ISSN No:-2456-2165

# Comparative Evaluation of the Diametral Tensile Strength of Four Commercially Available Luting Cements: An in - Vitro Study.

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**Abstract :-**

**Background and Objectives: The foremost goal of any clinician is providing the patient with a restoration which preserves the longevity of fixed partial dentures and regaining the lost function. In the oral environment, dental luting agents must withstand masticatory and parafunctional stresses. They should maintain their integrity while transferring stresses from crowns or fixed partial dentures to tooth structure. The purpose of this in vitro study was to compare and evaluate the diametral tensile strength of four commercially available luting cements.**

**Method: A total of 120 samples were prepared of which 30 samples were prepared for Group A (GC gold label 1 luting and lining cement), 30 samples for Group B (Ivoclar Vivaglass cem), 30 specimens for Group C (3M ESPE Rely X Luting cement) and 30 specimens for Group D (Kerr Nexus RMGI). Pre formed polyethylene molds measuring 6.0±0.1 mm in diameter and 3.0±1. 0mm in thickness (ISO Standard 9917) are machined to prepare standardized cylindrical cement blocks. In these groups, based on duration of immersion in artificial saliva each group will be subdivided into three subgroups of 10 samples each.**
**For diametral tensile strength testing, the specimens were subjected to Universal Testing Machine.The values were collected and statistically analysed.**

**Results: The Resin modified Glass ionomer cement Kerr Nexus RMGI showed significantly the highest mean diametral tensile strength followed by 3M ESPE Rely X Luting cement, Ivoclar Vivaglass cem and then GC gold label 1 luting and lining cement. All the groups exhibited the highest mean tensile strength at 24 hrs followed by $4^{th}$and $7^{th}$ day after the immersion in artificial saliva. A statistically significant difference P<0.001 was observed between the values of all the groups.**

**Conclusion: The Resin modified Glass ionomer cement Kerr Nexus RMGI had the highest diametral tensile strength followed by 3M ESPE Rely X Luting cement, Ivoclar Vivaglass cem and then GC gold label 1 luting and lining cement.**

***Keywords:-*** *Resin modified Glass ionomer cement, diametral tensile strength, Kerr Nexus RMGI, 3M ESPE Rely X Luting cement, Ivoclar Vivaglass cem, GC gold label 1 luting and lining cement, Fixed Partial Denture, Universal Testing machine.*

## I. INTRODUCTION

The clinical success of fixed prostheses is heavily dependent on the cementation procedure. Loss of crown retention was found to be the second leading cause of failure of traditional crowns and fixed partial dentures.[1]In the oral environment, dental luting agents must withstand masticatory and parafunctional stresses. They should maintain their integrity while transferring stresses from the crowns or fixed partial dentures to tooth structure. They are designed to retain restorations, appliances, posts and cores in a stable, long-lasting position in the oral environment.Retention mechanisms for restorations secured by cements are reported to be chemical, mechanical and micromechanical. Retention of the restoration is usually achieved by a combination of two or three mechanisms depending on the nature of the cement and the substrate.

The dental cements should have adequate resistance to dissolution in the oral environment, strong bond through mechanical interlocking and adhesion, high strength under tension, biocompatible, good manipulation properties such as acceptable working and setting time.[2]

Cements having high compressive, shear, flexural, diametral tensile strength are preferred. Glass ionomer cements (GICs) are commonly used for cementation of indirect restorations.There are several types of cement available for the permanent retention of indirect restorations. These include zinc phosphate, zinc silicophosphate, polycarboxylate, glass ionomer, resin modified glass ionomer and composite resin cements.

Glass ionomer cement is based on acid–base reaction between aluminosilicate glass powder and an aqueous solution of polymers and copolymers of acrylic acid, including itaconic, maleic and tricarboxylic acid. This cement was given the genetic name Glass-ionomer cement (GIC) and the trivial name was ASPA (Aluminosilicate polyacrylate).

Glass ionomer cement has its own disadvantages. Its pH is lower than that of zinc phosphate cement during setting which leads to post cementation hypersensitivity. Therefore, calcium hydroxide coating should be applied to areas close to the pulp to reduce the pulpal irritation. It is weakened by early exposure to moisture.

To overcome certain disadvantages of Glass ionomer cements. The hybrid cements or resin - modified polyalkenoate cements are developed to increase the strength and decrease the solubility of conventional glass ionomer cements. There are various resin modified glass ionomer cements which are extensively used in Fixed Prosthodontics. They are indicated for permanent cementation of all metal, metal-ceramic and all ceramic restorations.

RelyX Luting, Kerr Nexus are the commercially available luting cement that offers a perfect mix of convenience. Rely X luting cement is an advanced resin-modified glass ionomer with paste-paste delivery from the Clicker Dispenser that is easy to mix, load, seat and remove. With high bond strength and virtually no postoperative sensitivities itensures optimum results for routine cementations.

The compressive and diametral tensile strengths are common tests to determine the mechanical properties of glass ionomers. Diametral tensile strength is an important mechanical property that must be assessed in luting cements because several cements are extremely friable and have a susceptibility to mechanical failure. It is an alternative method of testing the brittle materials, in which the ultimate tensile strength of a brittle material isdetermined through compressive testing. This test is widely used due to its relative simplicity and reproducible results.[3]

## II. AIM OF THE STUDY

The Aim of this study is to compare and evaluate the diametral tensile strength of four commercially available luting cements after immersion in artificial saliva.

## III. MATERIALS AND METHODOLOGY

### A. *Fabrication and distribution of specimen:*

- Preparation of specimens:
  Pre formed polyethylene molds measuring 6.0±0.1 mm in diameter and 3.0±1.0mm in thickness (ISO Standard 9917)[4]machined to prepare standardized cylindrical cement blocks (figure 1 & 2). The molds are washed and sterilized chemically using hydrogen peroxide of concentration 3 % weight / volume. Thecements are mixed on the mixing pad according to manufacturer's instructions and immediately poured into the molds (figure 5 and 6).

  The assembly are placed for 1 hr. at room temperature to ensure complete set of the cements. The specimens were removed carefully from the molds (figure 7) and are inspected thoroughly to detect any voids and such sample will be discarded. Excess material is trimmed using 120 grit sand paper and these samples were stored in artificial saliva (figure 8).

| | |
|---|---|
| Group A<br>GC gold label 1 luting and lining cement<br>n =30 | Sub group 1 - for 24 hrs. n=10<br>Sub group 2 - for 4th day n=10<br>Sub group 3 - for 7th day n=10 |
| Group B<br>Ivoclar Vivaglass cem<br>n =30 | Sub group 1 - for 24 hrs. n=10<br>Sub group 2 - for 4th day n=10<br>Sub group 3 - for 7th day n=10 |
| Group C<br>3M ESPE Rely X Luting cement<br>n=30 | Sub group 1 - for 24 hrs. n=10<br>Sub group 2 - for 4th day n=10<br>Sub group 3 - for 7th day n=10 |
| Group D<br>Kerr Nexus RMGI<br>n=30 | Sub group 1 - for 24 hrs. n=10<br>Sub group 2 - for 4th day n=10<br>Sub group 3 - for 7th day n=10 |

Table 1: Distribution of specimen

### B. *Testing specimen for diametral tensile strength:*

The specimens of all respective groups are dried using blotting paper and subjected to diametral tensile test. The cylindrical specimens of dimensions 6.0 ± 0.1 mm in diameter x 3.0 ± 0.1 mm in thickness (according to specification ISO Standard 9917) were tested under compressive load which were placed by a flat plate of the Universal Testing Machine against the side of the cylindrical specimen (figure 12). The load was applied vertically on the lateral portion of the cylinder, at a crosshead speed of 1.0 mm/min, producing tensile stresses perpendicular to the vertical plane passing through the center of the specimen.

After each compressive test, the fracture load (F), in Newton's (N), was recorded and the diametral tensile strength ($\sigma_t$) (in MPa) was calculated as follows:

$$\sigma_t = 2F/\pi dh$$

where: d: diameter (6±0.1 mm)

h: height (3±0.1mm) of specimens

π: 3.1416.

## IV. STATISTICAL ANALYSIS OF DATA

*A. Statistical Analysis:*

Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0. Released in 2013. Armonk, NY: IBM Corp., was used to perform statistical analyses.

*B. Descriptive Statistics:*

Descriptive analysis includes expression of Diametral Tensile Strength in terms of Mean & SD for each study group.

