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ORIGINAL ARTICLE

Effect of desensitizing agent on shear bond strength of an adhesive system

Awang RAR*, Masudi SM, Mohd Nor WZW

School of Dental Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia.

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Abstract Desensitization of teeth after cavity preparation has been recommended in an attempt to avoid post-operative sensitivity. However, there is concern regarding application effect of desensitizing agent on shear bond strength of the adhesive system used. The purpose of our study was to compare the shear bond strength of adhesive system in two different dentin surface treatments, with and without desensitizing agent. Sixteen extracted human premolars were sectioned off at the coronal portion to expose the flat dentin surfaces. The surfaces were finished using 600 Grit Wet Silicon Carbide abrasive papers. The premolars were randomly assigned to two groups: control and treated with MS Coat desensitizing agent. The desensitizer was applied according to manufacturer's instruction. Resin composite was bonded to each dentin surface using Prime & Bond® adhesive system. The composite resin was debonded by shear stress. Mann-Whitney Test was used in statistical analysis. Our result showed that application of MS Coat desensitizing agent on dentin surface had significantly reduced the shear bond strength of the adhesive system used ($z = -0.14$, $p < 0.05$). Thus, we conclude that shear bond strength of Prime & Bond® NT (Dentsply, USA) adhesive system will be reduced if dentin surface is treated with MS Coat (Sun Medical, Japan) desensitizing agent.

Introduction

Dentin hypersensitivity is defined as a transient pain arising from exposed dentin, typically in response to chemical, thermal, tactile or osmotic stimuli, which cannot be explained by any other dental defect or pathology (Addy *et al.*, 1985). The reported prevalence of dentin hypersensitivity is between 10 to 35% depending on the population studied (Hefti and Stone, 2000).

Various theories have explained the mechanism of dentin hypersensitivity. However, the hydrodynamic theory by Brannstrom (1963) is widely accepted. The theory suggested that dentin tubules act as capillary tubes and that the fluid within them acts in accordance with the law of fluid movement. The rapid movement of fluid in dentin tubules, in response to certain stimuli might produce a deformation of nerve fibers wrapped around the odontoblast cells, which may cause distortion of intradental nerve and generate pain response (Brannstrom and Astrom, 1972).

The presence of tubules in dentin makes the tissue permeable, especially when the outer protective layer of enamel or cementum is removed. Many dental procedures such as root planing, cavity preparation, veneer and crown preparation involve stripping off the cementum or enamel layer exposing dentinal tubules. Consequently, this situation may lead to the occurrence of post-operative sensitivity.

Post-operative sensitivity is frequently encountered with the use of adhesives that require conditioning of the dentin (Akpata and Sadiq, 2001 and Unemori *et al.*, 2001). Incomplete sealing and continuous transudation of dentinal fluid through open dentinal tubules before polymerization of the adhesive may result in entrapment of water-filled blisters along the adhesive interface (Tay *et al.*, 1996). Compression of these blisters during mastication may cause, within the dentinal tubules (Brannstrom and Johnson, 1970), rapid fluid movement that activates the intradental nerve fibers (Narhi *et al.*, 1994), which results in post-operative sensitivity.

Christensen (1994) had described the desensitization of teeth after crown preparation in an attempt to avoid post-operative sensitivity. Current trend of desensitization tend to concentrate on tubules occluding approaches. Although the mechanisms of pain transmission across dentin are not fully understood, both dentin permeability and sensitivity are reduced when the dentinal tubules are occluded (Pashley *et al.*,

* Corresponding author:
Tel.: +609-766 3761 Fax: +609-764 2026.
E-mail address: rjazman@kb.usm.my

1978a, Pashley *et al.*, 1978b). Desensitizing agent that occludes dentinal tubules to some extent can significantly reduce fluid filtration across dentin and consequently lower the pain response (Jain *et al.*, 1997). One way of relieving post-operative sensitivity in the clinic is adjunctive use of oxalate desensitizer on acid-etched dentin prior to adhesive application (Pashley *et al.*, 2001, Tay *et al.*, 2003). Pasley and co-workers (1992) demonstrated that sealing those dentinal tubules with polymeric resin desensitizer reduces sensitivity. However, they express their concern regarding effect of pre-treatment with a desensitizer on bond strength of bonding agent used. Hence, the objective of this study was to evaluate the effect of desensitizing agent on shear bond strength of a dentin adhesive system.

Materials and methods

Sixteen extracted sound human premolars were collected from the dental clinic in School of Dental Sciences, Universiti Sains Malaysia (USM). The teeth were randomly selected and divided into two groups, which contain eight teeth in each group. Each tooth was embedded in an acrylic resin up to cemento-enamel junction (CEJ) using a specially designed mould. Dimension of the mould was 20mm wide x 20mm wide x 15mm height. The coronal portion of each tooth was sectioned off to the level of dentino-enamel junction (DEJ) using a diamond disc. Occlusal surfaces were then carefully trimmed to expose the clean flat dentin surfaces. The teeth were checked to ensure the flat dentin surfaces were free from enamel remains. The exposed dentins were finished using 600 Grit Wet Silicon Carbide abrasive papers in a circular motion. Teeth were then rinsed and dried.

In group one, dentin surfaces were etched using Total Etch (Ivoclar Vivadent AG, Principality of Liechtenstein) containing 37% phosphoric acid for 15 seconds. Dentin surfaces were rinsed for 5 seconds and dried. Then, MS Coat (Sun Medical, Japan) dentin desensitizing agent was applied on each dentin surface using cotton pledget by pumping action for 60 seconds. Subsequently, Prime & Bond® NT (Dentsply, USA) adhesive system was applied according to manufacturer's recommendation. Cylinder shape composite resin, Filtek ™ Z250 (3M ESPE, USA) with dimension of 4mm diameter x 3mm height was packed on each side of the flat dentin surface. A specially designed metal mould was used to prepare the required dimension of composite resin. The same procedures were repeated for group two preparation, except that the dentin desensitizer was not applied in this group.

