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RESEARCH ARTICLE

EVALUATION OF SHEAR BOND STRENGTH ON DRY AND MOIST DENTIN WHEN TREATED WITH DIFFERENT DESENSITIZING andADHESIVE SYSTEMS

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ABSTRACT

Objectives: This research was designed to investigate the effect of rewetting the dry dentin with two different desensitizing agents on the shear bond strength of resin composite to dentin.

Material and methods: A total of 120 freshly extracted, sound human molars were used in this study. They were divided into three main equal groups (n=40) according to the type of solvent used either water/ethanol, ethanol or acetone based. Each group was further subdivided into four subgroups, 10 teeth each (n=10), according to the condition of dentin substrate, either dry, moist,rewetted by Seal and Protect or rewetted by VivaSens desensitizing agents (total subgroups were 12). A Flat dentin surface was prepared, different surface treatments previously described were applied. Composite was bonded to the treated surfaces and shear bond strength testing was done using universal testing machine.

Results: For water/ethanol based adhesive (Adper Single Bond 2) , the highest mean shear bond strength value was recorded in case of dry dentin surface, dry dentin rewetted by Seal and Protect desensitizer, Moist dentin substrate, andthe specimens of dry dentin rewetted byVivaSens desensitizer showed the lowest shear bond strength value.For both ethanol based adhesive (Excite) and acetone based adhesive (Primeand Bond NT), the highest mean shear bond strength values were recorded in case of dry dentin rewetted with Seal and Protect desensitizer, moist dentin, dry dentin substrate, and the specimens of dry dentin rewetted with VivaSens desensitizer showed the lowest shear bond strength value.

Conclusion: Seal and Protect desensitizing agent was effective as a rewetting agent and can render the bonding procedure asless technique sensitive. On the other hand, using VivaSens desensitizerreduced the effectiveness of dentin bonding agents to thedentin surface.

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INTRODUCTION

Recent advances in esthetic restorations revealed significant improvement in dental adhesive systems .The objectives of these advances are to establish an effective bonding to tooth substrate (Bowen *et al*., 1982; Swift, 1995).

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Bonding to enamel is well known as being very clinically reliable since its introduction in 1955. The acid etch technique has provided an ideal surface morphology to achieve adhesion (Pashley, 1991; Gwinnett, 1994). Although this technique has revolutionized dentistry over the last two decades, dentin is still a challenge due to the wet tubular ultra-structure and heterogeneous composition of dentin substrate (Nakabayashi, 1982; Pashley *et al*., 1992). For contemporary adhesive systems, dentin bonding requires the removal or modification of the smear layer and superficial demineralization through the application of an acid etchant (Swift *et al*., 1999; Kanka, 1992).

Although chemical reactions between chemical bonding agents and dentin have been reported, it is generally accepted that dentin bonding relies primarily on micromechanical interaction, similar to enamel bonding, mediated by the permeation of resin monomers into acid conditioned dentin. The entanglement of polymerized adhesive resin with collagen fibrils and residual hydroxyapatite crystals generates an interfacial structure called the hybrid layer or resin dentin inter-diffusion zone (Tay *et al*., 1996; Perdigao *et al*., 1999). Exposure of the collagen fiber network by acid etching creates favorable conditions for micromechanical retention of an adhesive system, but the collagen network can collapse on itself due to loss of its structural support (Perdigao *et al*., 1998; Swift *et al*., 1997). Furthermore, in case of etch and rinse technique, if the exposed collagen is strongly air dried before the bonding procedure, it may collapse over the underlying unaffected dentin (Brannstrom, 1984; Clinical Research Associates, 1993). when demineralized collagen is kept moist, the fibrils are observed as being upright and separated by wide inter-fiberillar spaces, resulting in better opportunities for resin infiltration and higher bond strength when compared to that had been excessively air dried (Felton *et al*., 1991; Buonocore, 1955).

