

Original Article

Effect of different cavity conditioners on microleakage of glass ionomer cement with a high viscosity in primary teeth

Romina Mazaheri¹, Leila Pischevar², Ava Vali Shichani¹, Sanas Geravandi³

Departments of ¹Pediatric Dentistry and ²Restorative Dentistry, Dental Faculty, Isfahan (Khorasgan) Branch, Islamic Azad University, ³Dentist, Isfahan, Iran

ABSTRACT

Background: Glass ionomer cement is a common material used in pediatric dentistry. The aim of this study was to evaluate the microleakage of high-viscosity glass ionomer restorations in deciduous teeth after conditioning with four different conditioners.

Materials and Methods: Fifty intact primary canines were collected. Standard Class V cavities (2 mm × 1.5 mm × 3 mm) were prepared by one operator on all buccal tooth surfaces, including both enamel and dentin. The samples were divided into five groups with different conditioners (no conditioner, 20% acrylic acid, 35% phosphoric acid, 12% citric acid, and 17% ethylenediaminetetraacetic acid [EDTA]). Two-way — ANOVA, Kruskal–Wallis and Mann–Whitney tests were used to compare the means of microleakage between the five groups. The significance level was set at $P < 0.05$.

Results: There was no significant difference between the means of microleakage in incisal (enamel) and gingival (dentin) margins ($P = 0.34$). Furthermore, there was no significant difference between the means of microleakage in enamel and dentin margins ($P = 0.4$). There was a significant difference between the means of microleakage in different groups ($P = 0.03$).

Conclusion: Within the limitations of this study, it is suggested that 20% acrylic acid and 17% EDTA be used for cavity conditioning which can result in better chemical and micromechanical adhesion.

Key Words: Cervical restoration, dental leakage, glass ionomer cement, primary tooth

Received: October 2013

Accepted: June 2014

Address for correspondence:

Dr. Ava Vali Shichani,
Dental School Faculty,
Isfahan (Khorasgan) Branch,
Islamic Azad University,
Isfahan, Iran.
E-mail: ava_v_s@yahoo.com

INTRODUCTION

Glass ionomer cement is a commonly used material in pediatric dentistry. This cement is composed of calcium alumina silicate glass particles combined with polyacrylic acid. Mechanico-chemical bond to enamel and dentin is a distinguished characteristic of this cement. Fast application and gradual fluoride release have made this element one of the most commonly used materials in pediatric dentistry.^[1,2] To establish an effective adhesion,

close contact between the tooth structure and the glass ionomer cement is required. Yilmaz *et al.*^[3] have reported that the goal of conditioning is to eliminate smear layer and surface contamination that can reduce the cement's adhesion to the tooth surface, particularly dentinal surfaces. It has been shown that the conditioners' concentration and method and time of application can affect smear layer removal. It has also been stated that the acidic nature of glass ionomer cements can partially dissolve the smear layer. El-Askary and Nassif^[4] and Glasspoole *et al.*^[5] stated that conditioning of the tooth surface can increase the bond strength of the glass ionomer and lead to better adhesion to the dental hard tissue.

At first, it was believed that smear layer should be preserved to protect the pulp from toxic stimuli and reduce outward tubular flow. While using highly concentrated cements, water is absorbed from

Access this article online



Website: www.drj.ir
www.drjournal.net
www.ncbi.nlm.nih.gov/pmc/journals/1480

the dentinal tubules and causes sensitivity due to hydraulic pressure.

However, today it has been emphasized that smear layer does not provide a stable substrate for adhesion and bonding of the restorative material to the tooth surface. Gradually, this layer dissolves under restorative material as a result of hydrolysis process and results in microleakage, bacterial penetration and pulpal inflammation.^[3] Therefore, the smear layer should be either modified or completely dissolved and removed.

Since little research has been carried out concerning the effects of different conditioning agents on conventional glass ionomer with high-viscosity bond to the tooth structure and most of them have focused on studying the bond strength, especially in the permanent teeth and no study has compared the effects of these four conditioners (20% acrylic acid, 35% phosphoric acid, 12% citric acid, 17% ethylenediaminetetraacetic acid [EDTA]), this study was designed to investigate the microleakage of high-viscosity glass ionomer restorations in deciduous teeth after conditioning with four different conditioners.

