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Research Report

Microleakage difference between total-etch and self-etch bonding in bulk fill packable composite restoration after carbonic acid immersion

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ABSTRACT

Background: *Bulk fill packable composite that can be applied to a depth of 4mm in cavities is widely used in posterior teeth restoration. Unfortunately, this composite is subject to potential microleakage which occurs due to erosion resulting from the consumption of carbonated drinks containing carbonic acid. Nevertheless, microleakage can be reduced by bonding applications the etch technique of which is divided into two forms; self-etch bonding and total-etch bonding.* ***Purpose:*** *This study aims to determine the difference in microleakage between total-etch and self-etch bonding in bulk fill packable composite following carbonic acid immersion.* ***Methods:*** *This study constitutes experimental laboratory research utilizing 28 incisors bovine teeth which were cleaned, immersed in 0.01% NaCl, and randomly divided into four groups. The cervical area of the teeth of all groups were prepared through the creation of cylindrical shapes 2mm in diameter and 3 mm deep. Groups I and III used total-etch bonding, while groups II and IV used self-etch bonding. Groups III and IV were control groups, whereas groups I and II were treatment groups (immersed in carbonic acid) for 24 hours. Thermocycling was carried out in all groups which were subsequently immersed in 1% methylene blue for 24 hours after which the teeth were cut in a buccolingual direction using a diamond disc wheel. Microleakage was subsequently evaluated by calculating the amount of methylene blue passing between the restoration wall and cavity using a Stereomicroscope and scanning electron microscope (SEM). The data was then analyzed using Kruskal Wallis and Mann Whitney U tests.* ***Results:*** *There was a significant difference between the control groups and treatment groups ($p<0.05$). The microleakage in Group 2 was higher than that of other groups.* ***Conclusion:*** *The microleakage of total-etch bonding was lower than self-etch bonding in bulk fill packable composite after carbonic acid immersion.*

Keywords: *bulk fill packable composite; carbonic acid; microleakage; self-etch bonding; total-etch bonding*

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INTRODUCTION

Composite resin is considered a popular restorative material since it not only has high aesthetic value and strong physical mechanical properties, but also demonstrates long-term stability and can be employed in the treatment of almost all classifications of GV Black carious lesions.[1,2] A number of innovations in the development of composite materials have been introduced, one of which is to intended to simplify its restoration technique while maintaining its physical properties. Bulk-fill composites are ones that can be applied up to a depth of 4mm and are consequently capable of reducing processing time. Another characteristic of bulk fill composites is that they are not only effective against polymerization shrinkage, durable, and not easily fractured, but also possess sound dimensional stability.[3] Bulk fill packable composite resins not only have high viscosity which enables them to adapt quickly to dentin, but also considerable mechanical strength rendering them suitable for use in posterior teeth.[4,5] Nevertheless, it is known that microleakage in bulk fill packable composites is greater than in flowable composites which can be prevented through the administration of dentin bonding.[5]

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Microleakage is caused by dimensional changes and unfavorable adaptation to the cavity wall.[6] A bonding material is one that increases the bond strength between the composite resin and tooth structure, enhances retention of restorations, and reduces microleakage along the surface between dentin and composite resin.[7] Bonding applications can be classified into one of two etching techniques, namely; total-etch and self-etch.[8]

One required characteristic of a restoration is the ability to resist degradation which in the oral cavity is a complex phenomenon related to the disintegration and dissolution of the restorative material present there.[9] Degradation in composite resins can also take the form of material loss due to erosion.[10,11] Significantly, acidic drinks with a pH below the critical level for the demineralization of enamel (4.5-5.5) have the potential to cause erosion.[11] Carbonated drinks are one of the non-alcoholic varieties with a high acidity level. A major ingredient of carbonated drinks is carbonic acid which has a pH of 2.37 and a concentration of 56.693 mg/mL.12 Composite resins are said to be degraded due to acid exposure in artificial saliva with a low pH.[12]

Unfortunately, it is not yet certain which bonding technique demonstrates the optimum attachment to dentine. A previous study posited that total-etch bonding has more minimal microleakage than the self-etch variety.[13] In contrast, another prior investigation stated that the self-etch bonding demonstrates less microleakage than the total-etch variety.[14] Meanwhile, another study revealed that no significant difference exists in microleakage resulting from the total-etch dentin bonding or its self-etch counterpart.[15] Hence, this study aims to determine the difference in microleakage between total-etch and self-etch bonding in bulk fill packable composite after carbonic acid immersion.

