Effect of different contaminants on the shear bond strength of a newly introduced self-etch adhesive system used with moisture protective barrier-An invitro study

Kumar P[1], Sharma R[2], Saroha K[3], Sharma P[4], Singh V[5]

[1]Associate Professor, [2]Professor, [3]Ex-PG Student, [4]Professor and Head, [5]Senior Lecturer, Department of Orthodontics, I.T.S. Centre for Dental Studies and Research, Ghaziabad, U.P, India

ABSTRACT

Aim and Objective: To assess and compare the shear bond strength of brackets bonded with two different self-adhesive systems with and without contamination (Water, Saliva and Blood) and to evaluate the effect of Salivatact on the shear bond strength obtained with Beauty Ortho Bond.

Material and Method: 15 premolars each (a total of 180) were bonded with Transbond XT plus, Beauty Ortho Bond and Beauty Ortho Bond with salivatact under various conditions i.e. dry, water, saliva and blood contamination. The shear bond strength and the ARI values were obtained and evaluated statistically.

Results: Transbond plus had the maximum bond strength in dry condition and when contaminated with water or saliva. The bond strength of Beauty Ortho Bond with and without salivatect was similar in dry condition and when contaminated with water or saliva.

The shear bond strength was lowest after the blood contamination in all the groups and highest for dry condition. Contamination with water and saliva resulted in similar strengths for all the groups. The bond strength achieved with all the three contaminants (water, saliva, blood) was similar when Salivatact was used.

Conclusion: Contamination decreases the bond strength for all the groups and this decrease is maximum in case of blood contamination. Bond strength of Transbond color change adhesive is higher than that of Beauty Ortho Bond under all conditions except when contaminated with blood using Salivatect. Beauty Ortho Bond using Salivatact had higher bond strength when contaminated with blood.

Received: 21-02-2015
Accepted: 28-03-2015

Keywords: Bracket bond strength, Beauty ortho bond, Blood contamination.

INTRODUCTION

Buonocore in 1955 demonstrated the increased adhesion of attachments to tooth surface by conditioning enamel surface with 85% phosphoric acid for 30 seconds.[1] This finding of Buonocore was brought into use in orthodontics by G.V. Newman in 1965 when he used epoxy resins to bond orthodontic attachments to teeth.[2] Since then various advances in bonding systems in the form of better bonding materials, increase in bond strength, different types of curing systems, decrease in curing times as well as combining the various steps of bonding have led to ease of bonding and thus their increased popularity. [3]

Conventional direct bonding of orthodontic brackets to the enamel surface involves three different agents: an enamel conditioner, a primer, and an adhesive resin. Besides being time-consuming this procedure requires a dry environment, which sometimes can be difficult to achieve. Moisture contamination is the most common reason for bond failure with composite resins and debonded brackets are inconvenient, delay treatment, require extra-appointments and might compromise treatment outcomes.[4]

Self-etching primers combine etching and priming in one single component with the advantage of saving time and reducing both the technique-sensitiveness and the chances for contamination.[5] Since these products are effective in bonding to enamel they have been used for direct bonding of orthodontic brackets.

Transbond Plus with Self-etching Primer (TPSEP, 3M Unitek, Monrovia, CA, USA) was the first self-etching primer commercialized for orthodontic purposes, and the one that has been mainly reported in the literature.[6]

Different studies have found that TPSEP can achieve adequate bond strength levels when applied to a dry enamel surface. Bond strength after saliva contamination, both before and after the application of TPSEP has also been reported in the literature.[7, 8] Beauty Ortho Bond, a newly developed light-cure orthodontic adhesive system has recently been introduced for orthodontic bonding. The manufacturers claim that Beauty Ortho Bond has a fluoride release and reabsorbing property and causes less decalcification of enamel. The material is supplied with an additional syringe of salivatect which enhances the bonding under moist conditions as it acts as a protective barrier against saliva contamination without hampering the bonding. The use of Salivatect is optional (only for cases

