



EVALUATION OF SHEAR BOND STRENGTH OF COMPOSITE TO DENTIN REWETTED WITH A DESENSITIZER- AN IN-VITRO STUDY

Dr. Sundaresan Balagopal¹, Dr. Bahavathi Ananthan Hemasathya², Dr. Ramasamy Saravanan Gayathri³, Dr. M. Anisha Sebatni⁴, Dr. Vasudevan Navabharathy⁵

¹ MDS. MSc., Professor and HOD, Department of Conservative Dentistry and Endodontics, Tagore Dental College and Hospital, Rathinamangalam, Chennai – 600127.

² MDS. Associate Professor, Department of Conservative Dentistry and Endodontics, Tagore Dental College and Hospital, Rathinamangalam, Chennai – 600127.

³ MDS., Senior Lecturer, Department of Conservative Dentistry and Endodontics, Tagore Dental College and Hospital, Rathinamangalam, Chennai – 600127.

⁴ MDS., Senior Lecturer, Department of Conservative Dentistry and Endodontics, Tagore Dental College and Hospital, Rathinamangalam, Chennai – 600127.

⁵ Post Graduate, Department of Conservative Dentistry and Endodontics, Tagore Dental College and Hospital, Rathinamangalam, Chennai – 600127.

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Address for Correspondence: Dr. Bahavathi Ananthan Hemasathya, M.D.S., Villa No 91, Casagrande Urbano, Ponmar, Vengadamangalam Road, Ponmar, Chennai-600127

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ABSTRACT:

Aim: The aim of the study was to evaluate the shear bond strength of composite to dentin with 2 different dentin bonding agents after dry dentin is rewetted with a desensitizer.

Materials and Methods: Sixty human mandibular molars were taken and the occlusal surface was ground to expose flat dentinal surface. The samples were divided into two major groups Group I and Group II based on the bonding agent used. In Group I Gluma Bond5 was used and in Group II Adper Single Bond 2 was used. Each major group is subdivided into three subgroups a, b and c with ten samples each. Sub Group 'a' is moist dentin group.-Sub Group 'b' is dry dentin group, Sub Group 'c' is rewetted dentin group. The desensitizer used is GLUMA Desensitizer. All these samples were thermocycled and the shear bond test was performed using Instron Universal Testing Machine.

Results: Dry dentin rewetted with GLUMA Desensitizer followed by GLUMA Bond5 showed highest shear bond strength than that of other subgroups. The data was analysed using ANOVA and Tukeys honestly significant test.

Conclusion: Desensitizer used as a rewetting agent increases the shear bond strength of composite on dry dentin.

Keywords: Glutaraldehyde, rewetting.

INTRODUCTION

Adhesive dentistry has been replacing conventional dental amalgam because of its high aesthetic property, minimal tooth preparation and satisfactory longevity during function and it helps evade mercury toxicity inherent with dental amalgam. The adhesive property of composite

restorations to enamel is based on a strong and durable micromechanical bond between enamel and bonding agent. ^[1] Acid etching is a prerequisite to achieve this bond. Conventionally, enamel is etched, rinsed and dried to expose the partially demineralised enamel rods. The bonding resin penetrates the exposed enamel rods and retains the composite to the enamel. ^[2] Compared to

enamel bonding, dentin bonding is complex due to its structure, rich organic matrix and moisture content. [3] Dentinal bonding is also through demineralising of the dentinal matrix and hybridizing it with the resin bonding agent. [4] Often clinical situations require restoration involving enamel and dentin. The use of air syringe to dry enamel also desiccates the dentin with resultant collapse of the weak dentinal collagen scaffold. This affects the penetration of bonding resin to achieve hybridization and bonding. Only moisture in dentin preserves the micromorphological integrity of collagen. Hence, water chasing bonding agents are introduced that would displace the moisture and establish satisfactory penetration into the enamel and dentin for retention. But most studies show that capillary penetration of bonding agent into the dried enamel establishes strongest bond strength to enamel. [5] Hence, clinicians prefer drying of the enamel to gain maximum retention. To overcome the problem associated with bonding to dehydrated dentin the suggested practice is to rewet the inadvertently dried dentin with water. [6] Care should be taken while drying or rewetting of dentin so that dentin should not be over wet or over dried. Over wetting can cause phase separation between the hydrophobic and hydrophilic components. Moreover, even remnant water can be one of the cause for postoperative sensitivity often encountered with resin composite restoration. [7] To preserve collagen as well as to avoid or minimise postoperative sensitivity, a balanced application of rewetting agents are used on the dry dentin. A few studies have shown that application of desensitizing agents may resolve the problem of post-operative sensitivity and also maybe a satisfactory substitute for water as rewetting agent. [8] Hence the purpose of this study was to evaluate the shear bond strength of a selected composite to dentin rewetted with the selected desensitizer and when used with two different dentin bonding agents.

