Original Article

Influence of three different types of desensitizing agents on bond strength of etch-and-rinse and self-etch adhesive system on dentin: An *in vitro* study

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Abstract

Aim: To determine the effect of three different dentin hypersensitivity treatment procedures on the microtensile bond strength of etch and rinse and self-etch adhesive system.

Materials and Methods: Eighty extracted intact human permanent lower premolars were decoronated, and dentin was exposed on the buccal surface. The teeth were randomly assigned to two experimental groups of 40 teeth each: etch and rinse system or self-etch system. The 40 samples assigned were further randomly assigned to four desensitizing treatment subgroups: Control, Gluma, NovaMin, and GC tooth Mousse with 10 samples per subgroup. Desensitizing treatment was performed two times each day for 2 weeks respectively. The exposed dentin was subjected to etch and rinse or self-etch adhesive system bonding agent as per the group and restored using composite to 4-mm thickness. Samples were then subjected to universal testing machine for microtensile bond strength.

Results: The bond strength to the dentin obtained with etch and rinse adhesive system group where significantly higher ($P < 0.05$) when compared to self-etch adhesive system. However, there was no significant effect of the desensitizing agent on the microtensile bond strength in its own. Scanning electron microscope imaging reviled tubular occlusion in all specimens treated with desensitizer.

Conclusion: The bond strength was majorly impacted by the type of adhesive system used. While the desensitizing agents used in the study had little or no adverse effect on the bond strength of composites to dentin surface.

Keywords: Bond strength; etch and rinse adhesive system; GC tooth mousse; Gluma; NovaMin; self-etch adhesive system

INTRODUCTION

Dentine hypersensitivity (DH) is known as short, sharp pain that emanates from the exposed dentine in reaction to stimuli, typically thermal, evaporative, tactile, osmotic, or chemical that cannot be linked to any other dental ailment or defect.[1] DH is closely related to dentin exposure.[2] DH can be managed in an invasive or noninvasive way. The majority of patients choose noninvasive management alternatives as their initial course of treatment since they are straightforward and affordable.[3]

Adhesive compounds can be used following desensitization therapy because they are proven to produce better benefits than other local desensitizers, but the effect of the desensitizer treatment on dentin bond strength is inconclusive.[4] A systemic study found that the type of adhesive employed (etch-and-rinse or self-etch) has a significant impact on the preservation of noncarious

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cervical lesion restorations.[5] Earlier studies have reported that dentin desensitizing therapy has a negative impact on the bonding strength of the self-etch primer. In contrast, studies have also reported that the administration of a dentin desensitizing agent had no negative effects on bond strength.[6] Therefore, it is unclear how the desensitizer therapy could affect the dentin bond strength.

With these diverse reports in the literature, the present study was proposed with the primary aim of investigating the influence of three types of desensitizing treatment, (1) an in-office method, Gluma, desensitizer application, at-home (2) NovaMin-containing toothpaste and (3) Casein phosphate-amorphous calcium phosphate (CPP-ACP) containing tooth mousse on micro-tensile dentin bond strength of etch and rinse system (ERS) and self-etch system (SES) adhesive systems.

MATERIALS AND METHODS

Eighty sound extracted mandibular premolars were collected for this study and stored in artificial saliva before the experimental procedure.

These teeth were randomly divided into two groups based on the type of bonding agent used:

- Group 1: Etch and rinse adhesive system
- Group 2: Self-etch adhesive system.

Each group was further subdivided into four subgroups based on the desensitizing agent used.

- Subgroup A: Control group (no treatment with the desensitizing agent)
- Subgroup B: GC tooth mousse - CPP-ACP
- Subgroup C: NovaMin-Sensodyne protect and repair
- Subgroup D: Kulzer Gluma Desensitizer.

Preparation of specimen

After obtaining the institutional ethical committee clearance, the roots of the teeth were sectioned using a slow-speed diamond disc at the cemento-enamel junction. The coronal portion of the teeth was sectioned into buccal and lingual halves along the central groove using a water-cooled diamond disc. The buccal half of all teeth was used for the experimental procedure. Using a standard grit diamond rotary cutting instrument, the buccal surface of each specimen was ground flat to expose a dentin surface of approximately 4 mm × 4 mm. The exposed dentin surface was finished with a fine grit diamond rotary cutting instrument.

