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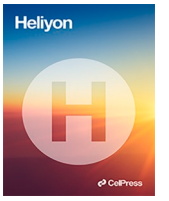

Research article

Comparison of retention of cast crown luted with glass ionomer cement in presence of two different types of desensitizer agent on extracted teeth-an in vitro study

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A B S T R A C T

Background: Dentin hypersensitivity is common problem between procedure of vital tooth preparation and cementation procedure of final prosthesis. So, use of desensitizing agents may be helpful to minimize the errors.
Aim: To Compare retention of cast crown luted with glass ionomer cement in presence of two different types of desensitizer agent on extracted teeth.
Material: Desensitizing agents used are bioactive Glass and GLUMA, Glass Ionomer Cement has been used as luting agent. Other required items are crown cutting bur, airotor handpiece, spatula, glass Cement carrier, microtip brush, universal testing machine.
Methodology: In this study total number of 60 premolars with good coronal anatomy, which are extracted for orthodontic purposes, were collected from Department of oral and maxillofacial surgery, Institute of dental Sciences. Then they were mounted individually in die stone block. Tooth preparation for the metal prosthesis of maxillary and mandibular premolars was carried out following the standard principles of tooth preparation use milling surveyor and they are grouped randomly into Group A- Luting cement (Control group), group B- Luting cement + Kulzer Gluma Desensitizer, group C- Luting cement + Bioactive glass. After fabrication of metal coping, tooth conditioning has been carried out then cementation was done using GIC. Retention of coping was checked using universal testing machine.
Result: A comparison was made for the mean stress value within three groups. GIC + Bioactive had the highest mean stress (6.52 ± 1.81) followed by Control group (3.88 ± 2.37). GIC ± Gluma had the least mean stress of 2.59 ± 1.19.
Conclusion: Bioactive glass + GIC exhibited higher retentive value as compared to prosthesis luted only with GIC and GIC + Gluma. So clinically it can be inferred that for vital tooth preparation bioactive glass can be used as desensitizing agent for the intermediate period till the permanent crown is luted.

1. Introduction

Dentine hypersensitivity is one of most common condition in dentistry. No matter where the exposed dentine is, it exhibits an excessive reaction to the administration of a stimulus [1]. In various demographics and investigative techniques, the incidence of dentine hypersensitivity ranges from 4 to 69% [2]. Although dentine hypersensitivity can affect people of any age, affected people fall into the 0–60 age range, commonly 30 and 40 years of age [3]. When it comes to the tooth types implicated, the canines and premolars are the commonly impacted teeth. The part of the cervical region most frequently impacted is the buccal aspect [4]. There are some theories which explains how dentine sensitivity happens, according to published research, there are three main pathways for dentinal sensitivity [5].

- Direct innervation theory.
- Odontoblast receptor.

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- Fluid movement/hydrodynamic theory.

There are some thermal, touch and other test to check the dental sensitivity. Tools like air/water syringe, dental explorer, percussion testing, bite stress tests, and ice cubes are also used to conduct test [6].

Active treatment of sensitivity involves the use of desensitizing agent, and moderate to severe tooth sensitivity can be managed. Many agents are used to occlude dentinal tubules such a phosphate bonded, sodium fluoride, stannous fluoride, Gluma, bioactive glass [7–11]. Gluma desensitizer is composed of 5% glutaraldehyde with 35% hydroxyethyl methacrylate. It is a biological fixative because of glutaraldehyde, due to reaction with plasma proteins from dentinal fluid it has been found that the dentinal tubules get blocked. Hydroxyethyl methacrylate has capacity to infiltrate in etched area [12].

The bioactive glasses were introduced by Hench, a novel synthetic material. These glasses are capable of to make a bond with living tissue [13]. Classify as class A and class B (Table 1).

Bioactive glasses are mainly made of silicon, sodium, calcium, and phosphorus oxides with specific percentages. The glass releases fluoride ions when it comes in contact with fluid. When the bio glass particles come in contact with saliva they interact. Three processes take place; leaching and formation of silanols, dissolution of the glass network, and precipitation. For occluding dentinal tubules for desensitization precipitation is an important process [14].