MATERIALS AND METHODS

In this *in vitro* experimental study, 50 intact primary canines with no caries, restorations, fractures or cracks with root resorption of <1/2 root length, that were extracted due to orthodontic interventions, were collected from pediatric dentists' private offices in a 6-month period and kept in 12% thymol solution at room temperature.

The remnant soft tissues were removed from the dental surfaces using a scalpel; then, they were cleaned by brush and low-speed handpiece and water. Afterwards, they were kept in distilled water at room temperature.

Standard class V cavities were prepared by one operator on all buccal tooth surfaces using sharp diamond flat fissure bur (Kavan 0/135/008, Iran) and high-speed rotary instrument (NSK, Japan) with water spray. The cavity dimensions were: 2 mm incisogingival length and 1.5 mm depth and 3 mm mesiodistal width. In all cavities, 1 mm of the cavity length was above and 1 mm of it was beneath cementum-enamel junction. A new bur was used for every 10 teeth. All teeth were placed in distilled water after cavity preparation.

Later, the specimen were randomly divided into five groups, each including ten teeth. In the first group (control group), after cavity preparation, rinsing and drying, a cotton pellet was placed in the cavity to avoid complete dehydration of the tooth,^[3] then the cotton was removed and the capsulated high-viscosity conventional glass ionomer (EQUIA, Fuji IX GP extra, GC Dental Co., Tokyo, Japan) was placed in the cavities according to the manufacture's recommendations (trituration was for 10 s at 4200 cpm) using its special applicator.

In the second group, at first, cavity conditioning was carried out using 20% acrylic acid (Merck KGaA, Darmstadt, Germany) for 10 s by micro brushes and rubbing movements. Then, cavity was rinsed using water spray for 15 s and water and air spray for another 15 s. After that, a piece of cotton was placed in the cavity and gently dried for 5 s using air spray; then, the cotton was removed and the cavity was filled by glass ionomer restorative material.

In the third, fourth and fifth groups, respectively, all stages were the same as Group 2, except that 35% phosphoric acid gel (Ultra-Etch, Ultradent Products Inc., USA) for 10 s, 12% citric acid (Merck, Darmstadt, Germany) for 15 s and EDTA 17% (Merck, Darmstadt, Germany) for 60 s were used as conditioners.

After cavity filling, polishing, coating with GC Fuji varnish and storing the teeth in distilled water at room temperature for 24 h, the specimens were subjected to thermocycling procedures 500 times at a range of 5-55°C with an immersion time of 30 s. (First, 5°C ± 2°C, then, room temperature, next, 55°C ± 5°C, after that, back to room temperature and finally, 5°C ± 2°C).

After thermocycling, all of the teeth apices were sealed using sticky wax and all the teeth surfaces as well as the mesial and distal margins of the restoration up to 1 mm of the incisal and gingival margins were covered with two layers of nail polish to eliminate any unwanted dye penetration.

The specimens were soaked in 2% fuchsin dye solution for 24 h. After removing them from the solution, they were washed with water, the nail polish was removed and each tooth was cut buccolingually along the tooth's long axis direction using a diamond disc and cutting machine (Vafain industry, Tehran, Iran), Later, each one of the prepared mesial and distal sections was numbered. The amount of

microleakage was determined by three individuals separately, using a stereomicroscope with 28 times magnification. For each tooth, the highest amount of microleakage obtained was used for microleakage grading procedure.

Marginal leakage classification was based on color penetration in incisal and gingival margins of the restorations as follows:

Incisal margin (enamel):

- 0 = No dye penetration in tooth restoration interface.
- 1 = Dye penetration in tooth restoration interface which at most has spread to the dentino-enamel junction (DEJ).
- 2 = Dye penetration in tooth restoration interface which at most has passed DEJ, but has not reached the axial wall of the cavity.
- 3 = Dye penetration in tooth restoration interface which at most has reached the axial wall of the cavity.
- 4 = Lateral dye penetration in enamel that has reached the dentin.

Gingival margin (dentin):

- 0 = No dye penetration in tooth restoration interface.
- 1 = Dye penetration in tooth restoration interface which has spread to less than 1/2 of the distance to the axial wall.
- 2 = Dye penetration in tooth restoration interface which has spread to more than 1/2 of the distance to the axial wall.
- 3 = Dye penetration in tooth restoration interface that has reached the axial wall.
- 4 = Lateral dye penetration in dentin that has reached the pulp.^[6]

For statistics, all microleakage grades of the specimens were recorded in prepared forms. Then, considering the number of each specimen, the grades of each group were collected.

