Microleakage of Composite Resin Restorations Using a Type of Fifth and Two Types of Seventh Generations of Adhesive Systems: A Comparative Study

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Abstract

Introduction: In recent dentin adhesive systems etching of enamel/dentin are achieved simultaneously. The objective was to evaluate the microleakage of composite restorations using Single Bond2 (5th generation), Clearfil S3 Bond and G Bond (7th generation). **Methods:** Class V cavities were prepared on 45 extracted intact premolars with gingival margins at the cementoenamel junction and they were randomly divided into 3 groups (n=15) based on the type of adhesives: Single Bond2 (5th generation), Clearfil S3 Bond and G Bond (7th generation). After applying the adhesives, the cavities were filled with Z250 composite resin. The occlusal and gingival microleakage was evaluated using 2% basic fuchsin staining technique. Data were analyzed using Kruskal-Wallis and Bonferroni corrected Mann-Whitney U tests. **Results:** The mean rank of occlusal microleakage exhibited significant differences by comparison of G Bond, Clearfil S3 Bond and Single Bond2 (21.07, 30.67) and 17.27, respectively) (P=0.005). There was a significant difference in gingival microleakage of different bonding agents (34.40, 17.83 and 16.77 for G Bond, Clearfil S3 Bond and Single Bond2, respectively) (P<0.001). There was a significant difference in occlusal microleakage of Clearfil S3 Bond and Single Bond2 (P= 0.003), but no significant difference was found between Clearfil S3 Bond and G Bond (P=0.025). No significant difference was observed between occlusal microleakage by G Bond and Single Bond2 (P=0.238). The difference in gingival microleakage was significant by G Bond compare with Single Bond2 and Clearfil S3 Bond (P<0.001and P<0.001, respectively). **Conclusion:** The microleakage of class V composite restorations in permanent teeth using the Single Bond2 was lower than that with the use of G Bond in gingival margins. The sealing ability with Single Bond2 was superior to Clearfil S3 Bond in occlusal margin but they were equally effective at gingival margin.

Key words: Bonding agent, Composite resin, Dentin, Enamel, Microleakage.

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Introduction

Nowadays, the popularity and interest in aesthetic composite resin restorations has increased, but there are some considerations about application of these dental materials (1).

The most important defect of dental composite resins is the polymerization shrinkage that creates microscopic gaps between the material and the cavity walls, particularly adjacent to dentin (2). Penetration of bacteria and oral fluids through the gaps is termed microleakage. It is known that persistence of this phenomenon may cause recurrent caries, tooth hypersensitivity, marginal discoloration of restorations and inflammatory reactions of the pulp, necessitating further treatment and even root canal therapy (3,4,5). Thus, the success rate of composite resin restorations is dependent upon adhesion to dental hard tissues to maintain the filling material within the cavity and prevent microleakage (3).

Unlike enamel which has clinically stable and established bond, adhesion to dentin is hardly achieved (6). The bond strength of dentin adhesives in laboratory has been improved so that the bond strength to dentin may be obtained comparable to that with enamel (1).

Currently, the manufacturers of adhesive systems are trying to simplify the application process. In the latest generation of adhesive systems, the conditioner, primer and adhesive resin are simultaneously applied and no mixing is required (7).

The amount of microleakage with the use of different adhesive systems is controversial. The superiority of the fifth generation of dentin bonding agents compared with the seventh generation has been shown in the most studies, but some investigations have found no significant difference or even have reported the superiority of Clearfil S3 Bond as a dentin bonding of the seventh generation (8–10). Vinay et al. found less microleakage value by Clearfil S3 Bond compared with Single Bond and G Bond (11). However, Tabari et al. found no significant difference between mean values of microleakages by Clearfil S3 Bond, Single Bond and G Bond in primary teeth (12). In addition, Kasraei et al. observed no significant difference between microleakage values of Cl-II cavities filled by packable composite with adhesives of Clearfil S3 Bond and Single Bond (13).