METHODS AND MATERIALS

Materials Used:

- a) Human Permanent Molar Teeth.
- b) Distilled water (Nice Chemical laboratory Supplies Ltd, Kochi, Kerala)

- c) Self-cure acrylic resin to mount the tooth. (DPI-RR cold cure, 10162, India)
- d) GLUMA Etch 35 Gel (Heraeus Kulzer GmbH, Hanau Germany,63450)
- e) GLUMA Desensitizer (Heraeus Kulzer GmbH, Hanau Germany, K010512)
- f) Composition: 2-hydroxyethyl methacrylate, 36.1% Glutaraldehyde, 5.1% Water
- g) GLUMA Bond5 (Heraeus Kulzer GmbH, Hanau Germany, K010515)
- h) Composition: HEMA, 4META, Methacrylate, Polycarboxylic acid, Glutaraldehyde, Solvent, Ethanol and water
- i) Adper Single Bond 2 Adhesive (3M, ESPE Dental Products, St.Paul, MN, USA, 51202)
- j) Composition: MDP Phosphate monomer, Dimethacrylate resins, HEMA, Vitrebond copolymer, filler, Ethanol, Water, Initiators, Silane.
- k) Tygon tubes of height 2mm and diameter 5mm. (Tygon S3™,SAINT GOBAIN E-3603, North America)
- l) Charisma Smart (Heraeus Kulzer GmbH, Hanau Germany, K010512)
- m) Composition: Bis-GMA and TEGDMA, 64% filler (by volume) Barium aluminium fluoride glass (0.02 – 0.07) Silicon dioxide (0.01 – 0.04 um
- n) Light Curing Unit- Blue Phase (Ivoclar Vivadent, Schaan, Liechtenstein, Switzerland)
- o) Universal testing machine- Instron (INSTRON 3380 Series, Massachusetts, USA)

Methodology:

Sixty freshly extracted, caries-free human permanent molars were debrided using periodontal curettes and were stored in distilled water until use. Flat dentin surface was created on the occlusal surface of extracted teeth with slow-speed diamond disk under continuous water cooling. Then, each tooth was mounted in a chemically cured acrylic resin, such that 3-4 mm of the crown will be exposed. (Figure1).



Figure 1: Exposing the Dentin

The specimens were divided into two major groups of thirty teeth each, depending upon different bonding agents used as Group I and Group II (Table 1). Group I: GLUMA Bond5 group and Group II: Adper Single Bond 2 adhesive group. These two groups were subdivided into three subgroups a, b, and c consisting of ten teeth in each sub group.

In Group Ia after etching and rinsing, the dentin is made visibly moist by gently blotting with absorbent paper. Then GLUMA Bond5 is applied in two coats and polymerised for 20 seconds as per manufacturers’ instructions. In Group Ib after etching the dentin is dried with air syringe to desiccate the substrate. Then, GLUMA Bond5 is applied as in group Ia.

In Group Ic after etching and desiccating the substrate as in group Ib, the dentin is rewetted with GLUMA Desensitizer which was applied in two coats and allowed to penetrate for 30-60 seconds and dried by applying a stream of compressed air until the fluid film had disappeared and the surface is no longer shiny and then rinsed thoroughly with water according to manufacturer’s instruction. The excess water was blot dried and this was followed by application of GLUMA Bond5 as in previous sub groups. For the subgroups in Group II, the procedures similar to the subgroups in Group I were followed except that the bonding agent used was Adper Single Bond 2 as per manufacturer’s instructions instead of GLUMA Bond5.