Two-way ANOVA, Kruskal–Wallis and Mann–Whitney tests were used to compare the mean microleakage between the five groups. The significance level was set at $P < 0.05$.

RESULTS

Table 1 shows the mean of microleakage in different groups based on incisal or gingival margins.

The two-way ANOVA revealed that there was no significant difference between the means of microleakage in incisal (enamel) and gingival (dentin) margins ($P = 0.34$). Furthermore, the Mann–Whitney test showed that there was no significant difference between the microleakage in enamel and dentin margins ($P = 0.4$). Figure 1 shows the mean of microleakage in enamel and dentin margins.

The two-way ANOVA also showed a significant difference between the means of microleakage in different groups ($P = 0.03$), which means the type of the conditioner affects the amount of microleakage. Furthermore, the Kruskal–Wallis test confirmed these results and showed that the amount of microleakage was not equal in all five groups ($P = 0.04$). Figure 2 shows the mean of microleakage in different groups based on the type of the conditioner.

The mean of microleakage in EDTA and acrylic acid groups was significantly less than citric and phosphoric acid groups ($P = 0.04$ and $P = 0.045$, respectively). The citric acid and phosphoric acid groups showed no significant difference regarding the amount of microleakage ($P = 0.33$).

The amount of microleakage was significantly higher in the control groups compared with other groups ($P = 0.045$).

Table 1: Mean microleakage in different groups based on incisal and gingival margins

Location	Group	Microleakage	
		Mean	Standard deviation
Incisal margin (enamel)	Control	3.1	1.4
	Acrylic acid	2.1	1.6
	Phosphoric acid	2.5	1.4
	Citric acid	2.3	1.6
	EDTA	1.3	1.6
	Total	2.5	1.4
Gingival margin (dentine)	Control	2.9	1.6
	Acrylic acid	2	1.3
	Phosphoric acid	2.9	1
	Citric acid	2.7	1.5
	EDTA	2.2	1.4
	Total	2.3	1.6
Both incisal and gingival margin	Control	3	1.5
	Acrylic acid	2.1	1.4
	Phosphoric acid	2.7	1.2
	Citric acid	2.5	1.5
	EDTA	1.75	1.5

EDTA: Ethylenediaminetetraacetic acid

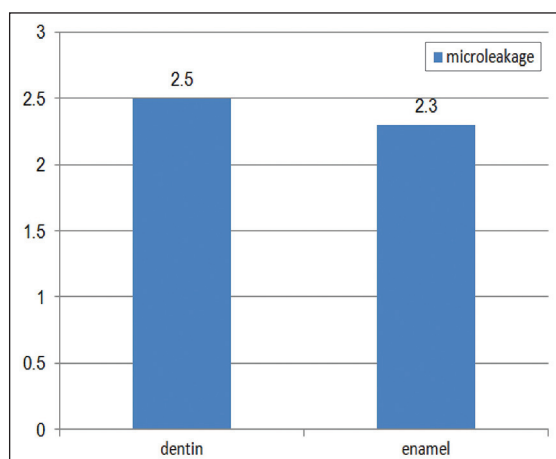


Figure 1: Mean microleakage in enamel and dentinal margins.

DISCUSSION

Mechanico-chemical bond to both enamel and dentin is an important feature of the glass ionomer cements. The hydrophilic free carboxyl groups within the cement bond to the dentin and increase the surface wetness in order to make hydrogenic bonds between the two surfaces. Ion exchange occurs between the two surfaces and calcium ions exchange with phosphate ions.^[2] A close contact between the dental structure and glass ionomer is required for an effective adhesion. Some researchers have reported that conditioning of the dental surfaces increases the glass ionomer's bond strength and leads to better adhesion to dental hard tissue.^[3,4]

Different materials such as 5% and 12% citric acid, 10%, 20% and 25% acrylic acid, 17% EDTA, and 35% phosphoric acid have been used to condition dental surfaces.^[5-10] Many researches have shown a decrease in the amount of microleakage and an increase in the bond strength of the glass ionomer to dental surfaces using different conditioners.^[3,5,10-14] Some researchers believe that the acidic nature of glass ionomer causes partial dissolution of the smear layer; so, there is no benefit in applying conditioners. The residual dentin's thickness can be the cause of the conflicting results reported in different studies.^[12,15,16]

