05 was considered to be significant.

## Results

The difference in the diametral tensile strength was assessed and Group A had the highest tensile strength (40.741±9.025) followed by Group B (18.844±4.183) whereas Group C had the least (12.467±5.375). On post hoc Tukey's analysis, the diametral tensile strength of Group A was statistically significantly different from Group B and Group C (p=0.000) (Table 2).

**Table 2:** Mean Diametral Tensile Strength of the Three Study Groups

| Groups | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Sum of squares | df | F | p value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | | |
| Group A | 10 | 40.741 | 9.025 | 2.853 | 34.2848 | 47.1972 | 4398.546 | 2 | 51.607 | 0.000* |
| Group B | 10 | 18.844 | 4.183 | 1.322 | 15.8512 | 21.8368 | | | | |
| Group C | 10 | 12.467 | 5.375 | 1.699 | 8.6217 | 16.3123 | | | | |
| $p$<0.05 is statistically significant | | | | | | | | | | |

The difference in the shear bond strength between the three groups showed that Group A had the highest shear bond strength (2.451±0.616) followed by Group C (1.757±0.292) whereas Group B had the least (1.713±0.534). The difference in the shear bond strength between the groups was statistically significant (p=0.002) (Table 3).

**Table 3:** Mean Shear Bond Strength of the Three Study Groups

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Sum of squares | df | F | p value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | | |
| Group A | 11 | 2.451 | 0.616 | 0.18586 | 2.0377 | 2.8659 | 3.774 | 2 | 7.538 | 0.002* |
| Group B | 11 | 1.713 | 0.534 | 0.16109 | 1.3547 | 2.0726 | | | | |
| Group C | 11 | 1.757 | 0.292 | 0.08816 | 1.5608 | 1.9537 | | | | |
| $p$<0.05 is statistically significant | | | | | | | | | | |

## Discussion

An ideal restorative material should be biocompatible, aesthetically pleasing and resistant to all the challenges faced in the oral cavity that could lead to the wear of the material [3].

For decades dental amalgam has fulfilled its role as a versatile restorative material for ages. Nevertheless; it's many shortcomings such as the lack of adhesion, lack of aesthetics and use of mercury can affect the patient's health adversely [6]. Therefore, a material with superior adhesive and aesthetic qualities resulted in the advent of glass ionomer cements (GIC) characterized by the highest release of fluorine ions among the dental materials. Despite the myriad of advantages, several drawbacks of moisture sensitivity, longer setting time, short working time and lower resistance to the masticatory forces was also observed [7].

To improve conventional GICs properties, GC Fuji IX were developed especially for pediatric and geriatric purposes in late 1990s. It is a self-adhesive, self-curing with a true 'bulk-fill' reaction and can thus be used as a reliable alternative of amalgam in pediatric dentistry due to the short lifetime of deciduous teeth [8]. In order to enhance the mechanical properties, the powder/liquid ratio was increased, higher molecular weight polyacrylic acid was used and a modified FAS fillers was also introduced into the powder [9].

FujiCEM 2 a second-generation RMGIC that incorporates high-elastic crosslinking monomers to increase strength, high fluoride release, low film thickness and exceptional marginal integrity was introduced. This cement is indicated for a broad array of all types of metal-, resin-, and zirconia-based inlays, outlays and crowns and bridges [10].

Cention N is classified as a "bulk-fill" tooth-coloured alkasite material. It is a self-curing material with the optional of light curing with blue light in the wavelength range of 400–500 nm. The initiating system for the self-curing process consists of copper salts, hydrogen peroxide and thiourea [9, 11].

Since, these two recent dental cements have very few studies regarding their clinical performance and physical properties, hence, our *in vitro* study is aimed at evaluating and comparing the diametral tensile strength and shear bond strength of Cention N, FujiCEM 2 with a conventional glass ionomer cement.

In the present study, we have compared the diametral tensile strength and shear bond strength because the major dislodging forces in the oral cavity occur at the tooth restoration interface. Therefore higher tensile and shear bond strength implies better bonding of the material to tooth [9].

