EFFECT OF SALIVA CONTAMINATION AND DIFFERENT DECONTAMINATION MODES ON DENTIN BOND STRENGTH DURING BONDING WITH SINGLE BOTTLE ADHESIVE

* Suresh B.S ** Pushpa R.

** Professor, **Associate Professor, Department of Conservative and Endodontics, Kothiwal Dental College and Research centre, Moradabad (U.P.)*

ABSTRACT

The objective of the present study is to evaluate the different mode of decontamination of saliva on dentin bond strength. Buccal/lingual surfaces of 48 extracted human molars were wet ground to create flat dentin surface, to serve as bonding area for single bond and the hybrid composite resin. The experimental teeth were then categorized into six groups of 8 teeth each and treated in the following manner. Group 1 control (without contamination), Group 2 etched surface is contaminated with saliva and saliva is decontaminated by air drying. Group 3 etched surface is contaminated and saliva was decontaminated by rinsing and blot drying.group4 uncured adhesive surface contaminated, saliva is decontaminated by rinsing and blot drying. Group 5 cured adhesive surface is contaminated, decontamination of saliva was done by rinsing and air drying. Group 6 treated similar to Group 5 with additional adhesive application after air drying. All teeth were mounted in iron mould and subjected to universal testing machine for shear bond strength. Lowest mean bond strength was found in Group2 which was significantly lower than all other Groups ($p<0.01$). Group5 and Group6 were significantly lower than Group1, 3 and 4. Based on this study it was found that one bottle adhesive systems are less sensitive to salivary contamination in contrast to previous generation adhesives.

KEYWORDS: ***saliva contamination, air drying , blot drying , shear bond strength***

INTRODUCTION

Adhesion to dentin has been the subject of considerable interest with increased demand on the esthetic restorations by patients and the clinical practitioner. Bonding agents have undergone dramatic changes in chemistry and clinical use over the last few decades. In order to obtain successful adhesion between resin composite and tooth structure, it is necessary that the adhesive substrate should not be contaminated with fluids, such as saliva[1-5], blood[2], plasma[1-4], saline[1].

Since dental adhesives and composite are very vulnerable to contamination it is very much important to achieve moisture control during the use of these materials. The difficulty of achieving moisture control is a common problem encountered in restorative dentistry, especially when rubber dam isolation is impossible. Many carious lesions are found in areas that are difficult to isolate, especially when the site is near or at the gingival margin where saliva contamination is more likely to occur.

Today, bonding to hard tissue like tooth can be accomplished by using one of the two adhesion strategies: the etch and rinse or the self- etch approach. On contrary to etch and rinse approach, the conditioning step in self-etch systems is not separated from the priming step and therefore, demineralization and infiltration occurs simultaneously.[6]

Self- etch systems are also more user-friendly than the etch and rinse approach, as separate etching step and the consequential management of dentin moisture was completely eliminated.[6]

Different research centers have shown that, in spite of their user-friendliness and low technique sensitivity some one-step self-etch adhesives exhibit relatively low bond strength values to both enamel and dentin, when compared to two-step self-etch or etch-and-rinse systems[7-9]. Hence in this study single bottle adhesive (total etch) system which is considered to be gold standard in performance was used to investigate the effect of saliva contamination on dentin adhesion.

In this study, shear bond strength, one of popular in vitro measure to test the effectiveness of dentin bonding agent has been utilized to measure the bond strength of the saliva contaminated dentin surface.

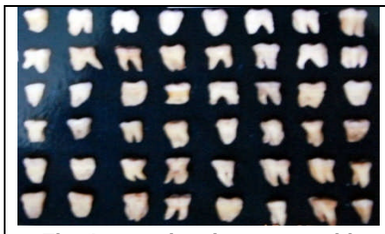


Fig .1. sample- six groups with eight teeth each

Fig. 2: Armamentarium

Fig. 5: Hounsfield Universal Testing Machine

Fig. 3: Materials

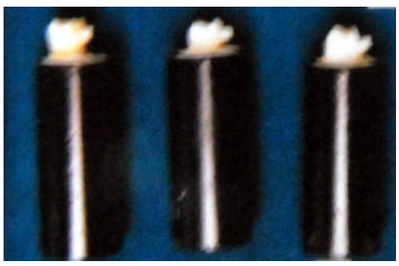


Fig.4: Specimens mounted in Iron Moulds

Material and methods (Fig.1 to Fig.5)

Materials used in this study were Single bond (3M, U.S.A) adhesive, scotch bond etchant(35% phosphoric acid gel), Z-100 (3M,U.S.A) Hybrid composite, fresh human whole saliva. Forty eight extracted human molar teeth were collected, after mechanical debridement of their surfaces; they were stored in normal saline. The buccal or lingual surfaces of molars were wet ground serially with 240-600 grit silicon carbide paper to create flat dentinal surfaces to serve as bonding area for the hybrid composite resin. The experimental teeth were then categorized into 6 groups of 8 teeth each. The teeth were mounted in iron mould using self cure acrylic. The mounted teeth were treated in the following manner for each group.