The present study was conducted to evaluate the microleakage of composite resin restorations using two bonding agents of the seventh generation compared with a bonding agent of the fifth generation on permanent teeth. The null hypothesis was: Microleakage values of composite resin restorations at occlusal and gingival margins using the Clearfil S3 Bond and G Bond were significantly lower than that with the use of Single Bond2.

Materials and Methods

A total of 45 human premolars of the individuals aged 15–25 which were extracted within three months for orthodontic reasons, were used in this in-vitro study. The study protocol was approved by Ethics Committee of Babol University of Medical Sciences.

Adhesive agents of Clearfil S3 Bond (Kuraray, Japan), G Bond (GC, Japan) and Single Bond 2 (3M, USA) and Z250 composite resin (3M, USA) were applied for filling the cavities and the clear self-cured acrylic resin for mounting the teeth.

In order to disinfect the specimens, they were immersed in 1% chloramine T solution for 24 hours at room temperature (14). Then standard class V cavities were prepared on the buccal surfaces with occlusal margins on the enamel and gingival margins on the cementum. Cavity preparation was carried out using a high-speed handpiece with #008 fissure diamond burr (Teezkavan, Iran) under a continuous air and water spray. Considering the length of fissure head of burr (3mm), cavities were prepared with the following dimensions: 2 mm of occlusogingival height, 3 mm of mesiodistal width and 1.5 mm of axial depth. A new burr was used for each 6 cavities. After washing and refining, the cavity dimensions were checked out by a probe and teeth with correct cavity preparation were divided into three groups (n=t15) based on the type of the bonding agent.

The adhesive agents were applied as follows: G Bond was left undisturbed on the dried cavity for 5–10 seconds, after that gentle air flow was used from an air syringe and light-curing was performed for 10 seconds. Clearfil S3 Bond was placed on the cavity surface for 20 seconds and then exposed to a gentle air flow for 5 seconds, followed by light-curing for 10 seconds.

For using the Single Bond 2, enamel and dentin walls were etched using 37% phosphoric acid gel for 20 and 15 seconds respectively, the gel was rinsed for 10 seconds and the cavities were gently air dried. Then, the mentioned bonding agent was placed on the prepared tooth surface for 5 seconds and exposed to air flow and finally light-cured for 10 seconds.

Then, Z250 composite resin was used to fill the cavities in two layers each with 1 mm thickness. The Astralis 7 light-curing unit (Ivoclar Vivadent, Leichtenstein) was applied to polymerize the resin composite, layer by layer each for 40 seconds at a light intensity of 400 mW/cm2 as determined by a radiometer (Kerr, USA).

After immersion of samples in distilled water for 24 hours, they were subjected to 500 thermal cycles in water bath at 5±2–55±2oC (NEMO Thermocycling machine, Iran) (15). All the apices were then sealed with sticky wax and the tooth surfaces were painted by two layers of nail polish leaving 1 mm around the restoration. The specimens were then suspended in 2% basic fuchsin for 24 hours at room temperature (16).

Subsequently, the samples were washed in running water, dried with absorbent pad and were mounted in self-curing acrylic resin. The specimens were then sectioned longitudinally using the diamond disc (Thickness of the blade=0.12mm, D&Z, Germany) into two mesial and distal slices.

The greatest degree of dye penetration was recorded for occlusal and gingival margins of each section on a non-parametric scale from 0 to 3 based on the ordinal ranking system (10) described in Table 1.

All the samples were observed under a stereomicroscope (Motic Micro-optic, Industrial Group Co. LTD, Japan) at a magnification of ×20 to measure dye penetration.

Degree of penetration was scored to convert the ranking data to quantitative data. Data were analyzed using SPSS version 21. Statistical analysis was carried out by Kruskal-Wallis test at the significance level of $P<0.05$ and Mann-Whitney U tests with Bonferroni correction (corrected α-value=0.017).

