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The Effect of Saliva Contamination on Shear Bond Strength of Orthodontic Brackets When Using a Self-Etch Primer

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ABSTRACT

The purpose of this study was to assess the effect of saliva contamination on the shear bond strength of orthodontic brackets, at various stages of the bonding procedure using a new self-etch primer. Brackets were bonded to 52 extracted human molars according to one of the following four protocols. Group I (uncontaminated control): A self-etch acidic primer, Angel I (3M/ESPE Minneapolis, Minn) was placed on the enamel for 15 seconds, gently dried with air, and light cured for 10 seconds. Precoated brackets APC II (3M Unitek, Monrovia, Calif) were then placed on the teeth and light cured for 20 seconds. Group II: The enamel surface was first contaminated with human saliva for 10 seconds, blown off with an air syringe for five seconds. The bonding procedure was then repeated as in group I. Group III: The self-etch primer was applied for 15 seconds, gently dried with air, and light cured for 10 seconds. The surface was then contaminated with human saliva for 10 seconds, blown off with an air syringe for five seconds. The precoated brackets were then bonded as in groups I and II. Group IV: The enamel surface was contaminated with human saliva for 10 seconds, blown off with an air syringe for five seconds. The self-etch primer was applied. The surface was then re-contaminated with human saliva for 10 seconds, blown off with an air-syringe for five seconds. The precoated brackets were then bonded as in groups I, II, and III. The results of the analysis of variance (F = 4.79) indicated that the shear bond strengths of the four groups were significantly different (P = .005). Tukey HSD tests indicated that contamination both before and after the application of the acid-etch primer resulted in a significantly lower (=1.7±1.4 MPa) shear bond strength than either the control group (=6.0±3.5 MPa) or the groups where contamination occurred either before (=4.8±3.3 MPa) or after (=4.8±3.3 MPa) the application of the primer. The new acid-etch primer can maintain adequate shear bond strength if contamination occurs either before or after the application of the primer. On the other hand, contamination both before and after the application of the primer significantly reduced the shear bond strength of orthodontic brackets.

KEY WORDS: Saliva, Contamination.

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INTRODUCTION Return to TOC

Various investigations have evaluated the shear bond strengths of different bonding systems on both normal and contaminated enamels.[1–5] Success of resin bonding systems to enamel was negatively affected by contamination with oral fluids such as saliva and plasma.[1,5] There was a reduction of about 50% in the mean shear bond strengths when resin composite was bonded directly to saliva-contaminated etched enamel surfaces compared with the uncontaminated surfaces.[1,5]

Fritz et al[6] evaluated the effects of saliva contamination on the bond strength of a 1-bottle adhesive system to enamel and dentin. Contamination and etching was performed with or without rinsing, before and after adhesive application, as well as before or after light activation. They reported that the 1-bottle adhesive systems were relatively insensitive to salivary contamination, provided that the contamination occurred before light curing of the adhesive and the surface was carefully rinsed and blotted dry.[6] Contamination of the cured adhesive layer had no significant effect on the enamel shear bond strength, but resulted in a 50% reduction in dentin shear bond strength.[6]

El-Kalla and Garcia-Godoy[7] compared the shear bond strengths of four single-bottle adhesives with enamel and dentin contaminated with human saliva in vitro. They reported that saliva did not affect the dentin shear bond strength of single-bottle adhesives. They also found that blot drying of saliva-contaminated enamel was sufficient to establish the same high bond strength of uncontaminated enamel. Although the mean shear bond strengths of the contaminated enamel and dentin were slightly decreased, the differences were not statistically significant. The presence of water in the salivary film probably facilitated penetration of the monomers dissolved in the acetone carrier.[7] Similarly, Hansen and Munksgaard[8] reported that the shear bond strength of saliva-contaminated dentin was slightly reduced, but the differences were not statistically significant.

