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Microleakage in Class V Cavities Restored with Sandwich Technique: Self-Etch versus Total-Etch Bonding Systems

[1]Narges Panahandeh [*2]Mahsa Sheikholeslamian [3]Hossein Farzaneh

[1]Assistant Professor, Dept. of Operative Dentistry, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[*2]Assistant Professor, Dept. of Operative Dentistry, School of Dentistry, Alborz University of Medical Sciences, Alborz, Iran. E-mail: mahsa.sheikh@gmail.com
[3]General Practitioner.

Abstract

Objective: Microleakage has always been a problem in restorative dentistry. To decrease microleakage, modern bonding systems, different application methods and sandwich technique have been recommended. The purpose of this study was to assess the microleakage in class V cavities restored with open sandwich technique using self-etch and total-etch bonding systems.
Methods: In this *in vitro* study, class V cavities were prepared on the buccal and lingual surfaces of 20 extracted sound human third molars and restored with sandwich technique. Fuji II LC glass ionomer (GI) was applied to the cavity floor. After curing, half the cavities received Single Bond and the other half, Clearfil SE Bond application and were all restored with Z250 composite resin. Specimens were immersed in 2% fuchsin solution for 24 hours. After copious water irrigation, specimens were sectioned and evaluated under a stereomicroscope to determine microleakage. Data were analyzed using the Mann-Whitney U test ($p<0.05$).
Results: The microleakage at the GI-composite interface was less than that at the occlusal and gingival margins; but this difference was not significant. No significant difference was found in microleakage between the two bonding agents in neither of the two layers.
Conclusion: The etch & rinse and self-etch systems are similar in terms of microleakage.
Key words: Bonding, Glass ionomer, Microleakage, Sandwich technique, Self-etch system, Total etch system.
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Introduction:

Patient demand for esthetic restorations has greatly increased. Advances in dental adhesive agents enable the clinicians to perform esthetic tooth restorations more conservatively and in a cost effective manner (1). Composite resins have numerous advantages including favorable esthetics and color match with tooth structure, preservation of tooth structure due to conservative, minimal preparation, bond to tooth structure, low thermal conduction and elimination of galvanic currents. However, they also suffer drawbacks such as technical sensitivity, secondary caries, higher wear compared to amalgam, and microleakage due to polymerization shrinkage (2). Microleakage is inevitable in composite restorations (3) and no dental restoration can provide an ideal seal. Microleakage is defined as clinically undetectable passage of bacteria and their products, fluids, molecules and ions through the cavity wall-restoration interface. Assessment of microleakage is a major criterion for evaluation of the success of restorations in the oral cavity. To decrease polymerization shrinkage and subsequent microleakage, methods such as incremental application, enamel bevel, slow polymerization and application of GI along with composite (sandwich technique) have been recommended. Based on previous clinical studies, sandwich technique provides higher retention and resistance and less post-operative tooth hypersensitivity compared to composite or GI alone (4). Sandwich technique benefits from the chemical bond of GI to tooth structure, its water sorption and subsequently decreased gap at the margins, pulp protection and anti-caries properties of GI, less dimensional changes due to low thermal conductivity of GI, less volume of composite required and subsequently decreased shrinkage stresses. Lower physical properties, lower esthetics, and higher solubility of GI compared to composite resins are among the shortcomings of this technique. Sandwich technique is performed in two forms of open and closed. Closed sandwich technique can effectively decrease microleakage; but, limited access may complicate or comprise proper application of GI. A good alternative is the open sandwich technique. Etch & rinse systems have been commonly used in open sandwich technique but are being replaced with the recent self-etch systems due to the ease of use and less procedural steps of application of self-etch systems, less post-operative tooth hyper-sensitivity, less technical sensitivity, and simultaneous enamel and dentin etching and priming without the need for rinsing (5). The rinsing step has been eliminated in self-etch bonding systems and thus, HEMA and methacrylate groups remain at the site enhancing the GI-composite bond. Whereas, in the total-etch systems, these materials are washed off from the site by rinsing. On the other hand, due to higher acidity of phosphoric acid compared to self-etch acidic primer, greater amounts of HEMA are separated from the GI surface attributing to the weaker bond of total etch compared to self-etch systems (6, 7).

Sjödin, *et al.* in 1995 evaluated the microleakage of Class II and Class V composite restorations with sandwich technique. The highest degree of microleakage was observed at the dentinal margins. Light-cure GI caused less microleakage than self-cure GI. Application of GI liner to the gingival floor of Class II cavities caused no reduction in microleakage due to the separation of GI from the cavity floor secondary to the polymerization shrinkage of composite (8). This study aimed to assess the efficacy of two different bonding systems for prevention of microleakage in class V cavities restored using the open sandwich technique.

