

Original Article

## Marginal Micro-leakage of Self-etch and All-in One Adhesives to Primary Teeth, with Mechanical or Chemo-Mechanical Caries Removal

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### Abstract

**Statement of Problem:** Chemo-mechanical caries removal is an effective alternative to the traditional rotary drilling method. One of the factors that can influence micro-leakage is the method of caries removal.

**Objectives:** To compare the micro-leakage of resin composite in primary dentition using self-etch and all-in one adhesives following conventional and chemo-mechanical caries removal.

**Materials and Methods:** Sixty extracted human primary anterior teeth with class III carious lesions were collected. The selected teeth were divided randomly into two groups each consisting of 30 teeth. In group 1 carious lesions were removed using Carisolv multi mix gel. In group 2, caries was removed using round steel burs in a slow-speed hand piece. Then, the specimens in each group were randomly divided into two subgroups (A and B) of 15 and treated by either Clearfil SE Bond (CSEB) or Scotch bond. All prepared cavities were filled with a resin composite (Estelite). All the specimens were stored in distilled water at 37°C for 24 hours and then thermocycled in 5°C and 55°C water with a dwell time of 20 seconds for 1500 cycles. The specimens were immersed in 1% methylene blue solution for 24 hours, removed, washed and sectioned mesiodistally. The sectioned splits were examined under a stereomicroscope to determine the micro-leakage scores. The data were analyzed using Kruskal-Wallis Test in SPSS version 21.

**Results:** There were no significant differences between micro-leakage scores among the four groups ( $p = 0.127$ ). Score 0 of micro-leakage was detected for 60% of the specimens in group 1-A (Carisolv + CSEB), 73% of the group 2-A (hand piece + CSEB), 80% of the group 1-B (Carisolv + Scotch bond), and 93% of the group 2-B in which caries was removed using hand piece and bonded with Scotch bond.

**Conclusions:** Although caries removal using hand piece bur along with using Scotch bond adhesive performed less micro-leakage, it would seem that the use of Carisolv doesn't adversely affect the micro-leakage of composite restorations while using self-etch or all-in one adhesives.

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## Introduction

Dental caries which is one of the most prevalent chronic diseases causes localized dissolution and destruction of the calcified tooth tissue [1]. Traditionally, in most of the countries worldwide, rotary instrument has been used most commonly method to remove caries of children's teeth [2] Excessive loss of tooth structure occurs as the result of conventional caries removal with burs [3]. Moreover, restorative dental treatment in children, using conventional drill, is traumatic primarily mostly because of the children and their parents' fear and anxiety [4].

Other limitations of using rotary instruments include causing pain and need for anesthetics, which is unpleasant to many children [2]. Moreover, in some cases like allergy, anxiety or other diseases, the usage of anesthetics can be restricted [5]. The changing perception of cavity preparation and the introduction of variety of adhesive systems in the market, directed the clinician to the use another method of caries removal [2].

In chemo-mechanical caries removal (CMCR) method, carious lesions that have been solved by the solution is removed and followed by complete removal using gentle excavation. It has been proved that CMCR is a gentle method that removes only the infected tissues, thereby preserving the healthy dental structures, avoiding pulpal irritation and patient discomfort [2,5]. The latest CMCR system called Carisolv has been introduced to the European market (in 1980s) as a descendant to Caridex system. This method is suggested to be used for treatment of deciduous teeth, dental phobia and medically compromised patients [6].

Resin composite is increasingly the material of choice for the restoration of primary teeth and new materials with simplified procedures are being widely introduced to the market. Micro-leakage is one of the most common problems usually occurs at the gingival margin of the restorations which may causes postoperative sensitivity, recurrent caries, marginal deterioration, pulp injury, and enamel fracture [7].

One of the factors that can influence micro-leakage is the method of caries removal. Kubo *et al.* [8] in their study of comparing the nano-leakage of three dentin adhesive systems bonded to Carisolv treated dentin found that the use of chemo-mechanical caries removal does not adversely affect the bond to caries-affected dentin. The results of the study conducted by Coelho Okida and his colleagues [9] also reported that the

method of caries removal did not influence the results of micro-leakage at any of the cavity margins. In the study by Ngujen *et al.* [10], the effect of Carisolv on the micro-leakage of composite restorations in the carious posterior human teeth was evaluated and no significant differences were observed between Carisolv and rotary instruments.

Dentin bonding agents also have an important role in reducing micro-leakage of the resin composite restorations. Self-etching adhesive has been a subject of interest especially with children due to simplifying the bonding procedure [11]. These bonding systems are being preferred over the traditional one since they eradicate the rinsing step, whereby the time of treatment and the need for patient compliance are reduced [12]. The new family of dental adhesives is also known as "universal" or "multi-mode" and represents the latest generation of adhesives on the market. They are designed under the "all-in one" concept [13].