Address for Correspondence:
Dr. Piush Kumar, Associate Professor, Department of Orthodontics, I.T.S. Centre for Dental Studies and Research, Delhi-Meerut Road, Murad Nagar, Ghaziabad, Uttar Pradesh, India -201206
Email: kumarpiush@yahoo.co.uk

prone to high saliva contamination) and does not alter the duration of light polymerization and bond strength (according to product manual).
There is a lack of orthodontic literature regarding shear bond strength of Beauty Ortho Bond when salivatact is used. Also the influence of water, saliva and blood contamination on the shear bond strength of Beauty Ortho Bond when used with and without salivatect have not been reported.

AIMS AND OBJECTIVES

The purposes of this in vitro study were:
To compare the shear bond strength of brackets bonded with two different self-adhesive systems (Transbond Self Etch Primer with Transbond Plus adhesive and Beauty Ortho Bond)
To assess the effect of different contaminants (Water, Saliva and Blood) on the bond strength of both the adhesive systems.
To evaluate the effect of Salivatact on the shear bond strength obtained with Beauty Ortho Bond with and without contamination.

MATERIALS AND METHOD

This study was conducted on 180 extracted human teeth collected from patients who had undergone extraction for orthodontic purpose. The teeth were stored in a solution of 0.1 % (wt. /vol.) thymol to prevent dehydration and bacterial growth. The buccal surfaces were cleaned and polished with non-fluoridated pumice paste applied with a rubber prophylactic cup on a slow-speed hand piece for 10 seconds, rinsed for 5 seconds and dried with oil and moisture free air spray for 5 seconds. Orthodontic stainless steel premolar brackets with .022 slot (Gemini Series, 3M Unitek) were used for this study.
The specimens were randomly divided into three groups and bonded according to one of the protocols described below. Each group had 4 sub-groups containing 15 teeth each.
Water, saliva, and blood were collected immediately before the contamination procedure. Water was taken from a water distiller machine. Saliva and blood were collected from one of the researchers. The donor was instructed to brush his teeth and refrain from eating for 1 hour so that saliva could be collected. To collect the blood, index finger was cleaned with alcohol and then punctured with a hypodermic needle.
Experimental groups were divided as follows:
Group 1- Transbond SEP with Transbond Plus adhesive was used for bonding of group 1. For group 1a the enamel surface was simultaneously etched and primed with Transbond Plus SEP, rubbed with the applicator brush for 5 seconds and then the bracket was bonded to the tooth surface using Transbond Plus color change adhesive. The specimen was light cured for 10 seconds each from mesially and distally. For subgroup 1b, 1c and 1d the tooth surface was contaminated before brackets were placed. The various contaminants used were water (1b), saliva (1c) and blood (1d). For this 0.1ml each contaminant was used with a syringe. The contaminant was just applied onto the tooth surface, air from an oil free spray was sprayed for 1 second to clear the contaminant and then the brackets were bonded to the tooth surface using Transbond Plus color change adhesive. The specimen was light cured for 10 seconds each from mesially and distally.
Group 2 - Beauty Ortho Bond adhesive was used for bonding of group 2. For group 2a the enamel surface was simultaneously etched and primed with equal mixing of primer A and primer B, rubbed with the applicator brush for 5 seconds and then the brackets were bonded to the tooth surface using Beauty Ortho Bond adhesive. The specimen was light cured for 10 seconds each from mesially and distally. For subgroup 2b, 2c and 2d the tooth surface was contaminated before brackets were placed. The various contaminants used were water (1b), saliva (1c) and blood (1d). For this 0.1ml of each contaminant was used with a syringe. The contaminant was just applied onto the tooth surface, air from an oil free spray was sprayed for 1 second to clear the contaminant and then the brackets were bonded to the tooth surface using Beauty Ortho Bond adhesive. The specimen was light cured for 10 seconds each from mesially and distally.
Group 3 - Beauty Ortho Bond adhesive was used along with Salivatact for bonding of group 3. For group 3a the enamel surface was simultaneously etched and primed with equal mixing of primer A and primer B, rubbed with the applicator brush for 5 seconds. After this salivatect was applied onto the bonding surface directly from the syringe and then the brackets were bonded to the tooth surface using Beauty Ortho Bond adhesive. The specimen was light cured for 10 seconds each from mesially and distally. For subgroup 3b, 3c and 3d the tooth surface was contaminated after application of salivatect and before brackets were placed. The various contaminants used were water (1b), saliva (1c) and blood (1d). For this 0.1ml each contaminant was used with a syringe. The contaminant was just applied over the salivatect present on the tooth surface, air from oil free spray was sprayed for 1 second to clear the contaminant and then the brackets were bonded to the tooth surface using Beauty Ortho Bond adhesive. The specimen was light cured for 10 seconds each from mesially and distally.
The specimens were then thermocycled (500×) between 5◦C and 55◦C, with a dwell time in each bath of 30 seconds and a transfer time between baths of 15 seconds. Twenty four hours after thermocycling, they were subjected to a shear load test in a Universal Testing Machine. A knife-edged shearing rod was used for the test at a