Table 1: Table for various Groups

Number of teeth(60)					
Group I (n=30)			Group II (n=30)		
GLUMA Bond5 and Charisma Smart			Adper Single Bond 2 and Charisma Smart		
Group Ia			Group IIa		
Moist dentin			Moist dentin		
Group Ib			Group IIb		
Dry dentin			Dry dentin		
Group Ic			Group IIc		
Rewet with Gluma desensitizer			Rewet with Gluma desensitizer		

Fabrication of composite cylinder:

Tygon tubes of 2mm height and internal diameter of 5mm were placed over the prepared dentin surface. Composite resin was filled in to the tygon

tube in single increment and was polymerized for 20 seconds using light curing unit as per the procedure followed by Vibha et al in 2016^[9]. The tube was then cut with No. 11 BP blade and removed. (Figure 2). The specimens were stored in distilled water for 24 hours at 37⁰C.



Figure 2: Fabrication of Composite cylinder

Thermocycling procedure:

The prepared specimens were then thermo-cycled in water baths set to 8⁰C and 48⁰C. The specimens were thermo-cycled for 2500 cycles with dwell time of 30 seconds at the set low and high temperatures with a transfer time of 10 seconds.

Shear bond strength evaluation:

The thermo-cycled specimens were subjected to shear bond strength evaluation using Instron Universal Testing Machine set at a crosshead speed of 1mm/minute. (Figure 3) The specimens were debonded using a knife edge at the tooth restoration. The break load values were recorded through a computer connected to it. The shear bond values were obtained in MegaPascal (MPa).



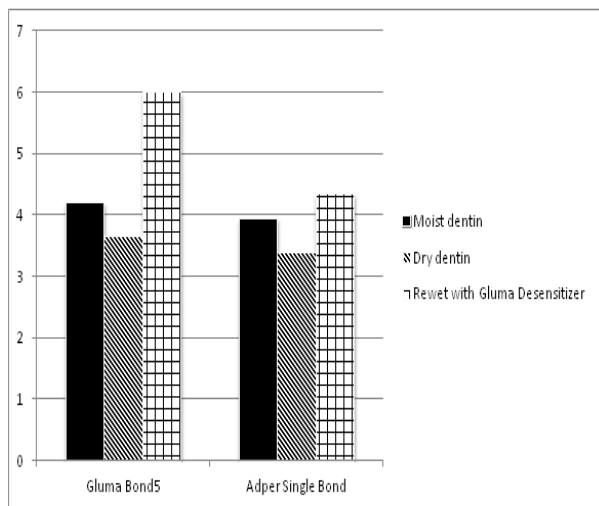
Figure 3: Shear bond strength evaluation using Instron

STATISTICAL ANALYSIS

The results were entered into a Microsoft excel sheet for calculation of statistics. One way analysis of variance (ANOVA) was used to evaluate the shear bond strength of composite on dentin. Tukey’s Honestly Significant test was used to identify the significant pairs at 5%.

Table 2: Shear bond strength values (MPa) for all subgroups

GROUPS	NO OF READINGS	MEAN (MPa)	STANDARD DEVIATION
Group Ia	10	4.20	0.59
Group Ib	10	3.65	0.88
Group Ic	10	6.00	0.91
Group IIa	10	3.95	0.68
Group IIb	10	3.40	0.87
Group IIc	10	4.35	0.81



Graph 1: Comparison of shear bond strength values.

RESULTS:

Table 2 shows moist dentin proved better strength than that of dry dentin. Dry dentin when rewetted with a GLUMA Desensitizer showed markedly more strength than that of dry and moist dentin. Dry dentin rewetted with GLUMA Desensitizer followed by GLUMA Bond5 and Charisma Smart showed more strength than that of other

subgroups (Graph 1). There was a significant difference in shear bond strength between the six subgroups using ANOVA.

DISCUSSION:

Composites are extensively used for both anterior and posterior restorations. Hybridization theory by Nakabayashi (1991) is the commonly accepted technique for dentin adhesion. After etching of dentin, collagen fibril network with inter and intra-fibrillar micro-porosities are exposed.^[10] Low viscosity monomers when applied on the etched dentin surface diffuse into the demineralised dentin and form a resin - dentin interdiffusion zone. When this is polymerized, there will be entanglement of the fibrils by the resin which creates a hybrid layer of resin-reinforced dentin. Hybrid layer thus formed establishes the bonding mechanism for many adhesive systems.^[10]

Various methods of drying the dentin have been experimented in the past with varying degree of success.^[11] Optimum moisture in dentin preserves the micro morphological integrity of collagen and formation of sufficiently bonding hybrid zone. The dentin is hence generally kept visibly moist to achieve optimum bonding, by gentle mopping with absorbent paper than air drying during restorative procedure using resin composite.^[12]

