Comparative Evaluation of Different Periods of Enamel Microabrasion on the Microleakage of Class V Resin-modified Glass Ionomer and Compomer Restorations: An *In vitro* Study

**Abstract**

**Context:** The design of the class V cavity presents a clinical challenge in the field of adhesive dentistry as the margin placement is partially in enamel and partly in dentin, and the trouble associated with this design is the microleakage at the dentinal margin. When these restorations undergo microabrasion due to cosmetic reasons, this trouble aggravates to the significant levels. **Aims:** The aim of this study was the measurement of microleakage of class V glass ionomer restorations over two different periods of enamel microabrasion. **Settings and Design:** This *in vitro* experimental study was conducted on 120 class V cavities which had been prepared on the buccal and lingual surfaces of 60 sound human premolars. One-half of the cavities were restored with the resin-modified glass ionomer cement (GIC) (60 cavities) and another half with the compomer (60 cavities). Finishing and polishing were performed. **Subjects and Methods:** Then, the teeth were classified into six groups (*n* = 20). Microabrasion treatment was performed with Opaluster (Ultradent Product Inc., South Jordan, UT, USA) for 0 (control no treatment), 60 and 120 s. Then, teeth were thermocycled between 5°C and 55°C, immersed in rhodamine B solution (24 h), and sectioned longitudinally in buccolingual direction. Dye penetration was examined with stereomicroscope (×10). Microleakage scores were statistically analyzed. The mean occlusal margin scores and gingival margin scores were compared between all the groups using the Kruskal–Wallis test, Mann–Whitney U-test, Wilcoxon signed-rank test, and *post hoc* comparison. There was a significant difference between Group 1a, Group 2a, Group 1b, Group 2b, Group 1c, and Group 2c. **Statistical Analysis Used:** Statistical analysis used in this study was Kruskal–Wallis test, Mann–Whitney U-test, Wilcoxon signed-rank test, and *post hoc* comparison. **Results:** The least microleakage scores were observed in occlusal margins of control groups (without microabrasion). Moreover, in both restorations, the microleakage scores in occlusal margins were higher than gingival margins, and compoglass had less microleakage in occlusal and occlusal plus axial walls of class V cavities compared with resin-modified GIC. Whereas, the light-cured glass ionomer had less microleakage in the gingival and gingival plus axial walls of class V cavities when compared with compoglass. **Conclusions:** The least microleakage scores were observed in occlusal margins of control groups (without microabrasion). Moreover, in both restorations, the microleakage scores in occlusal margins were higher than gingival margins.

**Keywords:** Esthetics, gingival margin, occlusal margin, stereomicroscope

**Introduction**

Microabrasion technique permanently aids the removal of white-brown discoloration of enamel leaving a compact layer of prismless enamel which has normal light reflection and luster. Finally, the micro-abriced enamel gives a glass-like appearance like normal teeth.\(^1\)

This study was given a consideration keeping microabrasion as an alternate procedure to other cosmetic treatments such as porcelain veneers, which can cause irreversible changes to the teeth whereas the physical structure of enamel will be minimally affected after microabrasion with the permanent results, with no long-term maintenance.\(^2\)

Dentistry has always aimed to achieve a restorative material with least toxicity to pulp and with the satisfactory seal at microscopic level. With the increasing demands of esthetics among the patients, the restorative management followed by microabrasion can be an option;\(^2\) keeping this in mind, the problem of microleakage which is associated with the enamel loss is considered as an important parameter to be studied.