Group 1: The dentin surface was etched with scotch bond etchant for 15 seconds followed by thorough rinsing with distilled water for 10 seconds, and blot dried with absorbent paper for removal of excess water. Two consecutive layers of bonding agent was applied after etching, adhesive was air dried for 5 seconds then light cured for 10 seconds. Teflon mould was then stabilized over the labial/buccal surface and a cylinder shaped specimen of composite resin(3 mm diameter and 2mm thickness) was obtained bonding to the labial or buccal surfaces of the incisor with the help of Teflon mould.

Group 2: After etching, rinsing and blot drying the bonding surface as in group 1, fresh whole human saliva was applied to the etched surface with the help of disposable brush and left undisturbed for 15 seconds. The saliva was then removed by a 5 second air blast. Further procedure of adhesive and composite resin application was done as in group 1.

Group 3: Procedure was similar to group 2, however, after 15 second contamination, then the saliva was removed with rinsing by distilled water for 10 seconds and blot dried.

Group 4: Etching and adhesive application was done and air dried and this uncured adhesive was coated with saliva. After 15 second dwell time, the surface was rinsed and blot dried as in group 3 and another two coats of adhesives applied, air dried and light cured. Further procedure of composite resin application was done as in group1

Group 5: The treatment of specimens were similar to group 4 except that adhesive was air dried and light cured for 10 seconds before contamination, after that saliva was removed by rinsing and air drying, later composite was applied as in other groups.

Group 6: Specimens were treated similarly to group 5 however, after decontamination of specimens by rinsing and air drying, another two layer of adhesive was applied, air dried and light cured for 10 seconds prior to composite application and curing.

All specimens were subjected to shear bond strength to Hounsfield universal testing machine at a cross head speed of 1mm/min until debonding occurred. Debonding stress in Mega Pascal, was then calculated by the ratio of maximum load in Newton to the cross sectional area of the bonded interface in millimeter.

The collected data were subjected to statistical analysis by using one way analysis of variance (ANOVA) and simultaneous comparison of significant difference was done by Duncan's multiple range tests (P<0.01).

Results

Table 1 and Graph 1 depict the shear bond strengths of different groups. The highest bond strength was found in group 1 with mean of 18.926 Mpa (control), the lowest bond strength was found in group 2 with mean of 4.051 Mpa which was significantly lower when compared to all other groups. Group 3 showed bond strength values with the mean of 18.675 Mpa which was not significantly lower when compared to group 1 and group 4 but it was significantly higher when compared to group 5 and group 6 (P<0.01). Group 4 showed mean bond strength of 18.390 Mpa which was not significantly lower when compared to neither group 1 nor group 3 but it was significantly higher than group 5 and group 6.

Group 5 and group 6 showed mean bond strengths of 9.495 Mpa and 9.525 Mpa respectively which was significantly lower than group 1, group 3 and group 4. There was no statistical difference between group 5 and group 6.

Discussion

Contamination by blood or saliva is a major clinical problem during restorative dental treatment when rubber dam isolation is not used. Often, the application of rubber dam is difficult or even impossible, e.g., when deep cervical lesions are restored or when indirect restorations are seated. Thus resin adhesives that bond effectively to enamel and dentin in spite of protein contamination, would be highly desirable.

TABLE I:
SHEAR BOND STRENGTH IN Mpa WITH MEAN AND STANDARD DEVIATION

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Mean	18.926	4.051	18.675	18.390	9.495	9.525
SD	0.491	0.865	0.842	0.622	0.592	0.979

TABLE II:
ANOVA TABLE (Dentin)

Source	SS	Df	MSS	F	P
Between groups	1605.0	5	321.00	-	< 0.001
Within groups	23.7	42	0.57	567.6	
Total	1628.7	47	-	-	