crosshead speed of 5 mm/min and a 50 kg load cell was used for the SBS test. Force was applied parallel to the tooth's surface at the bracket base-enamel interface and the shear load at the point of failure was recorded in Newton's (N).
The debonded enamel surfaces were examined with a stereomicroscope at 10 X magnification to determine the amount of composite remaining. The remaining composite was evaluated using the 4-point scale of Artun and Bergland, where 0 indicates no adhesive left on the tooth surface, implying that bond fracture occurred at the resin/enamel interface; 1 indicates that less than half the adhesive is left on the tooth surface, implying that bond fracture occurred predominantly at the resin/enamel interface; 2 indicates that more than half the adhesive is left on the tooth surface, implying that bond fracture occurred predominantly at the bracket/resin interface; and 3 indicates that all adhesive is left on the tooth surface with a distinct impression of the bracket base, implying that bond fracture occurred at the bracket/resin interface.[9]

Statistical analyses were performed. Descriptive statistics of shear bond strength (mean, standard deviation, median, minimum, maximum, and significance) were calculated for all groups. One-way analysis of variance (ANOVA) and Bonferroni tests were carried out for SBS and ARI, respectively, to determine significant differences among the groups. The statistical significance level was established at $p < .05$

RESULTS

Table 1 shows the bond strength values for each of the groups evaluated along with the intragroup statistical analysis. The shear bond strength was lowest after the blood contamination in all the groups and highest for dry condition. Contamination with water and saliva resulted in similar strengths for all the groups. The bond strength achieved with all the three contaminants (water, saliva, blood) was similar when Salivatact was used.

Table 2 shows the intergroup comparison between the various adhesive systems. Transbond plus had the maximum bond strength in dry condition and when contaminated with water or saliva. The bond strength of Beauty Ortho Bond with and without salivatact was similar in dry condition and when contaminated with water or saliva. In case of contamination with blood, Beauty Ortho Bond with salivatect had the maximum strength followed by Transbond and Beauty Ortho Bond without salivatect.

The ARI scores are used to define the site of bond failure between the enamel, the adhesive, and the bracket base through the remaining composite on the enamel surface. The mean ARI score with different contaminants are given in table 3. It was seen that Transbond plus had the highest ARI scores and Beauty Ortho Bond without Salivatact had the lowest scores. The group without contamination had increased values while those contaminated with blood had the least values. The ARI score for contamination with water and saliva were similar in all the three adhesive systems.

