The effect of a dentin desensitizer on the shear bond strength of composite to dentin using three different bonding agents: An in vitro study

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Abstract

Objective: The effect of dentin desensitizer Systemp on the shear bond strength of composite resin to dentin using three different bonding agents, i.e., Prime & Bond NT, Xeno V⁺, and Futurabond DC were evaluated.

Materials and Methods: Sixty recently extracted human premolars were divided into six groups of ten teeth each. The superficial dentin was etched with 37% phosphoric acid. In Groups I, II, and III, Prime & Bond NT, Xeno V⁺, and Futurabond DC, respectively, were applied to dentin and composite placed. Following application of dentin desensitizer Systemp in Groups IV, V, and VI, Prime & Bond NT, Xeno V⁺, and Futurabond DC, respectively, were applied to dentin and composite placed. The shear bond strength was evaluated. Data obtained were statistically analyzed using one-way analysis of variance, post hoc, and Dunnett’s test.

Results: Following application of dentin desensitizer Systemp, mean shear bond strength increased when Prime & Bond NT bonding agent was used while it decreased for Xeno V⁺ and Futurabond DC bonding agents.

Conclusion: Within the limitations of this in vitro study, it was observed that following application of dentin desensitizer Systemp, mean shear bond strength may increase or decrease depending on the bonding agents used.

Keywords: Dentin desensitizer; Futurabond DC; Prime & Bond NT; shear bond strength; Systemp; Xeno V⁺

INTRODUCTION

With the emergence of improved adhesives and composite resin systems, resin-bonded composite restorations have become predictably successful. However, polymerization shrinkage and postoperative sensitivity still remain a tough challenge for clinicians to deal with.[1] Several clinical studies indicate that up to 30% of the study population report postoperative sensitivity following posterior composite resin restorations.[2]

The postoperative sensitivity could be due to trauma from tooth preparation, leakage of the restoration with the resultant ingress of bacteria as a result of polymerization shrinkage, deformation of restoration under occlusal stress which in turn transmits hydraulic pressure to the odontoblastic processes.[3] The hydrodynamic theory of Brannstorm attributes dentinal sensitivity to chemical, thermal, or osmotic stimuli that cause the fluid within the tubules to flow inward or outward. This creates a mechanical disturbance that excites nerve fibers in the pulp and elicits a pain response.[4]

A few of the treatment modalities for hypersensitive teeth include reducing tubular fluid movements by reducing dentin permeability or reducing the excitability of intradental nerves with neurally active agents.[5] For this, desensitizing agents are used. They reduce the dentin permeability by occluding or sealing the dentinal tubules and contain components such as fluoride, triclosan, benzalkonium chloride, and glutaraldehyde.[6]

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Systemp is a desensitizer which can reduce hypersensitivity by occluding and sealing the exposed dentinal tubules.[7]

Prime & Bond NT, a fifth-generation bonding agent, is an acetone-based adhesive. It is a total etch bonding agent requiring a moist dentin surface for adequate bonding.[8]

Xeno V⁺, a seventh-generation bonding agent, is a one component self-etching adhesive that provides for simultaneous conditioning and priming of both enamel and dentin with improved bond strength.[9]

Futurabond DC, an eighth-generation bonding agent, is a dual-cured, self-etching adhesive, that is, reinforced with nanoparticles.[10]

The use of a dentin desensitizer before application of bonding agent may reduce the postoperative sensitivity associated with composite restorations, but its effect on bond strength using different generations of bonding agents need to be evaluated. Therefore, this study was done to evaluate the effect of dentin desensitizer Systemp on the shear bond strength of composite resin to dentin using three different generation bonding agents, i.e., Prime & Bond NT (fifth generation), Xeno V⁺ (seventh generation), and Futurabond DC (eighth generation). The null hypothesis was that there would be no change in the shear bond strength after application of a dentin desensitizer.