*C. Inferential Statistics:*

- One-way ANOVA test followed by Tukey's post hoc test was used to compare the Mean DiametralTensile Strength between 4 groups at different time intervals.
- Repeated measures of ANOVA test followed by Bonferroni's post hoc test was used to compare the mean Diametral Tensile Strength between different time intervals in each study group.
- The level of significance [P-Value] was set at $P<0.05$.

## V. PHOTOGRAPHS

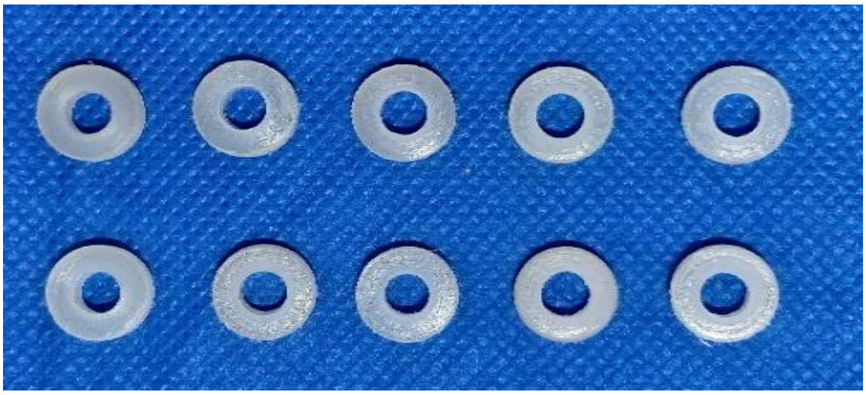

Fig. 1: Preformed polyethylene molds for fabrication of specimen

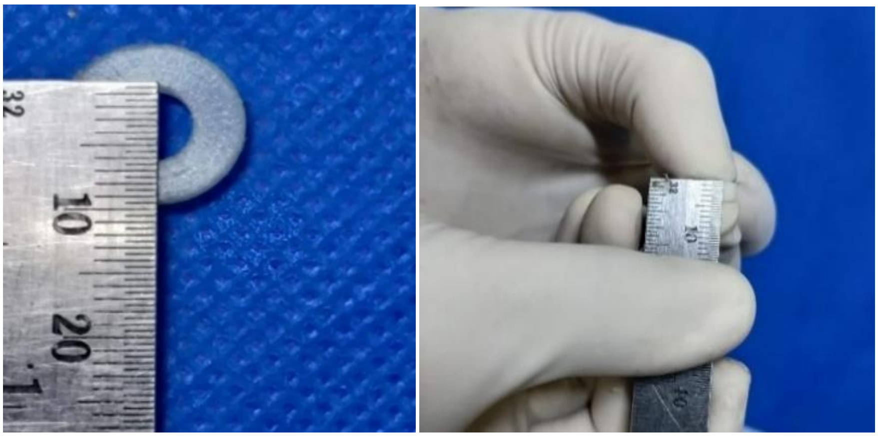


Fig. 2: Molds measuring $6.0\pm0.1$ mm in diameter and $3.0\pm\mathbf{1.0}$mm in thickness (ISO Standard 9917)


Fig 3: Commercially available luting cements
Group A : GC GOLD, Group B: VIVAGLASS, Group C: RELY X , Group D : KERR NEXUS


Fig. 4: Artificial Saliva(Moi-Stir)

