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# Microleakage in glass ionomer cement based restorative materials - An *in vitro* stereomicroscopic study

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## Abstract

**Background:** There have been many restorative materials being newly introduced for conservative restorations, but microleakage due to various reasons has been a major problem for failure of conservative restorations.

**Aim:** This study aims at comparing and evaluating the extent of microleakage in three commonly used glass ionomer cement (GIC) based restorative materials, namely, miracle mix, giomer and compomer with nano composites as standard material in enamel and dentin interface.

**Materials and methods:** Freshly extracted non carious premolars were collected and class I cavity with two millimetre depth was prepared and divided into four groups. They were then restored according to manufacturer's instructions and were treated with 0.5% basic fuchin dye for 24 h and then thermocycled. Later the samples were sectioned using hard tissue microtome and subjected to be viewed under stereomicroscope. All samples were compared and analysed.

**Results:** There was significant difference in microleakage scores between the three groups and between the control and the individual groups. Miracle mix had greater microleakage score than the other three test groups.

**Conclusion:** Microleakage was present in all samples. Amongst them control group nano composite had the least microleakage score, this was followed by compomer, giomer and miracle mix.

**Key words:**, giomer, microleakage, nano composite, compomer miracle mix

## Introduction

Microleakage happens in a defective interface that develops between a restoration and the tooth material, when a restoration gets withdrawn from the adjoining tooth surface. This may be due to many reasons like differences in coefficient of thermal expansion, polymerisation shrinkage, fracture, etc. This defect permits seepage of fluids, ions and bacteria into the crevice[1], leading to hypersensitivity and secondary caries[2]. Success of a restorative material is therefore largely dependant on the prevention of secondary caries

due to microleakage. Hence the search for one such restorative material with least microleakage is an important area of research.

Amalgam is a time tested material that has been widely used as a restorative material for its longevity, ability to withstand masticatory force and also has negligible microleakage [3]. On the other hand amalgam also has its own defects like thermal conductivity[4], lack of adhesion, thermal expansion[5], and marginal breakdown.

Glass ionomer cement (GIC) is a dentin substitute that is known for its biocompatibility, fluoride release and marginal integrity. It binds to teeth through chemical bonds. But the drawback includes low fracture toughness and vulnerability of the material to wear and tear[6].Composites have good compressive flexural and tensile strength, reduced water sorption quality, thermal expansion and polymerisation shrinkage. Hardness of composites is relatively high and it is due to the high filler content and cross linking resin structure. But the reduced thermal expansion and polymerisation shrinkage exceed that of the tooth structure. This leads to expansion and contraction induced stress at the resin tooth interface. These factors must be reduced to promote durability of the material [3].

Contemporary restorative materials that mix the major core materials like amalgam, glass ionomer cement and composites aims to seek the advantages of the two materials where further research is sought. Miracle mix is a combination of amalgam and glass ionomer cement which has good anticariogenic property and compressive strength than the conventional amalgam [7] . Miracle mix was proved to be better than conventional amalgam[8].

Giomer is another restorative material which is a combination of incorporated pre-reacted glass ionomer filler particles (PRG) in a resin matrix. It is a material with combined advantage of composite and glass ionomer cement with fluoride releasing property and can be light cured [9].

Poly acid modified resin composites (compomers) are made of 20% glass ionomer cement and 20% of light polarised resin components and this material is known to have fluoride releasing ability and good esthetic appeal[10] .

Nano composites have the characteristics of composites with additional benefits of nano filler particles. The increased filler content and the reduced size of the particles lower the polymerisation shrinkage. This study thus aims to evaluate the extent of microleakage in the newer restorative materials that are combination of glass ionomer cement with amalgam or composite with nano composite as control material.

**Materials and methods**

A total of 120 non carious human premolars extracted for orthodontic purpose were collected cleansed and stored in saline. They were divided into four groups of 30 samples each. Uniform Class I cavity of two millimetre depth at the central pit was prepared using hand piece and diamond bur and the depth of the cavity was measured with 245 bur. This two millimeter serves as a reference to measure the depth of penetration of the dye and each group was restored with their respective restorative materials (Table 1).