MATERIALS AND METHODS

This study constitutes an in vitro laboratory experimental research with post-only control group design which was granted ethical eligibility by the Ethics Commission of the Faculty of Dental Medicine, Universitas Airlangga (No. 368/HRECC.FODM/VI/2019). Certain stages were conducted in the course of this study. First, 28 samples of caries- and fracture-free bovine teeth (mandibular incisors) were removed intact from the jaw.[16] They were subsequently cleaned and soaked in solution before being randomly divided into four groups, each of which contained seven samples. All the samples were then prepared using low speed round and cylindrical diamond burs (NSK, USA) cylindrical in shape, 3 mm in diameter and 2 mm deep which were applied to the cervical area of the teeth. Cavity depth was examined by means of a straight probe.[17]

In the fifth step, the members of Group I and Group III were treated with total-etch bonding technique (Ivoclar Vivadent, N-Etch® Schaan, Liechtensein, Germany) and separate bonding. Meanwhile, Group II and Group IV were treated with a self-etch bonding technique using universal bonding materials (Ivoclar Vivadent, Tetric® N-Bond Universal, Schaan, Liechtensein, Germany). All groups were restored using bulk fill packable composite (Ivoclar Vivadent, Tetric® N-Ceram Bulk Fill, Schaan, Liechtensein, Germany) and irradiated for 20 seconds by means of a curing unit (Woodpecker® Light Curing LED.C Wireless, USA). The samples were then prepared for thermocycling and carbonic acid immersion.

Thermocycling was carried out in all sample groups for 120 cycles at 5° and 55° C. The samples were covered apically with dental wax to prevent further penetration. The coronal part was then coated twice with nail polish in an area up to 1 mm around the restoration. Group I and Group II were subsequently immersed in carbonic acid with a pH of 2.33 or a concentration of 56.693 mg/mL for 24 hours while the Control Groups, Group III and Group IV were immersed in distilled water for 24 hours. All sample groups were dried with tissue paper before immersion in 1% methylene blue solution for 24 hours. Following immersion, a buccolingual direction was cut in the middle of the restoration using a diamond disc wheel. (Intensive® Diamond Dental Disc Wheels, Switzerland).

Microleakage in restoration was evaluated by examining the penetration of 1% methylene blue solution at the margins of the overlap in the occlusal and gingival walls. Each sample was then assessed by three observers by means of a stereomicroscope (Zeiss® Stremi DV4, Germany) at 15x magnification. The microleakage was then evaluated with a scoring method based on that proposed by Didron *et al.* (2013),[18] namely; 0 = no colour penetration; 1 = colour penetration up to half of the cavity wall; 2 = total colour penetration of the cavity wall; 3 = colour penetration up to half of the axial wall; and 4 = colour penetration more than half of the axial wall (Figure 1).

More detailed observations of microleakage were conducted with a scanning electron microscope (SEM) (Zeiss® EVO MA 10, Germany) before the data was analyzed using a Kruskal Wallis Test and a Mann Whitney U Test with SPSS Software (IBM® SPSS Statistics 20, IBM, USA) with a p value of <0.05.

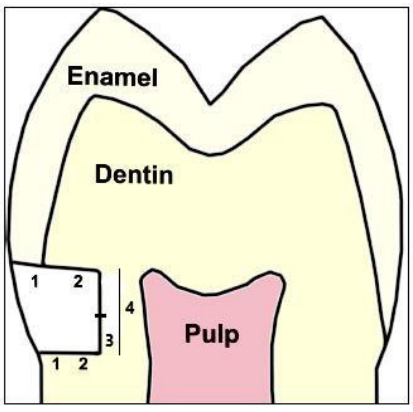

Figure 1. Microleakage scoring criteria.

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RESULTS

The contents of Table 1 shows that the highest mean score of microleakage was recorded by Group I with self-etch bonding technique after carbonic acid immersion. According to the Kruskall Wallis test results, a significant difference existed in all groups with a p value of 0.000 (p<0.005). However, the results of the Mann Whitney test (Table 2) indicated a significant difference between Group I with the total-etch bonding technique and Group II with the self-etch bonding technique after carbonic acid immersion. No significant differences existed between Group I employing the total-etch bonding technique; Group III employing the total-etch bonding technique, but without carbonic acid immersion; and Group IV employing the self-etch bonding technique, but without soaking in carbonic acid. Moreover, Group II employing the self-etch bonding technique demonstrated a significant difference from Group IV with the self-etch bonding technique, but without carbonic acid immersion. Meanwhile, no significant difference existed between Control Group III and Control Group IV.

