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Comparative evaluation of shear bond strength of two different GICs in pediatric dentistry: An in vitro study

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Abstract--Background: New restorative materials and techniques continue to appear in the market, the knowledge of which is required, to make an informed decision on the most suitable successful and cost effective treatment strategy. Aim: To compare and evaluate the Shear bond strength of different glass ionomer cements used in Pediatric dentistry. Materials and Methods: 60 Premolars were taken which were extracted due to orthodontic reasons. The extracted teeth were cleaned with a disinfectant and stored in distilled water at room temperature until further use. The teeth were divided into five groups: Group A: Anhydrous GIC, Group B: Giomer. All the samples were then subjected to shear bond strength test using universal testing

machine. The data collected was tabulated and statistically analyzed using Anova one way test followed by tukey post Hoc HSD test using SPSS 16.0 software. Results: The Mean Shear bond strength was found to be maximum for Group B (Giomer) i.e. 2.90 ± 0.55 . Conclusion: Research and technology has revolutionized dental procedures. This revolution has occurred at such a rapid pace that it has become almost overwhelming to the clinician who must take decision based on combination of experience and current trends. From the present study, it can be concluded that Giomer with PRG fillers promises high shear bond strength than other Glass Ionomer Cements for achieving good adhesion to resist various dislodging forces acting within the oral cavity.

Keywords---bonding, GIC, shear, strength.

Introduction

Dental caries is a prevalent chronic infectious, disease resulting from tooth-adherent specific bacteria, primarily *Streptococcus mutans* that metabolize sugars to produce acid, which over time, demineralizes the tooth structure.¹ From the year 2000 to 2016, the prevalence of dental caries varies in the range of 49% to 83%.² Restorative dentistry, in its infancy was dominated by the simple principle of “extension for prevention” laid down by G.V. Black. The only materials available at that time were amalgam and gold. These materials were unaesthetic and were incapable of forming any chemical bond with the tooth structure.³ Exhibition of adhesive properties of polycarboxylic acid in silicate cements, to improve aesthetics and for proper bonding of the material with the tooth structure led to the introduction of Glass Ionomer cements (GIC) by Wilson and Kent in 1972.⁴

GIC's possess many unique properties such as the ability to form chemical bonds with enamel and dentin. GICs contain significant amounts of fluoride which may protect against enamel decalcification but due to certain drawbacks like inadequate retention or simply lack of strength, toughness and limited wear strength, various modifications were introduced in order to repair the properties of Glass ionomer cements.⁵ Modifications have been made both in powder which include dried polyacrylic acid and liquid which contains water and tartaric acid led to the development of Anhydrous GIC.⁶ Gionomers are the recent addition to the class of anhydrous resin based restoratives that utilizes pre-reacted glass ionomer as fillers and can be used in class I, II, III, IV, V restorations of primary teeth. These are relatively a new type of restorative material and is formed by the hybrid of words “glass ionomer” and “composite”. This type of modification has improved the fracture toughness of Glass ionomer cement. The only drawback is the lower fluoride release of giomer which results in the formation of biofilm accumulation.⁷

Modifications in glass ionomer cement change the bond strength of the restorative material. The clinical success of restorative materials depend upon a good adhesion with dentinal surface to resist various dislodging forces acting within the oral cavity.⁸ Shear bond strength is the resistance to forces that slides restorative material on the tooth structure and is a measure of maximum stress

which can be applied at the bonding interface between the tooth and the restorative material. It is an important parameter for a successful restoration as the major dislodging forces at the tooth restoration interface have shearing effect. High shear bond strength implies better bonding of material to tooth.⁹ So, this study was undertaken to evaluate and compare the shear bond strength of different GICs used in Pediatric dentistry.