The samples were then stored in air tight containers for 24 h. They were then thermocycled for 500 times between $5^0$C to $55^0$C with dwell time of 30 seconds at each temperature [11] . The apex of the root was sealed with poly methylmeth acrylate. The entire tooth surface was coated with transparent nail polish leaving one millimeter surrounding the restoration tooth interface. The samples were allowed to dry and then immersion in 0.5% basic fuchsin dye at $37^0$C for 24 h and excess was washed off with distilled water and dried [12]. The prepared samples



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were sectioned using hard tissue microtome (Ellica SP 1600, Germany) and viewed under stereo microscope.

**Results**

In the present investigation the extent of microleakage was assessed in three different groups of different materials *viz.* Miracle Mix (Group 2) (Figure 2), Giomer (Group 3) (Figure 3) and Compomer (Group 4) (Figure 4) as compared to the Nano-composite (Group 1) (Figue 1) as control material. The lowest and highest microleakages noticed in the Micarcle Mix group were 2127.53 and 2178.42 µM, respectively. In case of giomer group, the lowest and highest microleakages were 960.43 and 1011.60 µM, respectively. Similarly, the lowest and highest values of microleakage ranged between 589.30 and 640.63 µM in compomer group. However, the control group 1 i.e. nano-composite group, exhibited least microleakage which ranged between 128.90 and 183.24 µM, as compared to other three experimental groups. The Mean ± S. D. values obtained for the groups 1, 2, 3 and 4 were 157.73 ± 17.22, 2156.38 ± 15.85, 991.57 ± 13.85 and 610.22 ± 19.64 µM, respectively (Table 2). Overall comparison by One-way ANOVA indicated the highest significance ($p < 0.0001$) among all the groups examined in this study (Table 2).

Post-Hoc Tukey HSD (Honestly Significant Difference**)** test was employed to find the interrelationship between the means of different groups. Among all the tested groups the group treated with nano-composite exhibited least microleakage and the group treated with miracle mix showed maximum leakage with highest statistical significance among all other groups ($p < 0.001$). The comparisons were also made amongst Group 2-Miracle mix *vs* Group 3-Giomer, Group 2-Miracle mix *vs* Group 4-Compomer and Group 3-Giomer *vs* Group 4-Compomer, however, it was found to be moderately significant at 1% level ( Table 3).

**Discussion**

Failure of a restoration is often a major problem in conservative dentistry. This is mainly due to shrinkage or ineffective adhesion to cavity walls [13]. Polymerisation shrinkage may be due to cavity size, shape, substrate type, location of margin, restorative materials and techniques in placing, C factor and polymerising the restoration [14,15]. Tooth and restorative interface can fracture if the shrinkage stress is greater leading to gap that promotes microleakage. Thermocycling is done to provide thermal stress, by the changing temperature that will increase the stress in the material and the leakage [16]. Dye penetration method is used to detect microleakage at the margins [17]. Gladys et al. has stated that microleakage is an inevitable threat to all kinds of restorative materials[18]. Miracle mix is a combination of glass ionomer cement and amalgam. This combination was selected to incorporate the advantages of both the products into one compound. But microleakage in miracle mix might be due to lack of binding between the metal and the composite. In this study maximum microleakage is noted in samples tested with these restorative materials and this may be due to the low compressive and flexural strength of this material compared to others [19,20]. Our study was congruent with the studies previously done by Saini et al. where miracle mix was proved to have more microleakage than other materials [20].