The risk with moist dentin is an over-wet condition that results in excessive water, which appears to cause phase separation of the hydrophobic and hydrophilic monomer components, resulting in blister and globule formation spaces at the resin dentin interface (Pashley, 1998; Fusayama *et al*., 1979). Both over-drying and over-wetting of the conditioned dentin may have undesirable effects clinically on bonding performance (VanDijken, 1986; Stanley *et al*., 1975; Van Meerbeek *et al*., 2001).It has been shown that the application of rewetting agents to dried dentin restore or sometimes increase the bond strength of certain types of adhesives to the same level as bonding to moist substrates (Eliades, 1994; Benderli, 1999) . On the other hand, teeth that are prepared for restorations, especially in large cavities or in case of crown preparations, are at risk of developing hyper-sensitivity because of large numbers of dentinal tubules that are exposed during preparation. Desiccation and frictional heat generated by preparation increase this hypersensitivity (Nakabayashi, 1992; Van Meerbeek *et al*., 1994). When exposed dentinal tubules are stimulated by changes in temperature or osmotic pressure, tubular fluid is displaced. Fluid movement is conveyed to nerve fibers in the pulp, causing stimulation that is interpreted as pain (Dunn, 2003; Miller, 2002). Certainly, using of desensitizing agents after teeth preparations has become a popular clinical technique (Andre, 2003; Aranha, 2006) and has been shown to be effective for that purpose (Pashley *et al*., 2003; Cobb *et al*., 1997). The objective of this study was to investigate whether the application of desensitizing agents on conditioned dentin as a rewetting agents (in addition to their main function as desensitizers for dentin hypersensitivity) using total etch adhesive with various organic solvents (acetone, water and/or ethanol based) would affect the shear bond strength of adhesive systems to resin composite or not.

MATERIALS AND METHODS

A total of 120 freshly extracted sound human molars were extracted for periodontal reasons and collected to be used in this study (The age of patients is between 12-18 years old and the extraction of teeth was due to the presence of sever form of Juvenile periodontitis that affect first molars and incisors).

After extraction, each tooth was cleaned from any periodontal shreds by scaling with sharp scalars then polished with a rotary hair brush and a slurry mix of pumice and water. Teeth were examined under light microscope to avoid selection of teeth with morphological defects or cracks. The selected teeth were stored in distilled water at 37 C^0 in an incubator (Kumtel, Turky) until they were used in the experiment. Materials used in this study are listed in Table (1)

Preparation of Specimens

The selected teeth were horizontally sectioned at the level of the furcation area by using a diamond saw to separate the crown from the roots, which were discarded afterwards. Each tooth was inserted vertically in a transparent acrylic mold filled with self-cure acrylic resin leaving about 3 mm of the crown above the surface. Acrylic blocks were prepared by using a specially constructed split copper mold, 1.5x2 cm in dimensions; with a copper ring to encircle it until the acrylic resin was set.

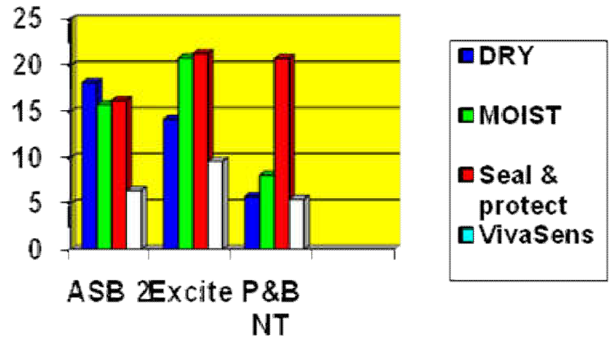

Fig. 1. Bar chart showing the mean shear bond strength in (MPa) of all adhesives with different dentin treatments

A separating medium was used to coat the inside of the split copper mold, self-cure acrylic resin was mixed on a glass slap, then applied and packed inside the split copper mold using a plastic instrument. Excess acrylic resin was removed by using wax knife to the level of split copper mold.After setting, the copper ring and the two halves of split copper mold were removed. The occlusal surface of the tooth in the acrylic block was ground at slow speed with a 180-grit silicon carbide paper mounted on a water-cooled wheel to create a flat dentin surface perpendicular to the horizontal base of the grinding machine, at depth not exceed 0.5 mm below DEJ. This was determined by making a hole that was drilled on the central fossa of the occlusal surface by using a round carbide bur till reaching the DEJ. This depth was remarked on all external surfaces of the crown. A graduated periodontal probe was used to confirm the depth.