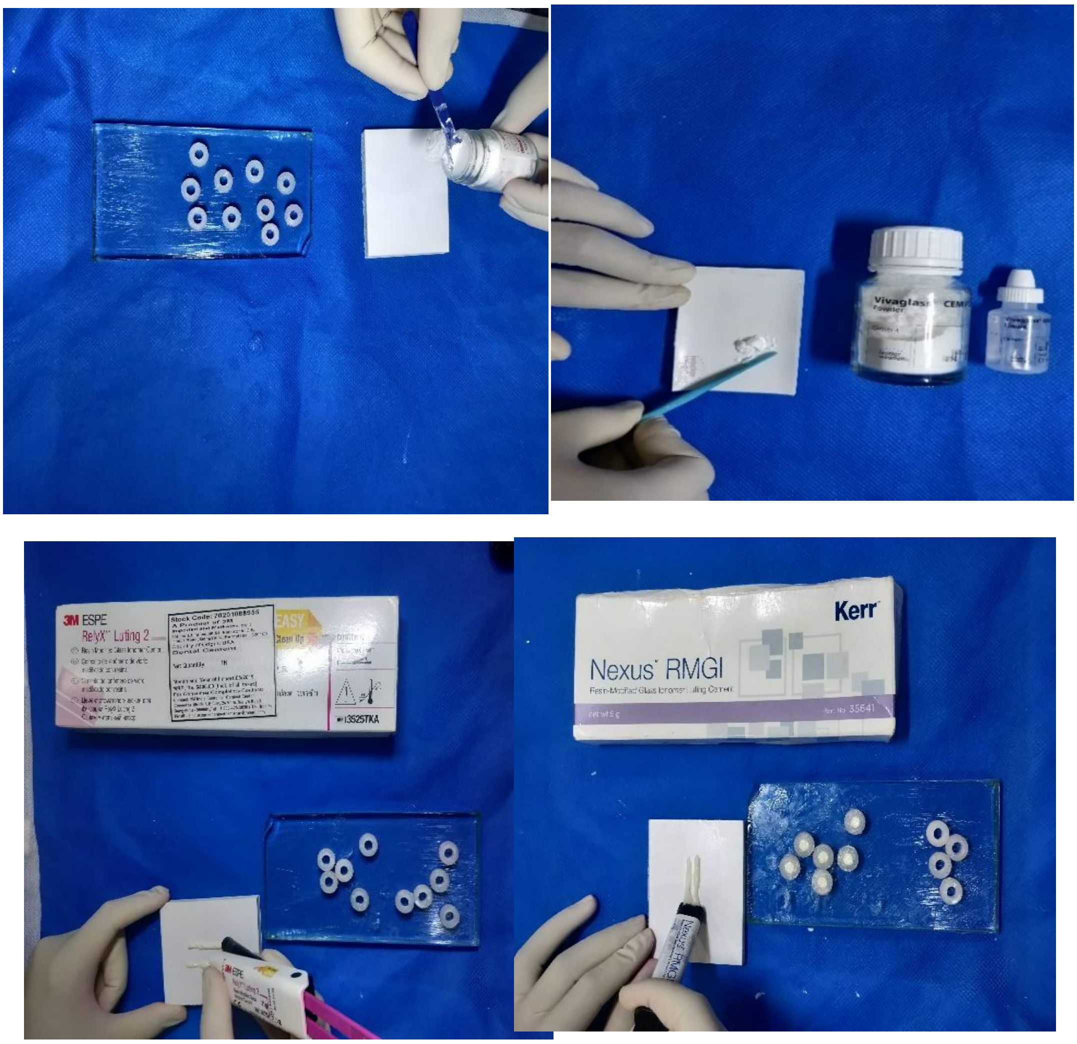


Fig. 5: Cements are mixed according to manufacturer’s instructions


Fig 6: The mixed cements are immediately poured into the molds

Fig. 7: Specimens are carefully removed from the molds


Fig. 8: The samples are placed in Artificial saliva

ISSN No:-2456-2165

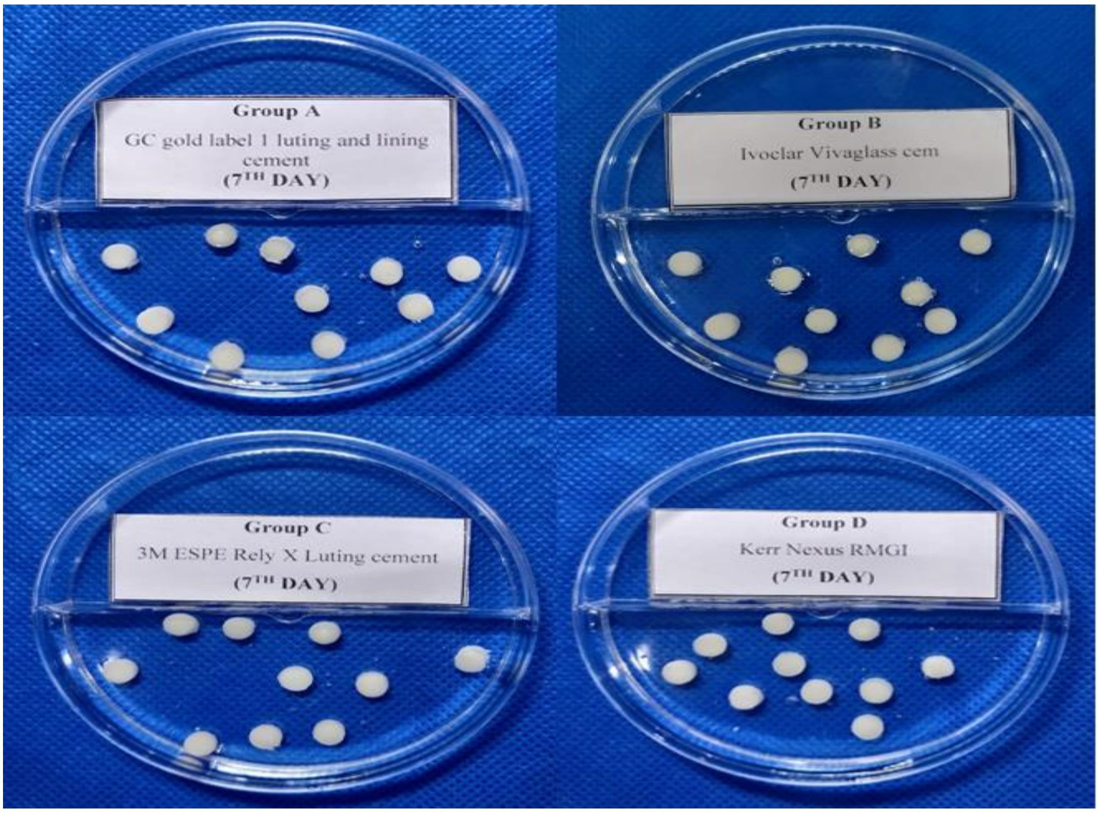


Fig. 9: The specimens are stored in the artificial saliva for 7 days

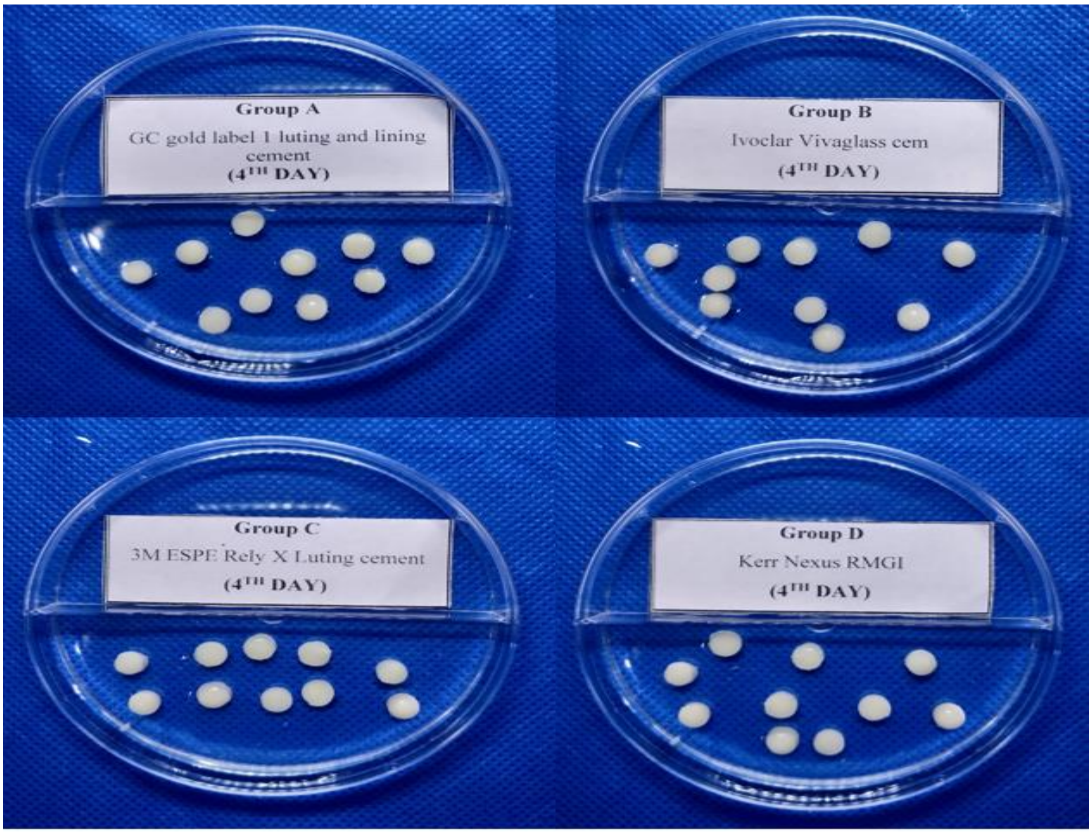


Fig 10: The specimens are stored in the artificial saliva for 4 days

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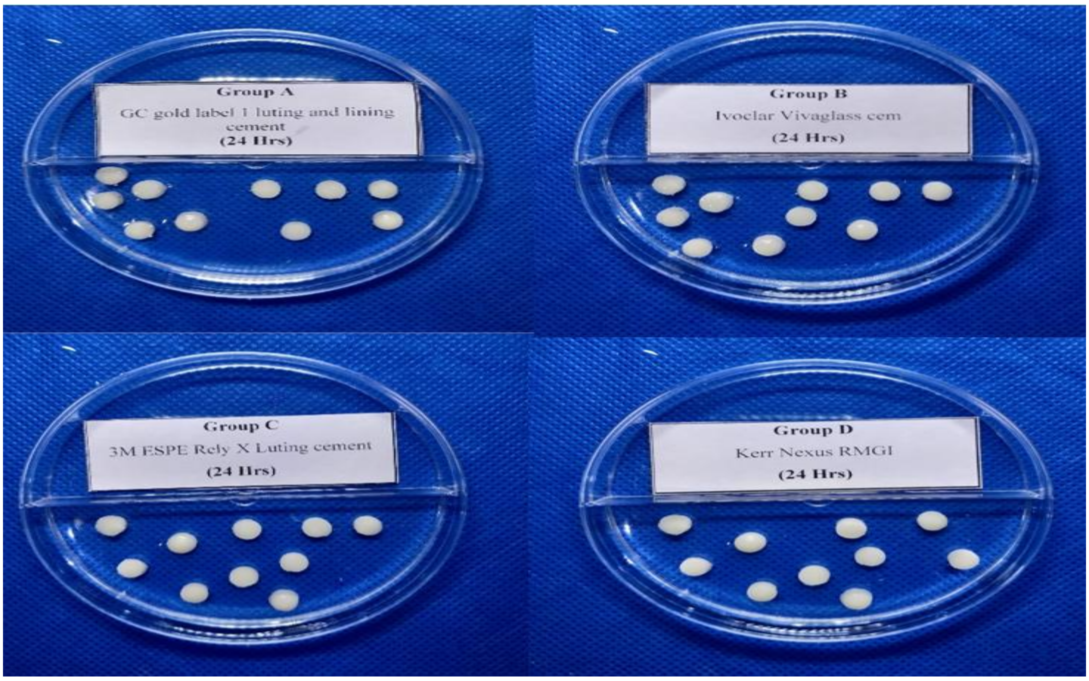


Fig. 11: The specimens are stored in the artificial saliva for 24 hrs


Fig. 12: Universal Testing Machine (UTM) for Diametral Tensile strength testing (Mecmesin Multitest 10-i)

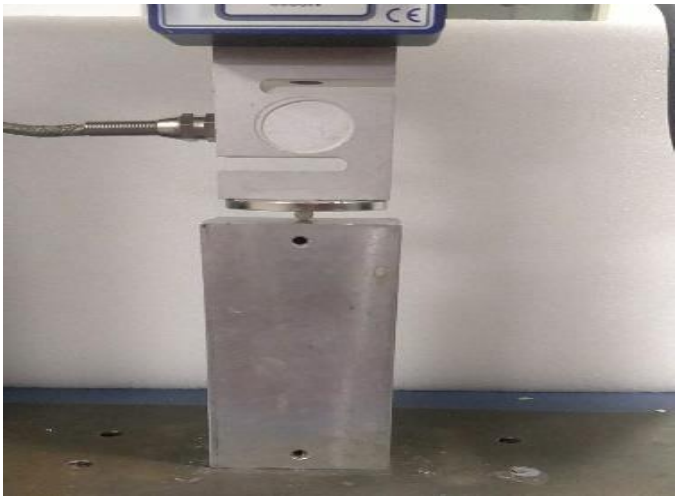

Fig 13: Specimens subjected to diametral tensile load by a flat plate of Universal Testing Machine