The British Standards Institution (1981) adopted the diametral tensile strength test for brittle materials like Glass Ionomer Cements (GICs) wherein, a compressive force is applied across the diameter of a cylindrical specimen by compression plates which was adopted in our study [12, 13].

To anticipate the thermal changes involved in a possible real oral cavity, two *in vitro* aging strategies were implemented. First the samples were immersed in distilled water for 7-10 days since alterations of the substrate caused by storage solutions can affect bond strength [14]. Second was the use of thermocycling ageing, where specimens are immersed in water baths at different temperatures between standardized intervals of time [15]. Hoshika *et al*. (2015) reported that the bond strength of restorative materials reduces with water aging [16].

In our study, the thermocycling was carried out for the shear bond strength specimens, in which, a temperature range of 5°-55 °C with a dwell time of 15s and transfer time of 10s for 500 cycles was done. Although the International Organization for Standardization (ISO, 1994), considered a protocol of 500 cycles as appropriate, a study by Stewardson *et al*., claimed that the 500 cycles would only correspond to the number of cycles estimated to occur in less than 2 months in the mouth [17].

In our study, the diametral tensile strength was found to be significantly higher in the Group A (Cention N) followed by

Group B (FujiCEM 2) and then Group C (GIC type IX). The shear bond strength was significantly higher for Cention N followed by Group C and Group B. The results are in accordance with the study by Iftikhar *et al*. where they concluded that the diametral tensile strength was lower for GIC (Fuji IX) when compared to that of Cention N [4]. A similar observation was made by Pathak *et al*. where on intergroup comparison, Cention N had the highest compressive strength, diametral tensile strength and shear bond strength than that of GIC II and GIC type IX [7].

Despite of the improvements made in GIC type IX, the mean value of shear bond strength (1.757 ± 0.292) was on the lesser side of the range as established in our study. In 2020, Naz *et al*. found that the highest mean value was for Cention N (14.38 ± 3.88 MPa) and lowest for Fuji IX (5.96 ± 0.91MPa) [3]. Carvalho *et al*. also evaluated the shear bond strength of conventional GICs and concluded their mean values to be lower [18].

Singh *et al*. determined from their study that composite resin (16.21 ± 1.12) had the highest shear bond strength value while lowest was conventional GIC (2.94 ± 0.91) [14]. In accordance with the results of our study, the results of the *in vitro* studies conducted by Mallya *et al*. and Verma *et al*. suggested mechanical properties of Cention N were significantly higher as compared to that of GIC Type IX [19, 20]. Eligeti *et al*., 2021 compared the shear bond strength of Cention N, Ketac Molar, Zirconomer and Fuji II LC. The mounted samples were stored in distilled water for 24 hours and thermocycled and reported that Cention N exhibited highest shear bond strength amongst all the restorative material [21].

However in an *in vitro* study by Moshaverinia *et al*. to compare the compressive, diametral tensile and flexural strengths of EQUIA Forte Fil with Fuji IX GP and ChemFil Rock, the results showed no significant difference between the compressive and diametral tensile strength of EQUIA Forte Fil and Fuji IX GIC specimens [22] that is in contrast to our findings. Holmer *et al*. evaluated the shear bond strength of the resin cement and the resin modified glass ionomer cement and concluded that Variolink Esthetic has a higher shear bond strength compared to Fuji Cem 2 [23].

The limitations of our study include the lesser sample size and we have only two properties have been evaluated namely diametral tensile strength and shear bond strength. Furthermore, since this is an *in vitro* study, mechanical strength can be quite different when compared to the dynamic changes that occur in the oral cavity in an *in vivo* setup. Thus, *in vivo* studies with larger sample size and comparison in terms of other properties must be exercised in the future.

## Conclusion

Therefore, from the present study, it can be concluded that Cention N had highest diametral tensile strength followed by FujiCEM 2 and lowest for the conventional glass ionomer cement. The mean value of shear bond strength was highest in Cention N and lowest for FujiCEM 2.

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