Compomer was evaluated to have lesser scores of microleakage than giomer in another study by Yadav et al.[21], compomers contain carboxylated methacrylate resin and fluoroaluminasilicate glass filler which might lower microleakage [10]. According to this study microleakage was recorded the least in samples restored with nano composites. The composite has high filler content with



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non aggregated 20 nm nano silica fillers and loosely bound agglomerated zirconia/silica is used. Thus the higher filler content in nanomcomposites the lower the polymerisation shrinkage and coefficient of thermal expansion of the composite [22]. The search for a perfect product is always a point of research. The order of microleakage in this study is miracle mix > giomer > compomer > nano composite.

**Conclusion**

Microleakage was present in all samples. Amongst them control group nano composite had the least microleakage score, this was followed by compomer, giomer and miracle mix.

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**Legends Table and Figure**

Table 1: Grouping of restorative materials

| Group | Material | Commercial name |
|---|---|---|
| Group 1 ( Control) | Nano composite | Filtek Z350XT ( 3M ESPE) |
| Group 2 | Miracle mix | Miracle Mix Capsules(GC) |
| Group 3 | Giomer | Beautifil II Giomer (SHOFU.INC.) |
| Group 4 | Compomer | F2000(3M) Compomer Restoration System |

Table 2: Assessment of Extent of microleakage in the different groups

| Group 1 | Group 2 | Group 3 | Group 4 | F value | p value |
|---|---|---|---|---|---|
| Nano composite | Miracle mix | Giomer | Bulkfil | | |
| 157.73±17.22 | 2156.38±15.85 | 991.57±13.85 | 610.22±19.64 | 78100.01 | < 0.0001 |

Table 3: Post-Hoc Tukey HSD (Honestly Significant Difference) test for interrelationship between the means of different groups

| Tukey's Multiple Comparison Test | Mean Diff. | q | Significance |
|---|---|---|---|
| Group 1-Nano-composite *vs* Group 2-Miracle mix | -1999 | 653.8 | $p < 0.001$ |
| Group 1-Nano-composite *vs* Group 3-Giomer | -833.9 | 272.8 | $p < 0.001$ |
| Group 1-Nano-composite *vs* Group 4-Compomer | -452.5 | 148.0 | $p < 0.001$ |
| Group 2-Miracle mix *vs* Group 3-Giomer | 1165 | 381.0 | $P < 0.01$ |
| Group 2-Miracle mix *vs* Group 4-Compomer | 1546 | 505.8 | $P < 0.01$ |
| Group 3-Giomer *vs* Group 4-Compomer | 381.4 | 124.8 | $p < 0.01$ |



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Figure 1: Stereomicroscopic view of Nano composite under 80X magnification

