Original Article

Effect of Multiple Adhesive Coating on Microshear Bond Strength to Primary Tooth Dentin

Beheshteh Malekafzali[1], Amir Ghasemi[2], Hassan Torabzadeh[3], Reza Hamedani[4], Nekoo Tadayon[4]

[1]Associate professor, Department of Pedodontics, Shahid Beheshti University of Medical Science Dental School, Tehran, Iran
[2]Associate professor, Preventive Dentistry Research Center, Research Institute of Dental Science; Department of Restorative Dentistry, Dental school, Shahid Beheshti University of Medical Science, Tehran, Iran
[3]Associate professor, Iranian center for endodontic research Research Institute of Dental Science, Department of Restorative Dentistry, Dental school, Shahid Beheshti University of Medical Science, Tehran, Iran
[4]Private Practice

Abstract

Objective: Multiple adhesive coating is a controversial topic, especially in primary dentition that should be clarified. We evaluated the effect of multiple consecutive adhesive resin coatings on the microshear bond strength (μSBS) of composite resin to primary tooth dentin utilizing a filled (Adper Single Bond Plus) and an unfilled (Adper Single Bond) adhesive resin.

Materials and Methods: Thirty extracted primary canines were randomly allocated into two groups based on the adhesive used. Dentin occlusal surfaces were exposed and further polished on 400, 600 and 800-grit silicon-carbide paper. The surfaces were divided into two halves in the labial-lingual orientation. After etching, the adhesives were used either in double coats, or four coats on the halves of the same tooth followed by air evaporation for each layer and finally light curing. Cylinders of composite were bonded to the dentin surfaces. After 24 h shear bond testing was evaluated by Bisco tensile tester. ANOVA, Student t test and paired t test were used for statistical analysis.

Results: The mean (standard deviation) for double coats or four coats in single bond were 31.99 (2.94) and 30.25 (2.69), while they were 29.18 (3.35) and 31.26 (2.07) in single bond plus, respectively. No significant differences were found between the double coated specimens and those receiving four coatings with both adhesives ($p>0.05$). Micro SBS values of Single Bond double coated specimens were significantly higher than Single Bond Plus ($p=0.02$). In four-coated specimens, there were no significant differences between Single Bond and Single Bond Plus ($p=0.26$).

Conclusion: Applying four coats of adhesive did not improve the μSBS to primary tooth dentin.

Key Words: Shear Strength; Dentin-Bonding Agents; Primary Tooth

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Corresponding author:
A.Ghasemi, Department of Preventive Dentistry Research Center, Research Institute of Dental Science; Department of Restorative Dentistry, Dental School, Shahid Beheshti University of Medical Science, Tehran, Iran

amir_gh_th@yahoo.com

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INTRODUCTION

Dental adhesive systems are agents used to promote adhesion between composite resin and dental structure. Since 1990, the dental adhesive systems have evolved through several generations with changes in chemistries,

mechanisms, number of bottles, application techniques and clinical effectiveness [1]. The total etch technique involves the removal of the smear layer and demineralizing subsurface dentin via acid etching [2]. Infiltration of demineralized collagen fibers with resin results in hybrid layers with resin tags. This procedure allows retention of the resin to the demineralized substrate micromechanically [3,4]. Resin penetration into the intertubular dentin seems to be of major factor influencing bond strength [4]. However, incongruity in the thickness of demineralization and hydrophilic monomer infiltration is an unsolved problem until now [5-7]. Thus, some authors have suggested placing multiple adhesive layers in an attempt to improve their clinical efficacy [8,9].multiple layering of solvent free total etch systems and even self etching primers were reported numerously [10-12]. Therefore, application of two or more layers is routinely used in the bonding procedure of most total-etch single bottle adhesives according to the instructions that were recommended. The first resin coat serves as a primer and starts substituting solvated adhesive co-monomers for water in the interfibrillar spaces of collagen fibril mesh. The additional resin applications may remove more water from the demineralized dentin or dentinal tubules permitting increased resin concentrations in the collagen fibril network [9].