Power et al[9] examined the effects of contamination by saliva, plasma, handpiece lubricant, zinc oxide-eugenol cement and noneugenol zinc oxide cement on the tensile bond strength of a dentin bonding agent used on human enamel and dentin. They reported that all contaminants, except the handpiece lubricant, reduced bond strengths by values ranging from 46% to 100%. The handpiece lubricant did not significantly affect the bond strength to enamel. For the contaminated dentin, they found that all contaminants reduced the bond strength by 40–100%.[9]

Oonsombat[10] evaluated the effect of surface contamination on the shear bond strengths of two new self-etching bonding systems. The enamel and dentin surfaces were contaminated with water, saliva, blood, and handpiece lubricant before the bonding procedures were initiated. They found that there were no statistically significant differences between either bonding systems regardless of the surface treatment.

Itoh et al[11] investigated the influence of contamination by water, human saliva, and blood on the bonding of metal brackets with a 4-META/MMA/TBB resin to etched enamel. They reported that water contamination did not affect the bond strength, but that saliva and blood contamination decreased the bond strength. Saliva and blood also behaved differently because of the differences in the types and amount of inorganic and organic substances in the two contaminants.[11]

Although there are a number of studies on the effect of contamination of the new self-etch primers in operative dentistry, the literature has little or no information on the effect of contamination on the new self-etch primer/adhesive systems during the bonding of orthodontic brackets. The purpose of this study was to assess the effect of saliva contamination on the shear bond strength of orthodontic brackets using a new self-etch primer.

MATERIALS AND METHODS Return to TOC

Teeth

Fifty-two freshly extracted human molars were collected and stored in a solution of 0.1% (weight/volume) thymol. The criteria for tooth selection included intact buccal enamel, not subjected to any pretreatment chemical agents, eg, hydrogen peroxide, no cracks caused by the presence of the extraction forceps, and no caries. The teeth were cleansed and then polished with pumice and rubber prophylactic cups for 10 seconds.

Brackets used

Metal brackets APC II (3M Unitek, Monrovia, Calif), precoated with the adhesive, were used. The average bracket base surface area was determined to be 11.7 mm^2.

Bonding procedure

The teeth were randomly divided into four groups and bonded according to one of four protocols.

Group I—uncontaminated control. The self-etch primer Angel I (3M/ESPE, Minneapolis, Minn) containing both the acid and the primer was placed on the enamel for 15 seconds, gently evaporated with air, and light cured for 10 seconds. The material used in the present study is predosed so that it is only used for one application. The unidose system in Angel I has two compartments: one contains methacrylated phosphoric acid esters, initiators, and stabilizers, whereas the other contains water, fluoride complex, and stabilizers. For activation, the two compartments are squeezed into each other and the resulting mix can be applied directly on the tooth surface. The precoated brackets were then bonded and light cured for 20 seconds.

Group II—contamination before primer application. The enamel surface was contaminated with human saliva for 10 seconds using a cotton tip saturated with the saliva. The enamel surface was blown off with an air syringe for five seconds. The self-etch primer, Angel I was applied on the contaminated surface with agitation for 15 seconds, lightly air-dried for five seconds, and light cured for 10 seconds. The precoated brackets were then bonded and light cured for 20 seconds as in group I.

Group III—contamination after primer application. The enamel surface was lightly dried. The self-etch primer was applied on the enamel surface with agitation for 15 seconds, lightly air-dried for five seconds, and light cured for 10 seconds. The enamel surface was contaminated with human saliva for 10 seconds, blown off with an air syringe for five seconds. The precoated brackets were then bonded and light cured for 20 seconds.

Group IV—contamination before and after primer application. The enamel surface was lightly dried. The surface was then contaminated with human saliva for 10 seconds, blown off with an air syringe for five seconds. The self-etch primer was applied on the contaminated surface with agitation for 15 seconds, lightly air-dried for five seconds, and light cured for 10 seconds. The contamination procedure was repeated once more. The precoated brackets were then bonded and light cured for 20 seconds.

After placement of the bracket on the enamel surface but before light curing, each bracket was subjected to a 300-g compressive force using a force gauge (Correx Co, Bern, Switzerland) for 10 seconds, after which excess bonding resin was removed using a sharp scaler. All samples were stored in deionized water at 37°C for 24 hours.