Fig 14: Specimen after fracture under diametral tensile load

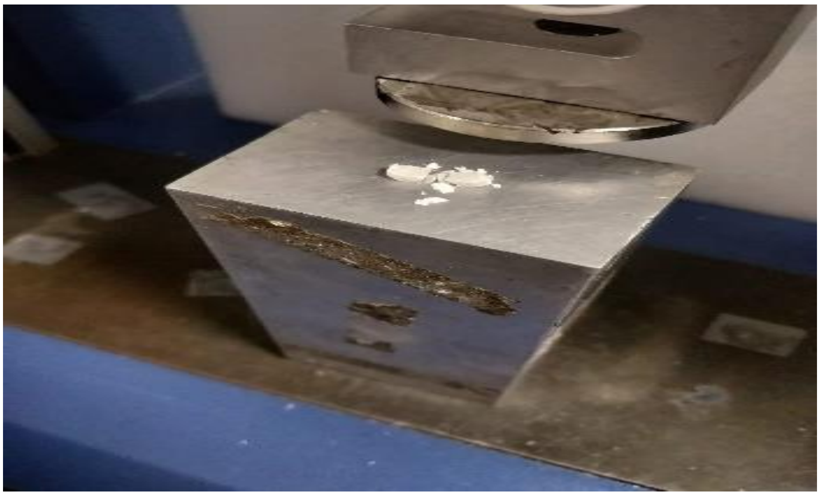

Fig. 15: The fractured specimen on UTM

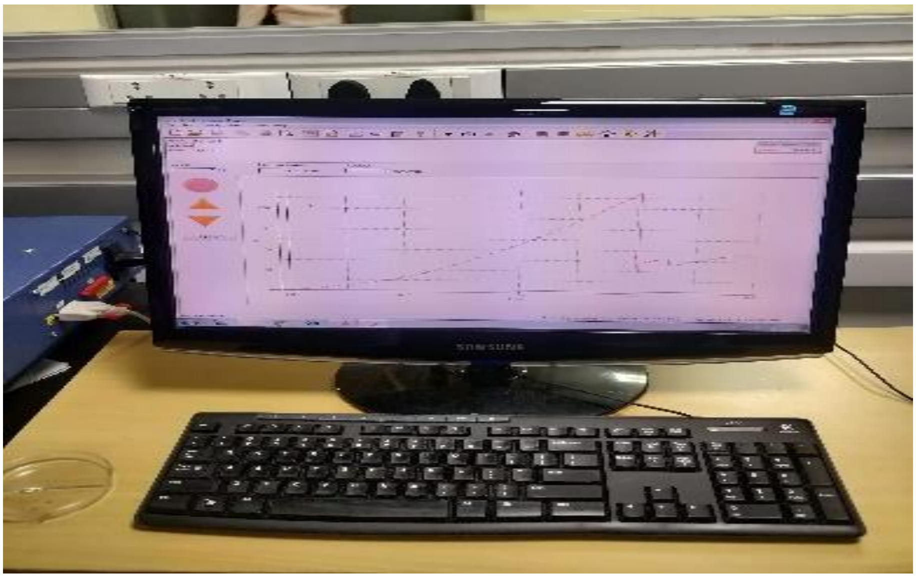

Fig. 16: The fracture load in Newton (N) is recorded

## VI. RESULTS

Load at break for each specimen was procured from the load-deflection curve that was obtained from the diametral tensile strength in an UTM. Using this value, diametral tensile strengths of all the specimens of groups A, B, C and D were calculated and tabulated in tables 2, 3, 4 and 5 respectively.

| **GROUP A: GC GOLD (in Mpa)** | | | |
|---|---|---|---|
| **SAMPLE NO** | **24 HRS** | **4 TH DAY** | **7 TH DAY** |
| 1 | 8.22 | 6.43 | 4.87 |
| 2 | 8.56 | 6.56 | 5.45 |
| 3 | 9.07 | 6.88 | 5.06 |
| 4 | 9.70 | 6.59 | 5.11 |
| 5 | 9.25 | 7.19 | 4.69 |
| 6 | 8.76 | 7.39 | 5.24 |
| 7 | 9.54 | 6.77 | 5.19 |
| 8 | 9.81 | 6.48 | 5.58 |
| 9 | 9.90 | 6.95 | 5.61 |
| 10 | 8.36 | 7.34 | 5.00 |

Table 2: Diametral tensile strength values of tested specimens of Group A
(GC gold label 1 luting and lining cement)

| **GROUP B: IVOCLAR VIVAGLASS CEM (in Mpa)** | | | |
|---|---|---|---|
| **SAMPLE NO** | **24 HRS** | **4 TH DAY** | **7 TH DAY** |
| 1 | 9.92 | 8.56 | 6.16 |
| 2 | 10.25 | 8.43 | 6.74 |
| 3 | 10.83 | 7.80 | 6.56 |
| 4 | 11.30 | 8.83 | 6.88 |
| 5 | 10.91 | 8.18 | 6.43 |
| 6 | 10.37 | 8.27 | 6.80 |
| 7 | 10.49 | 8.01 | 6.46 |
| 8 | 10.06 | 8.06 | 6.99 |
| 9 | 10.17 | 8.43 | 6.71 |
| 10 | 10.31 | 8.35 | 6.31 |

Table 3: Diametral tensile strength values of tested specimens of Group B
(Ivoclar Vivaglass cem)

| **GROUP C: 3M ESPE Rely X Luting cement(in Mpa)** | | | |
|---|---|---|---|
| **SAMPLE NO** | **24 HRS** | **4 TH DAY** | **7 TH DAY** |
| 1 | 14.41 | 9.56 | 6.74 |
| 2 | 13.02 | 10.22 | 7.69 |
| 3 | 13.23 | 9.92 | 7.79 |
| 4 | 14.38 | 9.36 | 7.72 |
| 5 | 13.35 | 10.06 | 6.88 |
| 6 | 13.78 | 10.31 | 6.80 |
| 7 | 13.89 | 9.71 | 7.38 |
| 8 | 13.52 | 10.48 | 7.94 |
| 9 | 14.19 | 9.99 | 6.96 |
| 10 | 14.31 | 9.77 | 7.20 |

Table 4: Diametral tensile strength values of tested specimens of Group C
(3M ESPE Rely X Luting cement)

| **GROUP D: Kerr Nexus RMGI(in Mpa)** | | | |
|---|---|---|---|
| SAMPLE NO | 24 HRS | 4 TH DAY | 7 TH DAY |
| 1 | 14.41 | 10.83 | 8.56 |
| 2 | 15.76 | 11.30 | 8.43 |
| 3 | 14.62 | 11.49 | 8.27 |
| 4 | 15.78 | 10.95 | 8.17 |
| 5 | 14.76 | 11.94 | 8.83 |
| 6 | 15.16 | 11.55 | 8.59 |
| 7 | 15.64 | 11.23 | 9.06 |
| 8 | 15.45 | 11.06 | 8.63 |
| 9 | 14.94 | 10.96 | 9.15 |
| 10 | 15.69 | 11.37 | 8.40 |

Table 5: Diametral tensile strength values of tested specimens of Group D
(Kerr Nexus RMGI)

| Groups | N | Mean | SD | Min | Max | P-Value |
|---|---|---|---|---|---|---|
| Group A | 10 | 9.12 | 0.62 | 8.2 | 9.9 | <0.001* |
| Group B | 10 | 10.46 | 0.43 | 9.9 | 11.3 | |
| Group C | 10 | 13.81 | 0.51 | 13 | 14.4 | |
| Group D | 10 | 15.22 | 0.51 | 14.4 | 15.8 | |
| * - Statistically Significant | | | | | | |

Table 6: Comparison of mean Diametral Tensile Strength between different groups at 24 hrs period using One-way ANOVA Test

| (I) Groups | (J) Groups | Mean Diff. (I-J) | 95% CI for the Diff. | | P-Value |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| Group A | Group B | -1.34 | -1.97 | -0.72 | <0.001* |
| | Group C | -4.69 | -5.32 | -4.06 | <0.001* |
| | Group D | -6.10 | -6.73 | -5.48 | <0.001* |
| Group B | Group C | -3.35 | -3.98 | -2.72 | <0.001* |
| | Group D | -4.76 | -5.39 | -4.13 | <0.001* |
| Group C | Group D | -1.41 | -2.04 | -0.78 | <0.001* |
| * - Statistically Significant | | | | | |

