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Original Article

Comparative evaluation of microleakage of composite restorations using fifth and seventh generations of adhesive systems

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Abstract

Introduction: Simultaneous etching of enamel and dentin using the novel generation of adhesive systems with contracted operational steps, has shown a good clinical efficacy. The aim of this study was to evaluate the microleakage of composite restorations using the V and VII generations of adhesive systems on primary teeth.

Methods: This study was performed on 45 human intact extracted primary teeth. Following class V cavity preparation, the samples were randomly divided into three groups included 15 teeth based on the type of bonding agent; Single Bond 2, Clearfil S3 Bond or G Bond. After applying the bonding agents, the teeth filled with composite Z250. The microleakage values of incisal and gingival margins were separately scored by 2% basic fuchsine staining based on a 0-3 ordinal ranking system. The data were analyzed by using Kruskal Wallis and Mann_whitney U tests.

Results: In overall, the score of microleakage at incisal (0.58±0.94) and gingival (1.06±0.19) edges did not have significant difference. Also, there was no significant difference between incisal and gingival microleakage considering the different types of bonding.

Conclusion: Regarding to less operational steps and lower risk of salivary contamination, the VII generation of dentin bonding agents can be applied for filling the class V cavities of primary teeth.

Key words: Adhesives, Composite resins, Dentin, Dental enamel

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ارزیابی مقایسه ای ریزنشت ترمیمهای کامپوزیتی با استفاده از نسل پنجم و هفتم سیستمهای چسبنده

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چکیده

مقدمه: اچینگ همزمان مینا و عاج با استفاده ازنسل جدید باندینگهای با مراحل کاری کمتر، کارایی بالینی خوبی نشان داده است. هدف از این مطالعه ارزیابی ریزنشت ترمیمهای کامپوزیتی با استفاده از سیستمهای چسبنده نسل پنجم و هفتم در دندانهای شیری می باشد.

مواد و روش ها: این مطالعه بر روی ۴۵ دندان شیری سالم کشیده شده انسان انجام شد. پس از تهیه حفره کلاس V، نمونه ها بطور تصادفی و با توجه به نوع باندینگ بکاررفته شامل Single Bond 2, Clearfil S3 Bond و G Bond به ۳ گروه ۱۵ تایی تقسیم شدند. پس از کاربرد مواد چسبنده، دندانها با کامپوزیت Z250 پر شدند. ریزنشت لبه‌های انسیزال و ژینژیوال بطور جداگانه به کمک رنگ آمیزی با فوشین بازی ۲٪ و بر پایه سیستم رتبه بندی ۳-۰ نمره گذاری شد. داد ه ها با آزمون Kruskal Wallis و Mann_whitney U tests آنالیز گردید.

یافته ها: بطور کلی نمره ریزنشت در لبه انسیزال (۰/۹۴±۰/۵۸) و ژینژیوال (۰/۱۹±۱/۰۶) تفاوت معنی داری نداشت. همچنین هیچ اختلاف معنی داری بین ریزنشتهای انسیزالی و ژینژیوالی با توجه به نوع باندینگ به کار رفته وجود نداشت.

نتیجه گیری: با توجه به مراحل کاری کمتر و خطر کمتر آلودگی به بزاق، ماده باندینگ عاجی نسل هفتم می تواند در ترمیم حفرات کلاس V دندانهای شیری بکار رود.

واژگان کلیدی: چسبنده، کامپوزیت رزین، عاج، مینا

Introduction

In recent years, the popularity and interest in beautiful restorations has been increased. In this respect, composite resins are the most commonly available materials for filling both anterior and posterior teeth. [1]

The success rate of resin restorations is dependent on adhesion to dental hard tissue that maintains the filling material inside the cavity and prevents microleakage. [2] Unlike to enamel with clinically stable and established bond, adhesion to dentin is hardly achieved. [3] Bonding system's development is a rapid and continuous process.