The 40 samples assigned to each adhesive system were further randomly assigned to four desensitizing treatment subgroups (A, B, C, and D) with ten samples per subgroup.

Desensitizing procedure

- Subgroup A: Control group
  No dentine treatment was done.

- Subgroup B: GC Tooth mousse - CPP-ACP (Tooth Mousse GC Corp., Tokyo, Japan)
  The samples were blot dried. The tooth mousse was applied to the exposed dentin for 3 min and washed off with water.

- Subgroup C: NovaMin-Sensodyne protect and repair
  Samples were dried with a blot. The paste was applied to the exposed dentin for 1 min, brushed using a toothbrush, and washed off with water.

- Subgroup D: Kulzer Gluma® Desensitizer
  The required amount of GLUMA Desensitizer was applied using an applicator tip. Gently rubbed on for 60s. Then dried the surface carefully in an air stream until the liquid film disappeared and the surface was no longer shiny.

Desensitization treatment was performed twice daily for 2 weeks with an interval of 12 h between treatments, for a total of 28 applications per sample. Samples were kept in artificial saliva at the room temperature during these 2 weeks. Subsequently, all samples of the three subgroups were stored in artificial saliva at the room temperature for another 2 weeks before the bonding procedure.

Bonding procedure

Etch and rinse system

The bonding agent Spectrum® Bond nano-technology dental adhesive (Dentsply Sirona, Konstanz, Germany) was used according to the manufacturer's recommendation. Briefly, the exposed dentin was etched with 36% phosphoric acid using DeTrey® Conditioner (Dentsply Sirona, Konstanz, Germany), for 15 s and then rinsed with water using the dental air-water syringe. After the dentin was slightly dry, the bonding agent was applied with a microbrush for 15s using light brushing motion, air-thinned for 3s and then light cured for the 20s (Woodpecker LED D unit, Guilin Woodpecker, Guangzhou, China). The exposed dentin (4 mm × 4 mm) was then restored with a 4 mm thick using Universal composite, Beautiful II (Shofu, Kyoto, Japan).

Self-etch system

BeautiBond™ (Shofu, Kyoto, Japan) bonding agent application was performed as per the manufacturer's recommendations. Briefly, the bonding agent was applied to the dentin surface with a disposable microbrush applicator and waited for 10s before air drying for 5s and then light curing for 10s. After this procedure, the exposed dentin was restored with a 4 mm thick using Universal composite, Beautiful II (Shofu, Kyoto, Japan).

Scanning electron microscope examination

Following restoration, all the samples from both groups were stored in artificial saliva for 2 weeks at the room temperature before bond strength testing. Then, one sample was randomly selected from each of the eight subgroups for the scanning electron microscope (SEM) analysis to observe the changes in the dentin surface consequent to desensitizer application and bonding agent interaction.

Microtensile bond strength evaluation

Using a slow-speed diamond disc under water coolant, each of the remaining 72 restored teeth (9 samples/subgroup) was sectioned to produce a composite-dentin block and teeth were then tested under a universal testing machine for microtensile bond strength (MBS).

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) software for Windows version 22.0 Released 2013. Armonk, NY, USA: IBM Corp. was used to perform the statistical analyses. The descriptive analysis includes the expression of study parameters in mean and standard deviation in each study group. One-way analysis of variance (ANOVA) followed by *post hoc* analysis was performed. The level of significance was set at $P < 0.05$.

RESULTS

The results in Group I, subgroup A (control group) showed the highest MBS with the mean value of 15.27 MPa. Within the subgroups treated with different dentin desensitizer, univariate ANOVA analysis revealed no statistically significant difference MBS.

The results in Group 2, Subgroup A (control group) showed the highest MBS with the mean of 13.52 MPa. Within the subgroups treated with different dentin desensitizer, univariate ANOVA analysis revealed no statistically significant difference MBS.

Among the subgroups treated with similar dentin desensitizer from the two different adhesive groups, results revealed a statistically significant difference ($P < 0.05$) in MBS [Table 1]. There was no statistically significant difference in MBS among the three dentin desensitizer treatment methods (subgroups) within each adhesive group (independent samples test). Pulling together the data from the three subgroups in one adhesive group (ERS or self-etch adhesive), the mean MBS with ERS (14.49 MPa) adhesive system was significantly ($P < 0.05$) lower than that observed with the self-etch (12.45 MPa) adhesive system [Figure 1].