Grouping of specimens

The specimens were divided into three main equal groups, 40 teeth each, according to the type of solvent used either water/ethanol, ethanol or acetone based, as follows: Group (W) Water/ethanol based adhesive (40 specimens), Group (E): Ethanol based adhesive (40 specimens) andGroup (A): Acetone based adhesive (40 specimens). Each group was further subdivided into four subgroups, 10 teeth each, according to the condition of dentin substrate, either dry, moist, rewetted by Seal and Protect and rewetted by VivaSens desensitizing agents. Subgroup I:

Table 1. Showing the mean shear bond strength values and standard deviation in MPa of all adhesives with different applied dentin treatments

Group Material	DRY DENTIN	MOIST DENTIN	Rewetting with Seal & Protect	Rewetting with VivaSens
ASB 2	18.11+/- 3.50	15.73 +/- 4.13	16.18 +/- 4.89	6.39 +/- 4.17
Excite	14.13 +/- 4.65	20.79 +/- 4.91	21.29 +/- 3.33	9.57 +/- 3.08
P&B NT	5.73 +/- 1.01	8.05 +/- 2.08	20.73 +/- 3.45	5.45 +/- 1.49

Dry dentin, Subgroup II: Moist dentin, Subgroup III: Dry dentin rewetted by Seal and Protect and Subgroup IV: Dry dentin rewetted by VivaSens.After etching, drying and rinsing, the subgroup (I) was achieved by received a 15-second air blast (using oil free compressed air from an air syringe, keeping the syringe 2 cm from the surface), Then applying different adhesive systems. The Subgroup (II) was achieved by blotting the dry dentin with gauze (blot-dry technique). In a subgroup (III), the dry dentin was remoistened by using the desensitizing agent (Seal and Protect) prior to application of the adhesive. While in Subgroup (IV), the dry dentin was remoistened by using the desensitizing agent (VivaSens) prior to application of the adhesive. All specimens were treated using 36% ortho-phosphoric acid, applied for a period 15 seconds, washed away using air-water spray for 15 seconds and dried using oil-free compressed air for another 5 seconds as prescribed by the manufacturer.

Application of desensitizing agents

1 – Seal and Protect and VivaSens

Specimens of the subgroup (III) were rewetted by Seal andProtect desensitizer. After acid etching and prior to receive the adhesives. Application of Seal and Protect was as follow: Seal and Protect was dispensed into a fresh applicator dish. Two tothree drops are required to rewet the dentin surface.Immediately after dispensing, ample amounts of SealandProtect wereapplied to the dentine surface till thoroughly saturated the dried dentine.The dentine surface left undisturbed for 20 seconds.Excess solvent was removed by blowing gently with air for a fewseconds from a dental syringe.Seal and Protect was cured for 10 seconds using a light curingdevice.A second layer of Seal and Protect was applied to ensure completeinfiltration and the excess solvent from the second layer was removedby blowing gently with air from a dental syringe.The last layer of Seal and Protect was cured for another 10 seconds.Specimens of the subgroup (IV) were rewetted by VivaSens desensitizer.VivaSens was applied using the disposable brush provided. Gently, the liquid rubbed into the dry dentin surface for at least 10 seconds. The liquid was evenly dispersed all over the dentin surface and was dried by gently blowing air on the treated surfaces for 10 seconds. There is no use of light curing device.

Application of adhesives

Generally, follow the instructions of manufacturers for adhesives application are mandatory. After the dentin was acid conditioned, rinsed, dried or rewetted either with blot-dry technique or with the desensitizing agents, every adhesive system was applied and scrubbed on the surface for 10 seconds, left undisturbed for 20 seconds then dried lightly, when the material was visibly thickened, a strong blast of air directed onto surface to disperse the remaining adhesive, light cured for 20 seconds.