**How to cite this article:** Bansal D, Mahajan M. Comparative evaluation of different periods of enamel microabrasion on the microleakage of class V resin-modified glass ionomer and compomer restorations: An *In vitro* study. Indian J Dent Res 2017;28:675-80.
Enamel microabrasion can eliminate enamel irregularities and discoloration defects or demineralization, especially in dental fluorosis, improving the appearance of teeth.[2]

Chan et al. showed that in exposed dentin surfaces after 20 times, 5-s applications of the microabrasive agent approximately removed 50 μm of dentin, and he had also evaluated the effect of microabrasion technique on dental materials and dental surfaces and showed that microabrasion increases surface roughness of glass ionomer cements to the extent that may contraindicate its usage.[3]

Although acid in the microabrasive agent cannot penetrate into pulp chamber, the penetration of acid into bared dentin may result in opening of dentinal tubules and hypersensitivity.[4]

Restoration of erosion, caries, or abfraction of cervical lesions is performed with several types of restorative materials. Resin-modified glass ionomers (RMGIs) and compomers were designed for this purpose. These materials theoretically release fluoride, and they are more suitable for patients with high caries incidence.[5]

The purpose of this study was to compare the marginal microleakage of a compomer with a RMGI after microabrasion, in class V cavity preparations. These materials were considered over composites for this study due to their cariostatic actions and simpler surface-conditioning techniques.

Subjects and Methods

In this in vitro study, sixty sound adult human maxillary premolars extracted for orthodontic reasons were collected and checked for dental caries, attrition, abrasion, fluorosis, and other defects of enamel, which, if noticed, were discarded. All the healthy looking teeth without any defect in the enamel were included in the study. The teeth were cleaned of soft tissues and debris and stored in 0.9% normal saline at room temperature for a mean time till use. The samples were randomly divided into two groups of 30 each (Group 1 and Group 2). In both buccal and lingual surfaces of all teeth, class V cavities were prepared with a No. 329 (pear-shaped) fissure (SS white) bur under water spray. The gingival margin of the cavity extended into cementum 1 mm below the cementoenamel junction.

The bur was changed after every five cavity preparations. The cavity dimensions were 3 mm occlusogingivally and 4 mm mesiodistally and 1.5 mm in depth. No bevel was placed. The cavity preparation was measured using a periodontal probe.

All of the cavities in Group 1 were filled with Fuji II LC (GC Corp.) and in Group 2 with a compomer (Compoglass F, Vivadent)

In Group 1, the cavity conditioner was applied for 20 seconds. After washing and drying the cavity walls, Fuji II LC was mixed as recommended by the manufacturer, the cavities were filled with Fuji II LC, and then, the restorations were light-cured for 40 seconds.

In Group 2, the cavities were cleaned using a water spray, and then, enamel was blotted dry. The bonding agent recommended for compoglass (Tetric N-Bond) was applied with a brush for 20 seconds. It was then blown with an oil-free air spray and light-cured for 20 seconds. The second coat of bonding agent was applied and immediately light-cured.

Next, the samples were filled with Compoglass F and light-cured for 40 seconds.

After the restoration was done, the finishing of the restoration with Soflex Discs (3M ESPE) for all the samples was carried out and was kept in water at room temperature for 24 hours. Microabrasion treatment was performed in experimental groups in 60 and 120 s periods. The microabrasion compound (Opaluster, Ultradent) was applied on the surfaces of teeth and restorations with a rubber cup for different periods.

Depending on restoration type and microabrasion time, all the specimens in Group 1 were subdivided into Group 1a, 1b, and 1c and in Group 2 into Group 2a, 2b, and 2c (n = 20) [Table 1].

In the groups with microabrasion time higher than 30 seconds, after each 30 seconds microabrasive agent application, the samples were thoroughly rinsed with air-water spray for 10 seconds to simulate the clinical condition.

All the samples were then thermocycled, water was used as the medium for thermocycling, and the samples were cycled through baths of 5°C ± 1°C and 55°C ± 1°C with a dwell time of 5 seconds. All the teeth were held in a plastic net completely immersed in the water bath during the procedure.