Results

The mean rank of occlusal microleakages exhibited significant differences by comparison of G Bond, Clearfil S3 Bond and Single Bond2 (21.07, 30.67 and 17.27, respectively) (P=0.005). In addition, there was a significant difference between the mean ranks of gingival microleakages of bonding agents (34.40, 17.83 and 16.77 for G Bond, Clearfil S3 Bond and Single Bond2, respectively) (P<0.001). There was a significant difference in occlusal microleakages of Clearfil S3 Bond compare with Single Bond2 (P= 0.003), but no significant difference was found between Clearfil S3 Bond compare with G Bond (P=0.025). Also, no significant difference was observed between occlusal microleakage by G Bond and Single Bond2 (P=0.238). The difference in gingival microleakages was significant by G Bond compare with Single Bond2 and Clearfil S3 Bond (P<0.001 and P<0.001, respectively). No significant difference was found between gingival microleakage by Clearfil S3 Bond and Single Bond2 (P=0.654). Table2 illustrated the frequency and mean ranks of occlusal and gingival microleakage based on type of adhesives.

Table1: Microleakage values based on dye penetration method (10)

Score	Description
0	No leakage
1	Up to half of the occlusal and gingival walls
2	Into the dentinal walls, not extended to the axial wall
3	Into the axial wall

Table2: Frequency of occlusal and gingival microleakage scores based on type of bonding agents
*Level of significance at P<0.05

Type of Bonding	Occlusal					Gingival				
	Score 0	Score 1	Score 2	Score 3	Mean rank	Score0	Score1	Score 2	Score 3	Mean rank
Single Bond2	13	1	0	1	17.27	3	1	0	1	16.77
Clearfil S3 Bond	4	6	4	1	30.67	12	2	0	1	17.83
G Bond	10	4	0	1	21.07	2	2	1	10	34.40
P-value	*0.005					*0.000				

Discussion

Concerning the risk of saliva contamination during the filling of cavities with composite resins, good clinical results may be achieved using the newer generations of bonding agents with short operational steps. Previously, the total-etch adhesive systems (eg. fifth generation) have been shown to be superior to self-etch systems (eg. seventh generation) because of stronger etching pattern. Also, self-etch adhesives are susceptible to separation of components resulting in the hydrolytic degeneration of adhesion layer (17). Unlike, several studies demonstrated no significant difference between the microleakage values with some adhesives of fifth, sixth and seventh generations of bonding agents (11,12,13). To further study of this incoherence, Single Bond 2, G Bond and Clearfil S3 Bond which are commonly used in composite restorations were selected for the current research.

To simulate the temperature dynamics of oral cavity, thermocycling was used with 500 thermal cycles in the present assay. Since, no significant difference was found between the bond strength of composite resin and microleakage value with 500, 1000, 2000 and 4000 cycles, thermocycling with 500 cycles that was commonly used in previous studies was selected (18, 19).

There are several different methods to assess the microleakage of composite restorations. Dye penetration method is the conventional method which was performed by various dyes including methylene blue, basic fuchsin and silver nitrate etc, (20) of which 0.2% basic fuchsin was used in the current research because it is considered as an easy, relatively inexpensive and comparable method.

As mentioned in results, the superiority of Single Bond 2 (fifth generation) was shown over two bonding agents of seventh generation; G Bond at the gingival margins and Clearfil S3 Bond just at the occlusal margin.

Single Bond 2, which contains nanoparticles of silica, penetrates better into collagenous web and influences the stability of the hybrid layer (21). In addition, the potential of chemical adhesion to calcium was found for Single Bond 2 because of polyacrylic acid (22, 23).

Among the seventh generation of bonding agents studied in this assay, Clearfil S3 Bond showed better results compared to G Bond at gingival margin. But they revealed no significant difference at occlusal margin. In Clearfil S3 Bond acetone is used as a primer solvent instead of alcohol. It has been demonstrated that adhesive systems containing acetone require a wet bonding technique and show less ideal hybridization. Also, this agent contains both hydrophilic and hydrophobic phases and because of molecular dispersion it results in a homogenous state at the molecular level, leading to the reduction or elimination of water droplets on the adhesive interface. On the other hand, the monomer of 10-methacryloyloxydecyl dihydrogen existed in the structure of the adhesive agent leads to decalcification and infiltration in tooth structure, producing a calcium-free chemical bond. All the characteristics mentioned above result in microleakage almost similar to that with Single Bond 2 (24-25).