Table-1 Descriptive and Statistical analysis for various groups under various contaminants

	Bonding Condition n=15	Mean ± S.D. (MPa)	ANOVA	Bonferroni Multiple comparisons
Transbond	Control	14.37± 2.99	F=25.592 p<.001	**** Blood v/s Control, Water and Saliva *** Control v/s Water and Saliva *Water v/s Saliva
	Water	11.18± 2.06		
	Saliva	11.08± 2.77		
	Blood	6.81± 1.31		
Beauty Ortho Bond	Control	12.04± 1.98	F=27.991 p<.001	**** Blood v/s Control and Saliva and Control v/s Saliva *** Water v/s Control and Blood * Water v/s Saliva
	Water	8.35± 1.91		
	Saliva	9.62± 1.89		
	Blood	5.89± 1.71		
Beauty Ortho Bond with Salivatect	Control	10.25±2.32	F= 5.90 p<.01	*** Blood v/s Control * Blood v/s Water and Saliva, * Control v/s Water and Saliva * Water v/s Saliva
	Water	8.56±1.92		
	Saliva	9.45± 1.67		
	Blood	7.77±1.34		

Significance * p>0.05. ** p < 0.05, *** p < 0.01, **** p < 0.001

Table-2 Descriptive and Statistical analysis of intergroup comparison between the various adhesive systems

	Adhesive System	Mean ± S.D (MPa)	ANOVA	Bonferroni Multiple comparisons
Control	Transbond	14.37± 2.99	F=10.519 p <.001	** Transbond v/s Beauty bond **** Transbond v/s Beauty bond+ salivatect * Beauty bond v/s Beauty bond + salivatect
	Beauty Ortho Bond	12.04± 1.98		
	Beauty Ortho Bond with Salivatect	10.25±2.32		
Water	Transbond	11.18± 2.06	F=9.677 p<.001	***Transbond v/s Beauty bond ***Transbond v/s Beauty bond + salivatect * Beauty bond v/s Beauty bond + salivatect
	Beauty Ortho Bond	8.35± 1.91		
	Beauty Ortho Bond with Salivatect	8.56±1.92		
Saliva	Transbond	11.08± 2.77	F=2.583 p >.05	* Transbond v/s Beauty bond * Transbond v/s Beauty bond + salivatect * Beauty bond v/s Beauty bond + salivatect
	Beauty Ortho Bond	9.62± 1.89		
	Beauty Ortho Bond with Salivatect	9.45± 1.67		
Blood	Transbond	6.81± 1.31	F= 6.171 p<.01	* Transbond v/s Beauty bond * Transbond v/s Beauty bond + salivatect *** Beauty bond v/s Beauty bond + salivatect
	Beauty Ortho Bond	5.89± 1.71		
	Beauty Ortho Bond with Salivatect	7.77±1.34		

Table-3 Descriptive analysis of ARI scores

	Transbond Plus	Beauty Ortho Bond	Beauty Ortho Bond with Salivatect	**Mean Score**
Control	2.33	1.87	1.87	**2.02**
Water	1.80	1.06	1.26	**1.37**
Saliva	2.13	1.06	1.33	**1.51**
Blood	1.26	0.73	0.80	**0.93**
Mean Score	**1.88**	**1.18**	**1.31**	**1.45**

DISCUSSION

The direct bonding of orthodontic brackets has revolutionized and improved the clinical practice of orthodontics.[10] 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.[11] The use of the new self-etch primers simplifies the clinical handling of adhesive systems by combining the etchant and the primer in one application.[12,13] A self-etching primer consists of acidic adhesive monomer, deionized water, activator, and stabilizer.[14] The bonding performance of an adhesive monomer can be mainly influenced by its hydrophilic acid moieties (i.e, carboxylic acid, phosphoric acid, and phosphoric acid moieties). When enamel is treated with these acidic monomers, the hydroxyapatite of enamel is demineralized, and the pH of the monomer is neutralized.[15] During the etching phase, the adhesive monomer penetrates to the etched tooth surface; then the hydrogen ions released by hydroxyapatite crystals are chelated in the primer, resulting in microlinkage to the hydroxyapatite.[16] The etching performance of self-etching primer is weaker than that of 37% phosphoric acid etching. As a result, the self-etching primer shows a more conservative etch pattern but has fewer adhesive penetrations, leading to lower bond strength.[17]