The samples were made to go through hundred cycles followed by drying the samples with blotting paper and sealed with nail varnish which was 1 mm short of the margins of each restoration. Then, all the specimens were immersed in the rhodamine B dye for a period of 24 hours at room temperature, after which they were removed and washed thoroughly.

| Table 1: Group division |
|-------------------------|
| Groups | Restorative material used | Time of microabrasion (s) |
| Group 1a | Fuji II LC | 0 |
| Group 2a | Compoglass F | 0 |
| Group 1b | Fuji II LC | 60 |
| Group 2b | Compoglass F | 60 |
| Group 1c | Fuji II LC | 120 |
| Group 2c | Compoglass F | 120 |
Then, the teeth were embedded in acrylic resin and sectioned longitudinally from the facial to lingual surface using a standardized diamond saw, under saline irrigation. Specimens were then used to assess microleakage using the dye method. The extent of dye penetration was observed under stereomicroscope (Nikon, Japan) with a magnification of ×10.

Both sides of specimen section were examined at the occlusal and gingival margins making a total of two occlusal and two gingival microleakage scores for each section using the following scoring system:[6]

- **0** = No dye penetration
- **1** = Partial dye penetration along the occlusal or gingival wall [Figures 1 and 2]
- **2** = Dye penetration along the occlusal or gingival wall but not up to the axial wall
- **3** = Dye penetration to and along the axial wall [Figure 3].

### Results

The mean occlusal margin scores [Table 2 and Box Plot 1] were compared between Group 1a, Group 2a, Group 1b, Group 2b, Group 1c, and Group 2c using the Kruskal–Wallis test, Mann–Whitney U-test, and post hoc comparisons [Table 3]. There was a significant difference between Group 1a, Group 2a, Group 1b, Group 2b, Group 1c, and Group 2c.

The mean gingival margin scores [Table 4 Box Plot 2] were compared between Group 1a, Group 2a, Group 1b, Group 2b, Group 1c, and Group 2c using the Kruskal–Wallis test, Mann–Whitney U-test, and post hoc comparisons [Table 5]. There was a significant difference between Group 1a, Group 2a, Group 1b, Group 2b, Group 1c, and Group 2c.

When comparing the occlusal and gingival scores for experimental groups [Table 6] using Wilcoxon signed-rank test, dye penetration was significantly higher at occlusal margin than gingival margin for Group 1c. The dye penetration was significantly higher at gingival margin than occlusal margin for Groups 2a, 2b, and 2c.

### Discussion

The most common cause of the failure of most of the restorative materials seems to be the microleakage because of which it is always been a topic of interest among the practitioners and researchers to look for a material with best adaptation to the cavity walls reducing percolation of the oral fluids.[7]

Enamel microabrasion is a chemical and micromechanical method that ensures removing a microscopic layer of the enamel surface while eliminating superficial discoloration.[1] In this technique, the chemical and the mechanical actions of the acid and abrasive, respectively, will simultaneously cause erosion and abrasion of the enamel surface.[10] Erosive

### Table 2: Occlusal margin scores

| Groups | Score 0 | Score 1 | Score 2 | Score 3 | Total |
|--------|--------|--------|--------|--------|-------|
| Group 1a | 15 | 4 | 1 | 0 | 20 |
| Group 2a | 16 | 3 | 1 | 0 | 20 |
| Group 1b (60) | 11 | 6 | 2 | 1 | 20 |
| Group 2b (60) | 13 | 5 | 2 | 0 | 20 |
| Group 1c (120) | 8 | 3 | 5 | 4 | 20 |
| Group 2c (120) | 10 | 5 | 3 | 2 | 20 |

### Table 3: Statistical analysis of occlusal margin scores

| Groups | Mean±SD | Median | IQR | Mean rank |
|--------|---------|-------|-----|----------|
| Group 1a | 0.30±0.57 | 0.00 | 0.00-0.50 | 50.38 |
| Group 2a | 0.25±0.55 | 0.00 | 0.00-1.00 | 47.90 |
| Group 1b | 0.65±0.88 | 0.00 | 0.00-1.25 | 62.80 |
| Group 2b | 0.45±0.69 | 0.00 | 0.00-1.00 | 56.33 |
| Group 1c | 1.25±1.21 | 0.50 | 0.00-2.00 | 77.80 |
| Group 2c | 0.85±1.04 | 1.00 | 0.00-2.00 | 67.80 |