The bond strength of dentin adhesives in laboratory has been improved so that the bond strength to dentine may be obtained as good as enamel. [1] The most important defect of dental composites is the polymerization shrinkage that creates a gap between dental material and a cavity wall particularly adjacent to dentin. [4] Crossing bacteria and oral fluids through the gap are named the microleakage. It is known that the continuity of this phenomenon may cause recurrent caries and needs to further treatment and even root canal therapy. [5, 6]

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 required. [7]

It is demonstrated that the level of microleakage using VII generation of bonding agents is similar to V generation. [8] Additionally, the tensile bond strength, failure and microleakage of class V restorations with V, VI and VII generations of adhesive systems on primary teeth were assessed and revealed no significant difference between self etch and total etch systems. Thereafter, due to just one operational step using the self etch system, its application seems to be easier in children. [9] The most studies on microleakage of VII

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generation of adhesive systems were performed on permanent teeth, so the present study was conducted to evaluate the effect of VII generation (Clearfil S3 Bond, G Bond) and V generation (Single Bond2) of bonding agents on microleakage of resin restorations of primary teeth.

Methods

A total of 45 human primary anterior teeth extracted within three months for orthodontic reasons were used in this experimental study. The study protocol was approved by Ethic Committee of Babol University of Medical Sciences. Adhesive agents of Clearfil S3 Bond (Kuraray, Japan), G Bond (GC, Japan) and Single Bond2 (3M, U.S.A) and the composite resin Z250 (3M, U.S.A) were applied for filling and the clear self cured acryl for mounting the teeth. In order to disinfection, the specimens were immersed into 1% chloramines T solution for 24 h at room temperature.

Then, the standard class V cavities were prepared at the cementoenamel junction of buccal surfaces with following dimensions: 2mm buccolingual width, 3mm occlusogingival height and 1.5mm axial depth.

Cavity preparation was done by the cylindrical plain cut diamond bur (Tizkavan, Iran) on high speed under air and water spray. A new bur was used for each of 6 cavities. After washing and revising the cavities, the teeth were divided into three groups included fifteen samples in each group based on the type of bonding agents.

The adhesive agents were applied as follows: G Bond was left undisturbed on the dried cavity for 5-10 s, after which gentle air flowing was done by the air syringe and light curing was performed for 10 s. Clearfil S3 Bond was placed on the cavity surface for 20 s and then exposed to gentle air flow for 5 s followed by light curing for 10 s.

For using the Single Bond2, following the simultaneous etching of enamel and dentin with 37% phosphoric acid, the mentioned bonding agent was placed on the prepared tooth surface for 5 s and exposed to air flow and finally light cured for 10 s. Then, the composite resin Z250 was used for filling the cavities in two layers.

The Astralis 7 halogenated light curing unit (Vivadent, Germany) with an intensity of 400 mW/cm^2 determined by the radiometer, was applied to polymerize the resin for 40 s. After immersion of samples into distilled water for 24 h, they were subjected to 500 thermal cycles at 5-55±2 ^{o}C water bathes.All apices were then sealed with sticky wax and the teeth surfaces were painted by two layers of nail polish leaving 1mm around the restoration.

The specimens were then suspended in 2% basic fuchsine for 24 h at room temperature. Following this, they were washed in running water, dried with absorbent pad and were mounted in the self cure acrylic resin. The specimens were then sectioned using diamond disks longitudinally in the buccal lingual plane into two halves. The greatest degree of dye penetration was recorded for incisal and gingival edges of each section on a non-parametric scale from 0 to 3 based on the ordinal ranking system [10] which described in tale1.

All samples were observed under the stereomicroscope (Motic–micro-optic-Industrial group Co. LTD, Japan) with magnification of 20×to measure the dye penetration. Degree of penetration was scored to convert the ranking data to quantitative data.

The data were analyzed by using SPSS version 17 software. Statistical analysis of data relating to incisal and gingival surfaces was done by Mann_Whitney U test. Comparing the mean value of microleakage based on experimental groups was conducted by using the Kruskal Wallis test.

Table1. The microleakage scores based on dye penetration (10)

Score	Description
0	No leakage
1	Leakage into enamel but not to dentin, up to half the incisal or gingival wall.
2	Leakage into incisal or gingival dentinal wall without extending to axial wall.
3	Leakage to the axial wall.