Debonding procedure

The teeth were embedded in acrylic in phenolic rings (Buehler Ltd, Lake Bluff, Ill). A mounting jig was used to align the facial surface of the tooth to be perpendicular with the bottom of the mold. Each tooth was oriented with the testing device as a guide, so its labial surface was parallel to the force during the shear strength test. A steel rod with one flattened end was attached to the crosshead of a Zwick test machine (Zwick Gm bH & Co, Ulm, Germany). An occluso-gingival load was applied to the bracket producing a shear force at the bracket-tooth interface. A computer, electronically connected with the Zwick test machine, recorded the results of each test. Shear bond strengths were measured at a crosshead speed of 5 mm/min.

Statistical analysis

Descriptive statistics including the mean, standard deviation, minimum and maximum values were calculated for each of the four test groups. The analysis of variance was used to determine whether significant differences were present in the bond strength between the groups. If significant differences were present, Tukey HSD posterior tests were used to determine which of the means were significantly different from each other. Significance for all statistical tests was predetermined at $P \leq .05$.

RESULTS Return to TOC

The descriptive statistics for the shear bond strengths of the four groups evaluated are presented in Table 1. The results of the analysis of variance (F = 4.79) indicated that the shear bond strengths of the four groups were significantly different (P = .005). Tukey HSD posterior tests indicated that the combined contamination, both before and after the application of the acid-etch primer, resulted in a significantly lower (=1.7 ± 1.4 MPa) shear bond strength than the control group (=6.0 ± 3.5 MPa), as well as for the groups in which contamination occurred either before (=4.8 ± 3.3 MPa) or after (=4.8 ± 3.3 MPa) the application of the primer.

DISCUSSION Return to TOC

The direct bonding of orthodontic brackets has revolutionized and improved the clinical practice of orthodontics. But there is a need to improve on the bonding procedure by saving time and also minimize enamel loss without jeopardizing the ability to maintain clinically useful bond strength. Traditionally, the use of acid etchants followed by a primer was an essential part of the bonding procedure of composite adhesives to allow good wetting and penetration of the sealant into the enamel surface.[12–14] The use of the new self-etch primers for orthodontic purposes has not been fully evaluated. In general, these new primers are thought to simplify the clinical handling of adhesive systems by combining the etchant and the primer in one application.[15–17] The earlier generation of acidic primers were selectively compatible with different adhesives and as a result either produced significantly lower bond strength or needed significantly more working time.[15]

The present study evaluated the effect of salivary contamination on a new self-etch primer. The findings indicated that the greater the salivary contamination during the bonding procedure, the greater the reduction in bond strength. More specifically, the mean bond strength decreased from 6.0 MPa with no contamination to 1.7 MPa with more extensive salivary contamination, an average reduction of 75%. With less extensive contamination, ie, either before or after the application of the self-etch primer, there was an average 25% reduction in the mean shear bond strengths.

More research is needed to determine the shear bond strength of these new self-etch primers in the first half-hour after bonding to simulate the time when the initial archwires are tied.

CONCLUSION Return to TOC

By reducing the number of steps during bonding with the use of acid-etch primers, clinicians are able to minimize enamel loss, save time, as well as reduce the potential for error and contamination during the bonding procedure. The present findings indicated that the new acid-etch primer can maintain adequate shear bond strength if salivary contamination occurs either before or after the application of the primer. On the other hand, the combined contamination both before and after the application of the primer significantly reduced the mean shear bond strength by 75%.

The present results indicated that the newly introduced self-etch primers, containing both the enamel etchant and primer have the potential to be successfully used in bonding orthodontic brackets even after light salivary contamination.