Upon testing, each prepared samples was placed horizontally on the base table of the Instron® 8874 (Instron Corporation, Canton) Servohydraulic testing system, and clamped to get stability during testing. The blunt edge probe was attached to the hydraulic actuator and the force was applied parallel and close to flat dentin surface. The force was applied at a crosshead speed of 0.5mm/min and load cell capacity was 25kN. The shear bond strengths were calculated by dividing the failure load by the bonded surface area. Since data in each group was not normally distributed, non-parametric method, Mann-Whitney Test was used for statistical analysis.

Results

Table 1 showed that shear bond strength of Prime & Bond® NT (Dentsply, USA) adhesive system treated with MS Coat (Sun Medical, Japan) desensitizing agent had lower median and inter-quartile range (IQR) value (4.80 ± 2.20 MPa) as compared to the group without desensitizing agent treatment (8.54 ± 2.01 MPa). Since data in each group was not normally distributed, non-parametric method, Mann-Whitney Test was used. When statistical analysis was carried out, shear bond strength of Prime & Bond® NT (Dentsply, USA) adhesive system treated with desensitizing agent showed significantly lower median and inter-quartile range (IQR) value when compared to the group without desensitizing agent treatment (z = - 0.14, p < 0.05).

Discussion

The purpose of the study was to look at the application effect of MS Coat (Sun Medical, Japan) desensitizing agent on shear bond strength of Prime & Bond® (Dentsply, USA) adhesive system. The study showed that shear bond strength of Prime & Bond® (Dentsply, USA) adhesive system treated with desensitizing agent showed significantly lower as compared to the group without desensitizing treatment.

Our study is in agreement with those found by Lehmann and Degrange (2005). In their study, they used two desensitizing agents, Gluma (Heraeus Kulzer, Indiana) and MS Coat (Sun Medical, Japan), and they found that both the desensitizing agent significantly reduced shear

Table 1 Comparing shear bond strength of Prime & Bond® NT (Dentsply, USA) adhesive system between two treatment variables

Variable	Treated with desensitizing agent (n = 8) Median (IQR)	Not treated with desensitizing agent (n = 8) Median (IQR)	z statistic [a]	p value [a]
Shear bond strength (MPa)	4.82 (2.20)	8.54 (2.01)	- 0.14	0.01

[a] Mann-Whitney Test

bond strength of Xeno 3 (Densply, USA) adhesive system. Another similar work by Soeno and co-workers (2001) found that application of MS Coat (Sun Medical, Japan) desensitizing agent significantly reduced the shear bond strength of Panavia luting agent. They also found that Saforide ammoniated silver fluoride desensitizer reduced bond strength in Super-Bond and Panavia luting agent. There were also other studies that reported the negative effects of applying desensitizing agent to shear bond strength of adhesive system (Sengun *et al*., 2005, Yiu *et al*., 2005).

MS Coat is a water-based resin-containing oxalate desensitizing agent. The oxalic acid from the agent reacts chemically with calcium ions from tooth structure to form the insoluble calcium oxalate crystals which will block dentinal tubules (Gillam *et al*., 2001, Kerns *et al*., 1991). Based on this phenomenon, outward fluid flow in the acid-etched dentin can be reduced by applying the oxalate desensitizer prior to adhesive application (Pashley *et al.*, 1993). Hence, the possibility of post-operative dentin hypersensitivity to occur is reduced.

When dentin is etched, calcium ions are depleted from the smear layer and underlying dentin. Therefore, the oxalate ions will diffuse further down the dentinal tubules until calcium ions are available for reaction to form calcium oxalate crystals (Tay *et al*., 2003). Reduction of dentin permeability is thus achieved via subsurface tubular occlusion, which should not be interfered the subsequent resin infiltration. Therefore, the shear bond strength of adhesive system used should not be differing from those dentin surfaces treated with oxalate desensitizing agents.

However, a study by Yiu *et al.* (2005) may unravel all the puzzles. They made evaluation on Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) of fractured surface of dentin treated with oxalate desensitizer, Ms Coat (Sun Medical, Japan). The adhesive systems used were fluoride contained adhesive system, Prime and Bond® NT (Dentsply, USA) and non-fluoride contained adhesive system, Single Bond (3M ESPE, USA). They noticed spherical globules scattered on dentin surface blocking the dentinal tubules at those bonded with Prime and Bond® NT (Dentsply, USA). Those spherical globules were similar to calcium fluoride (CaF_2) found on enamel (Dijkman *et al*., 1983, Nelson *et al*., 1983). Since Prime and Bond® NT (Dentsply, USA) adhesive system has a high fluoride content, the sources of fluoride to form spherical globule most probably comes from this adhesive agent. Furthermore, they found no spherical globules on non-fluoride containing adhesive system.

Those spherical globules found on the oxalate treated specimens may hinder adhesive infiltration and hybridization of demineralized dentin. The spherical globules may also contribute to stress raiser areas and that would create debonding at lower stress than would occur in their absence (Yiu *et al*., 2005).

From our study we can conclude that shear bond strength of Prime & Bond® NT (Dentsply, USA) adhesive system will be reduced if dentin surface is treated with MS Coat (Sun Medical, Japan) desensitizing agent.

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