The fact is that, dentin hypersensitivity during vital tooth preparation is a common issue in dentistry. Which may increase dentin permeability and cause pulpal irritation [15,16]. The likelihood of pulpal damage during and after preparation is influenced by a number of variables, including the heat produced by bur attrition, the amount of dentin that is still present, the permeability of the dentin and the techniques used to build provisional crowns like direct and indirect technique [17]. So, it is good to use desensitizing agents to avoid errors until cementation of final prosthesis [18].

The final cementation of a permanent prosthesis or a crown using luting cements such glass ionomer cement is known to cause tooth sensitivity [19]. After the tooth preparation is finished, precautions should be taken to prevent post cementation sensitivity. Therefore, especially before cementing the permanent restoration, desensitization of the exposed dentin is crucial to prevent or at least lessen the hypersensitivity of critical teeth [20]. Shirin Lawaf et al. employed Gluma desensitizing agent and retentive values of the prosthesis luted were obtained. These values did not show any significant difference from the prosthesis luted with GIC alone. Additionally, this study will put to use Gluma and bioactive glass as desensitizing agents prior to cast crown cementation with GIC. The hypothesis was bioactive glass group may give good retentive values comparing to another group.

So, aim of the study is comparison of retention of cast crown luted with glass ionomer cement in presence of two different types of desensitizer agent on extracted teeth.

2. Aim and objectives of the study

To Compare retention of cast crown luted with glass ionomer cement in presence of two different types of desensitizer agent on extracted teeth.

3. Materials and methods

3.1. Materials

Desensitizing agents used are bioactive Glass and GLUMA, Glass Ionomer Cement has been used as luting agent. Other required items are crown cutting bur, airotor handpiece, spatula, glass Cement carrier, microtip brush, distilled water, universal testing machine.

3.2. Methodology

In this study total number of 60 premolars with good coronal anatomy, which are extracted for orthodontic purposes, were collected from Department of oral and maxillofacial surgery, Institute of dental Sciences, so local ethical committee approval was not required. After the extraction, the teeth were disinfected with 5.2% sodium hypochlorite & stored in normal saline. Then they were mounted individually in die stone block (Fig. 1).

3.3. Tooth preparation

Tooth preparation for the metal prosthesis of maxillary and mandibular premolars was carried out following the standard principles of tooth preparation (Table 2). All the premolars prepared up to a height of 3 mm occluso-cervically from cemento-enamel junction with chamfer finish line. They were prepared by using milling surveyor (Fig. 2). Teeth were prepared with a straight hand piece attached to the milling surveyor to standardize the preparation. Then all the prepared teeth were sent to the laboratory (Blue Wheel

Table 1

Class A Bioactive glasses	Results in osteoconduction amd osteoproduction. Binds to both soft and hard tissues
Class B Bioactive glasses	Osteoconduction and only able to bind to hard tissues and not soft tissues.

Fig. 1. Extracted teeth.

Table 2

Tooth preparation		Measurement
Occlusal	Functional cusp	1.5 mm
	Non-Functional cusp	1.0 mm
Axial		3 mm
Finish line (chamfer)		0.5 mm
Taper		14°

Lab, Bhubaneswar) for fabrication of metal crown.

All the 60 prepared premolars were fabricated using lost wax technique. Metal crowns are fabricated in nickel-chromium alloy. All the premolars were divided into 3 groups of each 20 samples. Two types of Dentin desensitizers were used, Group A: Luting cement (Control group) [n = 20, 10 maxillary premolar and 10 mandibular premolar]. Group B: Luting cement + Kulzer Gluma Desensitizer [n = 20, 10 maxillary premolar and 10 mandibular premolar].

Group C: Luting cement + Bioactive glass [n = 20, 10 maxillary premolar and 10 mandibular premolar]. First group B and group C desensitizing agents are used after that cementation procedure was carried out after 1 week with GIC (Figs. 3 and 4). All the cemented metal crowns were subjected for testing under Universal testing machine at IMMT Bhubaneswar. All the cemented metal crowns were subjected for testing under Universal testing machine (Fig. 5). A metal jig was prepared to hold the cast in a stable position during the testing procedure. The testing part of the machine has two arms. One arm attached to the Metal jig, in which the cast was inserted.

Fig. 2. Tooth preparation on milling surveyor.

