Effect of carisolv and papacárie on the resin-dentin bond strength in sound and caries-affected primary molars

Doglas Cecchin¹, Ana Paula Farina², Franciele Orlando³, Eloisa Helena Corrêa Brusco⁴, Bruno Carlini-Júnior⁵

¹DDS, MS, Postgraduate Student, Endodontic Division, Department of Restorative Dentistry, Piracicaba Dental School, State University of Campinas, Brazil
²DDS, MS, Postgraduate Student, Prosthodontics Division, Department Prosthodontics and Periodontology, Piracicaba Dental School, State University of Campinas, Brazil
³DDS, Postgraduate Student, Department of Restorative Dentistry, University of Passo Fundo, Brazil
⁴DDS, MS, Full Professor, Department of Restorative Dentistry, University of Passo Fundo, Brazil
⁵DDS, MS, PhD, Assistant Professor, Department of Restorative Dentistry, University of Passo Fundo, Brazil

Abstract

Aim: This study evaluated the influence of different chemomechanical caries removal techniques on the bond strength of an adhesive system to caries-affected and healthy dentin. Methods: Thirty healthy teeth were randomly divided into three groups: Group 1 (control): no caries removal technique was applied; Group 2: chemomechanical technique using Carisolv®; and Group 3: chemomechanical technique using Papacárie®. Twenty caries-affected teeth were divided into two groups: Group 4: chemomechanical technique using Carisolv; and Group 5: chemomechanical technique using Papacárie. The teeth received the application of an etch-and-rinse adhesive system, were restored with composite resin, and then sectioned to obtain 4 hourglass-shaped slabs from each specimen, which were subjected to a microtensile bond strength test. Data were analyzed statistically by ANOVA and Tukey’s test (α=0.05). Results: G1 (13.387 ± 6.1074), G2 (18.123 ± 3.2611) and G3 (12.781 ± 4.5652) presented statistically significant higher mean bond strength values than the other groups (p<0.05), but did not differ significantly from each other (p>0.05). G4 (6.228 ± 5.3435) and G5 (6.482 ± 3.2076) presented the lowest mean bond strength values and were statistically similar to each other (p>0.05). Conclusions: Neither of the chemomechanical caries removal methods interfered in the resin-dentin bond strength. However, lower tensile bond strength was found to caries-affected dentin.

Keywords: chemomechanical caries removal; microtensile bond strength; etch-and-rinse adhesive system.

Introduction

Current dental restorative concepts are characterized by an increasing effort toward less invasive treatment of carious lesions¹. Because it appears that only soft, wet dentin is heavily contaminated with bacteria², any technique that effectively removes such infected dentin should be adequate to arrest the carious process, allowing altered dentin capable of being remineralized, to remain³.

Chemomechanical systems have been discussed as an alternative to conventional rotary systems⁴-⁵. Carisolv® (MediTeam Dental AB, Sävedalen, Sweden) is used to remove soft carious dentin with the aid of special curettes. It can be applied in adults and children, in many cases allowing treatment without the use of anesthesia, and can even be used in patients with special needs⁶.
system consists of two gels: one containing 0.95% sodium hypochlorite (NaOCl), and the other containing three amino acids (glutamic acid, leucine and lysine), sodium chloride, carboxymethyl-cellulose, sodium hydroxide and water. The effect of Carisolv is based on the action of NaOCl, which disintegrates the caries-affected dentin. The amino acids are used to intensify the effects of NaOCl on collagen denaturation and reduce the aggressive effect on sound dental tissue. According to Morrow et al., when NaOCl is in contact with an amino acid that has a high pH, chlorine reacts with amino groups, forming n-chloride amino acid, in such a way that free chlorine is active on the denatured tissue.