Transbond self-etch primer was one of the first self-etching primer commercialized for orthodontic purposes and a large number of studies have been reported on it.[6,7,18] Different studies have found that it can achieve adequate bond strength levels when applied to a dry enamel surface.[4-6] Bond strength after saliva contamination, both before and after the application of SEP has also been reported in the literature and various studies have given different results. Contamination after the self-etching primer resulted in a significantly lower bond strength.[2-4] However, when saliva was applied before the primer, no significant differences were found.[5]

One of the major problems associated with bonding in orthodontics is the amount of demineralization that takes place below and at

the margins of the bracket base. Beauty Ortho Bond is a newly developed light-cure orthodontic adhesive system which is a member of the Giomer family with surface pre-reacted glass ionomer (S-PRG) fillers to ensure fluoride release and recharge. The S-PRG fillers in the Beauty Ortho Bond paste have the property of releasing/recharging fluoride ions so as to help in remineralization of the tooth structure.

In case of Transbond SEP simultaneous etching and priming of the tooth occurs when phosphoric acid and a methacrylate group are combined to generate a methacrylated phosphoric acid ester, which is then applied onto the tooth. In case of Beauty Ortho Bond the manufacturer also claims that the mild self-etching HEMA-free primer of Beauty Ortho Bond causes minimal demineralization.

According to the manufacturer bonding is enhanced with the use of Salivatact under moist conditions as it acts as a protective barrier against saliva contamination without hampering the bonding. The composition of salivatact is not very clear but it forms a non-reactive layer over the etched area protecting it from further contamination.

The results that were achieved in the present study indicate that both Transbond SEP and Beauty bond provide adequate bond strength in dry conditions while the bond strength decreased in contaminated state. The decrease in bond strength was similar for both water and saliva while it was maximum when contaminated with blood. When Beauty Ortho Bond was used with salivatect there was adequate bond strength in dry conditions and the decrease in bond strength in contaminated conditions was less than when salivatact was not used.

Santos et al [6] have reported that there are different degrees of interference caused by water, saliva, and blood on bonding procedures due to the differing compositions of the substances. They reported that Saliva is more complex than water, and the difference in type and amount of inorganic and organic substances in blood makes it a greater mechanical barrier than saliva. Thus, it is reasonable that even with a hydrophilic bond system, blood interfered the most with SBS and was followed (in interference intensity) by water and saliva.

Shear bond experiments that tested similar materials under various enamel surface conditions have produced differing results; this may be the result of a number of other variables, such as thermocycling tests, shear bond machines, direction of the force used to debond the brackets, cross head speed, substrate, type of brackets, absence of standardization for applied moisture, the quantity and the application of different products, or other small variations in the materials and methods used.

In the orthodontic clinical routine it is more important to achieve adequate bond strength that allows for safe debonding than to obtain the greatest possible bond strength. Thus, ARI scores are used to define the site of bond failure between the enamel, the adhesive, and the bracket base through the remaining composite on the enamel surface. In orthodontic bond strength testing, cohesive fractures in the composite (ARI score 3) reflect the internal strength of the composite rather than the actual adhesion to the surface under study.

In this experiment, control group produced similar ARI scores. Under dry conditions, most of the adhesive remained on the surface of the teeth after debonding, indicating failure at the bracket adhesive interface. In case of contamination more of debonding occurred at tooth interface.

CONCLUSIONS

All the materials showed maximum Shear bond strength under dry conditions. It was found that contamination decreases the bond strength for all the groups and this decrease was maximum in case of contamination with blood. Shear bond strength of Transbond color change adhesive/Transbond self-etch primer was higher than that of Beauty Ortho Bond under all conditions except when contaminated with blood using Salivatect. Beauty Ortho bond with or without salivatect shows no significant difference in shear bond strength except when contamination was done with blood in which case Beauty Ortho Bond using Salivatect had higher bond strength.