This study showed that using conditioners results in significantly lower microleakage compared to the control group (no conditioner) ($P < 0.05$). This could be due to the elimination of debris, removal of smear layer, enamel rod exposure, partial demineralization and formation of microprossities in the enamel and dentinal surfaces, which results in an increased surface for chemical and microchemical bonding.^[3,5]

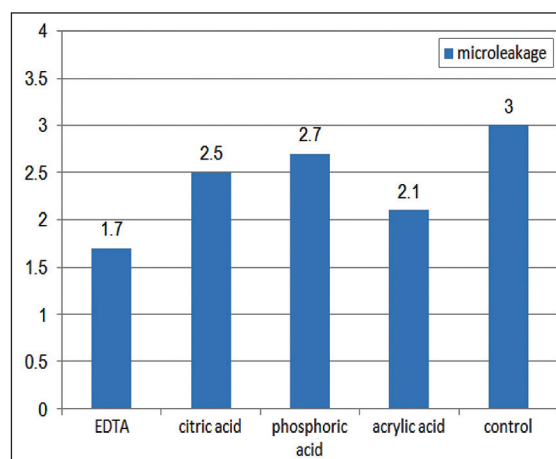


Figure 2: Mean microleakage in different groups (based on the type of conditioner).

Birkenfeld and Schulman^[17] have reported that etching the enamel before conventional glass ionomer application leads to formation of an undetectable morphologic unit with enamel and decreases the microleakage. Glasspoole *et al.*^[5] showed that using 10% polyacrylic acid for 20 s or 35% phosphoric acid for 15 s on enamel surface results in higher bond strength in Fuji II conventional GI. Scanning electron microscopic (SEM) studies by Castro and Feigal^[10] and Yilmaz *et al.*^[3] showed a decreased microleakage and a close contact at the enamel/restoration interface following the application of different conditioners in cavities filled by Fuji IX glass ionomer.

In this study, there was a statistically significant difference between microleakages using different conditioners ($P < 0.05$) and the least amount of microleakage was reported for 20% acrylic acid and 17% EDTA. Many studies have mentioned acrylic acid as an excellent conditioner for increasing the bond strength between dentin and glass ionomer.^[5,11,12,18] In his research, Powis *et al.*^[19] suggested acrylic acid as the most effective conditioner. This acid has little effect on dental tissues and removes the smear layer and surface contamination without opening the dentinal tubules more than needed.^[3] GC-conditioner is also available and recommended by the manufacturer, but it is not included in the package.

In an SEM study, Tanumiharja *et al.*^[12] reported that there was no smear layer in dentinal tubules and Fuji IX cement matrix had penetrated into the demineralized dentin following the use of 20% acrylic acid, which was in accordance with the present study. Although having neutral pH, EDTA can dissolve the mineral phase of the dentin without affecting the

dentinal proteins. It has been claimed that EDTA causes slight amounts of demineralization which facilitates penetration to dentin and adhesion to residual minerals without opening the dentinal tubules excessively.^[20,21] Studies that have shown an increase in the glass ionomer bond to the tooth tissue following the use of EDTA are in line with this study.^[4,20]

In this study, the mean of microleakage was significantly higher in the 12% citric acid and 35% phosphoric acid groups compared with the acrylic acid and EDTA groups. In addition to removing smear layer, phosphoric acid also removes a large amount of minerals, which results in a decreased level of surface calcium and phosphorus for adhesion purposes.^[4] Phosphoric acid also results in a vast opening of the dentinal tubules. This feature can be significant, while using resin modified glass ionomers where penetration of hydroxyethylmethacrylate monomer tags into dentinal tubules and collagen network is of a great value for increasing the bond strength.^[4,5,12,20] This is not, however, an advantage whilst using conventional glass ionomer.

Conventional glass ionomers bond to enamel, even with the presence of a smear layer, but surface conditioners have been found to improve the bond strength.^[5,13] In this study, there was not a significant difference between the mean microleakage in enamel or dentinal margins, which could be due to similar mineral composition.^[5]

CONCLUSION

Within the limitations of this study 20% acrylic acid and 17% EDTA are suggested to be used for cavity conditioning, which can result in better chemical and micromechanical adhesion.

