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Research Article

Effect of acid-etching on microleakage of a self-adhering flowable composite

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ABSTRACT

Background and aim: the present study aimed to assess microleakage of self-adhesive Vertise flow composite accompanied with etching, etching and bonding techniques and comparing them with Grandio Flow and Valux Hybrid composites. **Methods:** One-hundred standard class V cavities were prepared on the buccal and lingual surfacesof 50 sound human deciduous canines. The specimens were randomly allocated to five groups accordingly; Vertise flow composite (A), Vertise flow+Etching (B), Vertise flow+Etching+Bonding (C), Grandio flow (D), Valux hybrid (E) . The microleakage of each material was evaluated by the penetration depth of 1% methilene blue dye after 24 hours by visualizing by a stereomicroscope. The depth of penetration at dentine and enamel margin was evaluated by Mann Whitney and Kruskal Wallis analysis and the significance level was considered $p \leq 0.05$. **Results:** At enamel margin, Vertise flow demonstrated the greatest microleakage while Valux Hybrid had the lowest ones and there was a significant difference between Vertise flow(groupA) with groups B, C, D and E ($p<0.05$). At dentin margin, Vertise flow+etching demonstrated the greatest microleakage while Value Hybrid had the lowest values. **Conclusion:** Application of acid etching prior to self-adhering composite has no effect at enamel margin microleakage but it adversely affects microleakage at dentine margin. Co-application of etching and boding may reduce microleakage both at enamel and dentin margin.

Keywords: Self-adhering, flowable composite, acid etching, microleakage

INTRODUCTION

Field of adhesive materials is a dynamic topic with constant evolution in dentistry. Buonocore established etching technique first in 1955 which still is an integral part of several dental restorations. However, application of self-etch adhesives is simpler, more user-friendly and less technique sensitive (1). The mechanism of action of these materials lies on tooth demineralization with simultaneous penetration of filling material as well as chemical interaction between remaining hydroxy apatite and functional monomers (1). Due to popularity of user friendly and less time

consuming materials, manufacturers have focused on enhancing adhesives to reduce tooth preparation procedures, sensitivity and technical errors as well as enhancing bond to the tooth structure (2).

Flowable composites were first introduced in 1995 for restoring class V cavities (1). This resin based material have less fillers and accordingly, less modulus of elasticity which leads to reduced viscosity, enhanced marginal adaptation and could be delivered by injection (3). And their easy handling reduces chairside time (1). Accordingly, a new generation of flowable composites with self-adhering properties are developed and the first product launched in the market was Vertise Flow (Kerr, Orange, CA, USA) (4). It is assumed that this material does not require any preliminary preparation such as etching and bonding and may be directly applied in direct restorations and these composites may be known as the starting point of 8th generation adhesives or a combination of all-in-one adhesives and flowable composites (4). Adhesive flowable composites incorporate an acidic adhesive monomer (1) and bonding is established by the GPDM functional group with tooth calcium ions (4). In addition, it is claimed that micromechanical boding between the polymerized monomers and dentine collagen fibers enhance adhesion (4). Previous studies had demonstrated poor marginal integrity in enamel by self-etching lutings and adhesive. Accordingly, prior surface etching was recommended. On the contrary, there are controversial results regarding the effect of etching on dentin bonding to self-adhering resin cements and this limitation may also be associated with similar self-adhering based resins such as Vertise Flow (Kerr, Orange, CA, USA) (5). Six-month follow ups of class I restorations by flowabale Vertise Flow composite has demonstrated lack of sensitivity and failure (4) and there has been no significant difference in enamel marginal leakage between Vertise flowable composite and Premise applied with different application modes (5).

In application of Vertise flow composite, preliminary etching and bonding procedures are eliminated which may make it an appropriate material for pediatric fillings when there is lack of patient cooperation and isolation. But to the author's best knowledge, there are limited clinical and laboratory studies on efficacy of this filling material in deciduous teeth. Since laboratory microleakage studies is a reflection of sealing ability of the material in clinical setting (5), the authors aimed to assess microleakage of self-adhering Vertise Flow with etching or etching and bonding and also compare it with commonly used composites such as Grandio Flow and Valux Hybrid.

