Original Article

Microtensile Bond Strength of Single Bond and Adper Prompt-L-Pop Adhesives to Dentin

P. Alizadeh Oskoee [1], AA. Ajami [1], S. Savadi Oskoee [2], F. Pournaghi-Azar [3]

[1]Assistant Professor, Department of Operative Dentistry, School of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
[2]Associate Professor, Department of Operative Dentistry, School of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
[3]Postgraduate Student, Department of Operative Dentistry, School of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran

Abstract:

Objective: The aim of this study was to evaluate the microtensile bond strength to sound and caries-affected dentin using Single Bond and Adper Prompt-L-Pop adhesives.
Materials and Methods: Sixteen extracted human molars with carious lesions extended halfway through dentin were ground to expose the caries affected and the surrounding normal dentin. The samples were divided into two groups of eight samples each, including Single Bond (two-step etch and rinse) and Adper Prompt-L-Pop (one step self-etch). Z-100 (3M) was used for composite build-ups. The teeth were then sectioned and prepared for micro tensile bond strength test, at cross head speed of 1.5 mm/min. Data were analyzed by 1- and 2-way ANOVA.
Results: Bond strengths of Single Bond and Adper Prompt-L-Pop adhesives to sound dentin were significantly higher than to the caries-affected one ($P<0.001$), besides, bond strength of Single Bond to dentin was generally found to be higher than Adper Prompt-L-Pop adhesive ($P<0.001$).The interaction effect was not significant ($P=0.116$)
Conclusion: Bond strength to caries-affected dentin was compromised when one and two step adhesives were used.

Key Words: Dentin; Dentin-Bonding Agents; 3M Single Bond Dental Adhesive; Adper Prompt Self-Etch

Corresponding author:
P. Alizadeh Oskoee, Department of Operative Dentistry, School of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
parnianoskuee@yahoo.com

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INTRODUCTION

Adhesive materials now play a significant role in "minimally invasive restorative dentistry". This means that only the lost or diseased tooth structure is replaced by the restorative material that is to be directly bonded to the remaining sound tooth structure [1]. In an effort to simplify clinical procedures, 2-step and 1-step systems have been introduced [2]. Although most bond strength tests are commonly performed on sound dentin, the clinically common substrate involved is caries-affected dentin. The substrate contains intrinsic properties that are different from normal sound dentin such as reduced permeability due to formation of whitlockites within the dentinal tubules, and a partially demineralized intertubular dentin [3]. On the other hand, as a result of the cyclic demineralization process, changing of the mineral phase of caries–affected dentin may influence the formation of the hybrid layer [4]. Using a micro-method to evaluate bond strengths in specimens with small (1 mm^2) surface areas, it is made possible to assess the adhesion strength of resin composites to caries-affected dentin [5]. It has been shown that contemporary self-etch systems bond better to sound dentin than to the one affected by caries;

whereas, some total etch systems has shown better results on caries affected dentin [4].
The aim of the present study was to evaluate the microtensile bond strengths of "Single Bond" and "Adper Prompt-L-Pop" to sound and caries-affected dentin.

MATERIALS AND METHODS

Sixteen extracted human molars with occlusal caries extended approximately halfway through the dentin were used. All the teeth were cleaned of debris, stored in 0.5% chloramine T solution at 4 °C and used within a month. Occlusal surfaces were ground under running water using 600 grit silicon carbide papers to expose both carious and sound dentin. The teeth were driven into two groups (n=8). The carious dentin was detected using visual and tactile and staining techniques with caries detector (Seek & Sable Seek, Ultradent products, USA), removed with round burs and flattened with 600-grit silicon carbide paper to the same level as the adjacent sound dentin.
One-step self-etch adhesive, Adper Prompt-L-Pop (3M Dental Products, USA) and two step etch and rinse adhesive, Single Bond (3M Dental Products, USA) were applied on the prepared dentin surfaces following manufacturer's instructions [6] (Table 1). A composite crown (Z100, 3M ESPE Dental Products, USA) was built up applying three 1.5 mm thick layers to a height of 4 - 4.5 mm. Each layer was cured for 40 seconds light curing unit (Astralis 7, Ivoclar, Vivadent, Lichtenstein, 400 mw/cm^2).
The specimens were then vertically sectioned into 0.7 mm thick slices perpendicular to the bonded interface using a low speed diamond saw (Isomet, Buehler Ltd, USA). Each slice was carefully examined by light microscope to determine the type of dentin. The interface was hand-trimmed to form hour-glass shapes with approximately 1 mm cross sectional areas and stored in normal saline at 37 °C until all the samples were ready for micro tensile testing. After being thermo cycled in water baths at 5 °C and 55 °C with a 15 second dwell time per bath and 1000 cycles, they were stored in normal saline at 37 °C for 24 hours. A universal testing machine (Housfield Test equipment, LTD, H5KS, UK) at a crosshead speed of 1.5 mm/min was used to tension the samples. The data were analyzed by 2-way ANOVA at significance level of 0.05.

RESULTS

The mean bond strengths of all the groups were recorded (Table 2). Bond strengths to sound dentin were significantly higher than to caries affected one ($P<0.001$). In addition, there was significant difference between the bond strength resulted from the two adhesives, single bond presenting better results ($P<0.001$). The interaction effect of the two factors was not significant ($P=0.116$).