Table 7: Multiple pairwise comparison of mean diff. in Diametral Tensile Strength b/w groups at 24 hrs period using Tukey's Post hoc Test

The test result shows the mean diametral tensile strength during 24 hrs period between 4 groups. The Mean diametral tensile strength for Group A was 9.12 ± 0.62, Group B was 10.46 ± 0.43, Group C was 13.81 ± 0.51& Group D was 15.22 ± 0.51. This difference in the mean diametral tensile strength at 24 hrs period was statistically significant at P<0.001. Multiple pairwise comparison of mean between 3 groups at 24 hrs period revealed that Group D showed significantly highest mean diametral tensile strength as compared to other study groups at P<0.001. This was followed next with Group C demonstrating significantly higher mean diametral tensile strength as compared to Group A & Group B at P<0.001. Later Group B also showed significantly higher mean diametral tensile strength as compared to Group A at P<0.001. This infers that Group D showed significantly highest diametral tensile strength which was followed by Group C, Group B and least with Group A.

| Groups | N | Mean | SD | Min | Max | P-Value |
|---|---|---|---|---|---|---|
| Group A | 10 | 6.86 | 0.35 | 6.4 | 7.4 | <0.001* |
| Group B | 10 | 8.29 | 0.30 | 7.8 | 8.8 | |
| Group C | 10 | 9.94 | 0.35 | 9.4 | 10.5 | |
| Group D | 10 | 11.27 | 0.34 | 10.8 | 11.9 | |
| * - Statistically Significant | | | | | | |

Table 8: Comparison of mean Diametral Tensile Strength between different groups at 4 th day period using One-way ANOVA Test

| (I) Groups | (J) Groups | Mean Diff. (I-J) | 95% CI for the Diff. | | P-Value |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| Group A | Group B | -1.43 | -1.84 | -1.03 | <0.001* |
| | Group C | -3.08 | -3.48 | -2.68 | <0.001* |
| | Group D | -4.41 | -4.81 | -4.01 | <0.001* |
| Group B | Group C | -1.65 | -2.05 | -1.24 | <0.001* |
| | Group D | -2.98 | -3.38 | -2.57 | <0.001* |
| Group C | Group D | -1.33 | -1.73 | -0.93 | <0.001* |
| * - Statistically Significant | | | | | |

Table 9: Multiple pairwise comparison of mean diff. in Diametral Tensile Strength b/w groups at 4 th Day period using Tukey's Post hoc Test

The test result shows the meandiametral tensile strength during 4th day period between 4 groups. The Meandiametral tensile strength for Group A was 6.86 ± 0.35, Group B was 8.29 ± 0.30, Group C was 9.94 ± 0.35& Group D was 11.27 ± 0.34. This difference in the mean diametral tensile strength at 4th day period was statistically significant at P<0.001. Multiple pairwise comparison of mean between 3 groups at 4th day period revealed that Group D showed significantly highest mean diametral tensile strength as compared to other study groups at P<0.001. This was followed next with Group C demonstrating significantly higher mean diametral tensile strength as compared to Group A & Group B at P<0.001. Later Group B also showed significantly higher meandiametral tensile strength as compared to Group A at P<0.001. This infers that Group D showed significantly highest diametral tensile strength which was followed by Group C, Group B and least with Group A.

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| Groups | N | Mean | SD | Min | Max | P-Value |
|---|---|---|---|---|---|---|
| Group A | 10 | 5.18 | 0.30 | 4.7 | 5.6 | <0.001* |
| Group B | 10 | 6.60 | 0.26 | 6.2 | 7 | |
| Group C | 10 | 7.31 | 0.45 | 6.7 | 7.9 | |
| Group D | 10 | 8.61 | 0.32 | 8.2 | 9.2 | |
| * - Statistically Significant | | | | | | |

Table 10: Comparison of mean Diametral Tensile Strength between different groups at 7th day period using One-way ANOVA Test

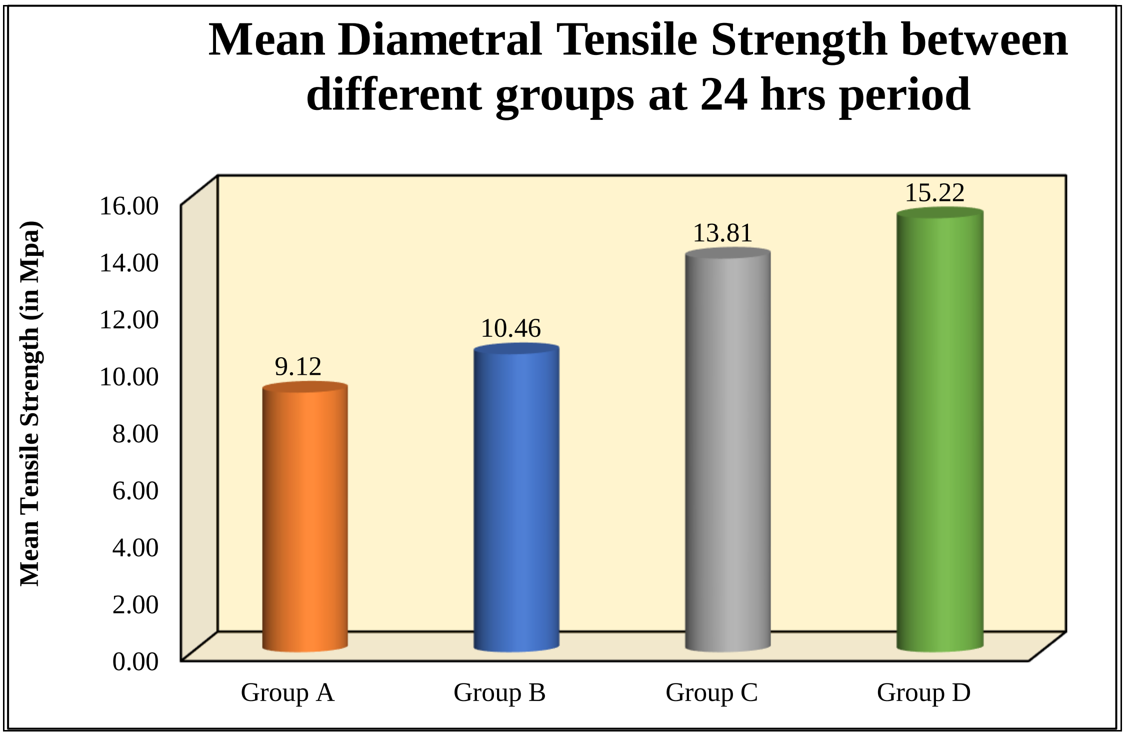
| (I) Groups | (J) Groups | Mean Diff. (I-J) | 95% CI for the Diff. | | P-Value |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| Group A | Group B | -1.42 | -1.84 | -1.01 | <0.001* |
| | Group C | -2.13 | -2.54 | -1.72 | <0.001* |
| | Group D | -3.43 | -3.84 | -3.02 | <0.001* |
| Group B | Group C | -0.71 | -1.12 | -0.29 | <0.001* |
| | Group D | -2.01 | -2.42 | -1.59 | <0.001* |
| Group C | Group D | -1.30 | -1.71 | -0.89 | <0.001* |
| * - Statistically Significant | | | | | |

Table 11: Multiple pairwise comparison of mean diff. in Diametral Tensile Strength b/w groups at 7th Day period using Tukey's Post hoc Test