Although this approach was shown to improve the performance of total-etch systems in permanent teeth, to date the bond strength of multiple applications of these systems to primary tooth dentin has not been reported. Whereas etching tend to more demineralization depth in primary dentin after an equal etching time it is considered that may needed more bonding penetration and also more application [13].

The aim of this study was to evaluate the effect of multiple consecutive adhesive resin coatings on the microshear bond strength (μSBS) of composite resin to primary tooth dentin compared with two applications of adhesive.

MATERIALS AND METHODS

Thirty extracted caries-free human primary canines were collected and disinfected in 0.5% chloramines, stored in isotonic saline at 4°C and used within three months following extraction. The teeth were randomly assigned to two main groups (n=15) bsed on the adhesive used (Table 1).

Each tooth was sectioned perpendicular to its longitudinal axis using a thin sectioning machine (Hamko, NY,USA) under a stream of water. Wet-sanding the dentin surface with 400, 600 and 800-grit silicon carbide paper was used for preparing flat dentin surface and standard smear layer.

The specimens were vertically sectioned through the center of each specimen forming buccal and lingual halves.

The prepared dentin surfaces were etched with 35% phosphoric acid (Scotchbond Etchant, 3M ESPE, St. Paul, MN, USA) for 15s, rinsed with running water for 10s and the excess water was removed by blotting with a cotton pellet.

Table 1. Mean (Standard Deviations) μSBS Values (MPa)

Material	Double Coats	Four Coats
Adper Single Bond	31.99 (2.94) aA	30.25 (2.69) aC
Adper Single Bond Plus	29.18 (3.35) bB	31.26 (2.07) bC

Same letters in uppercase indicate no statistical difference on columns, and in lowercase indicate no statistical difference on lines ($p<0.05$)

In the first main group, two layers of Adper Single Bond (3M ESPE, St. Paul, MN, USA) were applied on the buccal half of the specimen according to the manufacturer's instructions. On the other half (lingual) of the same tooth, four layers of Single Bond adhesive was applied. Adper Single Bond Plus (3M ESPE, St. Paul, MN, USA) was applied as two and four layers similar to Single Bond groups.

After air drying for each layer, the adhesive was irradiated for 10s with a light-curing unit (LED Radi plus, SDI) with a light output of 1600 mW/cm2. Consequently, a transparent tyngon tube (Miami lakes, FL, USA) with 0.7 mm diameter and 1 mm length was seated against the flattened dentin surface. The tube was filled with resin composite (Z100, 3M/ESPE, St. Paul, MN, USA) and polymerized for 40 seconds. After 24-hour storage in distilled water at 37°C, the specimens were tested in shear mode using Bisco tensile tester machine (Bisco, USA) with a crosshead speed of 0.5 mm/min. The μSBS in MPa was calculated using the following formula.

$$\frac{\text{Peak Load at Failure (N)}}{\text{Specimen Bonding Surface Area (mm}^2\text{)}} = \text{Shear Bond Strength}$$

The mean bond strengths were evaluated by two-way ANOVA (adhesive versus coatings) followed by tukey test at 0.05 significance level.

RESULT

Table 1 summarizes the μSBS values and standard deviations for all groups. The interaction of adhesive vs. coatings was statistically significant ($p < 0.01$). When double and four coated specimens were compared for μSBS values, a slightly higher mean value for those receiving four coatings was observed in the Single Bond Plus group. The converse was observed for the Single Bond group, where the mean value for the double coats was higher than that of four coats. However, these results were not significant. The bond strengths of double coats in the Single Bond Plus group were significantly lower than those of Single Bond ($p=0.02$); however, there were no statistically significant differences between four coats of Single Bond and Single Bond Plus ($p=0.26$).