**MATERIALS AND METHODS**

**Specimen preparation**

Sixty human maxillary premolars which were freshly extracted for orthodontic purpose and which were free of caries, anatomical defects, etc., were selected using a dental operating microscope (Pico, Carl Zeiss, Jena, Thuringia, Germany) at ×20 magnification. The teeth were divided into six groups of ten each. The teeth were thoroughly cleaned and stored in distilled water (Nice Chemical Laboratory Supplies Ltd, Kochi, Kerala, India). The specimens were prepared within 1 month of extraction. The roots were sectioned off with a diamond disc (SS White, Lakewood, New Jersey, USA). The occlusal surface of the crowns was sectioned with the diamond disc to expose the superficial dentin surface. Each tooth was then embedded into a rectangular metal mould of 1 cm × 4 cm using self-cure acrylic resin (Dental Products of India, Mumbai, Maharashtra, India) in such a way that the exposed occlusal dentin surface faced upward. The metal moulds with the acrylic resin were then stored in distilled water to dissipate the exothermic heat of polymerization. The superficial dentin was etched with 37% phosphoric acid (D-Tech Dental Technologies, Pune, Maharashtra, India) for 15s, then rinsed with water for 20s and blot dried with a moist cotton pellet leaving a moist glistening surface. In Groups I, II, and III, Prime & Bond NT (Dentsply, Konstanz, Baden-Wurttemberg, Germany), Xeno V⁺ (Dentsply, Konstanz, Baden-Wurttemberg, Germany), and Futurabond DC (Voco, Cuxhaven, Niedersachsen, Germany), respectively, were applied to dentin with the applicator brush and light cured according to the manufacturer’s instructions using a light-curing unit (Dentsply, Milford, Detroit, USA) of intensity 500 W/cm². In Groups IV, V, and VI, Systemp desensitizer (Ivoclar Vivadent, Schaan, Liechtenstein, Switzerland) was applied to dentin for 10s with an applicator brush and allowed to remain for 20s and then lightly dried with an air syringe. Prime & Bond NT, Xeno V⁺, and Futurabond DC were then applied to dentin of Groups IV, V, VI, respectively. Shade A2 of Filtek Z350XT (3M, ESPE Dental Products, St. Paul, MN, USA) composite resin was dispensed with a teflon-coated instrument (GDC, Hoshiarpur, Punjab, India) and condensed into a mould of 5 mm diameter and 4 mm height which was prepared using stainless steel bands (Denta, Roorkee, Uttarakhand, India) of size 0.180 × 0.005 inches and which were placed on the treated dentin surface in all the groups. The stainless steel mould was completely filled with composite in increments of 2 mm thickness and each increment was light cured for 40s. A Mylar strip (Samit Products, Jhandewalan, New Delhi, India) was adapted over the final increment of composite in the mould to obtain a uniform superficial surface and light cured for 40s. The stainless steel bands were cut using a scalpel and removed. The specimens were stored in distilled water [Table 1].

**Shear bond strength testing**

Each specimen was placed in between the jigs of the universal testing machine (Model 3345; Instron Corp, Canton, Mass, USA). A knife edge shearing chisel was engaged at the dentin-composite interface and force was applied perpendicular to the long axis of the specimen. The

**Table 1: The distribution of specimens and study groups**

| Groups (n=10) | Desensitizer | Bonding agent | Composite   |
|---------------|--------------|---------------|-------------|
| I             | None         | Prime & Bond NT | Filtek Z350 XT |
| II            | None         | Xeno V⁺        | Filtek Z350 XT |
| III           | None         | Futurabond DC  | Filtek Z350 XT |
| IV            | Systemp      | Prime & Bond NT | Filtek Z350 XT |
| V             | Systemp      | Xeno V⁺        | Filtek Z350 XT |
| VI            | Systemp      | Futurabond DC  | Filtek Z350 XT |
equipment was operated at a cross-head speed of 1 mm/min and the load to debond the composite was recorded in Newton (N). The shear bond strength (MPa) was calculated by the ratio of the maximum load in Newton (N) to the cross-sectional area (mm²) of the bonded interface.

Statistical analysis
The values obtained were statistically analyzed using computer software Statistical Package for Social Sciences (SPSS) (version 16.0) (SPSS Inc., Chicago, IL, USA). The data were expressed with the mean and standard deviation. Unpaired sample t-test was applied to find the statistical significance between the groups. One-way analysis of variance followed by post hoc and Dunnett’s test was applied for multiple comparisons. \( P < 0.05 \) was considered to be statistically significant at 95% confidence interval.

RESULTS
Maximum mean shear bond strength value was observed in Group IV, statistically significant compared to Groups I, II, V \( (P < 0.05) \). Minimum shear bond strength value was observed in Group V, significant compared to all other groups \( (P < 0.05) \). No significant difference was observed in shear bond strength value when Group III was compared with Group VI \( (P > 0.05) \). Shear bond strength value of Group I was significant compared to Groups II, IV, V \( (P < 0.05) \), not with Groups III, VI \( (P > 0.05) \). Shear bond strength value of Group II was significant compared to other groups \( (P < 0.05) \). Shear bond strength value of Group III was significant compared to Groups II, IV, V \( (P < 0.05) \), not with Groups I and VI \( (P > 0.05) \) [Table 2].