A second coat of adhesive was applied, dried immediately then light cured for 20 seconds. Dentin after treatment with two coats of adhesive should appear shiny. If it was appeared not shiny, another coat was applied and the same was done for a second coat.

Application of composite resin

A specially constructed copper mold was fabricated to ensure stabilization of the teeth embedded in the acrylic blocks. The upper end of the holder was fabricated to create a room for a split copper ring having a thickness of 2 mm and a central hole of 3 mm internal diameter. The lower end of the copper mold was screwed to permit the upward and downward movement of the upper end when the two compartments were screwed together in such a way that the central hole of the split copper ring gets in a full contact with the treated dentin surface when the tooth embedded in the acrylic block was inserted inside the copper mold.Composite resin was introduced out of the syringe into the central hole of the split copper ring directly on the dentin surface utilizing a gold plated composite instrument, until the hole was overfilled, then gross excess was removed with a plastic instrument.

A celluloid matrix was applied over the composite to produce a smooth surface followed by a transparent slide, over which two weights of 150 gm. Each was placed, one at each end to ensure standardized pressure during polymerization. A light curing unit was utilized to polymerize the composite resin by contacting the glass slide by the curing unit tip for 40 seconds as recommended by manufacturer. After light polymerization, the weights, the glass slide and the celluloid matrix were removed and any excess composite was removed out of the split copper mold with their attached composite discs. The specimens. were stored in distilled water in an incubator to be tested for shear bond strength after 24 hours.

Shear bond strength testing

Shear bond strength testing was conducted using the Lloyd computerized testing machine. A specially constructed stainless steel uni-beveled chisel shaped attachment was fixed to the upper Jig of the testing machine. A second specially constructed holder was placed on the lower Jig to insure stabilization of the acrylic block with the composite disc bonded to the tooth during the shear bond strength testing. Shear testing was performedwith a load cell of 50 KN, sensitivity 0.5 % and a crosshead speed of 0.5 mm/min. Shear bond strength values were recorded in kg/cm² and then transferred into mega pascal units [Mpa]. Results were tabulated and statistically analyzed. A one-way analysis of variance (ANOVA) was used to compare the different dentin shear bond strength values for different subgroups. Dentin treatments were compared using Tukey's multiple comparison procedure *(P-Values)* to control the overall statistical significance levels of the tests. .

RESULTS

Water/ethanol based adhesive (Adper Single Bond 2):

The shear bond strength values of Water/ethanol based adhesive (Adper Single Bond 2) to dentin after different dentin surface treatments were calculated. The highest mean shear bond strength value was recorded in case of dry dentin surface that reached (18.11 +/- 3.5 MPa). Moreover, the dry dentin rewetted with Seal and Protect desensitizer recorded (16.18 +/- 4.89 MPa), then Moist dentin recorded (15.73 +/- 4.13). On the other hand, the dry dentin rewetted with VivaSens desensitizer specimens showed the lowest shear bond strength value reaching only (6.39 +/- 4.17 MPa). The first three treatments were not statistically significant different at (p < 0.05); however, rewetting with VivaSens desensitizer was statistically significant lower than all other methods of treatments (p <0.0001).

Ethanol based adhesive (Excite)

The shear bond strength values ofethanol based adhesive (Excite) to dentin after different dentin surface treatments were calculated. The highest mean shear bond strength value was recorded in case of dry dentin rewetted with Seal and Protect desensitizer that reached (21.29 +/- 3.33 MPa). Moreover, the Moist dentin recorded (20.79 +/- 4.91 MPa), then Dry dentin recorded (14.13 +/- 4.56 MPa). On the other hand, the dry dentin rewetted with VivaSens desensitizer specimens showed the lowest shear bond strength value reaching only (9.57 +/- 3.08 MPa). The first two treatments were not statistically significant different at (p <0.05). Treatment with Seal and Protect desensitizer was statistically significant higher than treatment with dry dentin (p< 0.0002) and with VivaSens desensitizer (p < 0.0001). Dry dentin treatment was also statistically significant higher than treatment with VivaSens desensitizer (p< 0.0163).

