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Research Article

EFFECT OF SODIUM HYPOCHLORITE ON SHEAR BOND STRENGTH USING THREE DIFFERENT ADHESIVE SYSTEMS: AN *IN-VITRO* STUDY

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Abstract: The aim of this study was to evaluate dentin shear bond strength with and without sodium hypochlorite (NaOCL) application using three adhesive systems. Sixty recently extracted premolar teeth were sectioned at the cementoenamel junction, cleaned and stored in distilled water at room temperature . Teeth were embedded in acrylic resin blocks in such a way that buccal dentin surface was facing up and the exposed dentin surface was polished using a wet 600 grit silicon carbide paper. The samples were divided in to 6 groups of 10 in each group. Group-I - Prime and Bond NT , Group-II - Prime and Bond NT with 5% NaOCL, Group-III- Single bond, Group-IV- Single bond with 5%NaOCl, Group-V- Clearfil SE bond and Group-VI- Clearfil SE bond with 5%NaOCl. All the adhesive systems were applied according to the manufacturer instructions, except 5%NaOCl solution treated for 2 min in Group-II, Group-IV and Group-VI. After curing of respective adhesives in each group, brass rings having 4mm internal diameter and height were placed over dentin surface. Z-100 composite was used to fill the ring in increments. The resin increments were light cured for 40s each and the samples were stored at 370C in distilled water for 24hrs and submitted for shear bond strength (SBS) testing with a crosshead speed of 1mm/min by using Universal Testing Machine. The data was analysed by ANOVA and Dunnet's tests ($P<0.05$). There was significant difference between groups with or without treatment of NaOCL in Prime and Bond NT groups but not in Single Bond and Clearfil SE Bond groups. The mean average values of Load at break(Newton) and SBS (MPa) in MEAN±SD were: G-I (145.28±21.56), (11.55±1.23), G-II (243.29±56.42), (19.35±4.89), G-III (276.27 ±13.45), (21.98±2.18), G-IV (238.12±32.90), (18.94±2.34), G-V (208.28±12.52) (16.57±1.56), G-VI (169.07±45.24), (13.45±2.19). In this study it was found that the dentin shear bond strength of Prime and Bond NT increased after 5% Sodium hypochlorite application while that of Single Bond and Clearfil SE Bond decreased after Sodium hypochlorite application. However this being an in-vitro study, more in--vivo studies have to be carried out using several dentin bonding agents to understand the effectiveness of NaOCL on etched dentin and subsequently its effect on dentin shear bond strength.

Keywords: Prime and Bond NT, Sodium hypochlorite, Shear bond strength, Dentin, Universal Testing Machine.

INTRODUCTION

The majority of the adhesive bonding agents available today may be categorized into etch & rinse or self-etch systems. These systems are more simplified by combining etchant, primer and adhesive components[1]. The clinical success of composite restorations depends on adhesive systems that provide durable bonding of composite to dentin and effectively seal the dentin tubules to prevent postoperative sensitivity and micro leakage [2]. Most of these products are composed of organic solvents like ethanol or acetone that chase the water and bring the monomers into intimate contact with the exposed collagen fibers following acid etching of dentin [3]. Resin penetration into dentin with monomer impregnation of the exposed collagen resulting in formation of hybrid layer is widely accepted as an efficient method to improve the resin-composite bond strength to dentin [4]. The process of hybridization is believed to result from the infiltration of the primer into the open spatial network in the collagen matrix exposed by dentin demineralization and it's in situ polymerization [5]. Dissolution of collagen after acid conditioning may result in better resin diffusion by increasing dentin permeability and changing its composition leaving it with a layer of mineral exposed on its surface [6]. Several studies showed dissolution and removal of the organic collagen layer after acid conditioning and subsequent bonding directly to the partially demineralized layer may produce more durable adhesion to the hydroxylapatite component of the dentin substrate [7]. The present study was done to find the effect of NaOCL effect on bond strength of three different adhesive systems.

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MATERIAL AND METHODS

Chemicals and Instruments

Prime and Bond NT (Dentsply Caulk, Milford, USA), Single Bond (3M Dental Products Division, St. Paul, MN, USA), Clearfil SE Bond (Kuraray, Japan), Sodium hypochlorite (Vensons India, Bangalore), Universal Testing Machine (Instron, Model 1011, Instron Co, UK).