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REFERENCES Return to TOC

1. Benderli Y, Gokce K, Buyukgokcesu S. In vitro shear bond strength of adhesive to normal and fluoridated enamel under various contaminated conditions. *Quintessence Int.* 1999; 30:570–575. [PubMed Citation]

2. Hormati AA, Fuller JL, Denehy GE. Effects of contamination and mechanical disturbance on the quality of acid-etched enamel. *J Am Dent Assoc.* 1980; 100:34–38. [PubMed Citation]

3. Thomson JL, Main C, Gillespie FC, Stephen KW. The effect of salivary contamination on fissure sealant–enamel bond strength. *J Oral Rehabil.* 1981; 8:11–18. [PubMed Citation]

4. Silverstone LM, Hicks MJ, Featherstone MJ. Oral fluid contamination of etched enamel surfaces: an SEM study. *J Am Dent Assoc.* 1985; 110:329–332. [PubMed Citation]

5. Xie J, Powers JM, McGuckin RS. In vitro bond strength of two adhesives to enamel and dentin under normal and contaminated conditions. *Dent Mater.* 1993; 9:295–299. [PubMed Citation]

6. Fritz UB, Finger WJ, Stean H. Salivary contamination during bonding procedures with a one-bottle adhesive system. *Quintessence Int.* 1998; 29:567–572. [PubMed Citation]

7. El-Kalla IH, Garcia-Godoy F. Saliva contamination and bond strength of single-bottle adhesives to enamel and dentin. *Am J Dent.* 1997; 10:83–87. [PubMed Citation]

8. Hansen EK, Munksgaard EC. Saliva contamination vs. efficacy of dentin-bonding agents. *Dent Mater.* 1989; 5:329–333. [PubMed Citation]

9. Powers JM, Finger WJ, Xie J. Bonding of composite resin to contaminated human enamel and dentin. *J Prosthod.* 1995; 4:28–32. [PubMed Citation]

10. Oonsombat C. *The Effect of Surface Contamination on Shear Bond Strength of Self Etching Bonding Systems* [master's thesis]. The University of Iowa; Iowa City, IO 2002.

11. Itoh T, Fukushima T, Inoue Y, Arita S, Miyazaki K. Effect of water, saliva and blood contamination on bonding of metal brackets with a 4-META/MMA/TBB resin to etched enamel. *Am J Dent.* 1999; 12:299–304. [PubMed Citation]

12. Barkmeier WW, Erickson RL. Shear bond strength of composite to enamel and dentin using Scotchbond multi-purpose. *Am J Dent.* 1994; 7:175–179. [PubMed Citation]

13. Britton JC, McInnes P, Weinberg R, Ledoux WR, Retief DH. Shear bond strength of ceramic orthodontic brackets to enamel. *Am J Orthod Dentofacial Orthop.* 1990; 98:348–353. [PubMed Citation]

14. Triolo PT Jr, Swift EJ Jr, Mudgil A, Levine A. Effects of etching time on enamel bond strengths. *Am J Dent.* 1993; 6:302–304. [PubMed

Citation]

15. Bishara SE, Gordan VV, VonWald L, Olson ME. Effect of an acidic primer on shear bond strength of orthodontic brackets. *Am J Orthod Dentofacial Orthop.* 1998; 114:243–247. [PubMed Citation]

16. Bishara SE, VonWald L, Laffoon JF, Warren JJ. Effect of using a self-etch primer/adhesive on the shear bond strength of orthodontic brackets. *Am J Orthod Dentofacial Orthop.* 2001; 119:621–624. [PubMed Citation]

17. Chigira H, Koike T, Hasegawa T, Itoh K, Wakumoto S, Hyakawa T. Effect of the self etching dentin primers on the bonding efficacy of dentine adhesive. *Dent Mater J.* 1989; 8:86–92. [PubMed Citation]

TABLES Return to TOC

TABLE 1. Descriptive Statistics and Results of the Analysis of Variance and Tukey HSD Posterior Tests Comparing the Shear Bond Strengths in Megapascals (MPa) of the Four Groups Evaluated

Groups Tested	N	$\bar{x}$	SD	Range	Tukey HSD*
No saliva contamination (control)	16	6.0	3.5	1.8–13.3	A
Contamination—before primer	12	4.8	3.3	1.7–12.0	A
Contamination—after primer	12	4.8	3.3	1.3–12.9	A
Contamination—before/after primer	12	1.7	1.4	0.3–4.8	B
			F value = 4.79	P = .005	

* Groups with the same letter are not significantly different from each other.

N indicates sample size, $\bar{x}$, mean; SD, standard deviation; P, probability.

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