REFERENCES

1. Buonocore GM. A simple method of increasing the adhesion of acrylic filling materials to enamel surface. J Dent Res 1955;34:849-53.
2. Newman GV. Epoxy adhesive for orthodontics attachment: progress report. Am J Orthod 1965;51:901-12.
3. Godinho J, Oliveira SSA, Jardim L. Comparison of Two Self-Etching Primers and Effect of Saliva Contamination on Shear Bond Strength of Orthodontic Brackets. Rev Port Estomatol Cir Maxilofac 2007;48:197-203
4. Zeppieri IL, Chung CH, Mante FK. Effect of saliva on shear bond strength of an orthodontic adhesive used with moisture insensitive and self-etching primers. Am J Orthod Dentofacial Orthop 2003;124:414-9.
5. Vilchis RJS, Yamamoto S, Kitai N, Yamamoto K. shear bond strength of orthodontic brackets bonded with different self-etching adhesives. Am J Orthod Dentofacial Orthop 2009;136:425-30.
6. Santos BM, Pithon MM, Ruellas AC, Anna EF. Shear bond strength of brackets bonded with hydrophilic and hydrophobic bond systems under contamination. Angle Orthod2010.80:963-7.
7. Vicente A, Mena A, Ortiz AJ, Bravo LA. Water and saliva contamination effect on shear bond strength of brackets bonded with a moisture tolerant light cure system. Angle Orthod 2009;79:127-32.

8. Vilchis RJS, Ohasi S, Yamamoto K. effect of 6 self-etching primers on shear bond strength of orthodontic brackets. Am J Orthod Dentofacial Orthop 2009;135:424-5.
9. Årtun, J. and S. Bergland. Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment. Am J Orthod 1984. 85:333–340.
10. Britton J C, McInnes P, Weinberg R, Ledonx W R, Retief D H.Shear bond strength of ceramic orthodontic brackets to enamel. Am J Orthod Dentofacial Orthop.1990;98:348-53.
11. Triolo PT jr, Swift EJ jr, Mudgil A, Levine A. Effects of etching time on enamel bond strength. Am J Dent.1993;6:302-4.
12. Bishara SE, Gordan VV, Vonwald L, Olson ME. Effect of an acidic primer on SBS of orthodontic brackets. Am J Orthod Dentofacial Orthop.1998;114:243-7.
13. 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;119:621-4.
14. Trites B, Foley TF, Banting D. Bond strength comparision of 2 self-etching primers over a 3 month storage period. Am J Orthod Dentofacial Orthop.2004;126:709-16.
15. Velo S, Carano A, Carano A. self-etching vs traditional bonding systems in orthodontics:an in vitro study. Orthod Craniofac Res.2002;5:166-9.
16. Ikemura K, Tay FR, Endo T, Pashley DH. A review of chemical approach and ultramorphological studies on the development of fluoride releasing dental adhesives comprising new pre-reacted glass ionomer (PRG) fillers. Dent Mater J.2008;27:315-39.
17. Elekdag-turk S, Isci D, Turk T, Cakmak F. Six month bracket failure rate evaluation of a self-etching primer. Eur J Orthod.2008;30:211-6.
18. Turk T, Elekdag-turk S, Isci D, Cakmak F, Ozkalayaci N. saliva contamination effect on shear bond strength of self-etching primer with different debond times. Angle Orthod. 2007;77: 901-06.

How to cite this Article: Author Name: Kumar P, Sharma R, Saroha K, Sharma P**,** Singh V. Effect of different contaminants on the shear bond strength of a newly introduced self-etch adhesive system used with moisture protective barrier. - An invitro study. J Dent Specialities,2015;3(1):54-59

Source of Support: NIL
Conflict of Interest: None Declared