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Research

Comparative Evaluation of Microleakage and Shear Bond Strength of Glass Ionomer Cement, Composite, Resin Modified Glass Ionomer Cement Restorative Material: An In Vitro Study

Amanjot Singh[1*], Sumeet Singh Jaurha[2], Harkamal Pannu[3] and Amritpreet Kaur[4]

[1] BDS, Gian Sagar Dental College and Hospital, Patiala, Punjab, India.

[2] BDS, Harsaran Dass Dental College, Ch. Charan Singh University, Uttar Pradesh, India.

[3] BDS, Baba Jaswant Singh Dental College, Hospital and Research Institute, Ludhiana, Punjab, India.

[4] BDS, Gian Sagar Dental College and Hospital, Patiala, Punjab, India.

***Corresponding Author:** Amanjot Singh, DS, Gian Sagar Dental College and Hospital, Patiala, Punjab, India.*

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Abstract

Aim: Evaluation of microleakage and shear bond strength of glass ionomer cement, composite, resin modified glass ionomer Cement Restorative Material.

Material and Method: Thirty freshly extracted non carious teeth, free of cracks and restorations, collected for the present in-vitro study. Teeth were divided in three equal group i.e. group A: Glass Ionomer Cement. Group B: Resin Modified Glass Ionomer Cement, Group C: Composite Resin. All groups' shear bond strengths were evaluated using a universal testing machine. A rod in the shape of a chisel was positioned close to the bonded restorative material and directly next to the flat dentinal surface. To debond the material, a cross head of universal testing machine at a speed of 0.5mm/min was employed. Then, Mega Pascal Units (MPa) were used to calculate the shear bond strength. To evaluate the microleakage two coats of nail polish were applied to the samples, leaving a 1 mm window around the cavity boundaries. A wet cotton pellet was placed over the restoration to avoid desiccation while the nail polish was being applied. Inverted teeth were submerged for 24 hours at 37°C under vacuum in a solution of 2% Rhodamine-B dye. Only the coronal part of the teeth were dyed to avoid dye leakage via the root apices. The surface-adhered dye was washed off the specimens in tap water after removing them from the dye solution, and nail polish was then removed with a BP blade. The teeth were sectioned longitudinally in a bucco-lingual direction through the center of the restorations using a water-cooled low-speed diamond disc. The section with the greater leakage was evaluated with a stereomicroscope at ×25 magnification to determine the extent of dye penetration at the occlusal and gingival margins by two evaluators who were blinded to the experimental groups.

Result: Composite resin showed highest shear bond strength followed by Bond Strength of Resin Modified Glass Ionomer Cement and least with conventional glass ionomer cement. Microleakage was found lower in composite resin as compared to Resin modified glass ionomer cement and glass ionomer cement.

Conclusion: It can be stated that Composite resin and Resin modified glass ionomer cement have good shear bond strength and lower microleakage as compared to Glass Ionomer Cement.

Keywords: *RMGIC, Composite, Microleakage, Shear bond Strength*

Introduction

Restoring body parts that have been lost due to an accident or illness has long been a challenge for medical practitioners. Dental professionals have also faced challenges. Since the invention of dentistry, people have struggled with this issue, and a significant portion of dental science is still devoted to finding artificial materials that can replace missing tooth structure.[1,2] For many years, dental amalgam has been the preferred restorative material. The safety of dental amalgam has, however, been under increased scrutiny recently, mostly due to concerns about potential mercury toxicity.[3] Dental experts have developed alternative restorative materials in response to the rising demand for aesthetics. The preservation of tooth structure is crucial in the current era of adhesive dentistry. The use of bonded restorations in children has a significant importance considering the small size of deciduous teeth.[4]

