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Original Research

Comparative Evaluation of Comparative strength, Shear bond strength of Zirconia reinforced Glass ionomer and two conventional restoratives- An in vitro study

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ABSTRACT:

Background; Dental materials used for permanent restorations are intended to replace lost and defective dental tissues, be chemically stable and inert in the oral environment. **Aims and Objectives:** To compare and evaluate the physical properties of Zirconia reinforced Glassionomer with two conventional restoratives. To analyze the mechanical properties of the cements being tested. **Materials & methods;** For the compressive strength 120 cylinders of 8 mm height and diameter 4 mm were prepared using split teflon moulds for each group. Group 1 (Zirconomer), Group 11 (Hidence) Group iii (Posterior Extra) which were subjected to 1 day (24 h) and 7 day interval storage and CS values were obtained. For the Shearbond strength testing 60 specimens was bounded to flat dentinal surface by positioning polyvinyl moulds. Then mounted samples were stored in distilled water for 24 h and then subjected to Shearbond strength test using Universal testing machine. **Results;** Results shows that all the three group's shows that high Compressive strength but there was significant decrease in the mean CS in Hidence and Posterior extra groups at 7 day interval. Zirconomer reinforced GIC group showed highest Shearbond strength followed by Posterior extra group and least was seen in Hidence group and there was significant difference between Group 1 and Group 2. **Conclusion;** It can be concluded that Zirconomer reinforced Glassionomer at 7 days had no significant difference in the CS and at 24 hrs and good bond strength and sealing ability compared to other restoratives.

Key words; Compressive strength, Shear bond strength, Zirconomer.

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INTRODUCTION

Conventional GIC have been used in dentistry for over 40 years [1]. The attractiveness of these materials is their intrinsic properties that make them useful as restorative and adhesive materials.

These includes anti cariogenic property due to its ability to release and store Fluoride hence it has been an excellent choice of materials for the treatment of patients at high risk for caries, it also has excellent biocompatible property because the polyacrylic acid being a week acid with macromolecules of high molecular weight which are prone to join the calcium of the tooth, making it difficult to move inside the dentinal tubules being less irritating to the pulp tissue and low cytotoxic compared to resinous adhesives.[2]

The most common tests used for the determinations of the mechanical behavior of materials are CS, Diametric

tensile strength DTS, Shear bond strength, Flexural strength FS, surface hardness (Vikers hardness number or Knoop hardness number) and wear rate.
In the present study the mechanical properties like CS, SBS were evaluated which are critical indicators of success to resist masticatory and para functional forces. The clinical success of the newer restorative materials depends on a good adhesion with the dentinal surface to resist various dislodging forces acting on them.
Hence, the present study was undertaken to evaluate the Compressive strength, Shear bond strength of recently available Hidence and to compare it with the previously existing Posterior extra restorative material on Permanent teeth.
The objectives of the current study was to analyze the mechanical properties of the cements being tested.

Materials & methods;
This study was approved by the Institutional Research ethics committee (ECR) of Kalojinarayana Rao University of health science.Telangana state, Hyd, India and was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000.
A total of 60 samples were tested with 20 samples per group and each group is subdivided into 2 subgroup with 20 samples each. **[Table 1]**
In the present study the mechanical properties like CS, SBS were evaluated which are critical indicators of success to resist masticatory and para functional forces.

Compressive strength
Cs was evaluated on 60 specimens with universal testing machine. (Instron 3382 100 KN)
A compressive load was applied along the long axis of the cylinder at a crosshead speed of 1mm/min [3] The maximum force applied when the specimen fractured was recorded and the CS was calculated by the following equation [4]
$CS = 4F/N\ d_2$
Where F- failure load of the specimen.
d-diameter of the specimen.
Where p- is the maximum applied load (N) and d is the measured diameter of the sample (mm)

Shear bond strength (SS)
The sample were then subjected to SS test using Universal testing machine (Instron 3382 100 KN). (Fig 1)
The specimens were mounted in a Jig, while a straight knife edge was applied at the tooth-restoration interface at a crosshead speed of 0.5 mm/min^2 [5,6] load was applied until restoration failure occurred.
SS of each sample is calculated using the formula
Shear strength (Mpa) = Break force /bonding surface area.
Criteria for selection of the teeth. [7]
Inclusion criteria
1. With intact crown structure were included.
2. The selected teeth were either extracted for Orthodontic reasons or had exfoliated due to pre-shedding mobility.

