Original Article

An *in vitro* Study to Compare and Evaluate Microleakage and Compressive Strength of Two Different Types of Glass Ionomer Cements

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Abstract

Background: Numerous restorative materials are being used in dentistry to achieve adequate strength and restore esthetics. Microleakage around dental restorative material and strength to withstand the masticatory forces is major problem in dentistry. **Materials and Methods:** For the evaluation of microleakage, Class V cavities were prepared on forty extracted permanent premolars and divided into two study groups ($n = 20$): Group I (Type IX glass ionomer cements [G.I.C]), Group II (resin modified GIC [RMGIC]). Samples were thermocycled, stained with dye, sectioned, and scored for microleakage under stereomicroscope. For the compressive strength evaluation, 40 cylindrical specimens were fabricated measuring 3 mm × 6 mm and grouped into two study groups ($n = 20$): Group I (Type IX G.I.C), Group II (RMGIC). All were then subjected to Universal Testing Machine at crosshead speed of 1 mm/min. Kruskal-Wallis and ANOVA test were done for comparisons. Mann-Whitney Test and *post-hoc* Bonferroni test were done for multiple comparisons. **Results:** RMG.I.C showed less microleakage and high compressive strength. There was significant difference between the groups in microleakage and compressive strength levels. **Conclusion:** Within the limitations of this study, RMG.I.C showed better sealing ability and high compressive strength.

Keywords: Compressive strength, Glass ionomer, Microleakage, Resin modified glass ionomer cement.

Introduction

Restoration of carious teeth in children is of utmost importance since dental caries affects children and adults worldwide.[1] For restoration, several materials have been tried but the search for ideal restorative material with optimal durability and physical properties continues.[2] Recently, several tooth-colored restorative materials have been tried. However, glass ionomer cement (GIC) has been emerged as the most important tooth-colored restorative material. It was invented by Wilson and Kent in 1970.[3] It releases fluoride ions, bonds chemically with the tooth, and is easy to use. However, its disadvantage is that it has low mechanical strength and sensitivity to moisture during manipulation.[4]

Several modifications have been made in conventional GIC to overcome these limitations. GC Fuji IX was marketed in mid-1990s which has high powder: liquid ratio. Due to poor physical properties such as low fracture resistance, tendency to undergo surface crazing, its use was limited.[5] To overcome this problem, Resin-modified glass ionomers (RMGI) were developed in 1992. These materials along with the anti-carious potential of GIC combine the mechanical properties of a resin composite.[6]

Therefore, the present *in vitro* study was conducted to compare and evaluate the compressive strength and microleakage of Type IX G.I.C, resin modified G.I.C (RMGIC).

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Materials and Methods

A total of 40 extracted human maxillary and mandibular permanent premolars were used.

Inclusion Criteria

Teeth extracted due to orthodontic purposes.

Exclusion Criteria

Teeth with any developmental defect and fractured teeth.

Teeth were stored at room temperature in normal saline till further use. After retrieving from normal saline, standardized class V cavities of size 3 mm × 2 mm × 2 mm were made on the facial surface of each tooth, using straight fissure bur and inverted cone bur in a high speed air rotor hand piece with water coolant.

Forty teeth were randomly divided into 2 groups with 20 teeth in each.

Group I

Type IX GIC (GC gold label) was used. Using cotton pellet, dentin conditioner (10% polyacrylic acid) was applied on the walls of the cavity for 20s, rinsed thoroughly with water, and blotted dry with a cotton pellet. After mixing the material, restoration of the cavity was done as per the manufacturer's instruction. Petroleum jelly coat was applied over the restoration and the excess material was removed.

Group II

RMGIC (GC gold label II LC) was used. Dentin conditioning, rinsing was done and dried as in Group 1. Cement mixing and restoration were done according to manufacturer's instruction. Light curing was done for 20 s after removing the excess material.

Sample storage was done at room temperature for 24 h in distilled water. The specimens were subjected to thermocycling for 250 cycles between the temperature range of 5°C and 55°C with 30 s of dwell time in each bath and 10 s transfer time. After sample retrieval from thermocycling, two coats of nail varnish were applied on all tooth surfaces except 2 mm around the restoration, and root apices were sealed with wax. After that, teeth were stored in 0.5% methylene blue dye for 24 h, cleaning was done under tap water and nail varnish was removed. Using a diamond disc under water spray, teeth were sectioned longitudinally through the center of restoration in the bucco-lingual plane, and examination was done under stereomicroscope at a magnification of ×10. The part of sectioned tooth showing greater microleakage was considered in the study.

For compressive strength evaluation, a total of forty cylindrical specimens were prepared using plastic straws of dimensions 3 mm × 6 mm. A total of 40 samples were prepared and divided into 2 equal groups (n = 20): Group I Type IX GIC (GC gold label), Group II RMGIC (GC gold label II LC). All the materials were removed from the cylindrical mold after curing and setting and stored in distilled water for 24 h.