DISCUSSION
Following the application of dentin desensitizer Systemp, the use of Prime & Bond NT showed an increase in bond strength while the use of Xeno V⁺ showed a decrease. The use of Futurabond DC showed a decrease in bond strength but was not statistically significant. Hence, the null hypothesis that there would be no change in the shear bond strength after application of a dentin desensitizer was rejected.

Systemp desensitizer contains polyethylene glycol dimethacrylate which precipitates plasma proteins and leads to local concentrations in the dentinal tubules. Along with glutaraldehyde, it establishes stable, covalent bonds to proteins resulting in formation of firm protein plugs that occludes and seals the dentinal tubules thus reducing sensitivity.[11]

Prime & Bond NT, a single-bottle adhesive, contains nano fillers that supposedly reinforce the adhesive layer in the bonding interface. It also contains urethane dimethacrylate, a hydrophobic monomer for proper polymerization and cross-linking that bonds to surface-bound hydroxyl groups through its urethane. The presence of dipentaerythritol pentacrylate phosphoric acid ester (PENTA) facilitates the penetration of resin monomers into dentin for micromechanical bonding.[12]

The use of Prime & Bond NT following application of desensitizer showed an increase in bond strength. Dentin dehydration compromises the infiltration of the adhesive resin because of the collapse of the collagen network. The inclusion of water in the adhesive may re-expand the collapsed collagen fibrils and facilitate the infiltration of etched dentin by this acetone-based bonding agent. Acetone has been found to be a better solvent than water for resin monomers and it has the ability to displace water from the collagen network and facilitate saturation of conditioned dentin with primer components.[13,14] Systemp desensitizer may function as a rewetting agent before application of bonding agent.[15] Thus, along with Prime & Bond NT, it may result in optimal wetting. This dual wetting effect may facilitate better bond strength. Ravikumar et al. in a study found that Prime & Bond NT exhibited higher bond strengths after application of Gluma desensitizer.[19] A study by Bhatia et al. however found that the use of Prime & Bond NT did not exhibit a significant difference in bond strengths after application of Denshield and Sensodent-K desensitizers.[2]

Xeno V⁺ has high tolerance to storage conditions of up to 24°C due to monomers, namely, acrylic resins with amide groups, inverse functionalized phosphoric acid esters, and the use of tertiary butanol. The acidic monomer, acryloyl aminoalkyl sulfonic acid, is added to the formulation to increase the acidity. The presence of acrylic acid, a wetting aid, promotes the penetration of bigger cross-linking monomers into the tooth substrate.[9]

The re-wetting of dentin by the desensitizer along with the acrylic acid wetting aid in Xeno V⁺ may have led to
overwetting of dentin. The excess water in the etched dentin can result in an inadequate bonding substrate. The adhesive resin may undergo phase separation of the hydrophobic components when excess water is present resulting in resin globule formation. This may be the reason for the decrease in bond strength when Xeno V+ was used following application of desensitizer. A study by Margvelashvili et al. found that the use of Xeno V provided lower bond strengths compared to the use of Prime & Bond NT.\[19]\n
Futurabond DC contains significant amounts of highly functional nanosized cross-linking agents such as silica particles. It is available in a single use blister pack and has the property of being dual cured all in one.\[19]\n
The use of Futurabond DC following application of desensitizer showed a decrease in bond strength, but it was not statistically significant. Futurabond DC contains ethanol as the organic solvent which facilitates adequate wetting of the application surface.\[19]\ Thus, the wetting provided by Futurabond DC and the re-wetting by the desensitizer may have led to overwetting and weakening of the resin-dentin interphase. This may be the reason for the decrease in bond strength.

Even though the use of a dentin desensitizer before application of bonding agent may reduce postoperative sensitivity, it was observed that the dentin shear bond strength may increase or decrease depending on the bonding agent used.

Several factors influence in vitro bond strength to dentin such as the type and age of the tooth, the degree of dentin mineralization, the dentin surface being bonded, the storage media, the environmental relative humidity in substrates, and testing conditions.\[20]\ Other variables such as functional monomers, cross-linking monomers, solvents, inhibitors, and activators may also differ in proportions in bonding agents. The amount of monomers, diluents, and filler loads also vary.\[18]\ Moreover, desensitizing agents differ in composition and in their mode of action. All these factors could affect the shear bond strength. Due to the inherent limitations of an in vitro study, the bonding and sealing ability of bonding agents to dentin warrant further investigation. Further clinical trials using different desensitizers and bonding agents may be necessary before a final conclusion on the effect of desensitizers on dentin shear bond strength.