Exclusion criteria
1. Teeth with fractured crown any kind of developmental anomaly (or) caries were Excluded.
To avoid related structural changes occurring in dentin due to these factors.

Sixty Maxillary premolar with similar mesiodistal dimensions were utilized for assessing the SS.The samples were cleared of calculus and debris by ultrasonic scaling, placed in deionized water for 24 h and later embedded in cold cure acrylic resin (DPI-RR cold cure). [8,9].

Restoration of samples
All the specimens were allotted randomly into 3 groups including
Group 1 –Zirconomer.
Group 2-Silver reinforced.
Group 3- High strength posterior extra.
An apparatus known as a Jig with a Teflon template of height 2 mm and hole in the centre of diameter 3 mm was used. The inner walls of the hole were isolated with petroleum jelly to avoid of sticking of restorative material each time the Jig was used .The bonding Jig was positioned for each sample in such a way that the hole was perpendicular to the exposed dentinal surface of the tooth. The Jig was then tightened with a screw and bolt mechanism to receive restoration. (Fig 2)

GROUP 1 (Zirconomer)
A P/L ratio of 2:1 was used for manufacturer's instructions .The cement was carried using Amalgam carrier and condensed against cavity wall .After setting of the cement, the bonding Jig was coated with Coca butter (Petroleum jelly) for protection against moisture. The restored specimens of all groups were stored in distilled water at 37 0C for 24 hours.

GROUP 11 (Sliver reinforced GIC, HIDENCE manufacture by Shofuinc Kyoto JAPAN)
Conditioning of exposed dentinal surface was carried out with cotton pellet using GC dentin conditioner (GC co. TOKYO JAPAN). For 20 sec the surface was rinsed thoroughly with water and then bottled with a cotton pellet to remove the moisture's/l ratio were hand mix in a ratio of 1:1 confirming to manufacturer's instructions. Cement was then conducted into the exposed dentinal surface through the hole of the JIG after setting of cement, (Height -2 mm dentin-3 mm) bonded to dentinal surface .The cement surface was coated with silver reinforced GIC)(Shofu inc,Kyoto JAPAN).

GROUP 111 (Posterior GIC (FUJI IX GC) .
The etching of specimens was carried out using 37% phosphoric acid for 15 sec followed by rinsing with

water and air drying .Single bond plus (3 MESPE) was applied using applicator tip and air blown gently and cured for 20 sec.then composite restoration was done using Incremental technique and light cured.

TABLE 1; Materials and parameters evaluated with sample size
Sampling grouping;

Group A	Zirconomer reinforced GIC (Zirconomer) (Shofu Inc Kyoto ,JAPAN)	n=20
Group B	Silver reinforced GIC (HIDENCE) (Shofu Inc ,Kyoto,JAPAN)	n=20
Group C	High strength posterior Glassionomer type ix(HS posterior extra) (HS posterior Extra)	n=20