Materials and Methods

Sample Selection

60 Premolars which were extracted due to orthodontic reasons were taken.

Inclusion Criteria

- Teeth with intact crown
- Absence of any carious lesion

Exclusion Criteria

- Teeth having any surface defects on the enamel surface
- Micro cracks
- Any malformation/ developmental defect or sign of fluorosis

Sample Preparation

After extraction, teeth were cleaned of debris and blood clots in running water. After that, teeth were kept in 0.1% thymol solution for three weeks at room temperature. After three weeks, calculus was removed with the help of scaler and were stored in distilled water until needed.

Grouping of the samples

A total of 60 samples were randomly divided into 2 groups- Group A and B according to restorative material to be used. All the groups comprised of 30 samples each which were as follows:

- Group A - Anhydrous GIC
- Group B - Giomer

Preparation of Buccal Surfaces

The buccal surfaces of the extracted teeth were made smooth with the help of 320 grit silicon carbide paper. Each sample was thoroughly washed with water and then gently dried with air water syringe. A Propylene plastic straw (Fig.1) of diameter 3mm was taken and then the straw was cut into 3mm long pieces to have a template of 3mm length×3mm diameter (Fig.2). Then, the desired material was mixed and filled in the template and the filled template was placed on the buccal surface of the tooth (Fig.3) and kept for 24 hours to undergo the final

setting. After 24 hours, the straw was cut with the help of No12 BP blade (Fig.4) and the root portion of the samples were then mounted in self cure acrylic resin.

Application of Restorative Materials

Group A: Anhydrous GIC (Chemfill Superior): Two scoops of powder is mixed with 2 drops of liquid. The first part was mixed with water for 5 seconds and the second part was mixed for about 10 seconds. After that, the material was placed on the buccal surface using the template as in the procedure mentioned above.
Group B: Giomer (BEAUTIFIL II): The enamel was etched with 37% phosphoric acid, thoroughly washed with water and gently dried. Bonding agent was applied in one coat with a microbrush, was let stand for 10seconds and then gently air dried for 3 seconds. Finally it was light cured for 10 seconds. After that, the material was placed on the buccal surface using the template as in the procedure mentioned above.

Shear Bond Strength Testing

All the samples were then subjected to shear bond strength test (Fig. 5) using universal testing machine. The data collected was tabulated and statistically analyzed using Anova one way test followed by tukey post Hoc HSD test using SPSS 16.0 software.