TABLE III:
COMPARATIVE STATISTICS OF SHEAR BOND STRENGTH OF DENTIN IN SIX GROUPS

Groups	Shear bond strength (Mpa)		Pair wise comparisons				
	Range	Mean ± SD	II	III	IV	V	VI
I	18.007 – 19.552	18.926 ± 0.491	P < 0.01	NS	NS	P < 0.01	P < 0.01
II	2.771 – 5.540	4.051 ± 0.865	-	P < 0.01	P < 0.01	P < 0.01	P < 0.01
III	17.827 – 20.114	18.675 ± 0.842	-	-	NS	P < 0.01	P < 0.01
IV	17.448 – 19.407	18.390 ± 0.622	-	-	-	P < 0.01	P < 0.01
V	8.573 – 10.551	9.495 ± 0.592	-	-	-	-	NS
VI	8.303 – 11.080	9.525 ± 0.979	-	-	-	-	-

One way ANOVA (F-567.6 , P < 0.001)

Duncan's multiple range test

Compared to enamel bonding, several factors that contribute to the complexity in dentin bonding includes higher organic component in dentin, fluid pressure from the dentinal tubules, and the presence of smear layer.

Recent total etch adhesive contains primer and adhesive components in a single solution. This combination of primer and adhesive reduces application steps and duration of bonding procedure[10]. And hence it also makes bonding procedure less sensitive to contamination.

This present study is carried out to determine the efficacy of one bottle adhesive (single bond) after saliva contamination during different stages of bonding, starting from etching to final stage of composite application.

The composition of single bond was BIS-GMA, Dimethacrylates, HEMA, polyalkenoic copolymer, ethanol and water

Bonding surface of the specimen were first etched with 35% phosphoric acid gel for 15 seconds followed by rinsing with water for 10 seconds and blot drying of the surface with the tissue paper to remove excess water to leave visibly moist surface. This is referred to as "wet bonding" or moist bonding[11]. With single bottle adhesive wet bonding is advisable because excess drying after etching leads to collagen network collapse and closure of micro channels by the removal of apatite[11], in order to avoid the collapse of the collagen network, a moist bonding procedures has been proposed in which the primer (or primer adhesive) is applied to the moist or even wet dentin where the perifibrillar spaces are kept open with water.

These primer monomers contain hydrophilic groups (e.g.-OH, -COOH) for better compatibility of the resin monomers with moist dentin and hydrophobic methacrylate groups for the copolymerization with the bonding resin. Solvent ethanol which is volatile raises the vapor pressure of the water and causes some of it to become volatile. In addition it reduces the surface tension of the water and allows the spreading of the mixture along the surface that is otherwise coated with water. The solvent with resin mixture "chases and displaces" the water in dentinal tubules and peritubular spaces[12].

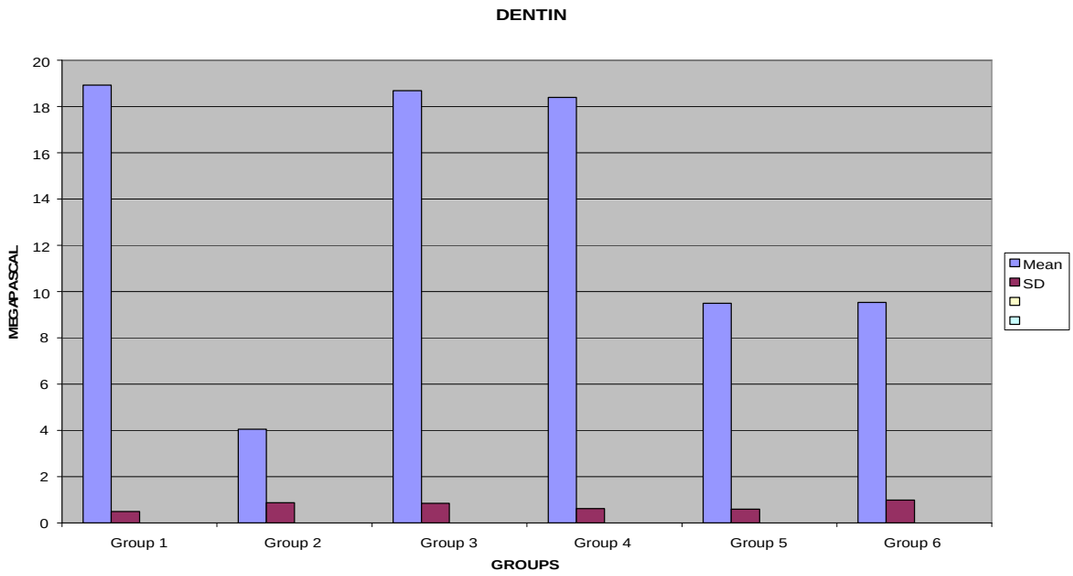
The results of this study were in agreement with the results of the other studies like Frits UB,Finger, WJ (1998), El Kalla IH, Gracia Goodoy (1997) and Abdalla AI, Davidson CL (1998).