DISCUSSION

The results showed that both Single Bond and Adper Prompt-L-Pop had significantly higher bond strength to normal dentin compared to

Table 1. Adhesive systems used in this study.

Adhesive System	Composition	Technique
Adper Prompt-L-Pop	Methacrylated phosphoric acid; Esters, Water; Bisphenol A Diglycidyl Ether; Dimethacrylate, 2-Hydroxyethyl Methacrylate	Mix using unit-dosed blister pack, apply with agitation, 15 seconds air dry, light cure for 10 seconds
Single Bond	37% phosphoric acid gel; 37% phosphoric acid gel; HEMA, Bis-GMA; H2O, Polyalkenoic acid; Copolymer	37% PA etching(15 seconds); rinse; blot dry; apply two coats of adhesive; light cure for 10 seconds

the one affected by caries as well as generally higher bond strength of Single Bond.

This study permitted testing of the bond strength of normal and caries-affected dentin. The microtensile bond strength test enables a more accurate measurement because the typical hour-glass design of the specimens imposes the highest consistent stress during testing [7]. In addition, this method allows the evaluation of interfacial bond strengths on areas smaller than 1 mm^2 [8].

The results showed that both Single Bond and Adper Prompt-L-Pop had significantly higher bond strength to normal dentin compared to the one affected by caries as previous studies have, which may be due to special characteristics of caries-affected dentin [3,9,10]. Peritubular dentin matrix of caries-affected dentin presents mucopolysaccharides or glycoproteins, these molecules may interfere either with wetting of fine porosities with the resin within both intertubular and peritubular dentin or with the conversion of adhesive monomers to polymeric networks [11].

There was a significant difference between the bond strength of Single Bond to sound and caries-affected dentin. This finding is different from the results reported by Pereira et al [3] in which the difference between the bond strength of Single Bond to sound and caries affected dentin is not statistically significant, however, it is in agreement with the results gained through studies carried out by Nakajima et al [12], Goracci et al [13], and Yoshiyama et al [9].

The structural or physical characteristics of the caries-affected collagen fibrils, exposed by etching with phosphoric acid, may be different from that of normal. The space between the collagen fibrils in normal dentin are occupied by normal calcium-deficient, carbonate rich apatite [12]. In caries-affected intertubular dentin, the mineral occupying the interfibrillar spaces can be different from that of normal apatite as a result of the cyclic demineralization. The residual cuff of peritubular dentin, found to remain within dentinal tubules of caries-affected dentin etched with 35% phosphoric acid gel, might be responsible for the lower bond strength to caries-affected dentin when compared to the sound one [14].

The bond strength of Adper Prompt-L-Pop was significantly lower than that of Single Bond both to normal and caries-affected dentin, which is similar to the results obtained by Gorraci et al [13] and Brackett et al [15].The susceptibility of polymerized resin matrices to hydrolytic degradation has particularly become a concern for self-etch materials containing high concentrations of acidic resin monomers drawing water, especially since it has been shown that single-step adhesives act as semi-permeable membranes allowing movement of water between the interface and the underlying dentin. This may accelerate the process of resin leaching. Methacrylate adhesive monomers (Adper Prompt-L-Pop) containing hydrophilic moieties including carboxylic acid and hydroxyl groups have been shown to absorb significant amounts of water when polymerized. Increased water absorption within the adhesive layer is believed to be highly correlated with lower bond strengths [16].

Caries-affected dentin contains deposits of whitlockite in its dentinal tubules [17]. When smear layers are generated on caries-affected

Table 2. Mean Bond Strengths and Standard Deviation (SD) of study groups in MPa.

Groups	N	Mean (SD)
PLP_1 Normal dentin	8	15.96 (1.13)
PLP_1 Caries-affected Dentin	8	5.33 (0 .83)
Single Bond Normal dentin	8	23.69 (1.30)
Single bond Caries-affected Dentin	8	11.05 (1.09)

dentin, it is likely that they include acid-resistant crystals and extrinsic proteins permeated into the mineral phase during demineralization cycles. These smear layers may be more resistant to the action of self etching primers than those generated from normal dentin. If the self-etching/self-priming resin cannot act through the smear layer into the underlying intact dentin matrix, it will only hybridize the smear layer resulting in no permeation of resin beyond it. Moreover, the acidity of the primer might also be buffered by the mineral components of the smear layer [18]. This tends to lead to low bond strengths.

On the contrary, Pereira et al [3] reported no significant difference between these two adhesives, bond strength-wise. This may be related to the thermocycling process done in our study. Factors such as adhesive type, conditioning of the substrate and the testing machine are the main differences between other similar studies and ours. The only similar study carried out to ours was Pereira et al [3] research and the only difference between the two was the thermocycling process which is likely to have caused different results. One of the limitations of the present study is that mode of failure (MF) was not evaluated. Assessment of this important factor with scanning electron microscopy may improve reliability and allows a better interpretation of the results. Therefore it is suggested to investigate the effect of factors such as thermal and load cycling, on the bond strength of adhesives to caries-affected dentin along with SEM analysis of MF.

CONCLUSION

Microtensile bond strength of Single Bond and Adper Prompt-L-Pop to sound dentin was significantly higher than that to caries-affected dentin.

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