Original Article

Comparison of Microleakage of Self-etch and Total-etch Bonding Agents in Primary Molar Class II Composite Restorations

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Received 27 February 2020and Accepted 2 June 2020

Abstract

Introduction: This study evaluated microleakage of flowable and conventional composite in primary molar class II restorations using self-etch and total-etch bonding agents. **Methods:** Class II standard cavities were prepared on proximal surface of 48 primary molars. These cavities were restored using GrandioFlow and Grandio composites and Futurabond DC and Solobond M as bonding agents. Teeth apices were sealed by wax and two-layer nail varnish was applied up to 1mm of restoration margins. Samples were subjected to thermocycling, stained by silver nitrate solution and sectioned mesiodistally. Microleakage was measured from the tooth-restoration margin to end point of dye penetration using a stereomicroscope with a 0-3 scale. Microleakage scores were analyzed using Kruskal-Wallis test in 4 groups and paired comparisons were performed using Monte Carlo test**.** **Results:** Microleakage was seen in all composite and bonding agent groups. Pairwise comparison showed no significant difference regarding the microleakage between groups (P>0.05) . **Conclusion:** Gradioflow as a flowable composite and Futurabond DC as a self-etch bonding agent both showed acceptable results in regard to microleakage. Considering the ease of application of flowable composites compared to conventional ones and shortening the treatment both flowable composites and self-etch bonding agents have showed promising results in pediatric dentistry

Keywords: Bonding Agents, Flowable composites, Microleakage, Primary molars

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Aslani F, Hejazi M, Baghalian A. Comparison of Microleakage of Self-etch and Total-etch Bonding Agents in Primary Molar Class II Composite Restorations. J Dent Mater Tech 2020; 9(2): 95-101.

Introduction

Resin-based materials have been used in dentistry for almost 60 years (1). These materials are acceptable because of their high efficiency in cosmetic dentistry(2). In early 1980s, new clinical data suggested that use of composite resins in posterior teeth did not result in acceptable outcomes due to insufficient physical characteristics in the posterior restorations (3). First-generation resins did not have favorable mechanical properties and experienced complications such as lack of dimensional stability and low elastic modulus, microleakage, wear, micro and macroscopic fractures (2, 4). In recent years, much efforts have been made to fabricate composites with physical and chemical properties similar to the tooth structure. Recent developments have focused on reducing polymerization shrinkage, improving physical properties, abrasion resistance and biocompatibility(5). Flowable composites have low viscosity and contain 20-25% less filler compared to conventional composites and are able to wet and adapt with the cavity surfaces quickly. Following the recent improvements in material characteristics, more recent generations of flowable composites include higher volume of fillers, which provides higher mechanical properties. Therefore, it suggested that these flowable composites can be used successfully in posterior restorations (6). Nanotechnology has provided the composite resins with smaller filler particle sizes in nano-scale dimension (3). These composites are suggested as an alternative to amalgam in the posterior teeth due to high strength, low shrinkage and acceptable aesthetics (7). Grandioflow and Grandio contain 80% w/w (65.6% volume) and87% w/w (71.4% volume) inorganic filler, respectively. Hence, both composites have high percentages of inorganic fillers that could affect final mechanical characteristic of the restorations. Polymerization shrinkage in flowable composite is one of the reasons that could create a gap between the composite material and tooth surface (8). This gap could cause penetration of bacteria, fluids, molecules and ionic particles to the interface of the tooth structure and restorative material. This process so called microleakage(9) is the main reason for excessive sensitivity, recurrent caries, pulp irritation and fractured restorations (10).

Despite improvements, no material has yet been able to create a full adaptation between restoration and cavosurafce margins (11, 12). The total-etch technique removes the smear layer and is used in a three-stage (4th generation) or a two-stage (5th generation) fashions (13). The most recent released product in adhesive materials is the seventh generation bonding agent which represents the latest simplification of adhesive system (14). The main advantage of this system is the elimination of the etching process and the use of primer and bonding at the same time. This helps to save time that was used for etch and rinse of teeth which eventually reduce the time of restoration procedure significantly. Shorter treatment time is highly valued in pediatric dentistry (15). For self-etch adhesives, surface demineralization of dentin and penetration of monomer into dentin happen at the same time (16). Hence, self-etch adhesives are suitable for pediatric dentistry because of short and simple restoration procedures they offer(17). Considering the superior characteristics of flowable compared to conventional composites, this study aimed to compare the microleakage level of nanohybrid flowable and conventional composites using total-etch and self-etch bonding agents