MATERIAL & METHODS

Fifty extracted sound human canine deciduous teeth were stored in 1% Chloramine T solution for disinfection and were stored in distilled water for 6 months at 4°C to avoid dehydration. Cavities with 3×2×1.5 dimensions (width×height×depth) were prepared on the buccal and lingual surfaces of the teeth with high speed instrument and a diamond cylindrical bur (837 KR, Intensiv, Grancia, Switzerland) with water cooling. The burs were replaced after each 5 preparations. The occlusal margin of the cavity was located on the enamel above the CEJ and its apical margin was 1 mm below the CEJ over the dentin or cementum. Specimen were randomly allocated to five groups based on the material and technique to be tested; Vertise Flow(A), Vertise Flow+etching (B), Vertise Flow+etching+bonding (C), Grandio Flow + etching+bonding (D), Valyx Hybrid+ etching+bonding (E).

All cavities, except for group A, were etched with 37% phosphoric acid gel (Kerr, Orange, CA, USA) for 20 seconds, rinsed for 30 seconds and air dried for 15 seconds. In groups C, D, E two layers of total etch bonding (Single Bond 2, 3M-ESPE, St Paul, USA) were applied following etching and air dried for 5 seconds. The composite resins were visible light cured for 20 seconds (QHT, Bonart, South Korea, 740 mW/cm2). In

group A, the cavities were filled with Vertise Flow according to the manufacturer's instruction without etching or bonding. In group B, the cavities were etch and rinsed and filled with Vertise Flow. In group C, D and E, the cavities were etched-rinsed and bonded followed by restoration with Vertise Flow, Grandio Flow and Valux Hybrid respectively.

Following these procedures, the samples were polished by a polishing disc (3M Brasil Ltd, Sumare, SP, Brazil) following storage in distilled water at 37°C for 24 hours. Afterwards, the teeth were thermocycled (Vafaeilnd, Iran) for 500 cycles between 5°C and 55°C for 30 s at each temperature. The foramen apical of the teeth was sealed by autopolymerized acrylic resin to avoid dye penetration. All surfaces of the teeth except fr the restoration and 1 mm surrounding surface were coated with 2 layers of nail varnish and left undisturbed to dry. The specimens were immersed in 1% methylene blue dye for 24 hours at 37°C. Afterwards, the samples were thoroughly rinsed with distilled water and sectioned longitudinally into two halves in a bucco-lingual direction by a diamond disc and water coolant. The samples were visualized by a single observer at 40X by a stereomicroscope to assess dye penetration at enamel and dentin margins. Dye penetration was quantitively and qualitatively scores as follow: 0- lack of dye penetration, 1-dye penetration up to half of the cavity wall, 2- dye penetration beyond half of the cavity, 3- presence of dye at the pulpal wall.

Statistical analysis

The statistical analysis was performed by statistical analysis software package (SPSS, version 19, IBM, USA). Kruskal-Wallis analysis was used for comparing microleakage among the groups and comparison of micro-leakage at enamel and dentin margin among the groups was performed by Mann-Whitney analysis. Significance level was considered $p \leq .05$.

RESULTS

Distribution and mean of dye penetration in enamel and dentin margin is illustrated in table 1. Vertise composite demonstrated the greatest microleakage at enamel margin (65/65) and Valux had the least values in this regard (41/65). There was a significant difference in dye penetration in enamel margin among the study groups ($p<0.05$). Mann Whitney analysis demonstrated a significant difference among groups A and C,D, E in enamel margin microleakage ($p<0.05$) but there was no significant difference between groups A and B in this regard.

Greatest microleakage at dentin margin was observed in Vertise Flow+ etch group (68.00) and the least was in Valux Hybrid group (35.50). There was no significant difference regarding microleakage at dentin margin between the groups ($p<0.01$). Comparison of study groups revealed a significant difference between groups A and E ($p<0.05$). There was a significant difference between groups B and C, D ($p< 0.05$) and E ($p<0.001$).