Results

The mean percentage of penetration depth (Microleakage) at incisal and gingival edges were determined 0.58±0.94 and 1.06±0.19 respectively, there was no significant difference between these two values (p=0.06). Additionally, the mean percentage of penetration depth in three experimental groups had no

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significant difference considering the selected margins. (table 2) Figure 1and 2 indicate the dye penetration into tooth structure. (figure 1,2)

Table2. The mean score of microleakage based on the type of adhesive agent

Tooth surface	Type of bonding agent	Mean±SD	P-value
Occlusal	G Bond	0.80±0.862	0.506
	Clearfil S^3 Bond	0.53±1.060	
	Single Bond 2	0.40±0.910	
Gingival	G Bond	1.27±1.223	0.780
	Clearfil S^3 Bond	1.07±1.280	
	Single Bond 2	0.93±1.387	

*** The level of significance was considered at p<0.05**

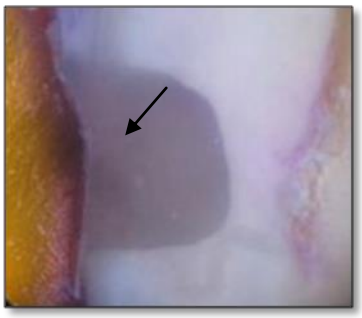


Figure1. Illustration of specimen with no leakage (Score0)

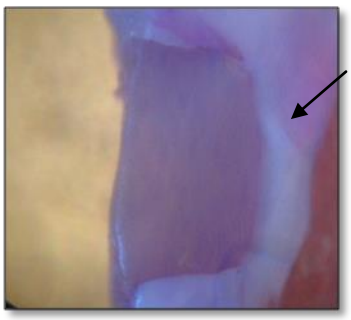


Figure 2. Illustration of specimen with the greatest leakage value (Score3)

Discussion

In the present study, although the level of microleakage at incisal margin was less than gingival floor, however there was no significant difference between these values. Diversity in the composition of dentine and enamel may cause different level of microleakage so that lack of enamel at gingival edge causes more leakage than at incisal margin. More organic ingredients of dentine and its tubular structure may interfere with attachment process. [4]

Additionally, dentinal tubules arrange roughly parallel to gingival margin of class V cavity thus, the classical structure of hybrid layer is damaged and consequently, the microleakage at dentinal wall of gingival edge occurs more than enamel margin. [11,12] Unlike, Some investigations which revealed no significant difference between leakage rate at gingival and incisal margins [13, 14], previous studies reported the higher rate of microleakage at gingival edge compare with incisal margins. [15, 16]

The diversity in understudied adhesive systems, the type of composite which used in different studies, the cavity type and the presence or absence of occlusal loading were considered the best explanation for this incoherence. [17] In agreement with the previous studies, we found no significant difference between overall microleakage with application of three different bonding agents. [9, 14, 18] In Clearfil S3 Bond the acetone was used as solvent primer instead of alcohol.

It is demonstrated that adhesive systems containing acetone require the wet bonding technique and show less ideal hybridization. Also, this agent contains both hydrophilic and hydrophobic phases and because of molecular dispersion makes a homogenous state at the molecular level led to reduction or elimination of water droplets on the adhesive interface. On the other hand, the monomer of 10-methacryloyloxydecyl dihydrogen presents in the structure of the adhesive agent causing decalcification and infiltration in tooth structure makes a calcium-free chemical bond.

Total characteristics mentioned above, cause the microleakage almost similar to Single Bond 2. [11] G Bond from VII generation of bonding agent revealed the same microleakage as Single Bond 2. Without exposure of collagen fibers, dentinal surfaces were slightly decalcified using the G Bond and its functional monomers reacted with the hydroxyapatite to form insoluble calcium. This interface is sturdy and durable. Additionally, G Bond containing more filler seals the tubules and improves the stability of resin-dentine hybrid layer. [19] Although, the supremacy of the V generation of bonding system to VII generation on permanent teeth was previously shown [20,21,22],

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however, in the current study no significant difference was found between the mentioned systems on primary teeth. In addition to the properties noted for the V and VII generations of bonding agents, the difference in structure and chemical, physiological and morphological composition of permanent and primary teeth seemed to be the cause for this finding. [8]

Primary teeth are less mineralized than permanent teeth and there are less concentration of calcium and phosphor in their peritubular and intertubular dentine. Also, there are less dentin permeability due to lower density and smaller diameter of dentinal tubules. [23] There are more porosity and less mineralization in primary tooth enamel than permanent one due to higher density of inter-rod space and connections. Additionally, less organized micro crystalline and more diffusion coefficient are found in primary tooth enamel. [24]

Finally, further studies are recommended to the authors by considering the larger sample size and longer thermocycling time (1000 cycles).

Conclusions

Since no significant difference was found in microleakage scores of the studied adhesive systems, it seemed that the VII generation of bonding agent applied in this study might be appropriate for pediatric dentistry because of fewer operational steps and lower risk of saliva contamination.

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Conflict of interest disclosure: The authors state that they have no conflict of interest.

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