**CONCLUSION**

Within the limitations of this in vitro study, it was observed that the mean shear bond strength of composite to dentin may increase or decrease depending on the bonding agent that is used following the application of dentin desensitizer Systemp.

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**Conflicts of interest**
There are no conflicts of interest.

**REFERENCES**

1. Auschill TM, Koch CA, Wolkewitz M, Hellwig E, Anweiler NB. Occurrence and causing stimuli of postoperative sensitivity in composite restorations. Oper Dent 2009;34:3-10.
2. Bhatia S, Krishnasawamy MM. Effect of two different dentin desensitizers on the bond strength of two different bonding agents to dentin: An in vitro study. Indian J Dent Res 2012;23:703-8.
3. Unemori M, Matsuya Y, Akashi A, Goto Y, Akamine A. Composite resin restoration and postoperative sensitivity: Clinical follow-up in an undergraduate program. J Dent 2001;29:7-13.
4. Nicola X. The dentine hypersensitivity patient – A total management package. Int Dent J 2007;57:411-9.
5. Pashley DH. Dentine permeability and its role in the pathobiology of dentine sensitivity. Arch Oral Biol 1994;39 Suppl 1:735-80S.
6. Küllünk S, Saraç D, Küllünk T, Karakas O. The effects of different desensitizing agents on the shear bond strength of adhesive resin cement to dentin. J Esthet Restor Dent 2011;23:380-7.
7. Stewardson DA, Crisp RJ, McHugh S, Lendenmann U, Burke FJ. The effectiveness of Systemp.desensitizer in the treatment of dentine hypersensitivity. Prim Dent Care 2004;11:71-6.
8. Gangurde LB, Pawar MG, Shenoy VU, Margasahayam SV. A comparative evaluation of the shear bond strength of three different fifth generation dentin bonding agents: An in vitro study. J Contemp Dent Pract 2014;4:1-5.
9. Dentsply.Xeno V+. Available from: http://www.dentsplymea.com/products/restorative/bonding-agents/xeno-v-0. [Last cited on 2016 May 13].
10. Joseph P, Yadav C, Satheesh K, Rahna R. Comparative evaluation of the bonding efficacy of sixth, seventh and eighth generation bonding agents: An in vitro study. Int Res J Pharm 2013;4:143-7.
11. Dundar A, Yavuz T, Onucoglu H, Danehshmor L, Yalcin M, Sengun A. Evaluation of the permeability of five desensitizing agents using computerized fluid filtration. Niger J Clin Pract 2015;18:601-6.
12. Arora S, Yadav S, Yadav H, Sharma S. A comparative evaluation of shear bond strengths of composite to dentin, using total etch and self etch dentin bonding agents – An in vitro study. Indian J Dent Sci 2015;7:30-6.
13. Tay FR, Gwinnett AJ, Pang KM, Wei SH. Resin permeation into acid-conditioned, moist, and dry dentin: A paradigm using water-free adhesive primers. J Dent Res 1996;75:1034-44.
14. Tay FR, Gwinnett JA, Wei SH. Relation between water content in acetone/alcohol-based primer and interfacial ultrastructure. J Dent 1998;26:147-56.
15. Ivoclar Vivadent Systemp. Available from: http://www.ivoclarvivadent.ru/document>Systemp. [Last cited on 2016 May 23].
16. 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;14:247-51.
17. Tay FR, Gwinnett JA, Wei SH. Micromorphological spectrum from overdrying to overwetting acid-conditioned dentin in water-free acetone-based, single-bottle primer/adhesives. Dent Mater 1996;12:236-44.
18. Margvelashvili M, Beloica M, Carvalho CA, Papacchini F, Cantoro A, Goracci C. Bonding potential of all-in-one adhesives to ground enamel. Int Dent SA 2014;11:54-9.
19. Voco Futurabond DC. Available from: http://www.voco.com/en/product/futurabond_dc/index.html. [Last cited on 2016 May 21].
20. Nair M, Paul J, Kumar S, Chakravarthty V, Krishna V, Shivaprasad. Comparative evaluation of the bonding efficacy of sixth and seventh generation bonding agents: An in-vitro study. J Conserv Dent 2014;17:27-30.