The effect of Carisolv on the micro-leakage of composite restorations in primary dentition using all-in one adhesive has not been widely evaluated. The purpose of this study was to evaluate the effect of CMCR method on the micro-leakage of composite restorations in primary dentition using two recent popular self etch dentin bonding systems. The null hypothesis is that the method of caries removal and bonding system do not affect the micro-leakage of resin composites used in primary dentition.

## Materials and Methods

To use the extracted teeth, we obtained the approval of ethics committee (Grant #5687) from Shiraz Dental School, Shiraz University of Medical Sciences. Sixty extracted human primary anterior teeth with class III carious lesions were collected, cleaned using scalpel and stored in 0.2% thymol solution. The selected teeth were divided randomly into two groups each consisting of 30 teeth. In group1, carious lesions were removed using Carisolv multi mix gel (Mediteam Dental AB, Savedalen, Sweden) according to the manufacturer's instruction. While applying pressure on the twin syringe mixing system, we mixed equal amounts of the two components. The mixed gel was applied to the carious dentin using special hand instrument and left for 30 seconds. The softened carious dentin was then removed by careful excavation with special non-cutting hand instrument. This procedure was repeated until the Carisolv gel

**Table 1:** Score criteria showing the amount of dye penetration; modified version of the method used by Diwanji *et al.* [14].

0° = No leakage
1° = Less than or up to one-half of the depth of the cavity preparation
2° = More than one-half of the cavity preparation involved, but not up to the junction of the axial and occlusal or cervical wall
3° = Dye penetration up to the junction of the axial and occlusal or cervical wall, but not including the axial wall
4° = Dye penetration including the axial wall

was no longer cloudy and the dentin surface hardened when scraped with a blunt dental explorer.

In group 2, the caries was removed using round steel burs in a slow-speed hand piece. Specimens in each group were randomly divided into two subgroups of 15 and treated by either Clearfil SE Bond (CSEB) or Scotch bond according to the manufacturer's instruction. The subgroups were designated as A and B (n = 15). All prepared cavities were filled with a resin composite (Estelite, Tokuyama, Tokyo, Japan) and cured for 40 seconds using Coltulux 2.5 unit (Coltene, Germany) with 500mW/cm<sup>2</sup> output. The restorations were polished using sequences of Sof-lex discs (3M ESPE Co.; USA) from coarse to fine.

All the specimens were stored in distilled water at 37°C for 24 hours; the root apices were sealed using sticky wax named as model cement (Kem Dent, England). Then, they were thermocycled in 5 and 55 °C water with a dwell time of 20 seconds for 1500 cycles.

The tooth surfaces were covered using two coats of nail polish except for the surface of restorations and 1 mm around them. The specimens were immersed in 1% methylene blue solution for 24 hours and then removed from dye solution and washed under running water. The teeth were sectioned mesiodistally with a high-speed diamond saw (Isomet; buchler, USA). The corresponding sectioned splits were examined under a stereo-scope (wild M8, Wild Co. Model MMS 235, Swiss) at 40x magnification to determine the micro-leakage scores and penetrating micro-leakage. The score criteria used to show the amount of dye penetration was a modified version of the method

used by Diwanji *et al.* [14], as shown in Table 1. The data were analyzed using Kruskal-Wallis test in SPSS, version 21.

## Results

The micro-leakage scores for all materials are shown in Table 2, and graphically in Figure 1. The lowest micro-leakage was obtained for group 2-B for the 93% scores 0, in which the caries was removed using round bur hand piece and resin composite bonded with Scotch bond (all-in one) system. The second lowest micro-leakage was of 80% score 0 that was found to be for the group 1-B (Carisolv + Scotch bond) followed by group 2-A and 1-A with 73% and 60% score 0 of micro-leakage respectively. The differences between micro-leakage scores among all four groups were not statistically significant ( $p = 0.127$ ). The detailed result of Kruskal-Wallis Test is shown in Table 3.