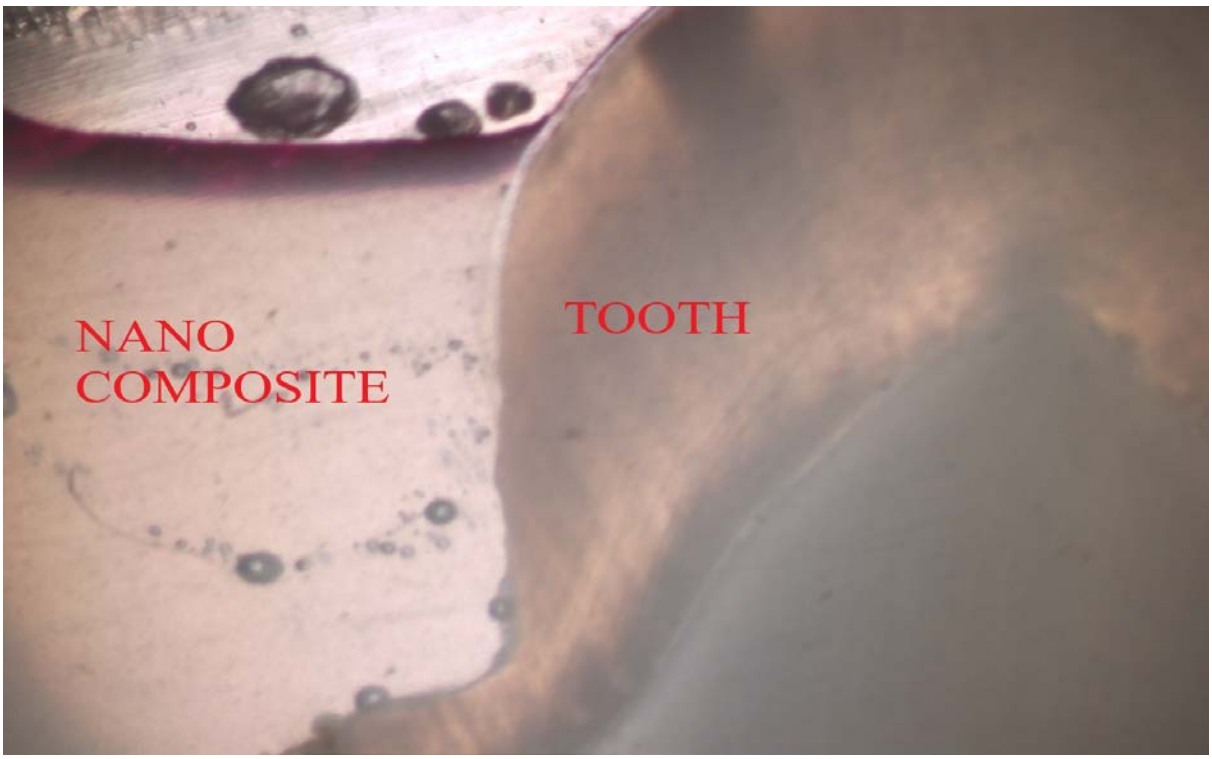


Figure 2: Stereomicroscopic view of Miracle mix under 80X magnification




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Figure 3: Stereomicroscopic view of Giomer under 80X magnification