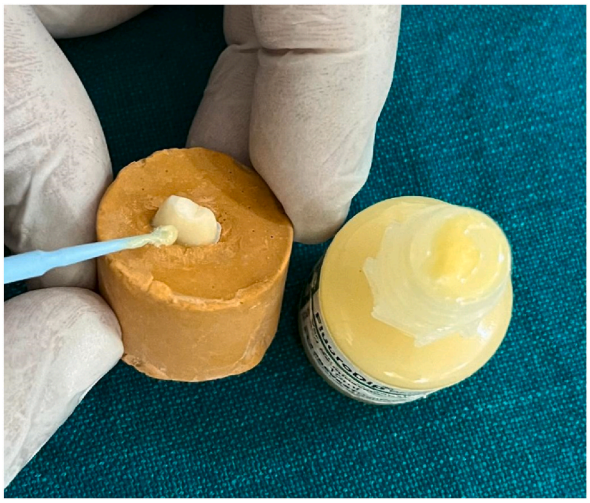

Fig. 3. Tooth conditions with agents.

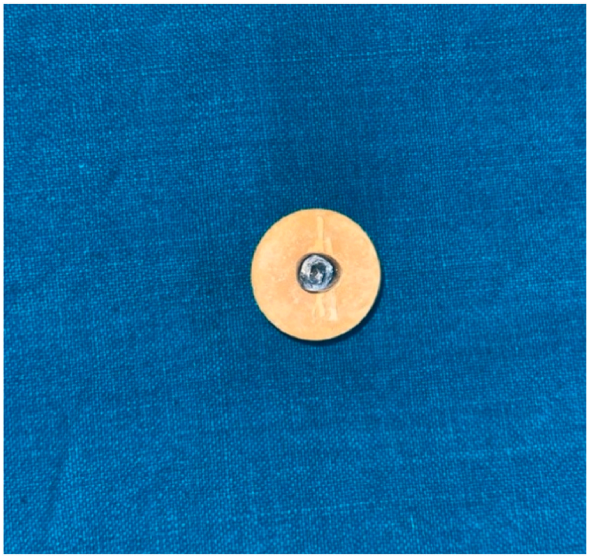

Fig. 4. Cementation of metal coping.

Another arm of the machine was attached to the wire, which was inserted through the hole over the crown. By doing this, a whole assembly was formed, engaged by the two arms of the machine, ready for testing. Then force was applied from the upper arm to pull the crown upward from the tooth. The force was increased gradually until the crown came out from the tooth. The maximum force applied is when the crown came out complete. Sixty samples reading were noted sequentially. All the data were sent to the statistician for statistical analysis (Quintessence Statistical services, Wardha).

4. Results

The data was subjected to both descriptive and analytical statistics. Shapiro-Wilk test which indicated that the data followed a normal distribution. As a result, parametric tests were employed to analyze the data. Specifically, the one-way analysis of variance (ANOVA) test was utilized to examine mean differences between the groups. Post hoc analysis was performed using Tukey's HSD test.

Software: SPSS (Statistical Package for Social Sciences) Version 24.0 (IBM Corporation, Chicago, USA).

Group A- Luting cement (Control group).

Group B- Luting cement + Kulzer Gluma Desensitizer.

Group C- Luting cement + Bioactive glass.

Output Tables.