In 2003, a Brazilian formulation for chemomechanical caries removal was introduced to the market under the brand name Papacárie® (Fórmula & Ação, São Paulo SP, Brazil). This product is a gel based on papain, a proteolytic cysteine enzyme that presents antibacterial and antiinflammatory properties. Papain acts as a debris-removing agent only on affected tissues, with no harmful effect to sound tissues close to the lesion because of the enzyme’s specificity. The presence of chloramine in its composition helps softening the carious affected tissues, with no harmful effect to sound tissues close to the lesion because of the enzyme’s specificity. The presence of chloramine in its composition helps softening the carious dentin, thus facilitating its removal. It also helps in the healing process, thus shortening the tissue repair time, and has antiinflammatory properties. Toluidine blue, also present in its composition, is a photosensitive pigment that fixes onto the bacterial membrane, and is also a potent antimicrobial agent.

In the operative treatment of carious lesions in dentin, the morphology and nature of the prepared dentin surface influences the bonding of adhesive restorative materials. However, little is known about the performance of adhesive systems on caries-affected dentin that has been excavated with these new minimally invasive systems. The purpose of this study was to evaluate the influence of different chemomechanical caries removal techniques (Carisolv and Papacárie) on the microtensile bond strength of an adhesive system to caries-affected and healthy dentin.

**Material and methods**

**Specimen Selection**

Fifty recently extracted or exfoliated human deciduous molars (30 sound and 20 carious teeth), stored in 0.2% thymol solution at 4°C maximum period of 30 days, were selected for this study. The teeth were washed under running water for 24 h to completely remove thymol residues and then examined under a x20 stereomicroscope magnification (Carl Zeiss, Jena, Germany). The sound teeth were selected after confirming the absence of caries lesions, restorations, fracture lines or fissures. The carious teeth were selected after confirming the presence of softened dentin tissue based on visual examination and analysis of surface hardness using an explorer. The selected teeth were subjected to sodium bicarbonate prophylaxis and rinsed thoroughly under running water.

**Specimen Preparation**

The region corresponding to the area of root resorption of the exfoliated deciduous molars was filled internally with increments of Z250 composite resin (3M/ESPE, St Paul, MN, USA). This procedure was carried out to reproduce the reabsorbed root portion and allow the tooth to be embedded in acrylic resin using a PVC cylinder (25 mm in diameter and 20 mm high) as mold. The extracted molars were also embedded in acrylic resin in the same way as the exfoliated molars.

The teeth were sectioned 2-mm below the occlusal surface using a double-faced diamond disk (KG Sorensen, Barueri, SP, Brazil) in a slow-speed handpiece in a water-cooled high-precision sectioning machine (Minitom; Struers, Copenhagen, Denmark). The occlusal surfaces were then polished (Abramin; Struers) with successively finer grit silicon carbide papers (600- to 1200-grit).

**Experimental Groups**

All teeth were treated and restored by the same operator and were randomly assigned to groups of 10 specimens each according to the technique used for caries removal. The 30 sound teeth were allocated to 3 groups: Group 1 (control): no caries removal technique was applied; Group 2: chemomechanical technique using Carisolv; and Group 3, chemomechanical technique using Papacárie. The 20 carious teeth were allocated to two groups that were treated with either Carisolv (Group 4) or Papacárie (Group 5). The compositions of the chemomechanical caries removal systems are described in Table 1.

In Groups 2 and 3, Carisolv gel and Papacárie gel, respectively, was applied on dentin surface for 30s, removed with gauze and other two applications were done. The surface was rinsed with distilled water and dried with cotton wool. After this, hybridization and restoration with composite resin was performed.

In Groups 4 and 5, Carisolv gel and Papacárie gel, respectively, was applied on the carious dentin surface and

<table>
<thead>
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<th>Table 1 - Materials used for caries removal</th>
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<tr>
<td><strong>Composition</strong></td>
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<tr>
<td>Carisolv gel Multimix</td>
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<tr>
<td>Papacárie</td>
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* according to the manufacturer
left for 30 s. The carious tissue was afterwards removed with a blunt curette that comes with the Carisolv® system kit, making back and forth movements were made. The excavated carious tissue was removed with gauze and the gel was reapplied for 30 s. The carious tissue was removed again with the blunt curette, and the gel was applied once again for 30 s. Thereafter, the surface was rinsed with distilled water, and hybridization and restoration with composite resin was performed.