### Table 4: Gingival margin scores

| Groups | Score 0 | Score 1 | Score 2 | Score 3 | Total |
|--------|--------|--------|--------|--------|-------|
| Group 1a | 15 | 4 | 1 | 0 | 20 |
| Group 2a | 12 | 5 | 3 | 0 | 20 |
| Group 1b (60) | 14 | 3 | 2 | 1 | 20 |
| Group 2b (60) | 10 | 3 | 5 | 2 | 20 |
| Group 1c (120) | 11 | 4 | 3 | 2 | 20 |
| Group 2c (120) | 8 | 4 | 5 | 3 | 20 |

### Table 5: Statistical analysis of gingival margin scores

| Groups | Mean±SD | Median | IQR | Mean rank |
|--------|---------|-------|-----|----------|
| Group 1a | 0.30±0.57 | 0.00 | 0.00-0.50 | 48.18 |
| Group 2a | 0.55±0.76 | 0.00 | 0.00-1.00 | 57.25 |
| Group 1b | 0.50±0.89 | 0.00 | 0.00-1.25 | 53.28 |
| Group 2b | 0.95±1.10 | 0.00 | 0.00-1.00 | 67.45 |
| Group 1c | 0.80±1.06 | 0.50 | 0.00-2.00 | 63.03 |
| Group 2c | 1.15±1.14 | 1.00 | 0.002.00 | 73.83 |

### Table 6: Statistical analysis of experimental groups

| Groups | Mean±SD | Median | IQR | Mean rank |
|--------|---------|-------|-----|----------|
| Group 1a | 0.30±0.57 | 0.00 | 0.00-0.50 | 48.18 |
| Group 2a | 0.55±0.76 | 0.00 | 0.00-1.00 | 57.25 |
| Group 1b | 0.50±0.89 | 0.00 | 0.00-1.25 | 53.28 |
| Group 2b | 0.95±1.10 | 0.00 | 0.00-1.00 | 67.45 |
| Group 1c | 0.80±1.06 | 0.50 | 0.00-2.00 | 63.03 |
| Group 2c | 1.15±1.14 | 1.00 | 0.002.00 | 73.83 |

Kruskal–Wallis test, Mann–Whitney U-test, *Significant difference.
SD=Standard deviation, IQR=Interquartile range

Dye penetration tests are well accepted, economical, and abrasive potential of the agent during microabrasion technique depends on various parameters, such as the pH, the concentration and the kind of acid, abrasive medium, time of instrumentation, and the mode of application (i.e., brushes, cups, and bur and discs can be used as a slurry carriers).[9]

In this technique, the chemical and mechanical actions of the acid and abrasive, respectively, will simultaneously cause erosion and abrasion of the enamel surface. Erosive
readily available, and nontoxic, so they are most preferred methods.\[10]\n
In this study, all the parameters were kept constant except the duration of microabrasion. The lowest microleakage score on enamel margins was observed in control groups (without microabrasion), and a significant difference was observed between the two experimental materials.