Materials and Methods

This study was approved by ethics committee of Qazvin University of Medical Sciences (IR.QUMS.REC.1394.64). For this experimental study, 48 extracted human primary molar teeth (D, E) due to orthodontic reasons or severe infection with at least one intact proximal surface were selected. After debridement of the teeth, they were stored in 0.5% Chloramine solution for seven days and then kept in distilled water at room temperature. Class II cavities were prepared on mesial surface of second primary molar or distal surface of first primary molar. Cavity preparation was performed to 4 mm Buccolingual width, 2 mm axial depth, gingival margin was placed in enamel and 1mm above the CEJ. Based on type of restorative composites and bonding agents, 4 goups were described as below:

1. GrandioFlow Composite (Voco GmbH, Cuxhaven, Germany) Futurabond DC (Voco GmbH, Cuxhaven, Germany) as the seventh generation bonding agent
2. Grandio Composite (Voco GmbH, Cuxhaven, Germany) with Futurabond DC
3. GrandioFlow Composite Solobond M (Voco GmbH, Cuxhaven, Germany) as the fifth generation bonding agent
4. Grandio Composite with Solobond M

For Futurabond DC, the cavity was rinsed and dried after preparation with a faint air jet to prevent desiccation of the cavity surfaces. Futurabond Dc single dose was activated according to the manufacturer’s recommendation, and a layer of bonding was applied on the surface for 20 seconds, dried with an air jet for at least 5 seconds, and cured for 10 seconds (Woodpecker Guilin, Guangxi, China). For Solobond M, after cavity preparation and according to the manufacturer's instructions, cavities were etched using phosphoric acid 34/9% (Vococid, Voco GmbH, Cuxhaven Germany) for 20 seconds. Then the cavities were rinsed with water for 20 seconds, dried and a layer of bonding was applied on the surfaces, allowed to sit for 30 seconds, and cured for 20 seconds. After applying adhesive on the surface, cavities were restored with Grandioflow Composite as flowable nanohybrid composite and Grandio Composite as a conventional composite with a maximum thickness of 2 mm and curint time of 20 seconds. After completing the cavity restorations, fillings were polished with fine polishing bur (Teeskavan, Tehran, Iran). Teeth were stored in normal saline at room temperature for 24 hours. All teeth were immersed in water baths at 5 and 55°C for 1000 cycles, with a dwell time of 60 seconds in each bath and a transfer time of 15 seconds. After thermocycling, apical foramina of each tooth was sealed with wax, and the entire surface of tooth was covered with two coats of nail polish from apex up to 1 mm of restoration margin (Padina, N103, Iran). Teeth were immersed in 1 molar silver nitrate solution (Ranbaxy India. Ltd) for 24 hours. Later, teeth were mounted in transparent acrylic resin (Dentsply, Dentsply Detrey GmbH, England). Then the teeth were washed for 5 minutes with water and placed in a developing solution (Champion, X-ray Iran, Iran) under fluorescent light overnight. After dye exposure, samples were washed with purified water for 5 minutes. Restorations were sectioned mesiodistally using a diamond blade (0/005mm) and water as coolant. (Mecatome T 201 A, Pressi, France). Sections from middle part of the restoration of each tooth were evaluated by stereomicroscope at 30X times magnification (N76097.98, MБC-2, Russia) Microleakage evaluation and dye penetration for each sample was evaluated by a person who was blinded to study groups. Dye penetration was measured from margin of dental restoration up to the end of dye penetration at both side of sections. The greater penetration was considered as reference. Microleakage was recorded based on the following criteria (13):

Score 0: No dye penetration (Fig. 1):

Score 1: Dye penetration along the occlusal or gingival wall up to one-third length of restoration. (Fig. 2):

Score 2: Dye penetration along the occlusal or gingival wall up to two-third but not less than one-third of the restoration length. (Fig. 3):

Score 3: Dye penetration along the whole length of the occlusal or gingival wall and along the axial wall. (Fig. 4):