Three applications of each gel were standardized in all experimental groups in order to remove soft, stainable, carious dentin was removed, exposing a relatively hard, caries-affected non-staining dentin, in the caries-affected teeth or healthy dentin at the same level in the sound teeth.

Restorative procedures

Enamel and dentin surfaces were etched with 35% phosphoric acid (3M/ESPE) for 15 s, rinsed with distilled water, and the excess was removed with absorbent paper, to leave the dentin visibly moist. Two consecutive layers of Single Bond adhesive system (3M/ESPE) were applied with a microbrush tip (KG Sorensen, Barueri, SP, Brazil) and light-cured for 20 s using a halogen light source (Ultralux EL appliance; Dabi Atlante, Ribeirão Preto, SP, Brazil).

After hybridization, three approximately 2-mm-thick increments of Z250 composite resin (Shade A2) were incrementally applied on dentin surface with a #1/2 spatula, each one light-cured for 20 s, reaching a total height of 6 mm. The restored specimens were stored in distilled water for 24 h. The materials used for hybridization and restoration are shown in Table 2.

Microtensile test

The samples were placed in a high-precision sectioning machine (Struers) and a double-faced diamond disk was used under water cooling to cut sequential 1.0-mm-thick sections in a mesiodistal direction to the long axis of the specimens, with caution not to separate the slices. The specimens were then removed from the acrylic resin base through a #1/2 spatula, each one light-cured for 20 s, reaching a total height of 6 mm. The restored specimens were stained with distilled water for 24 h. The materials used for hybridization and restoration are shown in Table 2.

Table 2 - Restorative materials.

<table>
<thead>
<tr>
<th>Composition*</th>
<th>Manufacturer</th>
<th>Batch No.</th>
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</thead>
<tbody>
<tr>
<td>Etchant Scotchbond</td>
<td>35% phosphoric acid, thickening agent composed of pyrogenic silica and water-soluble tensioactive agent.</td>
<td>3M/ESPE</td>
</tr>
<tr>
<td>Single Bond</td>
<td>Ethanol, Bis-GMA, silane treated with silica filler, 2-hydroxyethyl methacrylate, glycerol 1,3 dimethacrylate, acrylic acid and itoconic acid copolymer, and diurethane dimethacrylate</td>
<td>3M/ESPE</td>
</tr>
<tr>
<td>Composite resin Z 250</td>
<td>Zirconia/Silica, BIS-GMA, UDMA and Bis-EMA</td>
<td>3M/ESPE</td>
</tr>
</tbody>
</table>

*according to the manufacturer

Results

Table 3 shows the mean bond strength values (in MPa)
and standard deviations for the control and experimental groups. G1, G2 and G3 presented the highest mean bond strength values (p<0.05), but did not differ significantly from each other (p>0.05). G4 and G5 presented the lowest mean bond strength values (p<0.05) and were statistically similar to each other (p>0.05).

Discussion

The traditional caries removal method involves local anesthesia followed by the use of burs in low speed handpieces\(^5\). This method has the disadvantage of removing healthy, non-infected altered and infected dentin due to the cutting efficiency of the bur, resulting in an over-extended cavity preparation.\(^6\)-\(^17\). Moreover, the incidence of pulpal alterations due to the pressure or heat generated by the burs have been reported\(^15\),\(^17\). The chemomechanical caries removal methods appeared as an alternative, overcoming some of the inconvenient aspects, such as pain and discomfort, eliminating or diminishing the need for local anesthesia, and eliminating the noise during carious tissue removal\(^1\).

The present study used the microtensile test to evaluate the influence of the two chemomechanical caries removal methods (Carisolv and Papacárie) on the bond strength of the adhesive system to healthy and carious dentin. The use of healthy dentin allowed one to evaluate whether the chemomechanical methods had any influence on bond strength. The use of deciduous exfoliated or extracted teeth does not interfere in the bond strength values, as demonstrated in previous studies\(^18\)-\(^19\).