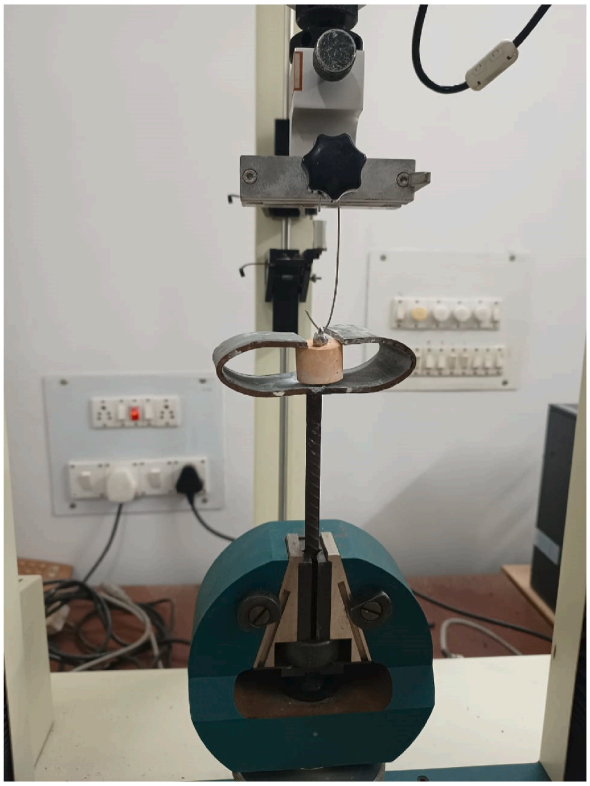

Fig. 5. Universal testing machine.

A comparison was made for the mean stress value within three groups (Table 3). The ANOVA test is used for the comparison and it is significant ($p < 0.001$). The group C (GIC + Bioactive) had the highest mean stress (6.52 ± 1.81) followed by group A – Control group (3.88 ± 2.37). The group B – GIC ± Gluma had the least mean stress of 2.59 ± 1.19.

Comparative analysis reveals significant differences in the mean stress value using post hoc pair test (Table 4). When a comparison was made between group A and C, a mean difference of −2.64 (95% C.I. −4.05–1.22) was found demographically significant ($p < 0.001$). Another comparison between group B and group C reveals a mean difference of −3.93 (95% C.I. −5.35–2.51) which was statistically significant ($p < 0.001$) (Fig. 6).

When group B was compared with group A, **NO** statistically significant ($p = 0.080$) difference in mean stress was seen.

The mean stress value in three groups of maxillary premolars was compared (Table 5). The ANOVA test is used for comparison and it is significant ($p < 0.001$). in mean stress among the three groups in maxillary premolar. The group C (GIC + Bioactive) had the highest mean stress (7.08 ± 1.72) followed by group A – Control group (4.15 ± 2.58). The group B – GIC ± Gluma had the least mean stress of 2.37 ± 1.72 (Fig. 7).

The mean stress was compared among the three groups in mandibular premolar (Table 6). The ANOVA test is used for comparison and it is significant ($p < 0.001$) in mean stress among the three groups in mandibular premolar. The group C (GIC + Bioactive) had the highest mean stress (5.84 ± 1.78) followed by group A – Control group (3.54 ± 2.19). The group B – GIC ± Gluma had the least mean stress of 2.68 ± 1.78. When control group was compared with Gluma group, **NO** statistically significant ($p = 0.441$) difference in mean stress was seen in mandibular premolar (Fig. 8).

5. Discussion

In the present study, retentive values have been deduced in metal crowns utilizing different desensitizing agent before permanent

Table 3
Comparison of the mean stress in between the three groups.

Groups	N	Mean	S.D.	S.E.	95% C.I.	Min.	Max.	F-value	*P*-value[#]
Group A	20	3.88	2.37	0.53	2.77–4.99	1.09	8.84	23.230	<0.001[†]
Group B	20	2.59	1.19	0.26	2.02–3.15	1.13	5.43		
Group C	20	6.52	1.81	0.40	5.67–7.37	3.62	9.80		

#The ANOVA test is used to derive the P value which is significant, $p < 0.05$.

Table 4
Post hoc pair wise comparison of mean for stress.

Groups	M.D.	95% C.I.	*P*-value*
Group A v/s Group B	1.29	−0.12–2.70	0.080
Group A v/s Group C	−2.64	−4.05–1.22	<0.001[†]
Group B v/s Group C	−3.93	−5.35–2.51	<0.001[†]

[#] Tukey's HSD post hoc test used calculate *P*-value which is significant, $p < 0.05$.