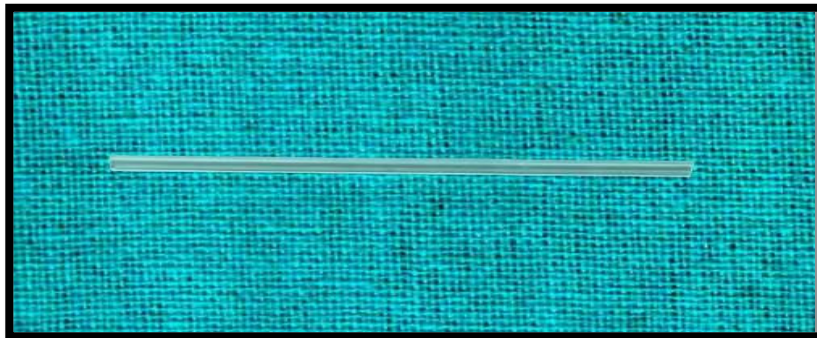


Fig. 1: Polypropylene Plastic Straw

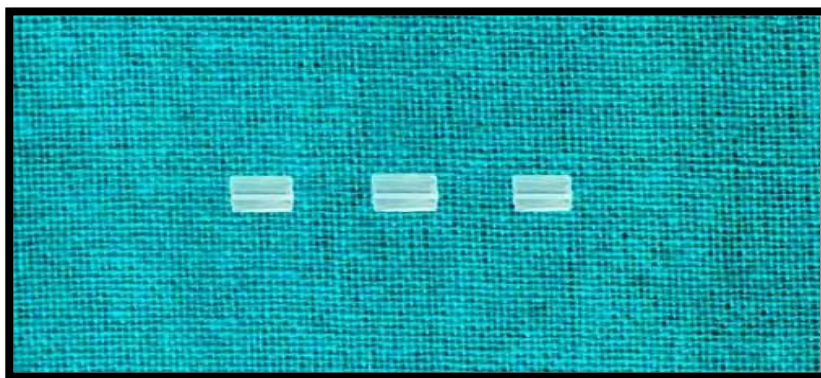


Fig.2: Pieces of straw of 3mm X 3mm diameter

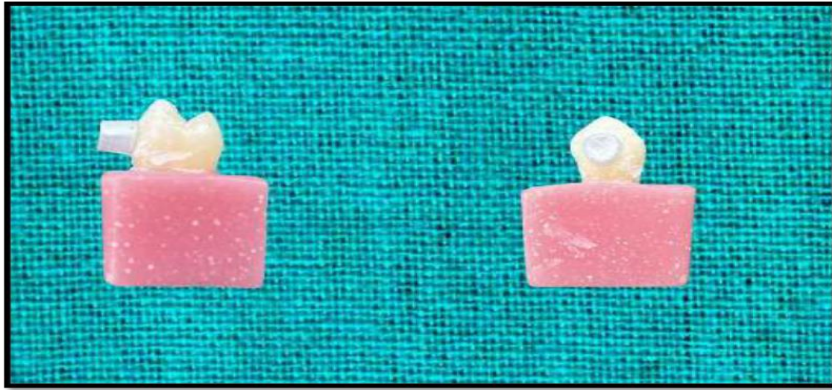


Fig.3: Placement of restorative material in the straw

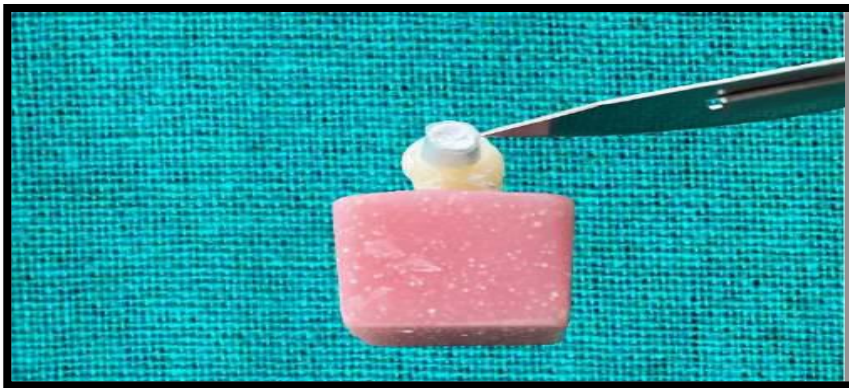


Fig.4: Scraping of the straw with the help of No 1BP blade

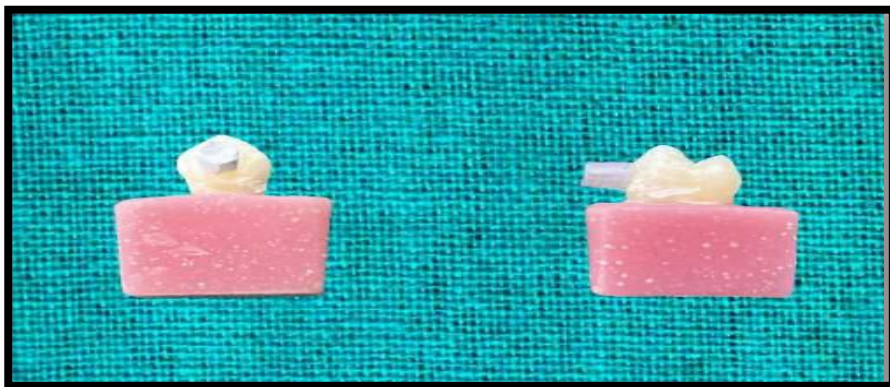


Fig.5: Final sample subjected for shear bond strength testing

Results

The sample consisting of 60 extracted premolars due to orthodontic reasons were collected. These samples were randomly divided into two groups (Group A and Group B) of 30 samples each (Table 1). On applying One way Anova test, the

mean shear bond strength value and standard deviation of Anhydrous GIC (Group A) was found to be 1.21 ± 0.22 while the mean shear bond strength value and standard deviation for Giomer (Group B) was 2.90 ± 0.55 (Table 2).