DISCUSSION

In spite of the numerous advances in composite and adhesive technology, there are yet problems associated with the contraction stress and bond to dentin [14]. Percence of fluid inside tubules,wetness of surface and more organic content of dentin makes adhesion more difficult than enamel. [15-17] The etching remove mineral phase and the collagen fiber become exposed, hence [18-20]. The maintenance of collagen network in wet condition helps to infiltrate the hydrophilic adhesive easier, while improper and incomplete monomer penetration limits the possibility of micromechanical retention [21-23]. The thickness, density and quality of the hybrid layer have been theorized to effect bonding [18.19]. However, if the depth of demineralization during the conditioning step is not met by the applied adhesive systems, then the unprotected collagen fibrils left on the base of the hybrid layer might allow faster water sorption and degradation [24-26]. Denuded collagens decrease the mechanical properties of the adhesive resin and permit the action of host-derived proteases [27]. It seems that improvement in bond strength and reduction in nanoleakage may be achieved when multiple coats of total-etch adhesives were used on sound dentin [8, 28]. It has been suggested that the repeated adhesive application may promote improved resin infiltration and subsequently decrease the microleakage [8,9]. Concerning the rationale behind the use of multiple applications in permanent dentin, the performance of total-etch adhesives can also be improved in primary teeth, especially because of more demineralization depth of dentin after etching [28].

However, in this study, the μSBS achieved following four consecutive applications, was not significantly different from those following double coats. Lack of improvement of bond strength with multiple coating or even decreasing were shown by Elkassas in acetone base total etch systems and permanent teeth [29].

Several differences in chemical composition or micromorphology exist between dentin of primary and permanent teeth, such as decreased mineralization, small size and lower concentration of dentinal tubules, decreased permeability, greater water content and more reactivity to acidic conditioner [30,31]. These factors may dictate bond strength in primary dentin. Moreover, several studies observed that the peritubular dentin was dematerialized rapidly during acid treatment in primary teeth and the hybrid layer was thicker for primary than permanent dentin; therefore, decreasing the available bonding might occur [32]. However, increasing the application layers and contact time of bonding with dentin improved diffusion and probably contributes to formation of resin tags even in lateral canals [33]. Double application of Single Bond allowed the achievement of higher resin-dentin bond strength values than those obtained with Single Bond Plus, but not significantly. Lower bond strength with Single Bond Plus adhesive might also be derived from inferior infiltration of the resin into the etched dentin due to a slight increase in the viscosity. Whereas Giannini suggested adding of the filler to adhesive does not essentially have to increase the mechanical properties and also result s are material dependent [34,35].

Additionally, Sadr showed that dimension and distribution of fillers in bonding have not significant effect [36]. Adper Single Bond Plus adhesive incorporates 10% by weight of 5 nanometer-diameter spherical silica particles. It has been suggested that the presence of filler in adhesives helps develop a uniform adhesive film and stabilizes the hybrid layer [37]. Agglomeration of the particles may additionally hamper resin infiltration. Although not significant, the μSBS of four coated Single Bond Plus specimens were higher. It has been suggested that the use of consecutive applications of adhesive allows more time for removal of water by inward diffusion of adhesive monomers and subsequent solvent evaporation from the interfibrillar spaces without increasing the thickness of the overlying adhesive layer [38]. However, this was not observed with Single Bond.

The increased bond strengths of Single Bond Plus specimens might be due to the chemical composition of the adhesive. Adper Single Bond Plus is a filled adhesive, it contains colloidal silica particles. Multiple applications of filled adhesive Adper Single Bond Plus increase the amount of the fillers and the thickness of the hybrid layer; therefore, this layer can reduce the detrimental effects of polymerization shrinkage and improve stress distribution during testing [39,40].Finally, it is noteworthy that the exact mechanism of multiple coatings on μSBS to primary dentin is difficult to interpret. In addition, it is difficult to obtain a more appropriate comparison of the results of this study because there is little reported research concerning the multiple coating technique in primary teeth. Examination of larger samples by means of scanning electron microscopy is suggested for further bond strength studies.

CONCLUSION

It can be assumed that the method of multiple coating during dentin bonding could not improve the bond strength for a total-etch adhesive in primary teeth.

AKCWNOLEDGMENTS

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