The microleakage in samples observed using a buccolingual 15x magnification stereomicroscopes that based on metylene blue as color penetration, the lowest microleakage score with a score of 1 occurred in Group III. Meanwhile, Group II recorded the highest microleakage score with a score of 4. Group I and Group IV produced almost identical microleakage scores with a score of 2. Furthermore, SEM observation results indicated that microleakage as a gap or cavity with an irregular shape and darker color than the surrounding tissue structure, (yellow arrows) was predominantly identified in Group II and Group IV. Contrastingly, no microleakage occurred in Group I and Group III (Figure 2).

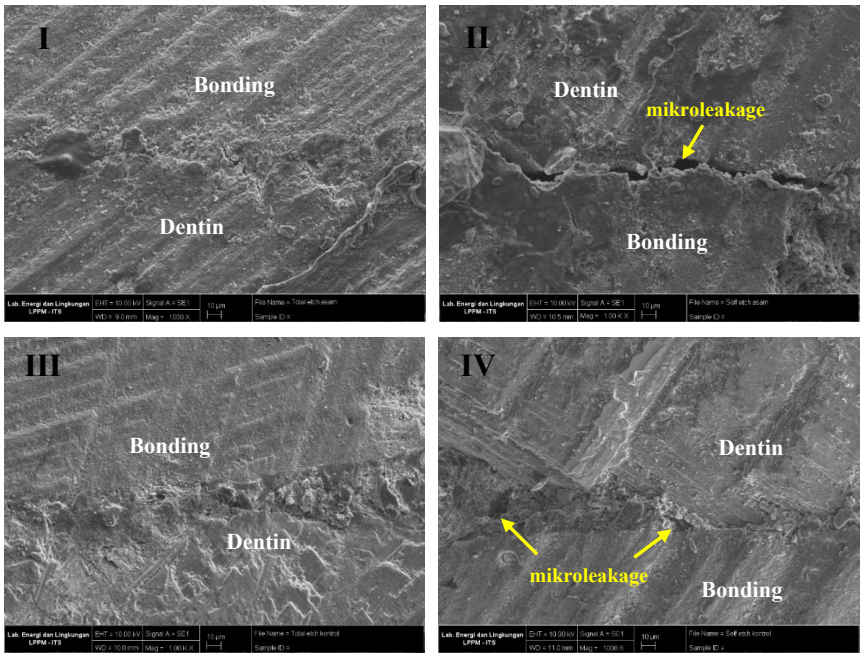

Figure 2. SEM results at 1000x magnification. (I) The total-etch bonding group with carbonic acid immersion. (II) The self-etch bonding group with carbonic acid immersion. (III) The total-etch bonding control group. (IV) The self-etch bonding control group. Arrows indicate microleakage on a border between bonding and dentin.

Table 1. Results of the difference test on the microleakage of total-etch bonding and self-etch bonding on bulk fill packable composite restoration after carbonic acid immersion for 24 hours

Groups	N*	Mean	Standard Deviation	P
I	7	1.7143	± 0.48795	0.000
II	7	3.8571	± 0.37796	
III	7	1.0000	± 0.81650	
IV	7	1.8571	± 0.69007	

Note: *number of samples

Table 2. Result of Mann-Whitney test

Groups	I	II	III	IV
I		0.001*	0.080	0.705
II			0.001*	0.001*
III				0.065
IV				

Note: *significant difference

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DISCUSSION

The results of this study indicated a significant difference in microleakage between total-etch bonding and self-etch bonding after carbonic acid immersion. The bonding material employed was of a universal adhesive type which contains 10-30% more water than a conventional bonding variety. This caused greater ionization of acid monomers resulting in an accompanying increase in the depth of the demineralized dentin. Therefore, deeper resin penetration was possible in producing adequate adhesion.[19]

The results of this study also revealed that Group I had fewer microleakage values than the other groups due to separate etching and rinsing application processes within the total-etch bonding. Therefore, the smear layer produced in the etching process would be eradicated during rinsing. The clean surface of the smear layer substrate is an indication of the exposure of the hydroxyl enamel group to hydroxyapatite crystals which renders the substrate hydrophilic with the result that wettability increases and results in deeper and stronger penetration of the bonding material monomer.[20] This process will then increase marginal adaptation culminating in the edge of the leakage that occurs in the total-etch bonding technique being smaller than that in its self-etch counterpart.[21] A previous study conducted by Tsujimoto *et al.* (2016),[22] similarly argued that the base surface of the enamel covered by the smear layer is hydrophobic resulting in a reduction in wettability.