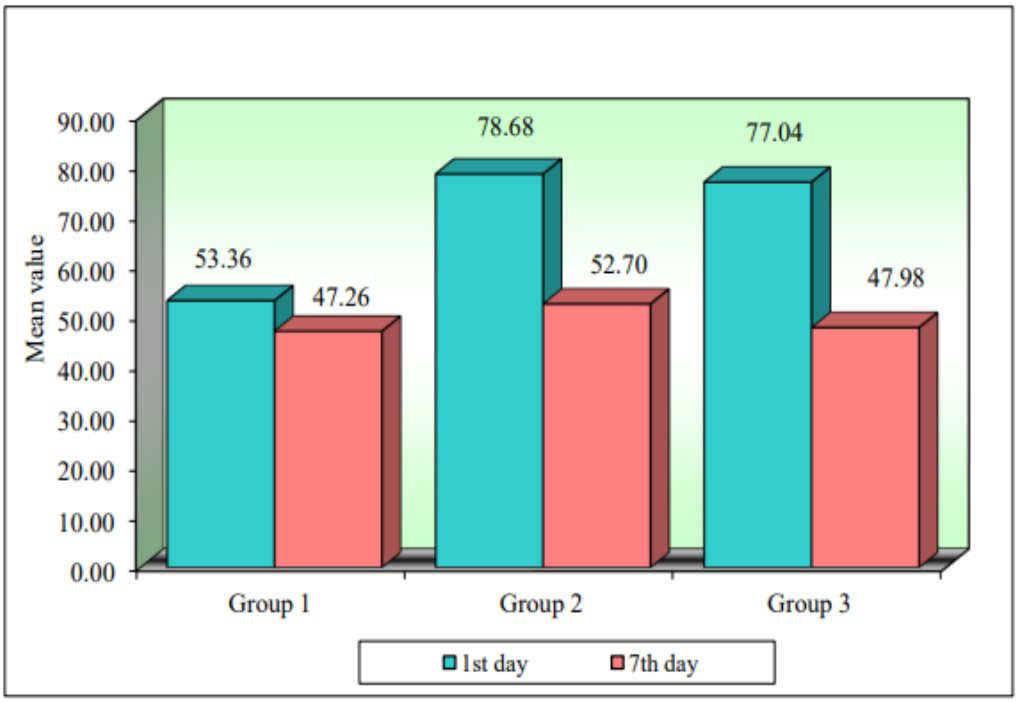
TABLE 2; Comparison of 1 day interval and 7 day interval with respect to compressive strength in three groups (Group 1 - Zirconomer, Group 2- Hidense, and Group 3- HS Posterior Extra) by unpaired t test

Group	Time	Mean	St dev	Mean diff	SD difference	% of change	Paired t	p-value
Group 1	1st day	53.36	7.87	6.10	8.19	15.35	3.3318	0.0035
	7th day	47.26	5.05					
Group 2	1st day	78.68	4.77	25.99	14.58	18.54	7.96683	0.0001
	7th day	52.70	12.19					
Group 3	1st day	77.04	9.49	29.06	11.78	15.29	11.0290	0.0001
	7th day	47.98	6.72					

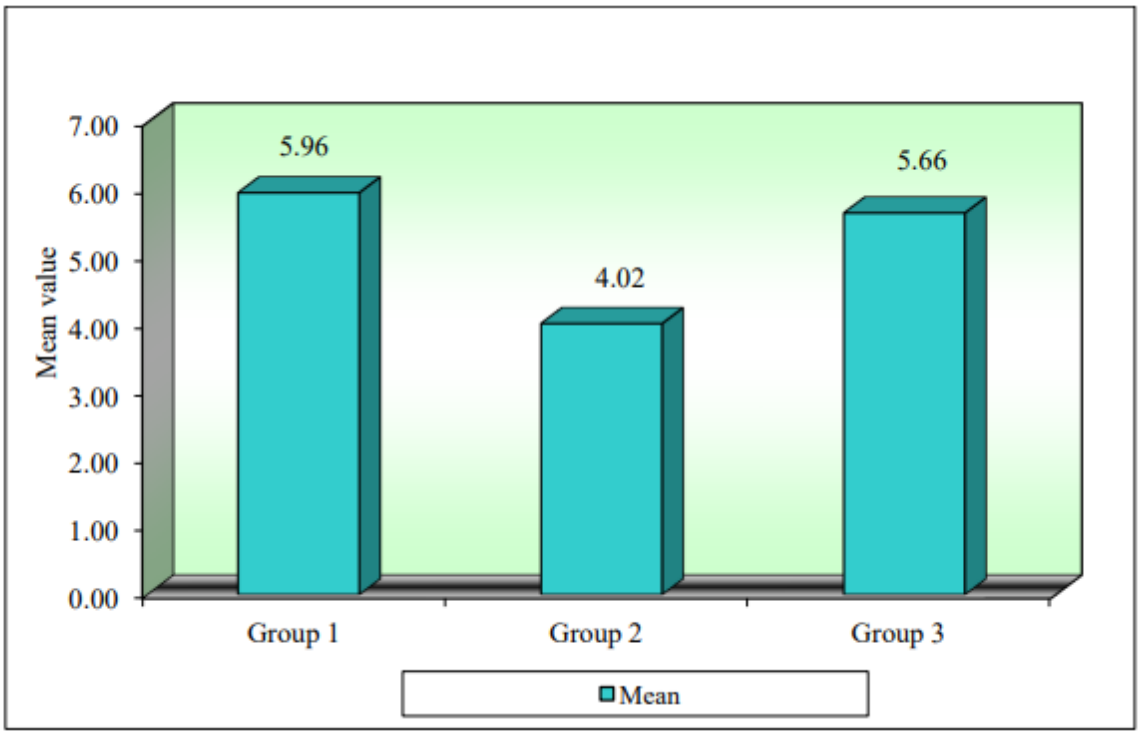
TABLE 3: Comparison of Shear Bond Strength of three groups (Group 1 - Zirconomer, Group 2- Hidense, and Group 3- HS Posterior Extra) by one way ANOVA test.