DISCUSSION

The results of the present study suggest that etching prior to application of Vertise Flow composite does not influence microleakage at enamel margin while it increases microleakage at dentin margin. It is assumed that surface preparation by etching and bonding with Vertise Flow composite decreases microleakage at enamel and dentin margins. In the present study, deciduous teeth were used due to availability and appropriate dimensions for preparing class V cavities. Since margin of Class V cavities could be placed on both enamel and dentin and identical cavities are easily reproduced, this was the type of cavity studied in this study. According to the studies by Kerejci et al and Cal, all cavities were prepared with 90 degree cavosurface without any bevel to increase marginal adaptation (6, 7). Most common methods for studying microleakage include isotope and dye penetration. The reason that dye method was used in this study was that it is easier, less complex, more accessible, less costly and provides more information (8, 9). Despite these advantages, this method is

accompanied with several shortcomings such as two-dimensional evaluation and loss of specimen during specimen sectioning (5).It is well known that self-etch adhesives are accompanied with limitations in maintaining marginal integrity specifically at enamel margin during function. Adhesive-free composites with similar bonding mechanism such as Vertise flow may also be accompanied with such a limitation (5).

material	name	Batch number	manufacture	Component	
Gel Etchant	37.5% phosphoric acid	3213200	Kerr, Orange, CA, USA	37.5% orto-phosphoric acid, silica thickener	
Vertise Flow	Light-cured, self-adhering flowable composite	3422056	Kerr, Orange, CA, USA	GPDM; Prepolymerized filler, 1-micron barium glass filler, nano-sized colloidal silica, nano-sized Ytterbium fluoride.	
Grandio Flow	Light-cured, nano-particle flowable composite	650823	Voco, Cuxhaven, germany	BisGMA, TEGDMA HEDMA, Glass ceramic	
Valux plus	Light-cured, hybrid, composite	19970108	3M Dental St. Paul, MN, USA	BIS-GMA TEGDMA Zirconia Silica	
Adper single bond plus	Light- cured, total etch bonding	51102	Adper3M, Scotch bond 2, 3M- ESPE, St, Paul USA	Bis-GMA, HEMA, dimethacrylates, ethanol, water, nanofiller, a novel photo-initiator system, a methacrylate functional copolymer of polyacrylic and polyitaconic acids	

The enamel microleakage of self-adhesive composites may be due to several factors, such as remaining smear layer beneath the composite, hygroscopic expansion of hydrophil acid resin and greater hydrolysis and viscosity than the bonding agents (10, 11). Phosphopric acid etches enamel, removes smear layer, and increases resin monomer penetration and the length of resin tags, and accordingly enhances adhesive stability and persistent marginal seal (12, 13).

In the present study, it was demonstrated that sole application of etchant is not effective and it may enhance marginal seal if followed by a bonding agent and the previous studies also support this finding (5, 14, 15).

Dentin etching exerts negative effects on self-adhering composites sealing which is due to their wettability however the marginal integrity of self-etch adhesives are not significantly deteriorated (5). Greater viscosity of Vertise Flow composites than adhesive solutions hampers the impregnation of collagen fibrils and exposed dentinal tubules by phosphoric acid which leads to deficient marginal seal and hydrolytic degeneration. On the other hand, inorganic composition of the dentin reduces by phosphoric acid application which deteriorates GPDM monomer chemical bonding. Comparing to enamel, dentin is not an ideal surface for bonding since it has less than 50% inorganic material and 20% water while enamel constitutes more than 90% inorganic material. In addition, tubular structure of dentin has made it a more complex surface for bonding (5).

Results of the present study demonstrated greatest dentin microleakage in Vertise Flow+Etching group and the least in Valux Hybrid group. Our results are accordant with the study by Rengo et al. that demonstrated increased dentin microleakage with etching prior to application of Vertise composite (5). In another study, Bektas et al revealed better marginal seal when Vertise self-adhering composite was applied with bonding agents comparing to sole use of this material. (16).

CONCLUSION

Application of acid etching and bonding prior to Vertise Flow self-adhering composite decreases microleakage at enamel and dentin margin.

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