Methods:

This experimental study was conducted on 20 permanent molar teeth with no caries or cracks and fully developed (mature) roots extracted within two months prior to the study. The teeth were immersed in 1% Chloramine T solution for 24 hours and then stored in distilled water at room temperature until the experiment. Two Class V cavities measuring 4mm mesiodistally, with 2mm axial depth and 3mm occlusogingival height were prepared in the buccal and lingual surfaces of teeth in such way that the occlusal margins were in the enamel and the gingival margin 1mm below the cementoenamel junction using a diamond fissure bur (diameter= 0.8 mm) and high-speed hand piece along with water spray. The bur was changed after preparation of five teeth. The 40 cavities created were randomly divided into two groups of 20. Using the open sandwich technique, the cavities were restored as follows: First, Fuji II LC glass ionomer (GC America, Alsip III) was prepared according to the manufacturer’s instructions to the gingival floor of the cavity in one layer filling half the cavity depth (1.5 mm) and cured for 20 seconds using a QTH light-curing unit (Art-12 Bonart, Taiwan) with a light intensity of 800 mW/cm2.

In the next step, specimens were divided into two groups of 20. In group 1, Clearfil SE Bond (Kuraray, Osaka, Japan) was used. Primer was applied to the entire cavity surfaces and the GI surface using a micro brush in an agitating fashion for 15 seconds. Then, air spray was used for 5 seconds in order for the primer solvent to evaporate. Bonding was then applied using another micro brush. Low-pressure air spray was used to uniform the bonding layer. Curing was done for 20 seconds.

In group 2, cavity walls and the GI surface were acid-etched with 37% phosphoric acid (Denfil, Vericom, Anyang, Korea) for 15 seconds and rinsed for 5 seconds. Low pressure air spray was used to eliminate excess water on the cavity walls and the GI surface. Single Bond (3M ESPE, St. Paul, MN, USA) was applied to the GI and cavity walls using a micro brush. To uniform the bonding layer, low pressure air spray was used for 5 seconds, curing was done for 20 seconds, and all cavities were then restored with A1 shade of Filtek Z250 composite (3M-ESPE, St. Paul, MN, USA) applied in one layer with 1.5 mm thickness and cured for 40 seconds. All cavities were restored with the same manner. Finishing was done with a knife-edge polishing bur followed by Sof-Lex discs. The specimens were immersed in distilled water at 37°C for 24 hours. In the next step, all teeth surfaces were covered with three layers of nail varnish (except for the restoration and one millimeter margin around it). The specimens were immersed again in distilled water for 24 hours and then restored in 2% fuchsin solution at room temperature for 24 hours. Next, they were rinsed under running water for 10 minutes.

Before sectioning, the specimens were fixed to the cutting machine at their respective location using sticky wax. The specimens were cut by an automatic milling machine (GH, England) at low speed (using diamond saw) along with water spray. A section was made in a buccolingual direction in such way that it passed the middle of the restoration on the buccal and lingual surfaces. The penetration depth of fuchsin into the sectioned surfaces was determined using a stereomicroscope (SZ61, Olympus Corporation, Japan) at 40X magnification. Dye penetration depth for each specimen was recorded as a qualitative variable and scored as follows (6, 9, 10):

0: No fuchsin penetration

1: Fuchsin penetrating to less than ½ of the cavity depth in the gingival floor

2: Fuchsin penetrating to more than ½ of the cavity depth in the gingival floor but not reaching the axial wall.

3: Fuchsin reaching the axial-gingival line angle but not penetrating into the axial wall.

4: Fuchsin penetrating into the axial wall.

SPSS was used for data analysis and the Mann Whitney U test was applied to compare microleakage at p=0.05 level of significance (11).

Results:

The results of Mann Whitney U test demonstrated that microleakage was less in self-etch compared to etch & rinse group; but this difference was not significant (p=0.126).

Table 1- The frequency of microleakage in study groups

Bonding			Rank					Total
			0.00	1.00	2.00	3.00	4.00	
Self-etch	Occlusal	Count	15	5	0	0	0	20
		Within area%	75.0%	25.0%	0.0%	0%	0%	100.0%
	Interface	Count	11	6	2	0	1	20
		Within area%	55.0%	30.0%	10.0%	0%	50.0%	100.0%
	Gingival	Count	2	5	2	2	7	20
		Within area%	20.0%	25.0%	10%	10%	35.0%	100.0%
Etch & resin	Occlusal	Count	13	7	0	0	0	20
		Within area%	65.0%	35.0%	0.0%	0%	0%	100.0%
	Interface	Count	11	3	1	0	5	20
		Within area%	55.0%	15.0%	5.0%	0%	25.0%	100.0%
	Gingival	Count	5	1	4	2	8	20
		Within area%	25.0%	5%	20.0%	10%	40%	100.0%

The mean microleakage at the GI-composite interface was lower than that in the occlusal and gingival margins of the restoration; but this difference was not significant either (p=0.678) (Table 1).