All the specimens were individually transferred to the Universal Testing Machine and a compressive load was applied along the long axis at a crosshead speed of 1 mm/min.

Results

The results were tabulated and the data were analyzed statistically using SPSS software version 21.0 and Epi-info version 3.0.

A statistical correlation was done for microleakage with the mean value scores of two study groups and it was found to be statistically significant ($P < 0.05$) [Table 1].

For the results of compressive strength, the mean value scores of both the groups were obtained and statistically analyzed using analysis of variance, and highly significant correlation was observed ($P < 0.01$) [Table 2].

The results showed that microleakage was more in Type IX GIC followed by RMGIC whereas mean value score for compressive strength was more for RMGIC.

Discussion

There is a continuous observation for the restorative materials which ensure adhesion with tooth structure and the material that can withstand the masticatory forces.[7] Microleakage and compressive strength test are the measure by which researchers and clinicians predict the restorative material performance. The requirement of restorative material with improved bond strength and characteristics so as to withstand the masticatory forces stress leads to advancement in the restorative dentistry.

For evaluating microleakage, 40 permanent premolars were taken up which were extracted for orthodontic purpose. The samples were divided into two groups equally and filled according to the manufacturer's instructions.

After completing the restorations, all the samples were subjected to thermocycling. All the samples were thermocycled for 250 cycles between the range of 5°C and 55°C, with a dwell time of 30 s to simulate the oral environment.

Table 1: Mean microleakage of two different groups

	Microleakage			
Groups	***n***	**Mean**	**SD**	**Mean rank**
Group 1 (TYPE IX)	20	2.05	0.78	32.85
Group 2 (RMGIC)	20	1.71	0.57	27.69

P=0.003*significant

Table 2: Mean compressive strength

	Compressive strength (MPa)		
Groups	***n***	**Mean**	**Std. Deviation**
Group 1 (TYPE IX)	20	103.82	13.22
Group 2 (RMGIC)	20	149.42	12.27

P<0.001*(significant)

Microleakage can be detected by several methods which include electrochemical method, radioactive tracers, scanning electron microscopy, use of dyes, chemical tracers, neutron activation analysis, air pressure, and fluid filtration. In the present study, the dye leakage method was used because it is a simple, inexpensive, fast technique.[8]

In the present study, more microleakage was seen in Type IX GIC as compared to RMGIC which was in accordance with the study conducted by Shruthi *et al*.[8]

In the present study, RMGIC showed less microleakage than Type IX G.I.C. The reason for this may be because of higher filler loading in resin modified type as compared to Type IX G.I.C that may have resulted in lower polymerization shrinkage and lower coefficient of thermal expansion, thus improving the long-term bonding to the tooth structure.[4] Murray *et al*. in their study show that RMGIC is the most effective restorative materials to prevent bacterial microleakage.[9]

The leakage produced by Type IX GIC and RMGIC is higher may be because of the reason that no primer was used with these glass ionomers.[4]

In our study, RMGIC showed less microleakage as compared to Type IX G.I.C. RMGIC show water sorption which is responsible for its good sealing ability, which is the function of the resin components, and resulted in subsequent material expansion which might decrease the marginal gaps between tooth and restoration. This was in agreement with the study conducted by Singla *et al*.[10]

In our study, Type IX G.I.C showed more microleakage than RMGIC. This behavior of Type IX G.I.C would probably have been due to its high viscosity, not allowing the wetting of the tooth surface properly, preventing the formation of good seal between tooth restoration interfaces. Mali *et al*.[11] found similar results exhibiting more microleakage with conventional glass ionomer as compared to resin glass ionomer and composite.

In the present study, compressive strength was measured by universal testing machine, named so as it can perform many standard compression and tensile tests on components, materials, and structures.

Compressive strength of RMGIC (149.42 MPa) was greater than Type IX GIC. The higher strength values of RMGIC may be because of the fact that Fuji II LC contains higher filler content which was reported to be 76.2% mass fraction.[12] The low compressive strength of Type IX G.I.C. may be attribute to poor mechanical properties such as toughness, low fracture strength, and high rate of occlusal wear as studied by Lohbauer.[13] Furthermore, a study by Xu and Burgess[14] investigated the fluoride release and compressive strength of resin modified and coventional GICs, compomers, and composites suggesting that the difference in physical and mechanical properties of resin modified and conventional GICs could be due to the composition of the filler which may affect the strength and solubility of the materials.

Conclusion

Within the limitations of the present study, none of the material could prevent microleakage. Type IX G.I.C shows more microleakage when compared to RMG.I.C. The compressive strength value was more for RMG.I.C. as compared to Type IX G.I.C.

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