Acetone based adhesive (Prime andBond NT)

The statistical analysis of the shear bond strength values ofacetone based adhesive (Primeand Bond NT) to dentin after different dentin surface treatments were calculated.

The highest mean shear bond strength value was recorded in case of dry dentin rewetted with Seal and Protect desensitizer that reached (20.37 +/- 3.45 MPa). Moreover, the Moist dentin recorded (8.05 +/- 2.08 MPa), then dry dentin recorded (5.73 +/- 1.01 MPa). On the other hand, the dry dentin rewetted with VivaSens desensitizer specimens showed the lowest shear bond strength value reaching only (5.45 +/- 1.45 MPa). The last two treatments were not statistically significant different at (p< 0.05). Treatment with Seal and Protect desensitizer was statistically significant higher than all other treatments (p< 0.0001). Moist treatment was statistically significant higher than dry dentin (p = 0.0287) and VivaSens desensitizer (p = 0.0110).

Comparison among different adhesives

A one-way ANOVA test showed that dentin treatment had a statistically significant effect on bond strength (p< 0.0001) when using the water/ethanol, ethanol, and acetone based bonding agents. Table 1and figure 1 are representing the mean shear bond strengths of all subgroups of different adhesives.

For the condition of dry dentin, the highest mean shear bond strength value was recorded in case of using Adper Single Bond 2 adhesive that recorded (18.11 +/- 3.50 MPa). Moreover, in case of using Excite adhesive it recorded (14.13 +/- 4.65 MPa). On the other hand, in case of using Prime and Bond NT adhesive it showed the lowest shear bond strength value recording only (5.73 +/- 1.01 MPa). For the condition of moist dentin, the highest mean shear bond strength value was recorded in case of using Excite adhesive that recorded (20.79 +/- 4.91). Moreover, in case of using Adper Single Bond 2 adhesive it recorded (15.73 +/- 4.13). On the other hand, in case of using Prime and Bond NT adhesive it showed the lowest shear bond strength value recording only (8.05 +/- 2.08). For the condition of dry dentin that rewetted by Seal and Protect desensitizer, the highest mean shear bond strength value was recorded in case of using Excite adhesive that recorded (21.29 +/- 3.33), Moreover, in case of using Prime and Bond NT adhesive it recorded (20.73 +/- 3.45).

On the other hand, in case of using Adper Single Bond 2 adhesive it showed the lowest shear bond strength value recording only (16.18 +/- 4.89).For the condition of dry dentin that rewetted by VivaSens desensitizer, the highest mean shear bond strength value was recorded in case of using Excite adhesive that recorded (9.57 +/- 3.08), Moreover, in case of using Adper Single Bond 2 adhesive it recorded (6.39 +/- 4.17). On the other hand, in case of using Prime and Bond NT adhesive it showed the lowest shear bond strength value recording only (5.45 +/- 1.49). Generally, the highest mean shear bond strength value of all subgroups was recorded in case of using Excite adhesive with dry dentin rewetted with Seal and Protect desensitizer that recorded (21.29 +/- 3.33 MPa). Moreover, in case of using Excite adhesive with the moist dentin recorded (20.79 +/- 4.91 MPa), then in case of using Prime and Bond NT adhesive with dry dentin rewetted with Seal and Protect desensitizer that reached (20.37 +/- 3.45 MPa). On the other hand, in case of using Prime and Bond NT adhesive with dry dentin rewetted with VivaSens desensitizer it showed the lowest shear bond strength value of all subgroups recording only (5.45 +/- 1.49).Excite adhesive system recoded the most accepted shear bond strength values among the three adhesive systems used in this study even in different dentin treatments (dry, moist, dry rewetted by Seal andProtct desensitizer and dry rewetted by VivaSens desensitizer).It recorded (14.13 +/- 4.65, 20.79 +/- 4.91, 21.29 +/- 3.33 and 9.57 +/- 3.08 MPa) respectively.Adper Single Bond 2 adhesive system follows Excite adhesive system that recorded (18.11+/- 3.50, 15.73 +/- 4.13, 16.18 +/- 4.89 and 6.39 +/- 4.17 MPa) respectively. The less accepted one was Prime and Bond NT adhesive that showed the lowest shear bond strength value among the three adhesive systems used in the study that recorded (5.73 +/- 1.01, 8.05 +/- 2.08 and 5.45 +/- 1.49 MPa) respectively with exception of better results in case of dry dentin rewetted with Seal and Protect that recorded (20.73 +/- 3.45 MPa)