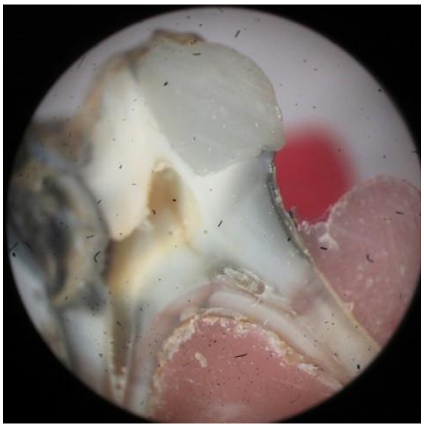

Fig. 1: Score 0

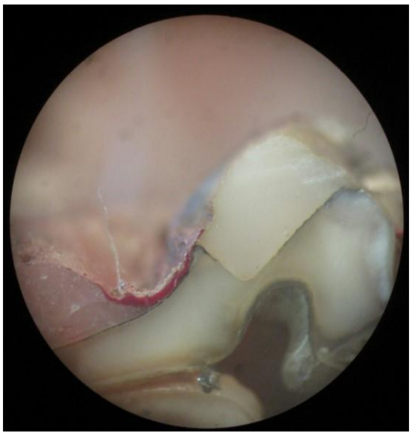

Fig. 2: Score 1

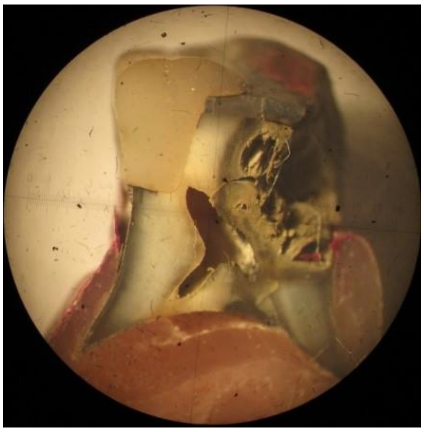

Fig. 3: Score 2

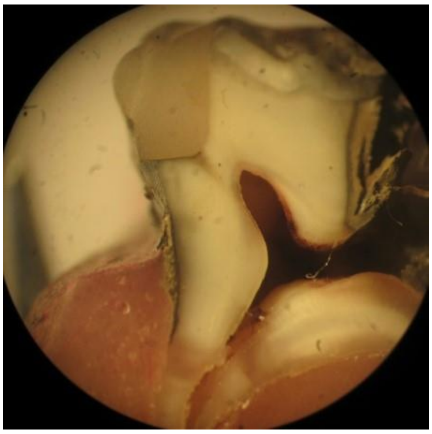

Fig. 4: Score 3

Stereomicroscope images of microleakage scores of composite restorations (magnification30×)

Statistical analysis

The data collected was analyzed using SPSS version 19 software. Non-parametric Kruskal-Wallis test was used to compare microleakage in four groups. A pairwise comparison of microleakage was conducted using the Monte Carlo test. The level of significance was established as $P \leq 0.05$ for all tests.

Results

Scores of microleakage at gingival margin of restorations in various groups are presented in Table I. The non-parametric Kruskal-Wallis test didn't show significant difference among the groups (P=0.056; Table I). Pairwise comparison with the Monte Carlo test also did not show significant difference between any of the groups (P>0.05) (Table II).

Table I: Frequency distribution of microleakage at the gingival margins in the studied groups

Groups	Score 0 N(%)	Score 1 N(%)	Score 2 N(%)	Score 3 N(%)	P-value
Grandio® Flow+ Futurabond DC	3(25.0)	4 (33.3)	2 (16.7)	3 (25.0)	0.056
Grandio® + Futurabond DC	3 (25.0)	7 (58.3)	2 (16.7)	0 (0)	
Grandio® Flow +Solobond M	3 (25.0)	4 (33.3)	5 (41.7)	0 (0)	
Grandio®+ Solobond M	7 (58.3)	4 (33.3)	0 (0)	1 (8.3)	

Table II: Pairwise comparison between groups

		P-value
Grandio®Flow+FuturabondDC	Grandio® +Futurabond DC	0/382
	Grandio® Flow+Solobond M	0/313
	Grandio® +Solobond M	0/196
Grandio®+ Futurabond DC	Grandio®Flow+Solobond M	0/345
	Grandio® +Solobond M	0/112
Grandio® Flow+SolobondM	Grandio® +Solobond M	0/056