REFERENCES

1. Dean RE, Avery DR, Mc Donald RE. Dentistry for the Child and Adolescent. 9th ed. St. Louis: Mosby Co.; 2011. p. 296-312.
2. Casamassimo PS, Fields HW, Mctigue DJ, Nowak AJ. Pediatric Dentistry Infancy through Adolescence. 5th ed. Philadelphia: Elsevier Saunders; 2013. p. 294-300.
3. Yilmaz Y, Gurbuz T, Kocogullari ME. The influence of various conditioner agents on the interdiffusion zone and microleakage of a glass ionomer cement with a high viscosity in primary teeth. Oper Dent 2005;30:105-12.
4. El-Askary FS, Nassif MS. The effect of the pre-conditioning step on the shear bond strength of nano-filled resin-modified glass-ionomer to dentin. Eur J Dent 2011;5:150-6.

5. Glasspoole EA, Erickson RL, Davidson CL. Effect of surface treatments on the bond strength of glass ionomers to enamel. Dent Mater 2002;18:454-62.
6. Duarte S Jr, Saad JR. Marginal adaptation of Class 2 adhesive restorations. Quintessence Int 2008;39:413-9.
7. Gordan VV. Effect of conditioning times on resin-modified glass-ionomer bonding. Am J Dent 2000;13:13-6.
8. Shafiei F, Mortazavi M, Masoum T. Effect of self-etching primers on the micro leakage of a resin-modified glass ionomer in saliva contaminated conditions: An *in vitro* study. J Dent Sch 2004;23:591-8.
9. Liberman R, Eli I, Imber S, Shlezinger I. Glass ionomer cement restorations: The effects of lasing the cavity walls on marginal microleakage. Clin Prev Dent 1990;12:5-8.
10. Castro A, Feigal RE. Microleakage of a new improved glass ionomer restorative material in primary and permanent teeth. Pediatr Dent 2002;24:23-8.
11. Di Nicoló R, Shintome LK, Myaki SI, Nagayassu MP. Bond strength of resin modified glass ionomer cement to primary dentin after cutting with different bur types and dentin conditioning. J Appl Oral Sci 2007; 15:459-64.
12. Tanumiharja M, Burrow MF, Tyas MJ. Microtensile bond strengths of glass ionomer (polyalkenoate) cements to dentine using four conditioners. J Dent 2000;28:361-6.
13. Hotz P, McLean JW, Sced I, Wilson AD. The bonding of glass ionomer cements to metal and tooth substrates. Br Dent J 1977;142:41-7.
14. Cortes O, Garcia-Godoy F, Boj JR. Bond strength of resin-reinforced glass ionomer cements after enamel etching. Am J Dent 1993;6:299-301.
15. Hewlett ER, Caputo AA, Wrobel DC. Glass ionomer bond strength and treatment of dentin with polyacrylic acid. J Prosthet Dent 1991;66:767-72.
16. Aboush YE, Jenkins CB. The effect of poly (acrylic acid) cleanser on the adhesion of a glass polyalkenoate cement to enamel and dentine. J Dent 1987;15:147-52.
17. Birkenfeld LH, Schulman A. Enhanced retention of glass-ionomer sealant by enamel etching: A microleakage and scanning electron microscopic study. Quintessence Int 1999;30:712-8.
18. Mount GJ. Buonocore Memorial Lecture. Glass-ionomer cements: Past, present and future. Oper Dent 1994;19:82-90.
19. Powis DR, Follerås T, Merson SA, Wilson AD. Improved adhesion of a glass ionomer cement to dentin and enamel. J Dent Res 1982;61:1416-22.
20. Fagundes TC, Toledano M, Navarro MF, Osorio R. Resistance to degradation of resin-modified glass-ionomer cements dentine bonds. J Dent 2009;37:342-7.
21. Osorio R, Erhardt MC, Pimenta LA, Osorio E, Toledano M. EDTA treatment improves resin-dentin bonds' resistance to degradation. J Dent Res 2005;84:736-40.

How to cite this article: Mazaheri R, Pischevar L, Shichani AV, Geravandi S. Effect of different cavity conditioners on microleakage of glass ionomer cement with a high viscosity in primary teeth. Dent Res J 2015;12:337-41.

Source of Support: Nil. **Conflicts of Interest:** The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.