Collection of samples

Sixty recently extracted premolar teeth for orthodontic purpose were sectioned at the cementoenamel junction, cleaned of debris and stored in distilled water at room temperature [8] (Sree Mookambika Institute of Dental Sciences, Kulasekharam, Tamil Nadu).

Preparation of samples

The buccal enamel of stored teeth were removed to expose dentin using diamond disk. Teeth were embedded in self-cure acrylic resin blocks in such a way that the exposed buccal dentin surface was facing up and slightly above resin block. The exposed dentin surfaces were polished using a wet 600grit silicon carbide paper [9,10]. These 60 specimens were divided into six groups of 10 specimens in each group.

Study design

Group-I - Prime and Bond NT
Group-II - 5% NaOCL + Prime and Bond NT [11]
Group-III- Single Bond
Group-IV- 5%NaOCl + Single Bond [12]
Group-V- Clearfil SE Bond
Group-VI-5% NaOCL + Clearfil SE Bond [13]

In the Group-I sample, dentin surface was etched with 36% phosphoric acid gel for 15 sec. The etchant gel was removed by rinsing with water for 30sec and then the dentin surface was blot dried using a moist cotton pellet to remove excess water and leave back a moist glistening surface with no pooling of water [14]. Prime and Bond NT was dispensed onto a clean disposable brush and the adhesive was applied to thoroughly wet all the dentin surface. The surface was allowed to remain fully wet for 20 to 30sec. Excess solvent was removed by gentle air drying for at least 5sec [15]. The adhesive was light cured for 10sec. Group-II- In this group , samples were prepared and treated with 5% NaOCL for 2 min and then rinsed with water and blot dried. Prime Bond NT adhesive was then applied. Group-III- Samples were prepared and two coats of Single Bond adhesive were applied. Group-IV- The dentin was treated with 5 % NaOCL for 2 min and Single Bond adhesive was applied. Group V- Samples were prepared and Clearfil SE bond applied. Group-VI- The dentin was treated with 5% NaOCl for 2 min and Clearfil SE bond applied [16]. After curing of respective adhesives in each group, brass rings having 4mm internal diameter and 4mm height were placed over dentin surface and firmly held in position. Z-100 composite resin was compactly packed against the dentin surface to fill the ring in increments. Each increment was light cured for 40 second each [17]. The light source from Astralis 3 (Vivadent) curing light polymerization unit having 400-500nm wavelength range was used for light curing the adhesives and composite resin. The samples were stored at 370C in distilled water for 24hrs prior to testing of shear bond strength [18].

Testing of shear bond strength (SBS)

Prepared samples were mounted horizontally onto the lower jaw of the Universal Testing Machine. The machine was interfaced with a computer through which operation of the equipment was controlled and shear bond strength was calculated. A 25 gauge stainless steel wire loop was hooked around the brass ring and attached to upper jaw of the universal testing machine which was activated to move upwards at a cross head speed of 1mm/min and was used to shear away the brass ring containing the composite adhered to dentinal surface. Load at fracture was recorded in Newtons and shear bond strength calculated from the load to the surface area value [19].

Statistical analysis

The data were analysed by t test between group comparisons and ANOVA followed by Posthoc test by using SPSS (16.0 version) software [20].

RESULTS

Load at Break (Newton) and Shear Bond Strength (MPa):

The results showed significant difference between Prime and Bond NT load at break and shear bond strength values with and without treatment of 5% NaOCL (Table - 1). Single Bond and Clearfil SE bond also showed same results (Table - 2, 3).There was significant increase in the load at break and shear bond strength values after treatment with 5% sodium hypochlorite in Prime and Bond NT adhesive system. Group-I showed significant difference compared with all other groups in load at break and shear bond strength values. There is no significant difference between group-II compared with group-III. Comparison of IV with other groups showed p value less than 0.05. It is considered statistically significant. Same results was observed when comparing group-V & VI with all other groups (Table-4).