This study showed that significant reduction in bond strength if contamination occurred after etching and removed only with air blast (group 2). This could be because of following reasons: air blasting is not sufficient to remove adsorbed salivary glycoprotein on the etched enamel surface; this adsorbed layer blocks the dentinal tubule as well as exposed peritubular or intertubular collagen network. This prevents penetration of adhesive monomer and subsequent resin tag formation[10,13-14]. Air blasting dries the dentin surface which causes collagen collapse and closure of perifibrillar spaces which intern inhibits effective hybridization1[15]. Air blasting causes collapse and denaturation of collagen fibrils protruding from the surface, resulting in a layer of amorphous material that restricts resin permeation[15, 16]. There will be partial elimination of HEMA from the meshwork under the impact of the air blast, which may result in less adhesive polymer per cross sectional area of the upper part of the hybrid layer.[14, 16] Bond was not significantly affected when contamination is removed by distal water after etching (group 3) and if contamination occurred after adhesive application before curing (group 4) this could be because of possible reasons: Rinsing is sufficient to remove all or at least sufficient amount of adsorbed protein to let the adhesive monomer diffuse and wet the hydroxyapatite[10, 13-14]. Presence of moisture left behind after blot drying might prevent possible adsorption of glycoprotein. Dentin bonding with one bottle systems mainly depends on the presence of water in the interstices of the collagen mesh which is dominating factor in the moist bonding technique. Presence of water in the saliva film left after rinsing probably facilitate penetration of monomer dissolved in volatile and water chasing solvent like ethanol.[13, 17] Organic water miscible solvents such as ethanel, acetone and HEMA have been shown to exert a stiffing effect on the demineralized dentin collagen. Stabilization is useful when the collagen matrix is hydrated, allowing the integrity of the interfibrillar space to be maintained and facilitating resin infiltration[18]. In addition Solvent ethanol/acetone seems to denature the glycoprotein sugars and remove the saliva contamination from the surface[19] and ethanol reduces the surface tension of water and allows the spreading of the mixture along the surfaces that are coated with water[18].

If the contamination occurred after adhesive being cured (group 5), and if after contamination removal another two layer of adhesive being applied before composite build up (group 6) there is a 50% reduction in bond strength compared to control. This results are in accordance with the results of other studies Frits and others (1998)[14], Yoo H.M and others[20](2006), Hitmi and others[21] (1999)

Probable reason for decreased strength could be:

Adsorption of glycoprotein to the poorly polymerized adhesive surface, where they might act as a barrier that prevent the complete wetting with the next increment of resin and thus prevents adequate copolymerization[14,21].Compromised copolymeriza tion with the subsequent resin layer by removal of



GRAPH 1: SHEAR BOND STRENGTH IN Mpa WITH MEAN AND STANDARD DEVIATION

the oxygen inhibited, unpolymerized surface layer while rinsing and drying[14]. Insufficient filling of collagen mesh with resin and it may be assumed that not all resin occupying the interstices of the collagen mesh is polymerized. Rinsing and drying after salivary contamination may therefore result in a collapsed collagen zone, deprived of resin. Addition of resin to this altered collagen surface will presumably not result in complete penetration to the level of the polymerized adhesive and in re-expansion of the network[14].

Incorporated or impregnated water on the partially cured resin might inhibit the further polymerization and copolymerization of the subsequent resin increment[22].This in vitro study demonstrated that recent one bottle adhesive are less sensitive to saliva contamination, nevertheless, it is very important to follow the rules of the moist bonding technique when saliva is removed.

CONCLUSION

Contamination of enamel and dentin surfaces during bonded restoration is highly relevant clinical matter, because it can ultimately lead to failure. Therefore, any kind of contamination of the bonding area should be avoided and this is still best accomplished by rubber dam. It may be concluded on the basis of this study that one bottle adhesive systems are less sensitive to salivary contamination in contrast to previous generation adhesives. Nevertheless, it is very important to follow the rules of the moist bonding technique when saliva is removed.