Groups	Mean	SD	SE
Group 1	5.96	0.90	0.20
Group 2	4.02	0.58	0.13
Group 3	5.66	0.62	0.14
F-value	43.0093		
p-value	0.0001		

GRAPH 1: Comparison of three groups (Group 1 - Zirconomer, Group 2- Hidense, and Group 3- HS Posterior Extra) with respect to compressive strength at 1 day and 7 day interval by unpaired t test.



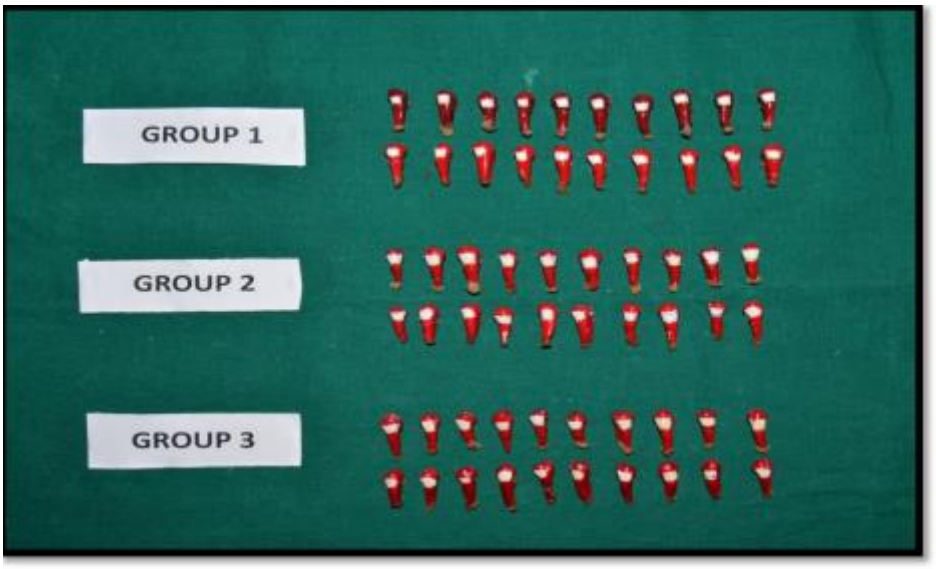
GRAPH 2: Comparison of the Mean Shear Bond Strength values of the three groups (Group 1 - Zirconomer, Group 2- Hidense, and Group 3- HS Posterior Extra).



Figures; 1 Shear bond strength testing using universal testing machine

Figures; 2 Sample for Shear bond strength testing restored with the help of cylindrical polyvinyl mold.

Figure 3; Sample after nail varnish application and apex impermibilization.



Finishing & polishing;
All the teeth were finished to contour with composite finishing bur 7910 and polished using soflex disc in a low-speed contra angle micro motor hand piece. The specimens were than stored in distilled water for 24 hours .After which the teeth were subjected to Thermo cycling for 300 cycles between 4 ^{0}c & 60 ^{0} c with a drill time of 15 sec .After wards 2 coats of dental varnish (Copalite, cooley & cooley LTD ,TX, USA) was applied to all tooth surfaces are sealed with sticky wax [Fig 3] and thin immersed in 5 % Methylene blue for 12 hours at room temperature. [10].

RESULTS
This table 1 shows Comparison of 1 day and 7 days with respect to Compressive Strength scores in three groups by unpaired t test. There is highly significant decrease in the CS between the 1 day interval to the 7 day interval in the group 3 and group 2. There is also significant decrease in the CS Values between the 1 day and 7 day interval in the group 1. [Graph 1]
This table 2 shows mean Shear bond strength values and their standard deviation of all three groups. The mean SBS values are highest in group 1 followed by group 3 and least in group 2. [Graph 2]

DISCUSSION
In the present study, Zirconomer reinforced Glassionomer (Zirconomer), Silver reinforced Glassionomer (Zirconomer), and Conventional Glassionomer with high viscosity (High strength posterior extra) have been tested.
The objective of the current study was to analyze the mechanical properties of the cements being tested. In

the present study the Mechanical properties like Compressive strength and Shear bond strength were evaluated which are critical indicators of success to resist masticatory and parafunctional forces.