In this study, the amount of microleakage at occlusal margin was less than that of gingival edge. This finding was consistent with previous studies (17). Unlike, some investigations reported a higher rate of microleakage at gingival edge compared with occlusal margins (5,26). Diversity in the composition of dentin and enamel may result in different levels of microleakage; hence lack of enamel at gingival edge results in more leakage compared to occlusal margins. A higher concentration of organic ingredients of dentin and its tubular structure may interfere with attachment process (2). Additionally, dentinal tubules arrange roughly parallel to gingival margin of class V cavity; therefore, the classical structure of hybrid layer is damaged and consequently, the microleakage at dentinal wall of gingival edge occurs more than that at enamel margin (24, 26).

It seems that the diversity in the studied adhesive systems, the type of composite resin used in different researches, the cavity type and the presence or absence of occlusal loading were considered the best explanation for this incoherence (27).

The present assay encountered with some limitations. The dye penetration method has been suspected because of very small molecules of dyes, the overestimated leakage and false positive results (28). So, another method such as bacterial leakage was recommended to verify the result of research. In addition, occlusal loading was shown to be effective in microleakage values, so, this variable is suggested to be considered in future studies.

Conclusion

The microleakage of class V composite restorations in permanent teeth using the Single Bond2 was lower than that with the use of G Bond in gingival margins. The sealing ability with Single Bond2 was superior to Clearfil S3 Bond in occlusal margin but they were equally effective at gingival margin.

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Refrences

1. Roberson TM, Heymann HO, Swift EJ. Art and Science of Operative Dentistry. 5th ed. St Louis: Mosby; 2006.p.135-279.
2. Khayat A, Lee SJ, Torabinejad M .Human saliva penetration of coronally unsealed obstructed root canals. J Endod 1993; 19: 458-481.
3. Ateyah AZ, Elhejazi AA. Shear Bond Strengths and Microleakage of four Types of Dentin Adhesive Materials. J Contemp Dent Pract 2004; (5)1: 63-73.
4. Silveira de AC, Incerti ST, orgliari FA, Mireless SS, piva E, Demarco FF. Microleakage of Seven Adhesive systems in Enamel and Dentin. J Contemp Dent Pract 2006; (7) 5: 26-33.
5. Basir L, Khaneh masjedi M , Kaviani A, Haghighizade M, Khalili E. Evaluation of microleakage of the self etch and fifth generation adhesive systems in fissure sealants among saliva contamination and non contaminated conditions .Beheshti Univ Dent J 2009; 27(3): 113-120.(Persian)
6. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surface. J Dent Res 1995; 34: 849-853.
7. Summitt JB, Robbins JW, Hiltion TJ, Schwartz RS. Fundamentals of operative Dentistry. 3th ed. USA: Quintessence publishing Co; 2006.p. 183-339.
8. Ziyad KM. Microleakage in class II composite Restorations Bonded with Different Adhesive systems. Scie 2008; Available at: http:// eprints.usm.my/9992/1/Microleakage-in-class-II-composite-Restorations-Bonded-with-Different-Adhesive -systems.
9. Stalin A, verma BR. Comparative evaluation of tensile – Bond Strength, fracture mode and microleakage of fifth and sixth generation adhesive systems in primary dentition. J Indian Soc Pedod Prev Dnt 2005; 23: 83-88.
10. Guglielmi CAB, Mohana A, Hesse D, Lenzi TL, Bonini GC, Raggio DP. Influence of ultrasound or halogen light on microleakage and hardness of enamel adjacent to glass ionomer cement. Int J Pediatr Dent 2012; 22:110-115.
11. Vinay S, Shivanna V. Comparative evaluation of microleakage of fifth, sixth, and seventh generation dentin bonding agents: An in vitro study. J Conser Dent 2010; 13(3): 136-160.
12. Tabari M, Esmaeili B, Alimihammadi M, Poorsattar Bejeh Mir A, Gharekhani S, Hajiahmadi M, Mollai M. Comparative evaluation of microleakage of composite restorations using fifth and seventh generations of adhesive systems. CJDR 2014, 3(2): 14-19.
13. Kasraei S, Azarsina M, Majidi S. In vitro comparison of microleakage of posterior resin composites with and without liner using two-step etch-and-rinse and self-etch dentin adhesive systems. Oper Dent 2011; 36(2): 213-21.
14. Pereira RA, de Araujo PA, Castaneda-Espinosa JC, Lia Mondelli RF. Comparative analysis of the shrinkage stress of composite resins. J Appl Oral Sci 2008; 16(1): 30-4.
15. Khodadadi E, Esmaeili B, Karimian N, Khafri S. Evaluation of microleakage of Ionoseal filling material as a fissure sealant agent. Caspian J Dent Res 2014; 3: 39-45.
16. Fleming GJP, Hall DP, Shortall ACC, Burke FJT. Cuspal movement and microleakage in premolar teeth restored with posterior filling materials of varying reported volumetric shrinkage values. J Dent 2005; 33(2): 139-146.
17. Ghahari A. Self-etch systems. 9th Congress of Iranian Association of Operative Dentistry. Oct 2009. Available at: http://www irden. com/amoozesh /dental/ 1345999.
18. Burger KM, Cooley RL, Garcia-Godoy F. Effect of Thermocycling Times on Dentin Bond Strength bond. J Esthetic Restorative Dent 1992; 4(6): 197-198.
19. Pazinatto FB, Campos BB, Costa LC, Atta MT. Effect of the number of thermocycles on