DISCUSSION

Because it is impossible to dry enamel without simultaneously drying dentin, the dentin collagen collapses easily upon air drying, resulting in the closure of the micro-pores in the exposed inter-tubular collagen (Tay*et al.*, 1996). The collapse of the collagen fibers upon drying may therefore be a result of the changes in the molecular arrangement. In a wet state, wide gaps separate the collagen molecules from each other, while in a dry state; the molecules are arranged more compactly. This is because extra-fibrillar spaces in hydrated type I collagen are filled with water, while dried collagen has fewer extra-fibrillar spaces open for the penetration of the monomers included in the adhesive systems (Sasaki, 1996). Aggressive water removal (i.e. over-dry) may also permit additional hydrogen bonds to form between collagen molecules that were previously bonded to water molecules, leaving no inter-fibrillar spaces. During air-drying, water that occupies the inter-fibrillar spaces previously filled with hydroxyapatite crystals is lost by evaporation, resulting in a decrease of the volume of the collagen network to approximately one third of its original volume (Rosenblatt *et al*., 1994). Both previously mentioned studies are in agreement with our results that revealed higher mean shear bond strength values in case of moist dentin than in case of dry dentin especially with the use of ethanol based adhesive (moist: 20.79 +/- 4.91 and dry: 14.13 +/- 4.65) and acetone based adhesive (moist: 8.05 +/- 2.08 and dry: 5.45 +/- 1.49) with exception of water/ethanol adhesive that gave a reversed result to the other two adhesives i.e. dry dentin gave higher mean shear bond strength values than in case of moist dentin (dry: 18.11 +/- 3.50 and moist: 15.73 +/- 4.13). On the other hand, results of Gwinnett in his study, revealed that the bond strength values of Gluma bonding agent (acetone based) were compromised by the presence of moisture. He stated that while Gluma is hydrophilic and acetone containing, it does not appear to possess the same behavioral characteristics embodied in the other systems as evidenced from lack of a bond to moist dentin (Reinhardt, 1997).

Both over drying and over wetting of dentin have undesirable effects on bonding strength. Even mild desiccation, which lead to collagen collapse may results in incomplete inter-tubular resin infiltration. On the other hand the resin infiltration was severely compromised in the presence of excessive water within the dentinal tubules and at their openings in the dentin surface. The continuity of the resin layer deteriorated; blister-like spaces formed on the dentin surface and resin globules were found around the tubular orifices and on the surface of the hybrid layer(Tay*et al*., 1996). This is in agreement with the results of water/ethanol adhesive that revealed decreasing in the mean shear bond strength values when applied to moist dentin than when applied to dry dentin. Excess water may be formed from two sources, remoistening using water and the water incorporated in the adhesive itself. Both lead to dentin over-wet.On the other hand, Swift and Triolo in their in vitro study tested the shear bond strengths of the Scotchbond Multi-Purpose adhesive (water based) to moist and dry enamel and dentin. The mean shear bond strengths for both enamel and dentin were higher when the surface was left visibly moist after etching. Bond strengths to moist and dry dentin were 21.8 and 17.8 MPa, respectively (Sasaki *et al*., 1996). Also in the study of Van Meerbeek *et al*., two water based adhesive systems OptiBond and Scotchbond Multi-Purpose were compared by transmission electron microscopy (TEM). Results revealed that no major differences in hybrid layer ultra-structure were observed when the two adhesive systems were bonded to either dry or wet dentin. When the adhesives were dry-bonded, no ultra-structural evidence of collapsed demineralized collagen, incompletely or not at all infiltrated by resin, could be detected. In addition, when the two adhesives were bonded to wet dentin, no signs of over-wetting phenomenon occurred (Perdigao*et al*., 1998). When air-dried demineralized dentin is rewetted with water, the collagen matrix may re-expand and recover its primary dimensions to the levels of the original hydrated state. This re-expansion occurs because the spaces between fibers are refilled with water and because type I collagen itself is capable of undergoing expansion upon rehydration (Pashley, 1991).