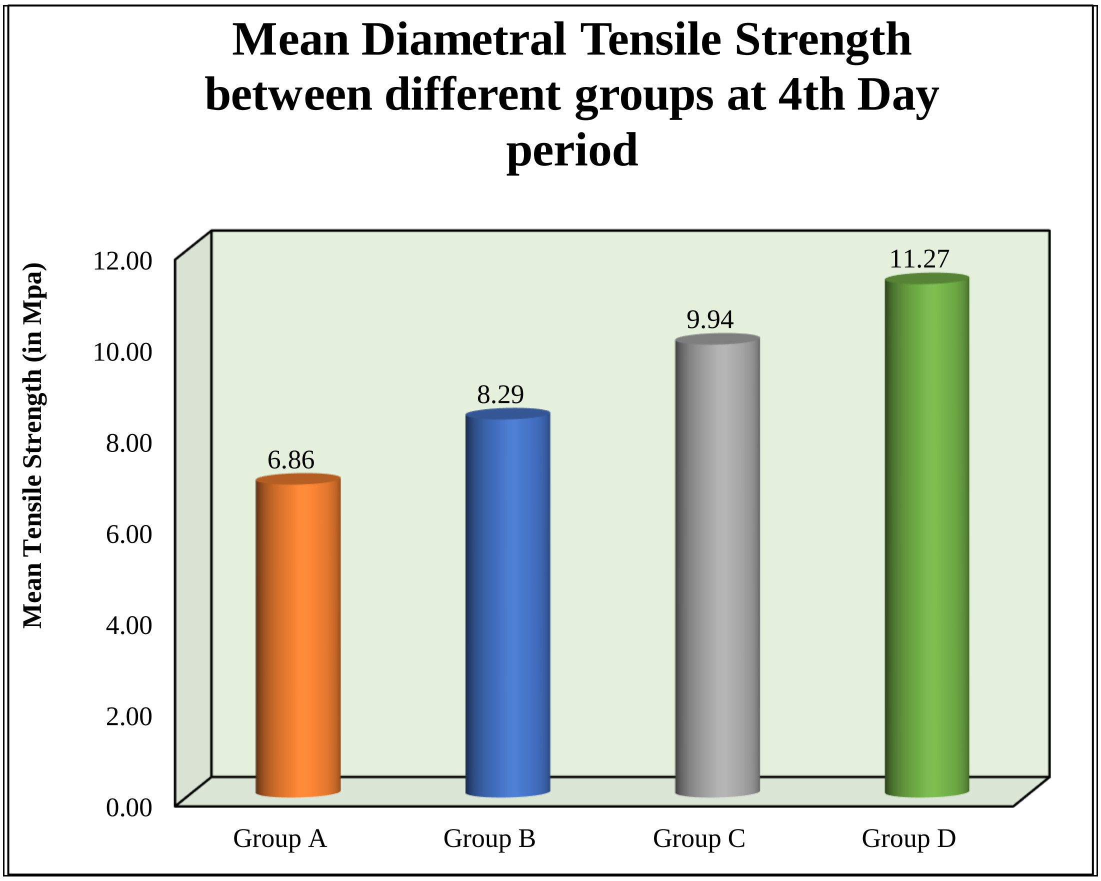
The test result shows the mean diametral tensile strength during 7th day period between 4 groups. The Mean diametral tensile strength for Group A was 5.18 ± 0.30, Group B was 6.60 ± 0.26, Group C was 7.31 ± 0.45& Group D was 8.61 ± 0.32. This difference in the mean diametral tensile strength at 7th day period was statistically significant at P<0.001. Multiple pairwise comparison of mean between 3 groups at 7th day period revealed that Group D showed significantly highest diametral mean tensile strength as compared to other study groups at P<0.001. This was followed next with Group C demonstrating significantly higher mean diametral tensile strength as compared to Group A & Group B at P<0.001. Later Group B also showed significantly higher mean diametral tensile strength as compared to Group A at P<0.001. This infers that Group D showed significantly highest diametral tensile strength which was followed by Group C, Group B and least with Group A.

| Groups | Time | N | Mean | SD | P-Value [a] | Sig. Diff | P-Value [b] |
|---|---|---|---|---|---|---|---|
| Group A | 24 hrs | 10 | 9.12 | 0.62 | <0.001* | 24h vs D4 | <0.001* |
| | 4 th day | 10 | 6.86 | 0.35 | | 24h vs D7 | <0.001* |
| | 7 th day | 10 | 5.18 | 0.30 | | D4 vs D7 | <0.001* |
| Group B | 24 hrs | 10 | 10.46 | 0.43 | <0.001* | 24h vs D4 | <0.001* |
| | 4 th day | 10 | 8.29 | 0.30 | | 24h vs D7 | <0.001* |
| | 7 th day | 10 | 6.60 | 0.26 | | D4 vs D7 | <0.001* |
| Group C | 24 hrs | 10 | 13.81 | 0.51 | <0.001* | 24h vs D4 | <0.001* |
| | 4 th day | 10 | 9.94 | 0.35 | | 24h vs D7 | <0.001* |
| | 7 th day | 10 | 7.31 | 0.45 | | D4 vs D7 | <0.001* |
| Group D | 24 hrs | 10 | 15.22 | 0.51 | <0.001* | 24h vs D4 | <0.001* |
| | 4 th day | 10 | 11.27 | 0.34 | | 24h vs D7 | <0.001* |
| | 7 th day | 10 | 8.61 | 0.32 | | D4 vs D7 | <0.001* |

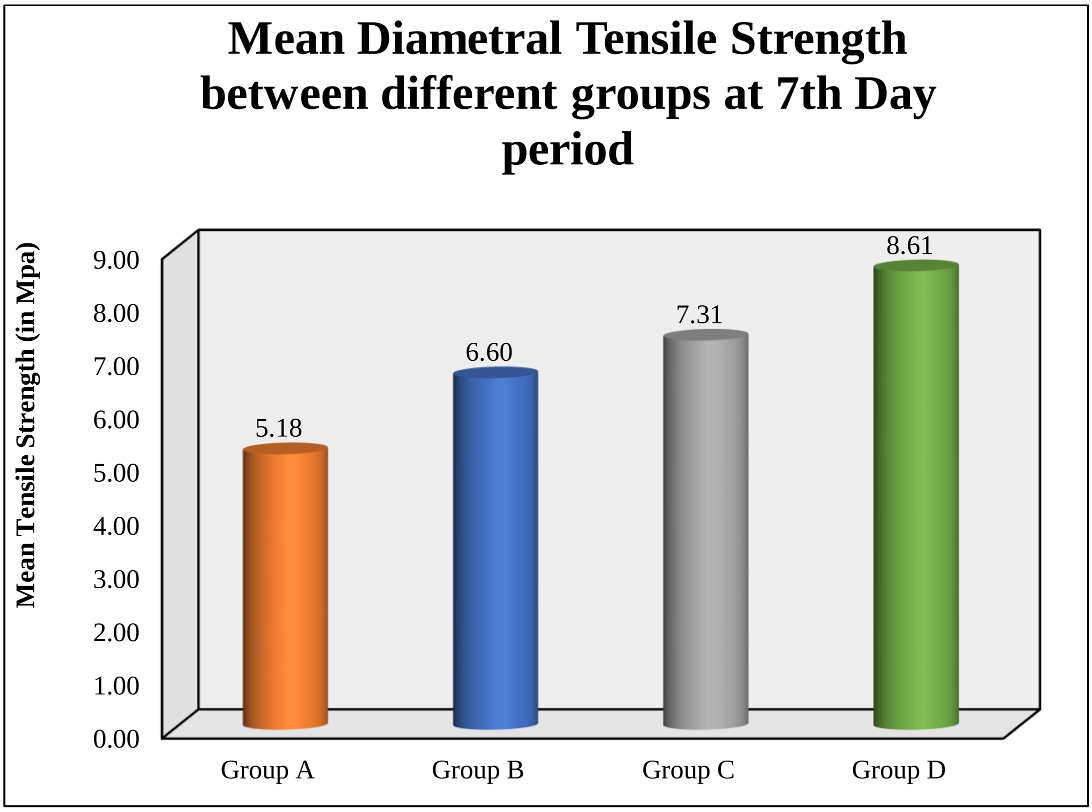
Table 12: Comparison of mean Diametral Tensile Strength b/w different time intervals in each group using Repeated Measures of ANOVA followed by Bonferroni's Post hoc Test