microleakage of resin composite restorations. Pesqui Odontol Bras 2003; 17(4): 337-341.
20. Hatibovic-Kofman S, Wright GZ, Braverman I. Microleakage of sealants after conventional, bur, and air-abrasion preparation of pits and fissures. Pediatr Dent 1998; 20(3): 173-76.
21. Brannstorm M. The hydrodynamic theory of dentin pain sensation in preparations, caries and dentinal crack syndrome. J Endodontics 1986; 12(10): 453-457.
22. Villela –Rosa ACM, Conclaves M, Orsi IA, Miami Pk. Shear bond Strength of self-etch and total-etch bonding systems at different dentin depths. Braz Oral res 2011; 25(2): 143-149.
23. Cardoso PE, Carrilho MRO, Francci CE, Perdigao J. Mircrotensile bond strengths of one bottle dentin adhesives. Am J Dent2001; 14(1): 22-24.
24. Perdigao J, Dutra – Correa M, Castilhos N, Carmo AR, Anauate- Netto C, Cordeiro HJ, et al. One – year clinical performance of self – etch adhesives in posterior restorations. Am J Dent 2007; 20: 125-133.
25. Koshiro K, Ikeda T, Inoue S, Sidhu S, Sano H. Nano interaction zone: A new concept of Resin – dentin Interface. J Dent Res 2005; 84: 522.
26. Santini A, Ivanovic V, Ibbetson R, Milia E. Influence of cavity configuration on microleakage around class V restorations bonded with seven self-etching adhesives. J Esthet Restor Dent 2004; 16: 128-136.
27. Arisu HD, Uçtasli MB, Eligüzeloglu E, Ozcan S, Omürlü H. The effect of occlusal loading on the microleakage of class V restorations. Oper Dent 2008; 33(2): 135-141.
28. Moradi S, Lomee M, Gharechahi M. Comparison of fluid filtration and bacterial leakage techniques for evaluation of microleakage in endodontics. Res J (Isfahan). 2015; 12(2): 109–114.

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