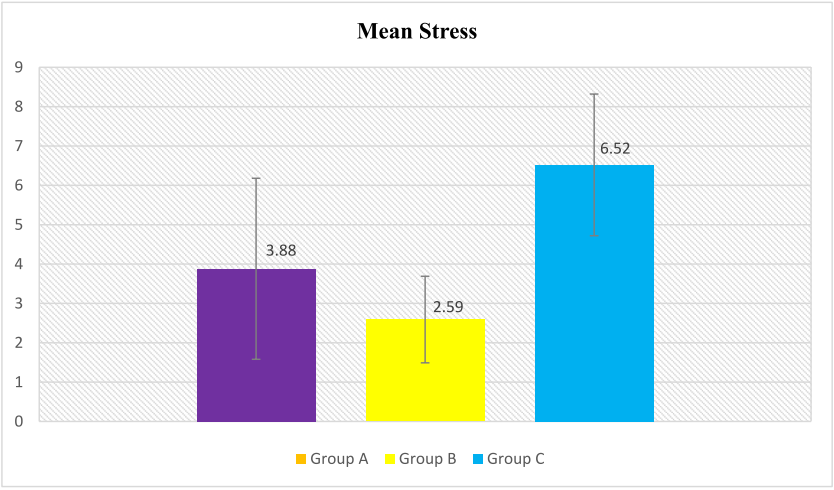

Fig. 6. Comparison of the mean stress among the three groups
Note: The error bar represents standard deviation.

Table 5
Comparison of the mean stress among the three groups in maxillary premolar.

Groups	N	Mean	S.D.	S.E.	95% C.I.	Min.	Max	F-value	*P*-value[#]
Group A	11	4.15	2.58	0.77	2.42–5.89	1.09	8.14	10.946	<0.001[†]
Group B	6	2.37	1.66	0.67	0.62–4.12	1.18	5.43		
Group C	11	7.08	1.72	0.51	5.92–8.23	4.25	9.80		

#The ANOVA test is used to derive the P value which is significant, $p < 0.05$.

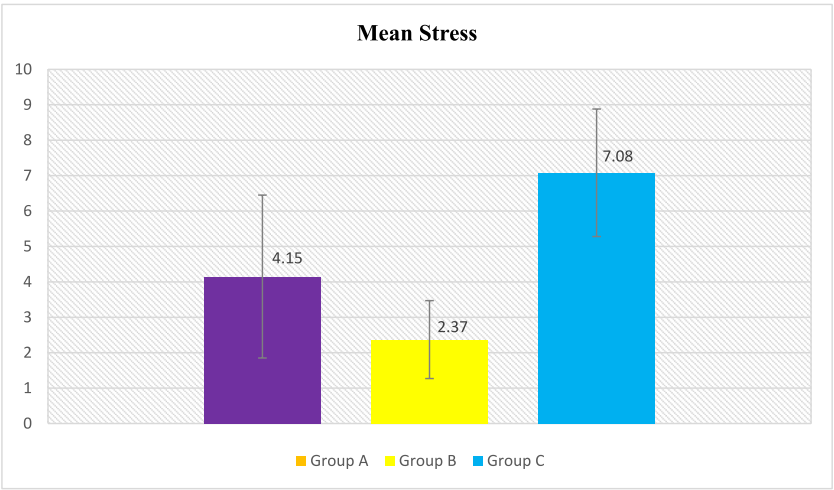

Fig. 7. Comparison of the mean stress among the three groups in maxillary premolars
Note: The error bar represents standard deviation.

Table 6
Comparison of the mean stress among the three groups in mandibular premolar.

Groups	N	Mean	S.D.	S.E.	95% C.I.	Min.	Max	F-value	*P*-value[#]
Group A	9	3.54	2.19	0.73	1.85–5.23	1.59	8.84	10.458	<0.001[†]
Group B	14	2.68	1.00	0.26	2.10–3.26	1.13	4.34		
Group C	9	5.84	1.78	0.59	4.47–7.21	3.62	9.71		

[#] The ANOVA test is used to derive the P value which is significant, $p < 0.05$.