Nevertheless, the acid etching application procedure can culminate in increased wettability in the enamel causing the formation of a small phi angle. As a result, bonding and composite resin material easily penetrates the entire cavity and good marginal adaptation is formed.[21] The increased wettability of the enamel will also alter the hydrophobic characteristics to hydrophilic ones through exposure to groups of cavities, thereby increasing chemical bonds on the substrate involved in the adhesive process.[23] Ultimately, the surface area and surface energy available for binding which are derived from the interaction between the composite resin and collagen dentin (hybrid layer) are greater. Therefore, the restoration is more resistant to thermocycling and erosion due to carbonic acid immersion. As with the results of this research, those of a previous study conducted by El Sayed *et al.* (2014)[7] argued that total-etch bonding experiences less extensive microleakage than self-etch bonding.

Furthermore, the results of this study found that Group II (using the self-etch bonding technique with carbonic acid immersion) was the group with the highest leakage. The self-etch bonding technique group did not go through the process of etching and rinsing and, consequently, the hydroxyapatite decalcification results (smear layer) were still present on the dentin surface. The smear layer chemically bonded with the functional monomer of acrylic phosphonic acid to form a smear plug (0.5 µm-5 µm) of total-etch bonding. These chemical bonds are stable but weak, leading to the formation of lower marginal adaptations.[24] 37%, phosphoric acid, is the etching material most frequently used to produce consistent microporosity. The etching process with weak acid, in this case present in self-etch bonding material, will cause irregularly formed microporosity of insufficient depth, thereby causing inadequate micromechanical retention and susceptible edge leakage.[23]

The influence of thermocycling and erosion caused by carbonic acid immersion causes not only self-etch bonding to demonstrate higher demineralization, but also induces the appearance of a gap allowing the low pH of the carbonic acid in carbonated drinks to soften Ca10 (PO4) 6 (OH) 2 hydroxyapatite crystals. Of the subsequently decomposing complexes formed, one is Ca^{+2} which will then be bound by carbonate ions to form $CaCO_3$.[25] Demineralization occurs continuously during consumption of carbonated drinks which have a low pH of 2.37. This condition, in turn, provides an opportunity for carbonic acid to penetrate and react to form a gap between the cavity and tooth restoration, resulting in the development of enamel porosity at the cast edge.[22,24]

Finally, the results of this study also confirmed no statistically significant difference in microleakage between Group III and Group IV ($p>0.005$). This is because both total-etch and self-etch techniques make equally effective marginal adaptations to the tooth structure surface. Similarly, a previous study conducted by Perdigão *et al.* (2003)[15] stated that both of these adhesive techniques produce microleakage that is not significantly different. Moreover, the application of universal bonding material in the two sample groups provided optimum adhesive strength to minimize microleakage ($p<0.05$). In conclusion, the level of microleakage in bulk fill packable composite restorations in total-etch bonding after carbonic acid immersion was lower than that in self-etch bonding.

REFERENCES

1. Cramer NB, Stansbury JW, Bowman CN. Recent advances and developments in composite dental restorative materials. J Dent Reseacrh. 2011; 90(4): 402–16.
2. Anusavice KJ, Phillips RW, Shen C, Rawls HR. Phillips' Science of Dental Materials. 12th ed. Budiman JA, Purwoko S, editors. Jakarta: EGC; 2013. p. 275–306.
3. van Ende A, de Munck J, Lise DP, van Meerbeek B. Bulk-fill composites: a review of the current literature. J Adhes Dent. 2017; 19(2): 95–109.
4. Jackson RD. Posterior composites and the new bulk-fill materials. Insid Dent. 2014; 10(8): 68–75.
5. Orłowski M, Tarczydło B, Chałas R. Evaluation of marginal integrity of four bulk-fill dental composite materials: in vitro study. Sci World J. 2015; 2015: 1–8.
6. Lokhande NA, Padmai AS, Rathore VPS, Shingane S, Jayashankar DN, Sharma U. Effectiveness of flowable resin composite in reducing microleakage - an in vitro study. J Int oral Heal JIOH. 2014; 6(3): 111–4.
7. El Sayed HY, Abdalla AI, Shalby ME. Marginal microleakage of composite resin restorations bonded by desensitizing one step self etch adhesive. Tanta Dent J. 2014; 11(3): 180–8.