References

1. *Pashly DH, Nelson R, Kepler EE, The effect of plasma and saliva constituent on dentin permeability. 1982,J Dent Res 61: 978-81*
2. *Abdalla AL, Davidson CL. Bonding efficiency and interfacial morphology of one-bottle adhesives to contaminated dentin surfaces, 1998, Am J Dent;11(60);281-5.*
3. *El-kalla IH. Saliva contamination and resin micromorphological adaptation to cavity wall using single-bottle adhesives , Am J Dent,1999,12; 172-6.*
4. *Xie J, Powers JM, McGuckin RS In vitro bond strength of two adhesive to enamel and dentin under normal and contaminated conditions. Dent Mater 1993,9:295-9.*
5. *El-Kalla IH, Garcia-Godoy F (1997). Saliva contamination and bond strength of single-bottle adhesives to enamel and resin. Am J Dent 10; 83-7.*
6. *Van Meerbeek B-De, Munck J. Yoshiday, Inaues, Vargas M, Vijay P, Van Landuyt Lambrechts P and Vanherele G Bounocore memorial lecture. Adhesion to enamel and dentin current status and future challenges operative dentistry ,2003, 28(3) 215-235*
7. *Inoue S, Vargas MA, Abe Y, Yoshida Y, Lambrechts P, Vanherle G, Sano H & Van Meerbeek B Microtensile bond strength of eleven contemporary adhesive to enamel American Journal of Dentistry 2003, 16(5) 329-334*
8. *Armstrong SR, Vargas MA, Fang Q &Laffoon JE(Microtensile bond strength of a total-etch 3-step,total-etch 2- step, self-etch 2-step, and a self-etch 1-step dentin bonding systems through 15-*

month water storage Journal of Adhesive Dentistry, 2003, 5(1) 47-56.

9. *Brackett WW, Ito S, Nishitani Y, Haisch LD & Pashly DH The microtensile bond strength of self-etching adhesives to ground enamel Operative Dentistry,2006, 31(3) 332-337.*
10. *Abdalla AI & Devidson CL Bonding efficiency and interfacial morphology of one- bottle adhesives to contaminated dentin surfaces American Journal of Dentistry ,1998, 11(6) 281-285*
11. *Bernd Haller, Albert Einsterin(2000) Recent developments in dentin bonding. American Journal of Dentsstry 13(1)219-223*
12. *Jocobsen T, Soderholm K.J. Effect of primer solvent, primer agitation and dentin dryness on shear bond strength to dentin,American Journal of Dentistry,1998;11;225-228*
13. *EI-Kalla IH &Garcia- Goday F: saliva contamination and bond strength of single bottle adhesives to enamel and dentin. American Journal of Dentistry, 1997,10(2); 83-7*
14. *Fritz UB, Finger WJ, Stean H salivary contamination during bonding procedure with a one- bottle adhesive system. Quintenssence International, 1998:29(9) 567-572*
15. *Tay F.R, Gwinnett, A.J, Pang K.M , Resin permeation into acid conditioned moist and dry dentin; A paradigm using water-free adhesive primers. Journal dental Research, 1996, 75; 1034-1044inger WJ, Markus B, Rewetting strategies for bonding to dry dentin with an acetone based adhesive. Journal of Adhesive Dentistry,2000, 2;51*
16. *Tay F.R, Gwinnett, A.J, Pang K.M; Resin permeation into acid conditioned moist and dry dentin; A paradigm using water-free adhesive primers. Journal dental Research, 1996;75; 1034-1044*
17. *Pashley DH, Sano H,Permeability of dentin to adhesive agents Quintessence International ,1993 ;24; 618-631.*
18. *Eriksson SO, Pereira PNR, Swift EJ Jr, Heymann HO,Sigurdsson A . Effect of saliva contamination on resin- resin bond strength dental materials, 2004;20(1)37-44*
19. *Yoo HM, Oh TS, Pereira PNR. Effect of saliva contamination on the microshear bond strength of one-step self-etching adhesive systems to dentin Operative Dentistry,2006;31(1), 127-134*
20. *Hitmi L, Attal JP & Degrange M Influence of time point of salivary contamination on dentin shear bond strength of 3 dentin adhesive systems Journal of Adhesive Dentistry ,1999, 1(3)219-232. 22*
21. *Jocobsen T, Soderholm K.J some effects on water on dentin bonding. Dental material ,1995; 11; 132-136*

Corresponding Author :

Dr. Suresh B.S. **M.D.S.**
Professor,
Depatment of Pedodontics and Preventive Dentistry
Teerthankar Mahaveer Dental College and Research centre, Moradabad (U.P.)
Mob. No.: 9997072999 E. mail:
abbisuresh@rediffmail.com