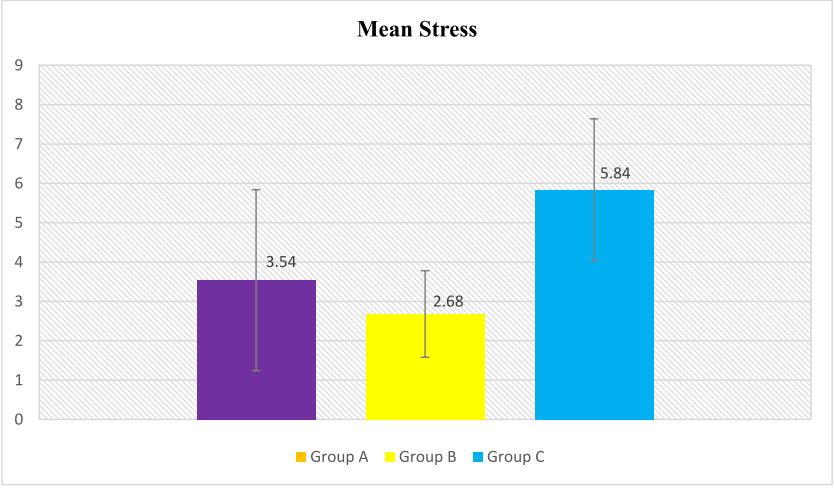

Fig. 8. Comparison of the mean stress among the three groups in mandibular premolars
Note: The error bar represents standard deviation.

cementation. According to the results, the efficacy of luting cement was affected due to presence of desensitizing agent in crown pull off test. The retention values are significantly more in Bioactive glass + GIC group compared to others.

As defined by Mc Lean Wilson the Glass ionomer cement was described as 'The cement has a glass and a polymer that is acidic, which sets by acid base reaction in between the available components. The primary demerit of GIC was the slow setting and desiccation due to moisture contamination. The low setting pH was considered the cause of post cementation problems [21]. Nimmy Anto et al. conducted an in-vitro study on extracted premolar to access the retentive strength of GIC cement and he found that mean retentive value of GIC was 2.276 MPa [22]. Mean retentive value of conventional GIC in our study is 3.88 MPa.

To avoid post-operative complications like dentinal sensitivity after tooth preparation and crown cementation many authors used different types of desensitizers with GIC.

Gluma is a commonly used desensitizing paste that has c glutaraldehyde along with hydroxyethyl methacrylate (HEMA). Glutaraldehyde contacts with dentinal tubules which is carried by coagulation of protein and amino acid whereas because of hydrophilic nature. When GIC and Gluma used together, Sonune Shital Jalandar et al. found that retentive strength was (in Kg) Gluma (41.14 ± 2.42) > Tooth mousse (40.32 ± 3.89) > GIC (39.09 ± 2.80) [23]. Saili M. Chandavarkar et al. found that these chemicals will show an effect on texture of the tooth that is prepared. This may directly affect the retention of luted full crowns and showed that Gluma had retentive values with (3.87 Mpa) [24]. Shirin Lawaf et al. found that the mean tensile bond strength was significantly higher in the Gluma desensitizer group (230.63 ± 63.8 N) compared to the control group (164.45 ± 39.3 N) [25]. In our study the Gluma group have low mean value comparing to another group which is of 226.40 ± 117.7 N. The mean value of Gluma desensitizer group in given studies and our study is similar. Difference in control group may be there because of the use of different cements for luting. Comparing these studies and our study it is suggest that there is no effect of Gluma on retention of crown.

Bioactive glass produces a certain response that forms a particular bond between tissue and substance. The Bioactive glass contains silicate and it is made up of 3D network when it is placed in the body adherent chemical bonds are formed especially with the tissues. The glasses can easily prevent from pain during hypersensitivity by adhering apatite crystals to close the tubular opening. Dong-Ae Kim et al. found that. In his study after 28 days, he found that the group of Bioactive glass + GIC had increased tensile strength compared to another group. In addition, Bioactive glass incorporated into GIC exhibited surface bioactivity. Tensile strength of Bioactive glass + GIC (11.3 ± 1.9 MPa) was significantly increased compared to that of others ($p < 0.05$, 8.2–9.5 MPa) [26]. Our study was conducted in dry environment so values Bioactive glass + GIC may get affected. But comparing to other groups the retentive values of Bioactive glass group was significantly more.

A comparison was made for the mean force value within three groups. The ANOVA test is used to derive the P value which is significant, $p < 0.05$ within three groups. Highest mean force value was recorded in group C (GIC + Bioactive glass) had the (546.95 ± 126.86) followed by group A – Control group (311.00 ± 210.56). The group B – GIC ± Gluma had the least mean force of $226.40 \pm$

117.71. Comparative analysis reveals significant differences in mean force in The post hoc pair test. When a comparison was made between group A and C, a mean difference of −235.94 (95% C.I. −355.69–116.19) was found. This value was statistically significant ($p < 0.001$). When a comparison was made between group B and group C the value −320.55 (95% C.I. −440.29–200.80) demographically significant ($p < 0.001$). Comparison was made between group A and group B, no statistically significant ($p = 0.214$) difference in mean force was seen.