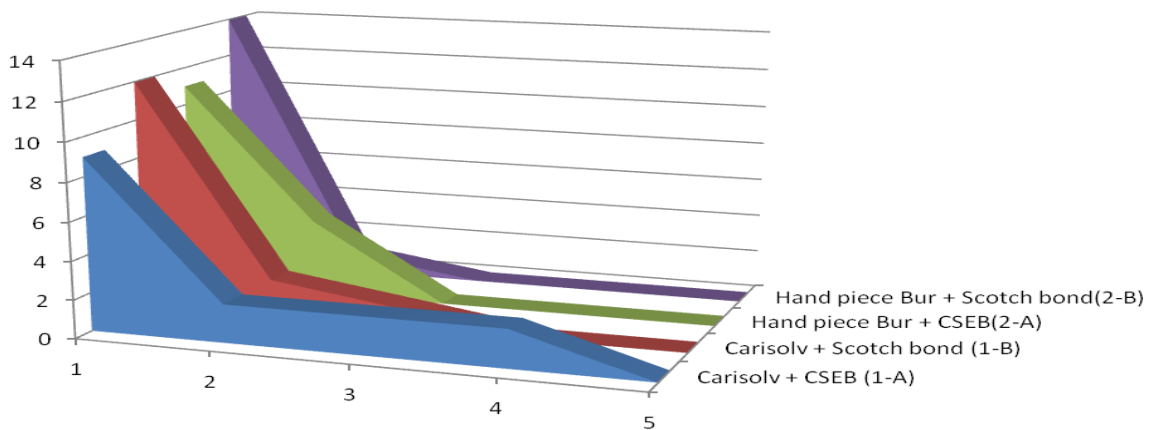
## Discussion

Marginal seal plays a major role in success of restorations. Marginal discoloration, recurrent caries, marginal deterioration and pulp damage can occur as a result of marginal leakage [15]. Method of caries removal may leave a particularly different amount of smear layer of the prepared dentin, which can affect the quality of bonding to the dentin and marginal seal [16].

Although there was no significant difference in the amount of micro-leakage between the four groups in the present study, the degree of micro-leakage in

**Table 2:** The frequency of micro-leakage scores in the tested groups

Groups		Micro-leakage scores				
		0	1	2	3	4
1-A	Carisolv + CSEB	9	2	2	2	0
1-B	Carisolv + Scotch bond	12	2	1	0	0
2-A	Hand piece Bur + CSEB	11	4	0	0	0
2-B	Hand piece Bur + Scotch bond	14	1	0	0	0



**Figure 1:** Micro-leakage scores in four groups of treatment

groups 1-A and 2-A seems to be more than that of groups 1-B and 2-B that may be due the remained Carisolv gel in the prepared cavity interlocking with the adhesive systems. Other researches have shown the trace of Carisolv gel despite water irrigation [17,18]. In the study of Kubo *et al.* [8] the thickness of the hybrid layers was slightly greater in the rotary group than in the Carisolv group. Carisolv treatment probably allows for preservation of most of the caries-affected dentin. The composition and nature of the affected dentin is different form normal dentin. There are less mineral contents in the affected dentin compared to normal dentin causing demineralization due to caries process, also has less hardness than normal dentin. The dentinal tub tubules of the affected dentin have been filled with mineral crystals that are more resistant against etchant agents [19]. Another reason could be attributed to the remnants of the carious dentin, since Carisolv may not remove the carious dentin completely. However, this study demonstrated that the use of chemo-mechanical caries removal does not adversely affect the bond to the caries-affected dentin [8].

The results of our study also showed that there was no significant difference in the amount of leakage between the two methods of caries removal (CMCR and rotary instruments) this is in agreement with

the results reported by Ngujen *et al.* [10] and others [9,20]. The results of other studies also show that the bond strength of the resin composite to dentin surface created by chemo-mechanical and conventional methods is almost similar [21,22]. Mousavinasab *et al.* [20] studied the micro-leakage of resin composite in the restorations of permanent posterior teeth following caries removal by Carisolv and rotary instruments. This study demonstrated that by applying etch and rinse adhesive system there was no significant difference in micro-leakage between conventional and chemo -mechanical caries removal methods.

In the present study, self-etch technique was used in primary teeth. The role of children’s compliance in success rate of bonded restorations that need proper isolation is definite. The self-etching adhesives eradicate the need of rinsing, therefore helps to reduce the time of treatment and the need for patient amenability especially in children [12]. Coelho Okida *et al.* [9] in a study compared the “etch and rinse” and “all-in one” adhesive systems after caries removal by CMCR and rotary instruments. They concluded that the adhesive system did not influence the rate of micro-leakage in the enamel margins and the techniques of caries removal did not affect the degree of marginal micro-leakage for enamel and dentin/cementum [9].

Results of our present study that is in agreement with those reported by Brandt *et al.* [23] revealed less micro-leakage in groups 2-B and 1-B than that of groups 1-A and 2-A (Table 2). A recent study indicated significantly higher bond strength for Carisolv than bur excavation using Clearfil SE bond on the primary caries affected dentin [24]. The better performance of scotch bond may be owing to its one step procedure decreasing the sensitivity of the usage

**Table3:** Description of micro-leakage score in the tested groups

Group	Mean± SD	Median	Mean Ranks	<i>p</i> * Value
1-A	0.80±1.1	.0000	36.40	0.127
1-B	0.26±0.6	.0000	29.40	
2-A	0.26±0.4	.0000	30.83	
2-B	0.06±0.2	.0000	25.33	

\*: Kruskal-Wallis H test

of Clearfil SE bond which has primer and bonding. In general, Carisolv® an effectively painless technique of caries removal performs to be of prospective complementary for use in clinical pediatric dentistry.

### Conclusions

Based on the limitation of this study, the results showed that the use of Carisolv doesn't adversely affect the micro-leakage of composite restorations while using self-etch adhesives. The interactions between Carisolv treated dentin surface and different bonding systems, including self each adhesive should be evaluated in micro-tensile test. Further research is required to study the hybrid layer and characteristics of resin/dentin interface following chemo-mechanical caries removal method.

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**Conflict of Interest:** None declared.

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