DISCUSSION

Dentin is a less favorable substrate than enamel for resin bonding. Many factors contribute to this situation- the high organic content of dentin, the presence of fluid, the odontoblastic processes in the dentinal tubules and the presence of a smear layer on prepared surfaces. Current dentin priming monomers are usually dissolved in acetone/and or ethanol which can displace water from the dentin surface and from the moist collagen network, thus promoting the infiltration of the monomers through the nano spaces of the dense collagen web and enhancing bond strength. The resin replaces the water within the pores between the collagen fibers. In the acetone based systems, the water chasing capability of the volatile resin solvent appears to displace the water effectively from the intertubular network resulting in optimal resin infiltration through the collagen network even in the over wet condition. In the present study Prime and Bond NT, Single Bong and Clearfil SE Bond was applied to exposed dentin of freshly extracted premolar teeth. The study shows that the bond strength values for Prime and Bond NT was higher after NaOCl treatment while the bond strength values of Single Bond and Clearfil SE bond decreased following NaOCL treatment. The positive effect of NaOCL on bond strength of Prime and Bond NT may be explained by the higher diffusibility of acetone as well as its higher capacity to displace the water. Furthermore, removing collagen could improve the contact of adhesive and hydroxyapatite crystals by enhancing dentin permeability. In the case of Single Bond and Clearfil SE bond, as these adhesive systems diffuses more slowly than acetone based systems, this short dwell time is insufficient to permit a full diffusion of the monomer in to the substrate. In this way nanometric porosities of intertubular dentin created by the NaOCl treatment were not reached by monomer leaving an adhesive interface with voids. This may explain the lowering of bond strengths in case of Single Bond and Clearfil SE bond.

Table.1: Comparison of Mean load at break (Newton) and Shear bond strength (MPa) values between Prime and Bond NT and Prime and Bond NT with 5% NaOCl

Groups	Load at break(Newton) (MEAN±SD)	Shear Bond Strength (MPa) (MEAN±SD)	P value
Group-I (Prime and Bond NT)	145.28±21.56	11.55±1.23	0.01
Group-II (5% Sodium hypochlorite +Prime and Bond NT)	243.29±56.42	19.35±4.89	0.01

Table.2: Comparison of Mean load at break (Newton) and Shear bond strength (MPa) values between Single bond and Single bond with 5%NaOCl

Groups	Load at break(Newton) (MEAN±SD)	Shear Bond Strength (MPa) (MEAN±SD)	p value
Group-III (Single Bond)	276.27±13.45	21.98±2.18	0.05
Group-IV (5% Sodium hypochlorite+ Single Bond)	238.12±32.90	18.94±2.34	0.05

Table.3: Comparison of Mean load at break (Newton) and Shear bond strength (MPa) values between Clearfil SE bond and Clearfil SE bond with 5%NaOCl

Groups	Load at break(Newton) (MEAN±SD)	Shear Bond Strength (MPa) (MEAN±SD)	p value
Group-V (Clearfil SE bond)	208.28±12.52	16.57±1.56	0.05
Group-VI (5% Sodium hypochlorite + Clearfil SE bond)	169.07±45.24	13.45±2.19	0.05

Table.4: Multiple comparison of Mean load at break (Newton) and Shear bond Strength (MPa)

Groups	Load at break(Newton) (MEAN±SD)	Shear Bond Strength (MPa) (MEAN±SD)
Group-I (Prime and Bond NT)	145..28±21.56	11.55±1.23
Group-II (5% Sodium hypochlorite+ Prime and Bond NT)	243.29±56.42*	19.35±4.89*
Group-III (Single Bond)	276.27±13.45*	21.98±2.18*
Group-IV (5% Sodium hypochlorite+ Single Bond)	238.12±32.90*,#	18.94±2.34*,#
Group-V (Clearfil SE bond)	208.28±12.52*,#, $,┼	16.57±1.56*,#, $
Group-VI (5% Sodium hypochlorite +Clearfil SE bond)	169.07±45.24*,#,$, ┼,‖	13.45±2.19*,#, $,┼, ‖

(*P<0.05 significant compared Group-I with Group-II,III,IV,V & VI, #P<0.05 significant compared Group-II with group-III, IV, V &VI, $P<0.05 significant compared Group-III with group V & VI, ┼P<0.05 significant compared Group-IV with group V& VI, ‖P<0.05 significant compared Group-V with group VI)

CONCLUSION

In this study it was found that the dentin shear bond strength of Prime and Bond NT (Acetone based) increased after Sodium hypochlorite application while that of Single Bond and Clearfil SE bond (Alcohol based) decreased after Sodium hypochlorite application. However this being an in-vitro study, it cannot mimic the in-vivo conditions. There is a requirement of more clinical trials using several dentin bonding agents to understand the effectiveness of Sodium hypochlorite on etched dentin and subsequently its effect on dentin shear bond strength.

CLINICAL SIGNIFICANCE

Bonding composite resins to dentin has wide application in restorative dentistry. Bonding of resin to dentin has proved to be a difficult challenge. Purpose of this study was to improve the reliability and predictability of dentinal adhesion.

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