Discussion

The results of this study did not show significant difference between using GrandioFlow composite with Solobond M bond and Grandio composite with Solobond M bond. The microleakage score of Grandio with Solobond M bonding was slightly less than microleakage of GrandioFlow and Solobond M bonding. In other pairwise comparison, no significant difference was observed between conventional and flowable composites as well as Solobond M compared to Futurabond DC bonding agents. In other words, in this in-vitro study we showed that flowable and conventional composites with total-etch and self-etch bonding agents are equally useful for decreasing microleakage in class II restorations of primary molars. Swanson et al. (18) showed that total-etch adhesives had less microleakage than the self-etch ones in primary teeth. In their study, they used Adper prompt L-pop as a self-etch adhesive which has very low pH of 1. Low PH will cause reactant to completely dissolve smear layer including smear plugs. This would form a thick hybrid layer which may fail to seal the tubules effectively causing increased chance of microleakage (19). In our study, Futurabond DC performed just like Solobond M in regard to extension of microleakage. The pH of Futurabond DC is around 2 and contains SiO2 nanoparticles which potentially increase mechanical properties of bonding system (20, 21). Tay and Pashley demonstrated that more aggressive nature of self-etch system can form a hybrid layer with a thickness similar to phosphoric acid conditioned dentin surface in permanent teeth (22). Gagliardi and et al. (23) evaluated microleakage of composite Charisma (Heraeus Kulzer) following application of 4th Generation (Durafill Bond), 5thGeneration (Single Bond, Prime & Bond NT, Etch & Prime 3.0, Excite) and 6th Generation (Prompt L-Pop) bonding agents; They found identical microleakage between total-etch and self-etch adhesives; Despite different adhesives used in their research, the results of the current study is consistent with this study regarding microleakage with different generations of bonding agents. However, Waldman et al. (19)Reported microleakage of one-step self-etch adhesives is more than total-etch or two-step self-etch adhesive. The reason is that in their study, the one-step self-etch bonding agent (One-up Bond F) has low viscosity and poor thixotropic characteristics that can flow smoothly in the cavity, therefore it cannot cover some areas of cavity which are up against the gravity(19). Stalin and et al. (13) observed no significant difference between one-bottle total-etch and self-etch adhesives in primary teeth restorations microleakage. According to similar results of two groups of our study, it seems reasonable to use self-etch adhesive as a bonding agent in primary teeth restorations(13). Since rinsing is not required for self-etch adhesives, the moisture of dentin and wet bonding does not cause any issue in this system. Because bonding hydrophilicity, it is likely that dentin moisture improves the seal (10). Futurabond DC is a self-etch adhesive - all-in-one that, that manufacturer claims that it can increase bond strength to enamel and dentin. This bonding has been reinforced with presence of nano-particles through the use of nanotechnology which increases the penetration of resin monomers and hybrid layer thickness. This phenomenon improves the mechanical properties of bonding systems (20, 21). Also, nano-sized silicon particles cause cross-link in resin bonded components and improves their structural properties. After its application on freshly cut enamel, the infiltration of bonding coincides with the etching process. In dentin, this bonding removes the smear layer by hydrophilic and acidic modified methacrylate component which causes demineralization and penetration into collagen fibers network and dentinal tubules. The main advantage of the 7th generation bonding system is omission of etching process and primer while bonding at the same time reducing various application steps. This shortening of different steps is very important in pediatric dentistry. Thus, use of these systems in pediatric dentistry is further emphasized according to results of this study. Grandioflow is Nanohybrid high filler flowable composite and, like the conventional composite (Grandio), contains SiO2 nanoparticles with functional ceramic particles. This composite has a specific resin matrix, which reaches the amount of filler to 80% by weight. Such amount of filler usually is found within packable composites. Because of the acceptable properties of Nano-hybrid composites, these composites are suitable for use in posterior areas. These composites have combined aesthetics properties of microfilled composites along with physical properties of hybrid composites (24, 25). Bucher et al in a case report prepared tooth with a total etch system(Syntac classic®) then filled with a flowable universal composite (Tetric Evo Flow®) and showed acceptable survival rate for CL II cavities in primary molars(26). Andersson-Wenckert et al also showed clinical durability of two years of Tetric flow composite in Class II primary molars(27) Needless to say, tetric flow is not considered a high filler flowable composite. Since filler level of composite could improve its physical properties, we suggest that Grandio flow could be a better option in the same clinical situation. Beun et al showed that Grandio and Grandio Flow as nanocomposite have mechanical properties at least as good as conventional hybrid (28). Microleakage is the leading cause of restoration failure through the creation of microscopic gap between dental composite and tooth margin (29). Dye penetration scores obtained from laboratory studies in mogeneral are higher compared with results of clinical studies (30). Despite the efforts for assessment of dental adhesive systems, no technique with accurate and predictable results is currently available (31, 32). There are so many clinical variables such as the operator experience and skill in dealing with various clinical situations. In oral cavity in clinical setting, beside thermal stress, mechanical and chemical stress are affecting the restorations. All these factors are related to microleakage. At the moment, there is no oral cavity simulated setting with identical characteristics to be used in studies. The most accurate method to measure microleakage is scanning electron microscope, which cannot be used in most studies because of its costs (33). Due to the availability and feasibility of detecting discrepancy in subsurface, dye penetration is used in most studies for microleakage assessment. Among dye penetration methods, silver nitrate has shown promising results when compared by electron microscopy in dentinal margins (34).

Conclusion

Comparison of microleakage in Nano-hybrid flowable and conventional composites with two types of self-etch and total-etch bonding agents in primary molar teeth class II cavities showed that none of the composites and bonding systems had the ability to prevent microleakage completely.

Therefore, whereas microleakage is relatively similar in flowable and conventional composites and bonding agents, the use of a self-etch bonding agent (Futurabond DC) and Grandioflow could be considered as a suitable treatment protocol in pediatric dentistry because of shorter application time of these products.

Acknowledgments

The authors would like to thank Dr. Asghar Mohammadpour Asl for his contribution in statistical analysis of this study.

Conflict of interest

The authors declares there is no conflict of interest in this study.

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