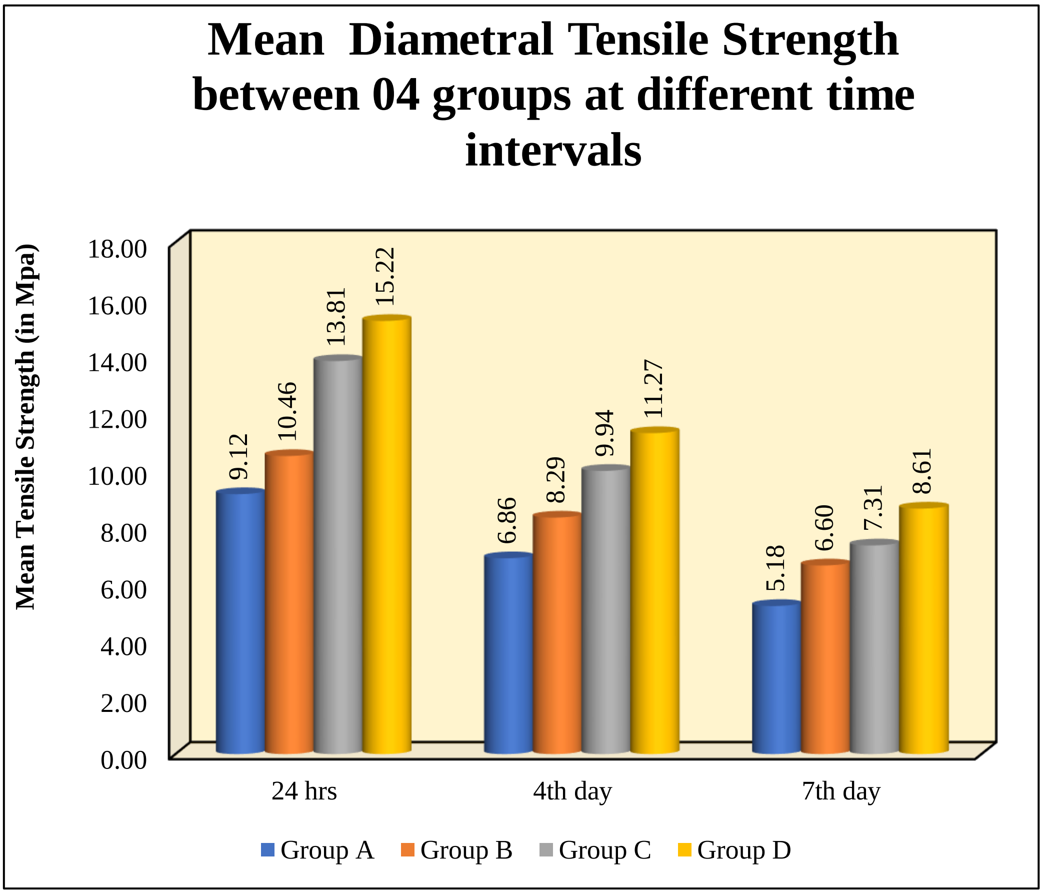

Graph 1: Mean Diametral Tensile Strength between different groups at 24 hrs period



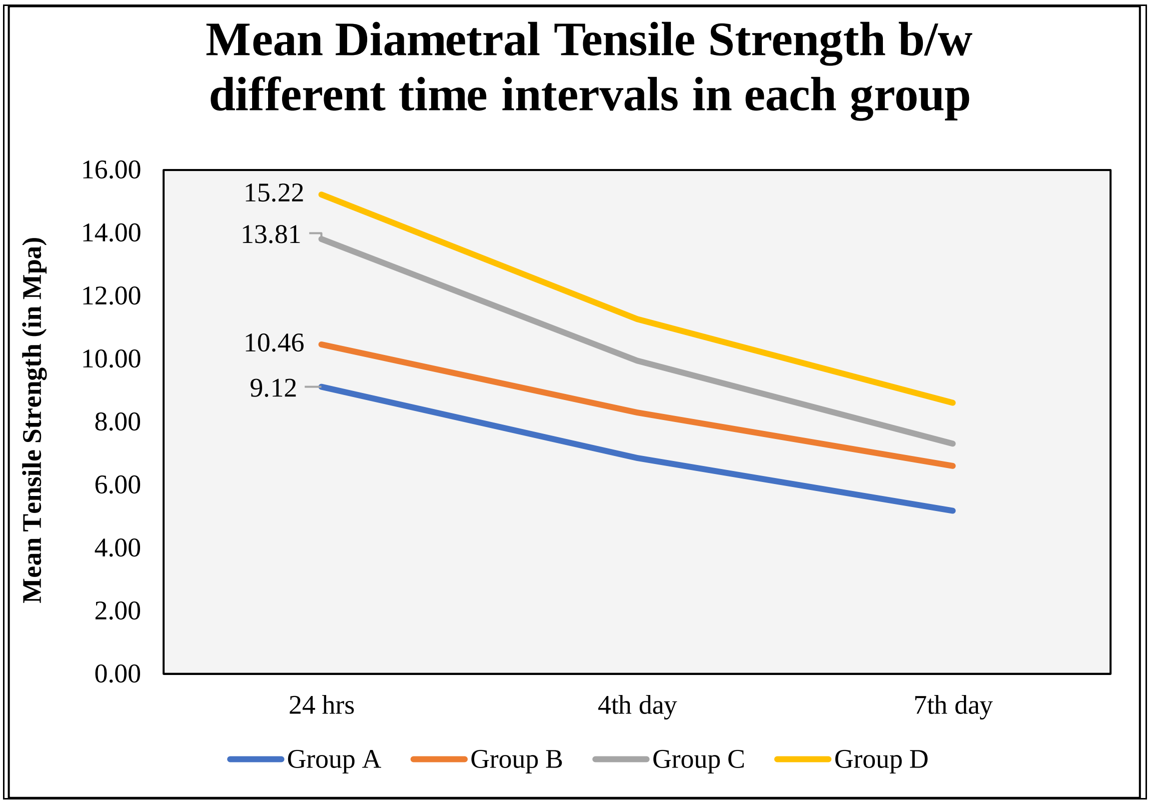

Graph 2: Mean Diametral Tensile Strength between different groups at 4th Day period




Graph 3: Mean Diametral Tensile Strength between different groups at 7th Day period




Graph 4: Mean Diametral Tensile Strength between 04 groups at different time intervals




Graph 5: Mean Diametral Tensile Strength b/w different time intervals in each group

## VII. DISCUSSION

The luting cements play a very major role in fixed prosthodontics. They are used to attach indirect restorations to prepared teeth and hence providing the patient with a restoration which preserves the longevity and pulp vitality of natural abutments of fixed partial denture and regaining their lost function.

The main function of luting cement is to fill the void at restoration – tooth interface and mechanically lock the restoration in place to prevent its dislodgement during mastication.[5]

According to Rosenstiel *et al*, an ideal luting agent must meet the basic mechanical, biological and physical properties such as good working time, flowability with minimum microleakage, low solubility in oral fluids, clinically acceptable compressive and tensile strength, adhesiveness, esthetics and cost effective.[6]

The demonstration of marginal leakage involving penetration of bacteria to the dentin interface and a reduction in retention of restorations lead to realization that luting cements should possess good wetting as well as bonding to enamel and dentin with less toxicity. These concepts lead to development of adhesive cements based on polyacrylic acid.

The luting cements are subjected to compressive and tensile stresses in the oral cavity during mastication which mandates the evaluation and introduction of newer luting cements in the field of fixed prosthodontics.

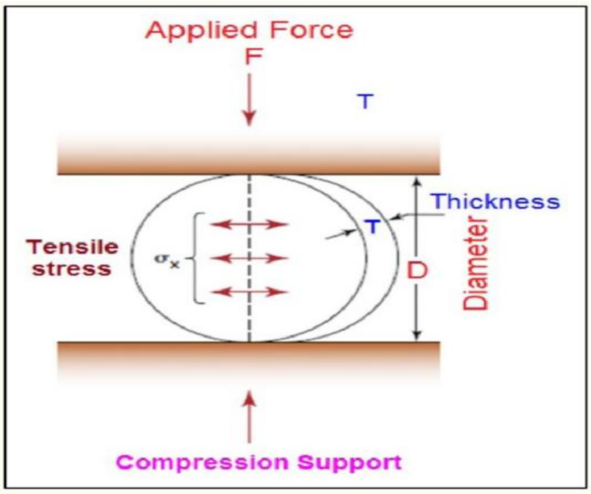



Fig. 17: Schematic representation of Diametral tensile strength where the force acting along $\sigma_x$ is called the diametral plane

Diametral tensile strength testing was developed to investigate brittle materials with little or no plastic deformation. It is a mechanical property that must be assessed because several cements are extremely friable and have a susceptibility to mechanical failure. This test is widely used due to its relative simplicity and reproducible results. In this test, a cylindrical specimen is subjected to compressive load in Diametral plane which is perpendicular to the longitudinal axis. (Fig: 17)

Additionally, it is the most common method for assessing the tensile strength of friable materials because it avoids the difficulties inherent to the flexural tensile strength test.[7]

Both diametral tensile and compressive strengths are considered a critical indicator of success because a high compressive strength is necessary to resist masticatory forces although the exact value is not known.