Data analysis showed that neither of the chemomechanical methods had influence on the bond strength of the adhesive system to healthy or carious dentin. This indicates that neither of the products seems to alter the dental substrate, which could interfere in the bond strength values. The lower bond strength to caries-affected dentin was probably due to the presence of altered dentin rather than the chemomechanical method per se.

Regarding the changes in dentin substrate promoted by the chemomechanical methods, the use of Carisolv on carious dentin caused alterations in the odontoblastic processes, but not in the dentin collagen\(^20\), thus not affecting the bond strength; it is more likely that the alterations in the odontoblasts are caused by the carious lesion before the application of the Carisolv\(^21\). As this product contains NaOCl in its composition, it breaks the cross-links between the dentinal collagen fibrils, denaturing them and dissolving the necrotic tissue. The bond between NaOCl and the amino acids reduces the effect of whole collagen denaturation and breaks only the bond between the affected collagen fibrils, without causing any molecular alterations. Furthermore, Carisolv removes only the non-remineralizable infected and necrotic dentin, preserving the subjacent non-infected dentin layer\(^22\), and not causing harm to the sound dentin surrounding the lesion\(^23\). Moreover, no adverse effects to pulp cells\(^24\) or gingival tissue\(^25\)-\(^27\) have been found.

Wennerberg et al.\(^12\) and Haak et al.\(^23\) have observed that the application of Carisolv makes dentin surface rough, though without interfering in the action of acid etching on dentin. In addition, caries removal with Carisolv does not produce smear layer, resulting in greater opening of the dentinal tubules, which optimizes the penetration of the adhesive systems\(^9\). Furthermore, Carisolv did not alter the mean bond strength values to dentin in the present study, which is in agreement with the findings of previous studies\(^16\),\(^21\),\(^25\).

Papacárie, a gel based on papain and containing chloramines and blue toluidine, is less costly than Carisolv and has similar use, indication and chemomechanical caries removal efficiency\(^10\). It does not harm healthy tissue and accelerates tissue healing. It acts only on carious tissue, which lacks the plasmatic protease inhibitor alpha-1-antitrypsin; its proteolytic action is inhibited on healthy tissue, which contains this substance\(^26\). In addition to papain, the chloramines present in the product have the potential of dissolving carious dentin by means of chlorination of the partially degraded collagen. This mechanism affects the collagen structure, dissolving hydrogen bonds and thus facilitating tissue removal\(^27\). In the same way as Carisolv, Papacárie did not change the microtensile bond strength values in the present study, as reported elsewhere\(^11\),\(^28\).

The carious dentin groups presented significantly lower bond strength than the healthy dentin groups. These findings are in agreement with those of previous studies\(^21\),\(^25\),\(^28\). The weakness of carious teeth was reported by Yoshiyama et al.\(^29\), who observed a larger number of cohesive failures in caries-affected dentin and a larger number of adhesive failures in healthy dentin. This can be explained by the fact that the high mineral loss in caries-affected dentin makes this substrate extremely porous\(^29\) and decreases its hardness\(^30\). The lower hardness of carious dentin can also be attributed to collagen matrix denaturation and to the smaller number of hydroxyapatite crystals that no longer fit correctly into the inter/intrafibrillar spaces of the collagen matrix. To the extent that there is any chemical bonding between carboxylic or phosphate derivations of methacrylates with the mineral phase, then fewer, larger crystals would offer less surface area for interaction. Moreover, ultrastructural analysis has shown a thicker hybrid layer in affected dentin than in healthy dentin\(^29\), suggesting easier diffusion of the acid and resin monomers due to the increase in porosity of the intertubular dentin. However, the penetration of acid into the dentinal tubules harms the infiltration of the resin monomers into the caries-affected dentin\(^31\), decreasing the bond strength\(^30\).

Although Papacárie and Carisolv present a potential to be used in caries excavation procedures, these products,
particularly Papacárie that is more recent in the market, needs further laboratory and clinical investigation to evaluate their efficacy and their effects on the bond strength of restorative materials to dentin.

In conclusion, neither of the chemomechanical caries removal methods interfered in the resin-dentin bond strength. However, lower tensile bond strength was found to caries-affected dentin.

References