Dehydration of dentin would result in the collapse of the collagen scaffold which otherwise helps in the formation of the hybrid zone that retain the restoration.^[10] Hence, inadvertent over drying can contribute to insufficiency of bonding of resin composite to dentin.^[12-14] The dentin could also get dehydrated because of the environmental conditions.^[15] In addition post-operative sensitivity following composite restorations in posterior teeth is a common problem experienced by clinicians.^[16,17] A lot of innovative techniques have been discussed in the literature to enhance the bond strength of composite to enamel and dentin.^[18] It has been demonstrated that rewetting with water revives the collapsed dentin matrix and returns the bond strength.^[6] It has also been observed that remnant water can also be one of the cause for postoperative sensitivity.^[7] Further, if the dentin is over wet there is a phase separation between the hydrophobic and hydrophilic

components that will end up with a blister or globule formation termed the 'over-wet' phenomenon.^[7] Hence, in order to achieve optimum bond and reduce the postoperative discomfort it has been suggested to rewet the dry dentin with dentin desensitizers such as Vivasens, System P, Densshield, Sensodent K^[19,20] Many proprietary rewetting agents are also available in the market such as Gluteraldehyde in water, MS coat, Tubilicid, Hurriseal and Protect^[19,20]. Gluma has an established effect of tubular occlusion and desensitizing open and exposed dentin.^[21] Therefore, in this study we have compared the shear bond strength of composite on dentin with two different bonding agents applied over application of 'GLUMA Desensitizer'.

In this study when GLUMA Desensitizer is used to rewet dry dentin along with GLUMA Bond5, it showed the best strength. Previous studies have also demonstrated that application of GLUMA Desensitizer after conventional etching of dentin has improved the efficacy of dentin bonding system.^[22-25] Schupbach et al in 1997 resolved that the increase in bond strength may be due to the synergistic action of Glutaraldehyde and 2-hydroxyl ethyl methacrylate (HEMA)^[21] In this study GLUMA Desensitizer is used over dry dentin as a wetting agent and the result was highly favorable.

According to this study, dry dentin rewetted with GLUMA Desensitizer along with bonding agent GLUMA Bond5 which is from the same manufacturer and Charisma Smart composite resin which is also from the same manufacturer showed highest bond strength. Unexpectedly, this group showed better bond strength than the conventional moist bonding procedure. This is in concurrence with similar studies by Soares et al in 2006 and Ritter et al in 2000 which also showed rewetting with desensitisers enhanced bonding than conventional moist dentin bonding^[22-24] Contrary to this study, Lehmann and Degrange showed conventional moist bonding to be superior than rewetting^[19] This can be due to change in composition of different rewetting agents used.

Dry dentin bonding demonstrated the least bond strength in this study. This is in concurrence with many other studies where similar result was achieved.^[12-14] Yet another observation in this

study was the achievement of higher bond strength when using same manufacturers' product. This is not an accidental finding as many studies of properties between inter and intra manufacturers products have revealed similar results^[26]

CONCLUSION:

Within the limitations of this study, it was observed that the shear bond strength of composite on dentin is more when dry dentin is rewetted with a GLUMA Desensitizer than conventional moist dentin bonding procedure. This gives a new insight that it may be acceptable to dry the etched enamel and dentin to achieve high bond strengths through dried enamel and desensitizer rewetted dentin.

It was also observed that products from same manufacturer demonstrated better result than mixing products of different manufacturers.

REFERENCES:

1. McLean DE, Meyers EJ, Guillory VL, Vandewalle KS. Enamel bond strength of new universal adhesive bonding agents. *Oper Dent.* 2015 Jun;40(4):410-7.
2. Crawford PJ, Whittaker DK, Owen GM. The influence of enamel prism orientation on leakage of resin-bonded restorations. *J Oral Rehabil.* 1987 May;14(3):283-90.
3. Swift EJ, Perdigao J, Heymann HO. Bonding to enamel and dentin: a brief history and state of the art, 1995. *Quintessence Int-English Edition.* 1995 Feb 1;26:95.
4. Piemjai M, Watanabe A, Iwasaki Y, Nakabayashi N. Effect of remaining demineralised dentine on dental microleakage accessed by a dye penetration: how to inhibit microleakage?. *J Dent.* 2004 Aug 1;32(6):495-501.
5. Meyer-Lueckel H, Paris S, Mueller J, Cölfen H, Kielbassa AM. Influence of the application time on the penetration of different dental adhesives and a fissure sealant into artificial subsurface lesions in bovine enamel. *Dent Mater.* 2006 Jan 1;22(1):22-8.
6. Finger WJ, Balkenhol M. Rewetting strategies for bonding to dry dentin with an acetone-based adhesive. *J Adhes Dent.* 2000 Mar 1;2(1).