White et al compared both diametral tensile and compressive strengths of six classes of adhesive cements and concluded that conventional powder- liquid GIC, encapsulated Glass ionomer adhesive cements and composite resin adhesive luting agents demonstrated significantly greater compressive and diametral tensile strength than the zinc phosphate cements.[8]

Glass ionomer was developed in the early 1970s. The first of the two components is an acid-soluble calcium fluoroaluminosilicate glass and the second is an aqueous solution of polyacrylic acid. When both components are mixed, an acid-base reaction occurs. The acid etches the surface of the glass particles, resulting in the release of calcium, aluminium, sodiumand fluoride.

An advantage of glass ionomers is their ability to bond with teeth. This adhesion occurs via a hydrogen bond between the carboxyl groups of the polyacrylic acid and the calcium in the tooth.

Additionally, these materials have a low coefficient of thermal expansion, similar to tooth structure, which allows them to maintain a bond to tooth structure and allows for the release of fluoride to the surrounding tooth.[9]The formation of fluorohydroxyapatite makes the restoration more resistant to demineralization.

The main disadvantage of glass ionomer cements is high initial solubility, poor strength,poor wear resistance and they are highly water sensitive during setting.

Decementation was found to be the second leading cause of failure of the traditional crown and fixed partial denture, which may be caused by cement fracture, dissolution and excessive shear forces. Cements having high compressive, shear, flexural, diametral tensile strength are preferred.[3]

Resin-modified glass ionomer cements were developed to overcome the high solubility of glass ionomers. These cements bond to the inorganic dentin via a link to the calcium ion in the dentin. As with glass ionomers, this is an acid-base reaction that occurs in an aqueous environment. By combining the advantages of glass ionomer and resin, these materials also release fluoride, have an increased resistance to microleakage, adhere to tooth structure and are less soluble than a conventional glass ionomer.

The fact that the polymerization occurs prior to completion of the acid-base reaction helps decrease the solubility of these products. This makes this material more advantageous in a moist environment.

Yoshida K et al demonstrated that resin luting cements were markedly less soluble than conventional luting agents when placed in fresh lactic acid solution at pH 4.0 every 24 hrs over a 30-day period.[10]

Ryan AK et al in their study concluded that the resin-modified glass-ionomer cement demonstrated the highest resistance to crack propagation which would resist fracture of the cement and would increase the longevity of the prosthesis.[11]

Results of the current study demonstrated that the mean diametral tensile strength was found to be highest in resin modified glass ionomer cements that is Kerr NEXUS RMGI and 3M ESPE RELYX luting cement at all tested time interval when compared to that of conventional glass ionomer cements (Ivoclar Vivaglass and GC Gold Label 1 Luting Cement)

The higher values for Kerr Nexus RMGI could be attributed to the fact that monomers together with initiators, catalysts and other additives form the reactive part of a resin-based restorative. The strong mechanical properties and good long-term stability can be attributed to the combination of UDMA, an aromatic aliphatic-UDMA and PEG-400 DMA, whichinterconnects (cross-links) during polymerization. UDMA is the main component of the monomer matrix. It exhibits moderate viscosity and yields strong mechanical properties. The highly cross-linked polymer structure is responsible for the high flexural strength.

In the present study the meandiametraltensile strength for Group A at 24 hrs was 9.12 ± 0.62, Group B was 10.46 ± 0.43, Group C was 13.81 ± 0.51 & Group D was 15.22 ± 0.59. This difference in the meandiametral tensile strength at 24 hrs period was statistically significant at $P<0.001$. This infers that Group D showed significantly highestdiametral tensile strength which was followed by Group C, Group B and least with Group A. (Table 6 &7)

Similarly at $4^{th}$ and $7^{th}$ day time interval Group D showed significantly highestdiametral tensile strength which was followed by Group C, Group B and least with Group A (Table 8 & 10)

The test result shows the highest meandiametral tensile strength between different time intervals in Group D. The Meandiametral tensile strength at 24 hrs was 15.22 ± 0.51, at $4^{th}$ day was 11.27 ± 0.34 and at $7^{th}$ day was 8.61 ± 0.32. This mean difference in the diametral tensile strength between different time intervals in group D was statistically significant at $P<0.001$.

At all the time intervals tested group D(KERR NEXUS RMGI) exhibited highest diametral tensile strength followed by group C (3M ESPE RELY X) when compared to conventional glass ionomer cements.

The resin modified glass ionomer cements would be the promising luting cement materials for use in fixed prosthodontics which would increase the longevity of the restorations fabricated.

## VIII. LIMITATIONS OF THE STUDY

The present invitro study had some limitations; **-**

- Thermocycling used to simulate oral environment was not carried out in this in-vitro study.
- Specimens were fabricated in cylindrical shape according to ISO standards, hence the effect of luting cement fabricated according to anatomical form could not be evaluated.
- Only one physical property that is Diametral Tensile Strength has been checked in this study.
- The time interval was only till $7^{th}$ day, the evaluation of luting cements for a long duration of time could be done in the future studies.

## IX. CONCLUSION

**Within the limitations of the study, the following conclusions were drawn: -**

- The resin modified glass ionomer cement showed the highest mean diametral tensile strength values when compared to that of conventional glass ionomer cements.
- The diametral tensile strength of Kerr Nexus RMGI Resin-modified Glass lonomer Cement was the highest followed by 3M ESPE Rely X Luting cement, Ivoclar Vivaglass and GC Gold Label 1 Luting and Lining
- The values of diametral tensile strength for all tested samples were highest at 24 hrs and gradually decreased at $4^{th}$ day followed by $7^{th}$ day.
- Among the tested groups, Kerr Nexus RMGI showed the highest mean diametral tensile strength values at $7^{th}$ day which was followed by 3M ESPE Rely X Luting cement, Ivoclar Vivaglass and GC Gold Label 1 Luting and Lining.The differences were statistically significant.

Resin-modified Glass lonomer Cements showed the superior strength property comparable to conventional glass ionomer cement. Hence, RMGICs can be widely used for luting the fixed partial dentures which would show promisable results and hence helps to increase the longevity of the restorations.

## REFERENCES

[1.] Diaz-Arnold AM, Vargas MA, Haselton DR. Current status of luting agents for fixed prosthodontics. *J Prosthet Dent* 1999 Feb 1;81(2):135-41.
[2.] Pegoraro TA, da Silva NR, Carvalho RM. Cements for use in esthetic dentistry. *Dent Clin North Am* 2007 Apr 1;51(2):453-71
[3.] Patil SG, Sajjan MS, Patil R. The effect of temperature on compressive and tensile strengths of commonly used luting cements: an in vitro study. *J Int Oral Health* 2015 Feb;7(2):13
[4.] Yap AU. Resin-modified glass ionomer cements: a comparison of water sorption characteristics. *Biomaterials* 1996 Oct 1;17(19):1897-900.
[5.] Lad PP, Kamath M, Tarale K, Kusugal PB. Practical clinical considerations of luting cement s: A review. *J int Oral Health*2014 Feb;6(1):116
[6.] Rosenstiel SF, Land MF, Crispin BJ. Dental luting agents: A review of the current literature. *J Prosthet Dent* 1998 Sep 1;80(3):280-301.
[7.] Carmello JC, Fais LM, Ribeiro LN, Claro Neto S, Guaglianoni DG, Pinelli LA. Diametral tensile strength and film thickness of an experimental dental luting agent derived from castor oil. *J Appl Oral Sc* 2012 Feb;20(1):16-20.
[8.] White SN, Yu Z. Compressive and diametral tensile strengths of current adhesive luting agents. *J Prosthet Dent*1993 Jun 1;69(6):568-72
[9.] Anusavice KJ. Phillip's Science of Dental Materials. 11th ed. St. Louis, MO: Mosby Elsevier; 2003
[10.] Yoshida K, Tanagawa M, Atsuta M. In-vitro solubility of three types of resin and conventional luting cements. *J Oral Rehabil* 1998 Apr;25(4):285-9.
[11.] Ryan AK, Orr JF, Mitchell CA. A comparative evaluation of dental luting cements by fracture toughness tests and fractography. *Proc Inst Mech Eng H I MECH ENG H*2001 Jan 1;215(1):65-73.