A comparison was made for the mean stress value within three groups. The ANOVA test is used for the comparison and it is significant ($p < 0.001$). The group C (GIC + Bioactive glass) had the highest mean stress (6.52 ± 1.81) followed by group A – Control group (3.88 ± 2.37). The group B – GIC ± Gluma had the least mean stress of 2.59 ± 1.19. Comparative analysis reveals significant differences in the mean stress value using post hoc pair test. When a comparison was made between group A and C, a mean difference of −2.64 (95% C.I. −4.05–1.22) was found which was demographically significant ($p < 0.001$). Another comparison between group B and group C reveals a mean difference of −3.93 (95% C.I. −5.35–2.51) which was statistically significant ($p < 0.001$). When group B was compared with group A, no statistically significant ($p = 0.080$) difference in mean stress was seen (Fig. 6).

The mean stress value in three groups of maxillary premolars was compared. The ANOVA test is used for comparison and it is significant ($p < 0.001$). In mean stress among the three groups in maxillary premolar. The group C (GIC + Bioactive glass) had the highest mean stress (7.08 ± 1.72) followed by group A – Control group (4.15 ± 2.58). The group B – GIC ± Gluma had the least mean stress of 2.37 ± 1.72. a post hoc pairwise comparative analysis, which is a statistical method used to compare the means of two or more groups after a significant result has been found in an initial analysis. The analysis found significant differences in mean force in the maxillary premolar, a tooth in the upper jaw. When comparing Group, A to Group C, a mean difference of −2.92 was found, with a 95% confidence interval of −5.15 to −0.69. This result was statistically significant, with a p-value less than 0.009. Similarly, when comparing Group B to Group C, a mean difference of −4.70 was found, with a 95% confidence interval of −7.36 to −2.05. This result was also statistically significant, with a p-value less than 0.001 (Fig. 7).

The mean stress was compared among the three groups in mandibular premolar. The analysis done by one-way ANOVA showed statistically significant differences ($p < 0.001$) in mean stress among the three groups in mandibular premolar. The group C (GIC + Bioactive glass) had the highest mean stress (5.84 ± 1.78) followed by group A – Control group (3.54 ± 2.19). The group B – GIC ± Gluma had the least mean stress of 2.68 ± 1.78. The post hoc pair wise comparative analysis also showed significant differences in mean stress in mandibular premolar. a mean difference of −2.29 (95% C.I. −4.19–0.39) was found in control group and bioactive glass group, which was significant ($p < 0.015$). A mean difference of −3.16 (95% C.I. −4.88–1.44) was found in Gluma group and Bioactive glass group, which was significant ($p < 0.001$). When control group was compared with Gluma group, no statistically significant ($p = 0.441$) difference in mean stress was seen in mandibular premolar (Fig. 8).

Dimensionally maxillary premolar teeth have large cross-sectional area compared to mandibular teeth. So maxillary premolars have higher values of retention as compared to mandibular teeth.

5.1. Limitations

However, this study was conducted in-vitro. Being conducted in a dry surrounding, it does not simulate the moist oral environment and this could indirectly affect the retention of the prosthesis. Secondly, retention of the prosthesis also largely depends on the manufacturing company of materials used in the study. It could be beneficial to include a comparison between different types of cast material. So further studies can be conducted in a wet environment and different type of luting agents can be used.

6. Conclusion

It can be concluded that the efficacy of luting cement was affected due to presence of desensitizing agent in crown pull off test. The case group including Bioactive glass and GIC exhibited higher retentive value as compared to prosthesis luted only with GIC and the group utilizing GIC with Gluma. So clinically it can be inferred that for vital tooth preparation bioactive glass can be used as desensitizing agent for the intermediate period till the permanent crown is luted.

Additional information

No additional information is available for this paper.

CRediT authorship contribution statement

Virvardhan Alias Shubham Patil: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

No Ethical approval required.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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