7. Al Qahtani MQ, Platt JA, Moore BK, Cochran MA. The effect on shear bond strength of rewetting dry dentin with two desensitizers. *Oper Dent*. 2003 May 1;28(3):287-96.
8. KÜLÜnk Ş, Sarac D, KÜLÜnk T, Karakaş Ö. The effects of different desensitizing agents on the shear bond strength of adhesive resin cement to dentin. *J Esthet Restor Dent*. 2011 Dec;23(6):380-7.
9. Vibha D, Prachi J , Lalitagauri Mandke M . Evaluation of Shear Bond Strength of Two Dentin Bonding Agents with Two Desensitizers (An In-Vitro Study) *Natl J Integr Res Med* 2016; 7(4): 117-124.
10. Nakabayashi N, Pashley DH. Hybridization of dental Tissues. Che.3, 1, 2. Tokyo: Quintessence publishing co Ltd; 1998.
11. Mathews IE, Arathi G, Balagopal S. Heat radiation vs air drying to remove interfacial water from self-etch adhesives. *Indian J Dent Res* 2008;19:147-9.
12. Kanca J. Resin bonding to wet substrate. 1. Bonding to dentin. *Quintessence Int* 1992;23:39-41.
13. Triolo PT Jr, Swift EJ Jr, Barkmeir WW. Shear Bond strengths of composite to dentin using six dental adhesives systems. *Oper Dent* 1995;20:46-50.
14. Haller B. Recent developments in dentin bonding. *Am J Dent* 2000; 13:44-50.
15. Chiba Y, Miyazaki M, Rikuta A, Moore BK. Influence of environmental conditions on dentin bond strengths of one-application adhesive systems. *Oper Dent*.2004 Sep 1;29:554-9.
16. Sancakli HS, Yildiz E, Bayrak I, Ozel S. Effect of different adhesive strategies on the post-operative sensitivity of class I composite restorations. *Eur J Dent*. 2014 Jan;8(1):15.
17. Auschill TM, Koch CA, Wolkewitz M, Hellwig E, Arweiler NB. Occurrence and causing stimuli of postoperative sensitivity in composite restorations. *Oper Dent*. 2009 Jan;34(1):3-10.
18. Paul P, Rosaline H, Balagopal S. The effect of hydrogel and solution of sodium ascorbate on the bond strength of bleached enamel. *J Conserv Dent* 2007;10:43-7.
19. Lehmann N, Degrange M. Effect of four desensitizers on the shear bond strength of three bonding systems. *Eur Cell Mater* 2005;9.Suppl(1):52-3.
20. Dijkman GE, Jongebloed WL, de Vries J, Ogaard B, Arends J. Closing of dentinal tubules by glutaraldehyde treatment, a scanning electron microscopy study. *Eur J Oral Sci*. 1994;102:144-50.
21. Schupbach P, Lutz F, Finger WJ. Closing of dentinal tubules by GLUMA Desensitizer. *Eur J Oral Sci*. 1997 Oct;105(5P1):414-21.
22. Soares CJ, Santos Filho PC, Barreto BC, Mota AS. Effect of previous desensitizer and rewetting agent application on shear bond strength of bonding systems to dentin. *Cienc odontol bras* 2006; 9(4):6- 11.
23. Ritter AV, Bertoli C, Swift EF Jr. Shear Bond Strengths of Gluma Bonding Systems to Dentin. *J Dent Res* 2000; 79:1852.
24. Ritter AV, Heymann HO, Swift EJ Jr, Perdigão J, Rosa BT. Effects of different re-wetting techniques on dentin shear bond strengths. *J Esthet Restor Dent* 2000; 12:85-96.
25. Bansal A, Shivanna V. Effect of Rewetting agents on the shear bond strength of different bonding agents when applied on dry dentin. *J Conserv Dent* 2007;10:26-32.
26. Ravikumar N, Shankar P, Indira R. Shear bond strengths of two dentin bonding agents with two desensitizers: An in vitro study. *J Conserv Dent* . 2011 Jul;14 (3): 247.