The stiffness of decalcified dentin increases when the tissue is dehydrated either chemically in water-miscible solvents, or physically in air. The increase in stiffness is reversed when specimens are rehydrated in water. Therefore, rewetting dentin after air-drying to check for the enamel frosty aspect may be an accepTable clinical procedure (Aasen, 1993). It is very difficult to either assess or standardize the ideal amount of moisture that should be left on the dentin surface before the application of the adhesive system. Ideally, water should form a uniform layer without pooling (over-wet) and without dry areas (over-dry). Therefore severe air-drying with an air-water syringe after rinsing off the etching gel is not recommended because it cannot produce a uniform layer of water on the surface. Numerous studies demonstrated that the excess water after rinsing the etching gel can be removed with a damp cotton pellet, a disposable brush, or a tissue paper without adversely affecting bond strengths (Tay *et al*., 1996; Perdigao *et al*., 1999; Van der, 1997). The most popular types of solvents that have been incorporated in adhesive systems by manufacturers are acetone, ethanol, and/or water. The use of adhesive systems on moist dentin is made possible by incorporation of the organic solvents acetone or ethanol in the primers or adhesives. Because the solvent can displace water from both the dentin surface and the moist collagen network, it promotes the infiltration of resin monomers throughout the nano-spaces of the dense collagen fibrils.

The "wet bonding" technique has been shown repeatedly to enhance bond strengths because water preserves the porosity of collagen network available for monomer inter-diffusion (Kanca, 1996; Perdigao *et al*., 1993). Moreover, some authors have suggested that the inclusion of water in the composition of adhesives (e.g. ethanol/water or acetone/water) may result in rewetting the collagen fibers in areas that are left not fully moist, thus opening the inter-fibrillar spaces to the infiltration of the priming resin (Tay *et al*., 1996; Perdigao *et al*., 1998). Therefore the simultaneous inclusion of both an organic solvent and water may be fundamental for the best infiltration of some adhesives into demineralized dentin. This could result in a less technique-sensitive procedure (Reinhardt, 1997). Results of our study were supported by this assumption as Adper Single Bond 2 (water/ethanol adhesive) gave the highest mean shear bond strength value among the three types of adhesives used in this study when applied to dry dentin that reached (18.11 +/- 3.50 MPa). On the other hand, the study of Miears *et al*. evaluated the effects of dentin moisture of two different storage times on the shear bond strength of resin composite bonded to dentin with Scotchbond Multi-Purpose Adhesive (water based). Results revealed the superiority of bond strength of moist dentin with no statistically significant differences was found for bond strengths to dry and to moist dentin for either storage time (24 hours and 90 days in 37^{o}C distilled water) (Miers *et al*., 1995).

Conclusion

According to the circumstances of this investigation and with respect to the material of the study, the following conclusions could be reported:

- Seal and Protect desensitizing agent was effective as a rewetting agent and can render the bonding procedure asless technique sensitive. On the other hand, using VivaSens desensitizerreduced the effectiveness of dentin bonding agents to thedentin surface.
- Although the total etch system is a sensitive technique, however, it still reveals accepted adhesion to dentin surface.
- Both over dry and over wet the dentin substrate reveal adverse effect on the shear bond strength values of total etch adhesives to dentin. The difficulty in achieving a balance between moist and drydentin makes the dentin bonding technique extremelysensitive.

Recommendations

The clinician should have a clear and thorough understanding of the chemical composition and adhesivemechanism of various dentin bonding agents.

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