Usually, diffusion-based adhesion can be developed between the glass ionomers and both enamel and dentin and this is unique to these materials and is a dynamic phenomenon. The polymeric nature of glass ionomer ensures a multiplicity of bonds between substrate and cement; under clinical condition, the scission of single bond does not lead to failure because this bond can reform.\[11]\n
Dye penetration (microleakage) in the gingival margins of compoglass restorations in this study was significantly more than in glass ionomer restorations. This confirms the results of the previous study, indicating a significantly greater degree of microleakage in gingival walls of compomers.\[12]\n
This might have occurred because of the higher resin content of compoglass compared to the glass ionomer. As a result, polymerization shrinkage was accompanied by higher microleakage in the gingival margin. Another factor is a hydrolysis phenomenon that appears after thermocycling.\[13]\n
In enamel margins with increasing the microabrasion time in both restorations, the microleakage increased. This increase can be attributed to simultaneous effects of erosion and abrasive wear. In enamel surface after contact with an aggressive acid such as HCl, demineralization occurs. Scherer et al. in scanning electron microscopy analyses observed that a slight etch or roughening of the enamel surface causes the rod peripheries to appear prominent at the 5-s application with the enamel microabrasion compound.\[14]\n
It is known that the resultant stress of polymerization shrinkage of resin can generate tensions between the restorative material and tooth substrate, which, consequently, can lead to generation of gaps between the adhesive interfaces.\[15]\n
| Occlusal margin score | Gingival margin score | \(P\) |
|-----------------------|-----------------------|-------|
| **Median** | **IQR** | **Median** | **IQR** | **Z** |
| Group 1a | 0.00 | 0.00-0.50 | 0.00 | 0.00-0.50 | 1.000 |
| Group 1b | 0.00 | 0.00-1.25 | 0.00 | 0.00-1.25 | -1.732 |
| Group 1c | 0.50 | 0.00-2.00 | 0.00 | 0.00-2.00 | -3.000 |
| Group 2a | 0.00 | 0.00-1.00 | 0.00 | 0.00-1.00 | -2.646 |
| Group 2b | 0.00 | 0.00-1.00 | 0.00 | 0.00-1.00 | -3.162 |
| Group 2c | 1.00 | 0.00-2.00 | 1.00 | 0.00-2.00 | -2.449 |

*Wilcoxon signed-rank test, *Significant difference, IQR=Interquartile range

Ajamia et al. compared microleakage between glass ionomer and compoglass, and they reported that in glass ionomer restorations, microleakage in occlusal margins was higher than gingival margins.\[16]\n
Bonding by glass ionomers is achieved by two ways, that is, by mechanical retention and by chemical chelation; the former plays a more important role. This confirms the reason why there is less microleakage in the gingival margins in which there is no enamel. The potential of glass ionomers for chemical bonding is only an advantage in situations where it is difficult or impossible to produce micromechanical retention.\[17,18]\n
Furthermore, the dimensional stability of the glass ionomer is the result of...
the presence of the dentinal tubule fluid in natural dentin during the polymerization process.\textsuperscript{[19]}

Dye penetration (microleakage) in axial walls from the gingival pathway was greater in compoglass restorations than that of glass ionomer restorations, this can be explained as compomers when compared to glass ionomers have lower bonding strength to dentin; thus, they need a stronger dentin-bonding material for this purpose. This affects the amount of microleakage of compoglass.\textsuperscript{[20]}

As the cervical region has lesser enamel available for bonding which results in lesser bonding surface area and consequently lesser bond strength, together with this, the polymerization shrinkage and the volume change due to the stress of thermocycling process also explains the gingival microleakage for compomer restorations in this study.\textsuperscript{[21]}

The human premolar in labial surface has a natural curvature (height of contour). Hence, it is possible that the enamel loss can be higher than the dentin. In other words, the microabrasive material in enamel margins is inadvertently more compressed.\textsuperscript{[3]}

A restorative material which seals equally well to both enamel as well as dentin is yet to be developed in dentistry.\textsuperscript{[22]}

The results of this study cannot be related to other studies because of lack of available data from researches using the similar methodologies.