Groups	N
Group A - Anhydrous GIC	30
Group B - Giomer	30

Table 1: Distribution of samples on the basis of groups of different restorative materials

Groups	N	Mean (Megapascal)	SD	F Value	P-Value
Group A - Anhydrous GIC	30	1.21	0.22	141.13	<.001
Group B - Giomer	30	2.90	0.55		

Table 2: Showing Mean shear bond strength Values and Standard deviation in different Study Groups using One way Anova Test.

Discussion

The adhesiveness of restorative materials to tooth structure is an important factor in current restorative technique. It prevents micro leakage, secondary caries, marginal discolorations and pulpal damage.¹⁰ Rather than using extension for prevention as a treatment guideline, emphasis is now placed on restriction with conviction. This has resulted in rapid development of new restorative materials.¹¹ The Glass ionomer cements, composites prove to be superior to amalgam in terms of biocompatibility, fracture resistance, good aesthetics and a good adhesion (bond) to the tooth surfaces. These tooth colored materials are not only used for the restoration of decayed areas but are also used for cosmetic improvement of smile by changing the color of teeth and reshaping disfigured teeth.^{12,13}

GIC's have been plagued by certain disadvantages due to its low resistance to wear, high sensitivity to moisture and dryness as well as poor aesthetics due to high opacity and surface roughness. In order to overcome these disadvantages modifications have been made with regards to increasing the amount of powder in proportion to liquid and reducing the mean particle size.¹⁴ To overcome the problem of high molecular weight of glass ionomer liquids which reduces their shelf life, Anhydrous GIC was invented. In this, polyacid is freeze dried and added to the glass fillers. This powder is mixed with 30% solution of tartaric acid and added to glass powder which is then mixed with distilled water.¹⁵

The clinical success of the newer restorative materials depends upon a good adhesion (good bonding) to resist various dislodging forces within the oral cavity. Several newer materials were launched in the market with laboratory data showing superiority of these materials over others.¹⁶ Group A (Anhydrous GIC) depicted the mean bond strength of about 1.21 ± 0.22 Mpa. Group B (Giomer) depicted the mean bond strength of about 2.90 ± 0.55 Mpa. This was in accordance with the study conducted by N Manuja et al (2011) who showed that the shear bond strength of Giomer was higher than Anhydrous glass ionomer cement and have better surface finish than conventional glass ionomer cements.¹⁷

According to Alumammar MF et al (2001), composite resins possess superior mechanical properties and better esthetics than conventional glass ionomer cements, however these require bonding agents because these are usually hydrophobic and thus doesn't adhere well to teeth.¹⁸

This is in accordance with the present study which shows that the mean bond strength of Giomer was higher amongst other cements. Giomer bond is a glass ionomer base, tricurable, all-in-one, filled adhesive based on PRG technology and consist of HEMA, UDMA, PRG filler, fluoroaluminosilicate glass, acetone, water and initiator. Due to inclusion of these fillers, Giomer possibly showed higher shear bond strength as compared to glass ionomer cement.¹⁹ Another study was conducted by Heba et al (2020) where shear bond strength of Giomer was found to be 3.514 ± 0.571 which is somewhat similar to our study.²⁰ Hence, it is recommended that these newer materials should be subjected to further biocompatibility, clinical studies and further evaluation.

Conclusion

Research and technology has revolutionized dental procedures. This revolution has occurred at such a rapid pace that it has become almost over whelming to the clinician who must take decision based on combination of experience and current trends. From the present study, it can be concluded that Giomer with PRG fillers promises high shear bond strength than other Glass ionomer cements for achieving good adhesion to resist various dislodging forces acting within the oral cavity.

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