Between the 1950s and the middle of the 1980s, dentists had access to two categories of direct tooth-colored adhesive restorative materials: composite resins and glass ionomer cement. Wilson and Kent originally presented glass ionomer cements (GIC) to the dentistry industry in 1972.4 The capacity of GIC to chemically attach to enamel and dentin is its primary property. Many high-viscosity, quick-setting glass ionomer cements, also known as viscous, packable, or condensable glass ionomer cements, have recently entered the market. Both composite resins and glass ionomer cement restorative materials have considerable benefits as well as drawbacks when viewed as separate material categories. The development of materials combining composite resin and glass ionomer cement has taken place in an effort to maximize each material's benefits while at the same time minimizing its drawbacks.[5,6] In general, three types of these materials have been developed: poly acid modified composite resin (compomers), resin modified glass ionomer cement (RMGIC), and most recently, giomers that contain pre-reacted glass ionomer particles. In the latter half of the 1980s, the first resin -modified glass ionomer cement (RMGIC) were released (Antonucci et al. 1988; Mitra 1989). The development of the light-cured glass ionomers was primarily done to address the issues of moisture sensitivity and poor early mechanical strength.[7]

It is crucial for a restorative material to have a strong marginal seal and bond in order to be long-lasting. A major issue in restorative dentistry is microleakage at the point where the restoration meets the tooth. The transfer of liquids, germs, ions, or chemicals between the tooth and restorations is referred to as microleakage. Researchers have studied the issue of microleakage and its effects on a number of disorders, including tooth discoloration under amalgam fillings, recurrent or secondary caries, and hypersensitivity of repaired teeth. To get the advantages of both glass ionomer and composite material, Mclean et al. devised the sandwich approach in 1985 as a solution to the marginal integrity issues related to class II composite restorations.[7-10] Hence the aim of present In- vitro study is to evaluate Microleakage and Shear Bond Strength of Glass Ionomer Cement, Composite, Resin Modified Ionomer Cement Restorative Material.

Material and Method

Thirty freshly extracted non carious teeth, free of cracks and restorations, collected for the present in-vitro study. Trans-illumination was done to rule out any cracks or defects in them. Specimens were then scaled and cleaned with pumice slurry used within a month of storage in aqueous chloramine solution (1%) at 4°C. Standardized cavity preparation on the mesial surface at the cementoenamel junction of each tooth was made using a 245 bur under a water-cooled, high-speed, air-rotor hand piece: the width was 5 mm, the occlusal depth was 2 mm, and the axial wall length was 6 mm. The bur was discarded after five tooth preparations. The enamel and gingival margin in dentin/cementum was prepared to a butt joint.

Grouping of specimens

Samples were randomly assigned into five groups of n = 10 cavities each:

- Group I - Glass Ionomer Cement (Fuji II)
- Group II - RMGIC
- Group III – Composite Composite Resin (Filtek Z-250)

Teeth were restored as per manufacture instruction.

Evaluation of Shear bond Strength

The samples from all three groups were kept in room-temperature normal saline for a full day. All groups' shear bond strengths were evaluated using a universal testing machine. A rod in the shape of a chisel was positioned close to the bonded restorative material and directly next to the flat dentinal surface.

To debond the material, a cross head of universal testing machine at a speed of 0.5mm/min was employed. Then, Mega Pascal Units (MPa) were used to calculate the shear bond strength.

Evaluation of Microleakage

After the thermocycling, the teeth were dried. Two coats of nail polish were applied to the samples, leaving a 1 mm window around the cavity boundaries. A wet cotton pellet was placed over the restoration to avoid desiccation while the nail polish was being applied. Inverted teeth were submerged for 24 hours at 37°C under vacuum in a solution of 2% Rhodamine-B dye. Only the coronal part of the teeth were dyed to avoid dye leakage via the root apices. The surface-adhered dye was washed off the specimens in tap water after removing them from the dye solution, and nail polish was then removed with a BP blade. The teeth were sectioned longitudinally in a bucco-lingual direction through the center of the restorations using a water-cooled low-speed diamond disc. The section with the greater leakage was evaluated with a stereomicroscope at ×25 magnification to determine the extent of dye penetration at the occlusal and gingival margins by evaluators who were blinded to the experimental groups.