**Conclusions**

The least microleakage scores were observed in occlusal margins of control groups (without microabrasion). Moreover, in both restorations, the microleakage scores in occlusal margins were higher than gingival margins, and compoglass had less microleakage in occlusal and occlusal plus axial walls of class V cavities compared with light-cured glass ionomer. Whereas, the light-cured glass ionomer had relatively lesser microleakage in the gingival as well as gingival plus axial walls when compared with compoglass.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Terry DA. A biomodification of tooth discoloration. Pract Proced Aesthet Dent 2006;18:226, 228-9.
2. Sundfeld RH, Sundfeld-Neto D, Machado LS, Franco LM, Fagundes TC, Briso AL, et al. Microabrasion in tooth enamel discoloration defects: Three cases with long-term follow-ups. J Appl Oral Sci 2014;22:347-54.
3. Chan DC, Lemke KC, Howell ML, Barghi N. The effect of microabrasion on restorative materials and tooth surface. Oper Dent 1996;21:63-8.
4. Griffin RE Jr., Grower MF, Ayer WA. Effects of solutions used to treat dental fluorosis on permeability of teeth. J Endod 1977;3:139-43.
5. Ajamia B, Makaremb A, Niknejadc E. Microleakage of class V compomer and light-cured glass ionomer restorations in young premolar teeth. J Mashhad Dent Sch 2007;31:25-8.
6. Mohammadi-Bassir M, Ebadi S, Fahimi MA. The effect of different periods of Enamel Microabrasion on the Microleakage of Class V Glass-Ionomer restorations. J Dent Sch 2015;33:254-61.
7. Shruthi AS, Nagaveni NB, Poornima P, Selvamani M, Madhushankari GS, Subba Reddy VV, et al. Comparative evaluation of microleakage of conventional and modifications of glass ionomer cement in primary teeth: An in vitro study. J Indian Soc Pedod Prev Dent 2015;33:279-84.
8. Meireles SS, Andre Dde A, Leida FL, Bocangel JS, Demarco FF. Surface roughness and enamel loss with two microabrasion techniques. J Contemp Dent Pract 2009;10:58-65.
9. Paic M, Sener B, Schug J, Schmidlin PR. Effects of microabrasion on substance loss, surface roughness, and colorimetric changes on enamel in vitro. Quintessence Int 2008;39:517-22.
10. Giray FE, Peker S, Durmus B, Kargil B. Microleakage of new glass ionomer restorative materials in permanent teeth. Eur J Paediatr Dent 2014;15:122-6.
11. Mount G. An atlas of cements. A Clinician’s Guide. 3rd ed. Goodwill Industries of East Texas, Inc.; 1990. p. 70-1.
12. Gladys S, Van Meerbeek B, Lambrechts P, Vanherle G. Marginal adaptation and retention of a glass-ionomer, resin-modified glass-ionomers and a polyacid-modified resin composite in cervical class-V lesions. Dent Mater 1998;14:294-306.
13. Rodriguez JA, De Magalhaes CS, Serra MC, Rodriguez AL Jr. In vitro microleakage of glass ionomer composite resin hybrid materials. Oper Dent 1999;24:89-95.
14. Scherer W, Quattrone J, Chang J, David S, Vijayaraghavan T. Removal of intrinsic enamel stains with vital bleaching and modified microabrasion. Am J Dent 1991;4:99-102.
15. Atoui JA, Chinelatti MA, Palma-Dibb RG, Corona SA. Microleakage in conservative cavities varying the preparation method and surface treatment. J Appl Oral Sci 2010;18:421-5.
16. Ajamia B, Makarem B, Niknejad E. Microleakage of class V compomer and light-cured glassionomer restorations in young premolar teeth. J Mashhad Dent Sch Mashhad Univ Med Sci 2007;31:25-8.
17. Bouschlicher MR, Vargas MA, Denehy GE. Effect of desiccation on microleakage of five class V restorative materials. Oper Dent 1996;21:90-5.
18. Chersoni S, Lorenzi R, Ferriery P, Prati C. Laboratory evaluation of compomers in class V restorations. Am J Dent 1997;10:147-51.
19. Ferrari M, Vichi A, Mannocci F, Davidson CL. Sealing ability of two “compomers” applied with and without phosphoric acid treatment for class V restorations in vivo. J Prosthet Dent 1998;79:131-5.
20. Marks LA, van Amerongen WE, Borgmeijer PJ, Groen HJ, Martens LC. Ketac molar versus dyract class II restorations in primary molars: Twelve month clinical results. ASDC J Dent Child 2000;67:37-41, 8.
21. Shih WY. Microleakage in different primary tooth restorations. J Chin Med Assoc 2016;79:228-34.
22. Pontes DG, Guedes-Neto MV, Cabral MF, Cohen-Carneiro F. Microleakage evaluation of class V restorations with conventional and resin-modified glass ionomer cements. Oral Health Dent Manag 2014;13:642-6.