According to Khoroushi M (2013)[11] the liquid / powder ratio influences the mechanical cement microstructure based on the trans electron microscopy evaluated and x ray micro-analysis.

In the present study, the Compressive strength CS of Zirconomer, Hidence and HS posterior extra were analyzed after 1 day and 7 day interval, storing them in distilled water.

The mean CS values for all 3 groups were high after 1 day interval compared to 7 day interval and the mean CS values after 1 day was highest for group 2 (78.68) followed by group 3 (77.04) and least for group 1 (53.36) the mean CS values in a group 1 after 7 days was 47.26, which showed no stastically significant difference when compared with 1 day interval, while there was stastically significant decrease in the CS values in group 3 (From 77.04-47.98) and group 2 (From 78.68 to 52.0 after 7 day interval.

In the present study, it was hypothesized that the setting process will continue with time and that the related mechanical properties will improve, but contrary to the expectations there was a reduction in the CS values later 7 days interval.

According to YAP AU (2003) [12] study mechanical properties of highly viscous GIC (Fuji ix GP fast) at 1 day and 7 Th day showed no significant difference between the 2 cements.

Pereora LC (2002)[13] reported similar findings in this study where the CS values at 24 h and after 1 week showed no significant difference but CS values increased with time. This is because at 24 h most of the cements had not reached maximum strength .In the present study, also there was no significant difference in the CS value for Group 1 (Zirconomer) at 1 day and 7 days but other groups showed a significant decrease in the CS values.

In the present study, the ratios were standardized according to the manufacturer's instructions however, there was decrease in the CS of the materials after 7 days.

Williams JA (1990) [14] has stated that the changes in the powder /liquid ratio will influence the mechanical properties of dental materials. The authors noticed that in clinical practice, cements are mixed to produce a wide range of powder/liquid ratios and the range of mixing ratios did not consider the manufacturers' recommended ratio for luting purposes. In the present study, the ratios were standardized according to manufacturer's instructions. However, there was decrease in the CS of the materials after 7 days.

Shear bond strength is a simple and widely used test to assess the bonding performance of restorative materials [15], particularly regarding the GICs, which present low bond strength, other tests may offer great difficulty to be applicable.[16 ,17]

Results of the present study showed that the mean SBS of Zirconomer was 5.96 MPa which was highest among the three groups and showed statistically significant difference between Hidense and statistically insignificant difference between High strength posterior extra.

Our study showed that SBS of Silver reinforced GIC (Miracle mix) to be 4.02 Mpa.These results are slightly lower than the values of SBS of Miracle mix in permanent teeth, which were found to be 4.08 Mpa. [18].

The SBS of Hidense was low, may be due to the probability that it has not reached its optimum strength at 24 h. It was expected to mature and strengthen over a period of several months. It can also be attributed to its intrinsic brittleness. Zirconomer and HS posterior extra showed significantly higher SBS. This could be due to micronization and treatment of the main glass components. Studies testing shear bond strengths of GICs to dentine have found values ranging from 1.32-4.10 57 .

In the present study, these values were higher, in the range of 4.09-5.96 MPa, which may represent some improvement of the reinforced and highly viscous GICs developed.

Wakeel AM (2015)[19] evaluated the Micro shear bond strength of conventional GI cement (Fuji IX, CGI), Resin modified GI (Fuji II LC, RMGI) and Nano-ionomer (Ketac N100, NI) to dentine and concluded that the SBS of Resin modified Glass ionomer (11.37) was high compared to CGI (4.82) and NI (7.47). In the present study, SBS values of group 1 and group 3 were lower than group 2 (RMGI) and higher than that of the group 1 (CGI).

Conclusion

The results of the study it can be concluded that the Zirconia reinforced glass ionomer at 7 days had no significant difference in the CS and at 24 hrs had good bond strength and sealing ability compared to other restoratives.

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