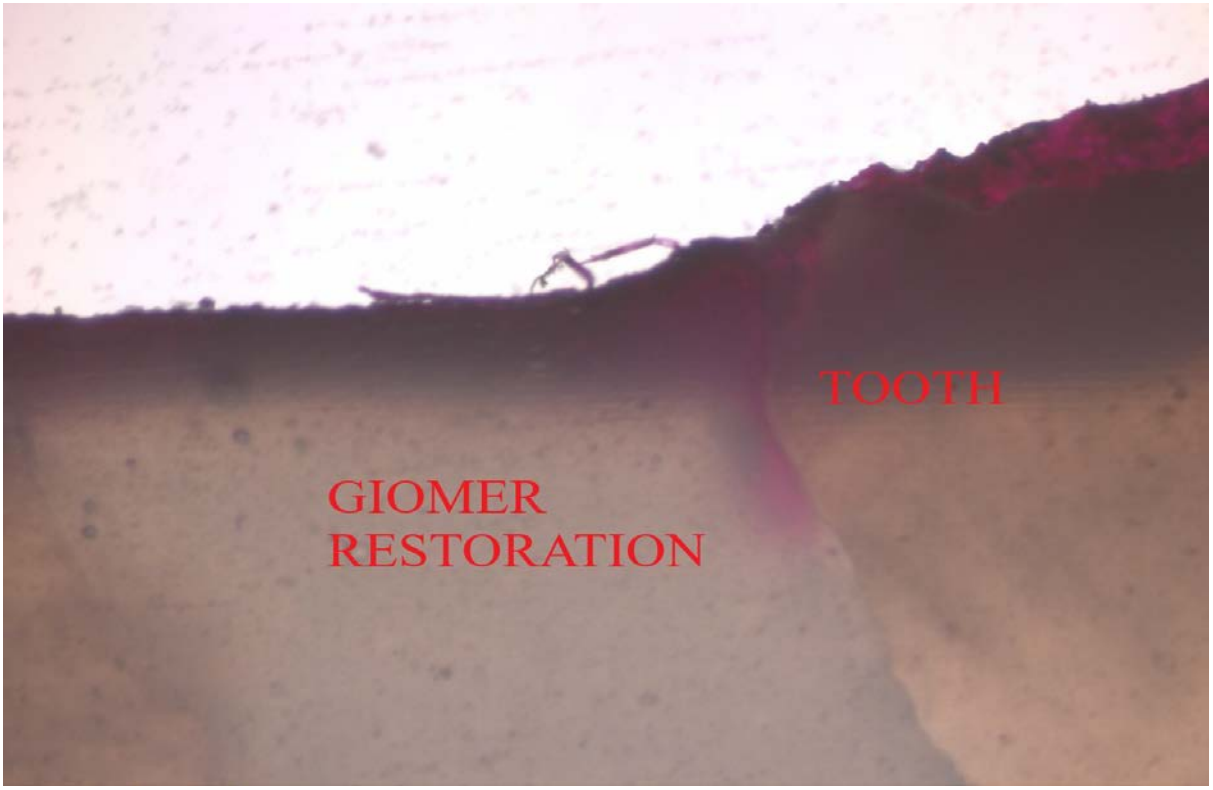
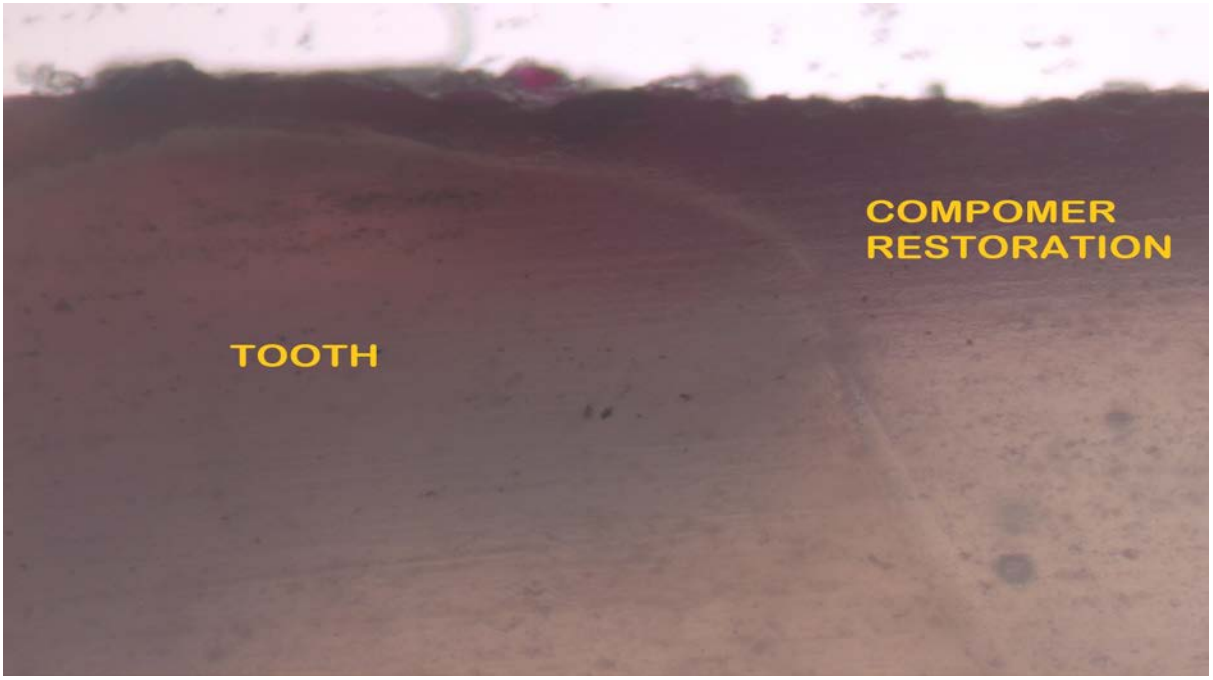



Figure 4: Stereomicroscopic view of Compomer under 80X



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