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.

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8. Muñoz MA, Luque I, Hass V, Reis A, Loguercio AD, Bombarda NHC. Immediate bonding properties of universal adhesives to dentine. J Dent. 2013; 41(5): 404–11.
9. Khan AA, Siddiqui AZ, Al-Kheraif AA, Zahid A, Divakar DD. Effect of different pH solvents on micro-hardness and surface topography of dental nano-composite: An in vitro analysis. Pakistan J Med Sci. 2015; 31(4): 854–9.
10. Sabdi S, Zaripah W, Bakar W, Husein A. Assessment of microleakage of few restorative materials after erosion by acidic solution. Arch Orofac Sci Sci. 2011; 6(2): 66–72.
11. Amaechi BT. Dental erosion and its clinical management. London: Springer International Publishing; 2015. p. 70, 100–10.
12. Felix KR, Bressan MC, Kanis LA, De Oliveira MT. Assessment of acid neutralizing capacity in cola-based drinks and energy beverages by artificial saliva. J Contemp Dent Pract. 2013; 14(4): 578–81.
13. Hegde M, Hegde PN, Ravi Chandra C. Morphological evaluation of new total etching and self etching adhesive system interfaces with dentin. J Conserv Dent. 2012; 15(2): 151–5.
14. Gupta A, Tavane P, Gupta PK, Tejolatha B, Lakhani AA, Tiwari R, Kashyap S, Garg G. Evaluation of microleakage with total etch, self etch and universal adhesive systems in class V restorations: An in vitro study. J Clin Diagnostic Res. 2017; 11(4): ZC53–6.
15. Perdigão J, Geraldeli S, Hodges JS. Total-etch versus self-etch adhesive: Effect on postoperative sensitivity. J Am Dent Assoc. 2003; 134(12): 1621–9.
16. Nurhapsari A. Perbandingan kebocoran tepi antara restorasi resin komposit tipe bulk-fill dan tipe packable dengan penggunaan sistem adhesif total etch dan self etch. ODONTO Dent J. 2016; 3: 8–13.
17. Yuan H, Li M, Gao Y, Liu HL, Li J, Guo B. Evaluation of microtensile bond strength and microleakage of a self-adhering flowable composite. J Adhes Dent. 2015; 17(6): 535–43.
18. Didron PP, Chrzanowski W, Ellakwa A. Effect of Temperatures on Polymerization Stress and Microleakage of Class V Composite Restorations. Open J Compos Mater. 2013; 03(04): 107–12.
19. Ritter A V., Boushell LW, Walter R, Sturdevant CM. Sturdevant's art and science of operative dentistry. 7th ed. St. Louise: Elsevier Mosby; 2018. p. 417–18.
20. Soares CJ, Faria-E-Silva AL, Rodrigues M de P, Fernandes Vilela AB, Pfeifer CS, Tantbirojn D, Versluis A. Polymerization shrinkage stress of composite resins and resin cements - What do we need to know? Vol. 31, Brazilian Oral Research. Sociedade Brasileira de Hematologia e Hemoterapia; 2017. p. 49–63.
21. Soetojo A. Penggunaan resin komposit dalam bidang konservasi gigi. Surabaya: PT. Revka Petra Media; 2013. p. 45–7.
22. Tsujimoto A, Barkmeier W, Takamizawa T, Latta M, Miyazaki M. The effect of phosphoric acid pre-etching times on bonding performance and surface free energy with single-step self-etch adhesives. Oper Dent. 2016; 41(4): 441–9.
23. D'Alpino PHP, da Rocha Svizero N, Carrilho M. Self-Adhering Composites. In: Dental Composite Materials for Direct Restorations. Springer International Publishing; 2018. p. 129–51.
24. Laurensia EK, Untara TE, Daradjati S. Perbedaan kebocoran mikro tumpatan resin komposit flowable bulkfill yang menggunakan bahan bonding total etch dan self etch. J Kedokt Gigi. 2014; 5(2): 56–62.
25. Prasetyo EA. Keasaman minuman ringan menurunkan kekerasan permukaan gigi (Acidity of soft drink decrease the surface hardness of tooth). Dent J (Majalah Kedokt Gigi). 2005; 38(2): 60–3.

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.

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