Discussion:

Several methods, such as the use of sandwich technique, have been recommended to overcome polymerization stress and prevent its consequences. GI cements can be used as an intermediate layer prior to the application of composite due to their favorable properties. When the GI cement is used as base or liner, its bond to the restorative material, particularly composite, affects the retention, durability and seal of the restoration (11). Less volume of composite in the sandwich technique can decrease shrinkage stresses (12). Superior performance of resin modified GI cements is due to their favorable setting steps resulting in a bond to dentin. Such immediate bond can resist the polymerization shrinkage of composite and subsequently decrease gap formation and microleakage (13).

Increased demand for esthetic, tooth-colored restorations has triggered attempts to find appropriate bonding agents. By the introduction of total etch adhesives, separate etching of enamel and dentin was skipped and the procedure was simplified. However, issues regarding under- or over-etching, under- or over rinsing and drying and their effect on bond strength still exist (10, 14).

Self-etch bonding agents have the advantage of causing less post-operative tooth hypersensitivity, which is due to the incomplete etching of dentinal tubules and subsequently less movement of dentinal fluids. This is due to the weaker acidity of these materials compared to two-step classic bonding agents benefiting from etching with phosphoric acid or other strong acids for etching of dentin surface. Moreover, simultaneous penetration of bonding agent and acid minimizes the risk of residual demineralized dentin not supported by resin. Moreover, due to the mild etching, it is expected that a higher content of mineral ions participate in the hybrid layer, which per se results in higher bond strength (2, 15).

The results of this study are in accord with the findings of many previous studies. Shadman, *et al.* in 2010 (6) and Deliperi, *et al.* in 2003 found no significant difference in microleakage between two-step self-etch (Clearfil SE Bond, Kuraray, Osaka, Japan) and etch & rinse (Prime & Bond, Dentsply, De Trey NT) systems. They attributed the adequate bonding of Clearfil SE Bond to 10MDP resin monomer used in the formulation of this bonding (16). Moosavi, *et al*. in 2010 found no significant difference in microleakage between the total etch and self-etch systems. Although the microleakage of self-etch was slightly lower than that of total etch (17).

Maleknejad, *et al.* in 2007 stated that the relative superiority of self-etch adhesives in terms of microleakage compared to total etch is attributed to the fact that in self-etch adhesives, a large number of pores (caused by demineralization) are filled with resin that later becomes polymerized (7).

Ghavamnasiri, *et al.* in 2008 evaluated the effect of GI application on microleakage of Class II cavities restored with sandwich technique and found no significant difference in microleakage between the open and closed sandwich techniques with light cure GI; although the mean microleakage was lower in closed technique (9). This finding is in accord with the results of Aboushala in 1995 (18) and Stockton in 2007 (19). However, limited access to posterior teeth may complicate the application of GI. Thus, open sandwich technique was used as an alternative in this study. Failure of restorations is mainly due to the continuous loss of GI due to its high solubility and low strength. But, some studies have confirmed the durability of open sandwich technique with resin modified GI (9). No restorative technique can yield microleakage-free restorations. Insignificant microleakage in the occlusal margin of restorations in both self-etch and total-etch groups in this study may be attributed to the enamel substrate at the area. Due to high mineral content and uniformityof its structural formulation, enamelis an acceptable and reliablesubstrate for micromechanical bond to composite. However, the current study demonstrated that the microleakage at the GI-composite interface was less than that at the occlusal (enamel) wall; although this difference was not significant. This can be attributed to the optimal bond of resin modified GI to composite. Such increased bond can be due to the unpolymerized HEMA on the surface of resin modified GI, accessibility of unreacted methacrylate groups to form a strong covalence chemical bond between composite and resin modified GI and presence of air inhibited layer on the surface of polymerized resin modified GI to increase unsaturated carbon double bonds. Microleakage at the composite-GI interface was not significantly different in the two bonding groups. One explanation is that rinsing in total etch systems has no effect on microleakage. Overall, the highest degree of microleakage was seen at the gingival wall. In the current study, no conditioner was used prior to the application of GI. Microleakage at the gingival wall may be attributed to the adequate bond between the GI and composite resulting in separation of GI from the tooth structure. However, most studies do not confirm 100% seal for GI bond to tooth even in absence of composite. At the gingival area of these restorations, dentin, the most challenging substrate for bonding, is present and this fact should be taken into account when interpreting the microleakage results at the gingival margin. Some researchers have used conditioners prior to the application of GI. Based on their findings, marginal gap was not observed in cavities restored with open sandwich technique but cohesive fracture of GI occurred in close proximity to dentin. Authors explained that dentin surface conditioning prior to GI application strengthens the bond to dentin to the level that it can result in cohesive failure in the GI (18, 20, 21).

Conclusion:

No statistically significant difference existed in terms of microleakage between etch & rinse and self-etch bonding systems in sandwich technique. Thus, due to the technical sensitivity of etch & rinse technique, self-etch adhesive is recommended as a suitable alternative for this purpose.

Conflict of Interest: “None Declared”

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