Values and its inference used in the present study are as follows:

- Score 0—no evidence of microleakage.
- Score 1—dye penetration up to half of the depth of the cavity–enamel restoration junction.
- Score 2—microleakage more than half of the depth of the cavity wall–dentin restoration junction.
- Score 3—dye leakage involves axial wall (cervical microleakage) and three-fourths of the occlusal depth and reaches the cavity floor (for occlusal microleakage). Dye penetration involves the cavity floor and extends further to the interface (microleakage at the interface between base and composite).

Results were tabulated and subjected to statistical analysis using the Chi squared test.

Result

Composite resin showed highest shear bond strength followed by RMGIC and least with conventional GIC (Table 1). Microleakage was found lower in composite resin and RMGIS to GIC (Table 2).

Table 1: Mean shear bond strength of various restorative materials.

Groups	Mean ± SD
Group A- GIC	3.21 ± 0.35
Group B- RMGIC	4.21 ± 0.32
Group C- Composite	7.32 ± 0.43

Table 2: Average microleakage of various restorative materials.

Groups	Mean ± SD
Group A- GIC	1.81 ± 0.33
Group B- RMGIC	0.93 ± 0.45
Group C- Composite	0.52 ± 0.32

Discussion

Dental caries, a microbiologic infection that affects the teeth and causes localized calcified tissue disintegration and destruction, is the term used in the current study for dental illness. The ideal restorative material should have favorable marginal adaptation, biocompatibility, chemical adhesion, and a comparable thermal expansion coefficient to the tooth. Dentin adhesion is a beneficial property to prevent pulpal damage, microleakage, marginal discoloration, and secondary caries.[11,12]

In the current study, the shear bond strength of the restorative materials was investigated along with microleakage because it is essential for enduring mastication forces. The greatest force needed to fracture the bond between a bonded restoration and the tooth surface is known as the shear bond strength, with the failure occurring at or very close to the adhesive interface.[13,14]

Polyacrylic acid as results aluminosilicate glass particles during the complicated acid-base setting reaction that takes place in GIC. The glass's calcium and aluminium ions start the cement's process of gelation and hardening. Polyacrylic acid complexes with the calcium ions on the tooth surface when the glass ionomer is applied to enamel or dentin, which causes a chemical reaction between the substrate and cement.[15]

In addition to the components found in traditional glass ionomers, RMGIC additionally includes polymerizable resin monomers in liquid (HEMA), initiators, and activators. The metal polyacrylate matrix and the poly HEMA matrix are formed when the powder and liquid are combined because of the acid-base reaction of the traditional glass ionomer and the polymerization reaction of the resin components.[16]

Shear bond analysis is just one of many in-vitro screening tests that can be performed to determine whether an adhesive material will ultimately be successful in the clinical setting. Due to numerous factors that could affect in vitro bond strength to dentin, including the type and age of the teeth, the degree of dentin mineralization, the dentinal surface being bonded, the storage media, the environmental relative humidity, and the difficulty of standardization, the validity of shear bond strength studies as predictors of clinical success is called into question.[17-19]

Shear bond strength value of Glass ionomer cement to teeth was the least and that of composite resin to teeth was the highest among the restorative materials tested. Similarly, Glass ionomer cement show highest amount of microleakage whereas composite resin showed least microleakage in our in-vitro investigation. The lowest shear bond strength was observed with glass ionomer cement this could be because they are susceptible to attack by moisture during the initial setting period. They have short working time, long setting and maturation time. Furthermore, they are susceptible to fracture and exhibit low wear resistance.[21]

Conclusion

It can be stated that Composite resin and RMGIC have good shear bond strength and lower microleakage as compared to Glass Ionomer Cement.

Limitation of study

Being an in vitro study, the current research has the obvious problem of not accurately simulating the environmental conditions of the oral cavity. Additionally, the results from samples or materials that fail cohesively do not reflect the strength of the connection itself but rather the weakness of the sample or substance. Therefore, testing procedures should be set up so that only adhesive fracture happens.

Conflict of Interest

The authors declare no conflict of interest.

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