Table 1: Mean microtensile bond strength for two different adhesive system groups in three different dentin desensitizer treatment regimens

Groups	*n*	Mean	SD	SEM	*P*	*t*
Control (A)						
1	9	15.2767	1.44622	0.48207	0.003	3.491
2	9	13.3225	0.67294	0.23792		
Gluma (B)						
1	9	14.2400	1.51014	0.50338	0.015	2.736
2	9	12.2513	1.47975	0.52317		
NovaMin (C)						
1	9	13.6311	2.14865	0.71622	0.041	2.242
2	9	11.6363	1.38258	0.48882		
GC tooth mousse (D)						
1	9	14.8056	1.81804	0.60601	0.028	2.423
2	9	12.4275	2.22739	0.78750		

SD: Standard deviation, SEM: Standard error of the mean

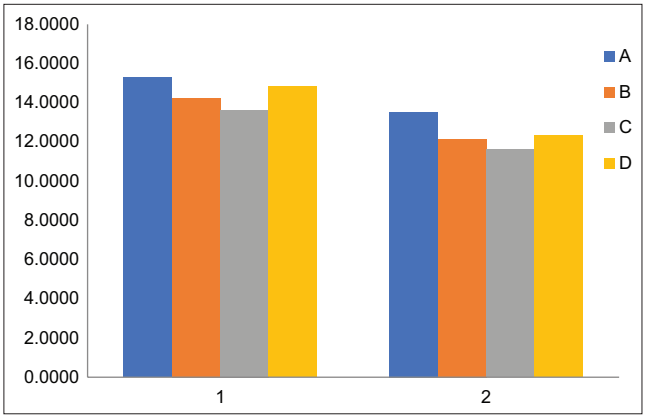

Figure 1: Comparison of mean bond strength of three desensitizing agents of Group 1 and Group 2. 1: Etch and rinse system, 2: Self-etch system, A: Control, B: Gluma, C: NovaMin, D: GC Tooth Mousse

DISCUSSION

DH is a common ailment and one of the most unpleasant illnesses.[7] Since noninvasive management options are simple and economical, most patients opt for them as their initial course of treatment.[3] Following desensitization therapy, adhesive compounds can be utilized since they have been shown to yield greater results than other local desensitizers.[4] Desensitizing agents applied on dentin generally decrease fluid flow by blocking the dentin tubules and thus prevent dentin hypersensitivity. The resin-dentin interface exhibits the tubule occluding effect, which may weaken the binding strength of composite restorations.[8,9]

In the current study, significantly lower MBS values of SES when compared to the ERS with no statistically significant difference in bond strength between the two adhesive systems were observed. On contrary, the dentin desensitizing treatment regimen that had no effect on bond strengths of the various desensitizing treatments. This result corroborates those of a previous Sabatini and Wu examination.[6]

The observation in the current study is that Gluma desensitizer did not effect on dentin bond strength when

compared to the control group, which is consistent with Sabatini and Wu's results.[6] This phenomenon is thought to be caused by Gluma's water and hydroxyethyl methacrylate content, both of which have been shown to aid resin diffusion into partially demineralized dentin and increase resin-dentin bond strength. It also improves mechanical properties, which can reduce resin dentin bond degradation.[6,10] SEM images of Gluma treated dentin demonstrated amorphous tubule occlusion [Figure 2d and h]. The two aldehyde groups of glutaraldehyde interlace with the amino groups of dentin collagen, causing tubule occlusion, as seen in SEM pictures of the current study.[11]

CPP-ACP therapy led to a minor and negligible reduction in bond strength to the dentin in comparison to the control group of the respective adhesive system, which is similar to Adebayo *et al*.'s[12] findings. Accordingly, Moule *et al*.[13] found that, in contrast to ERS, the bond strength of self-etching adhesives dramatically diminishes following CPP-ACP application as seen in the current investigation. This could be because of the penetration of monomers into the dentin considering that preetching with phosphoric acid or a cavity conditioner significantly increases the bond strength.[14] Comparing SEM imaging with CPP-ACP to other desensitizing agents, it was shown that the occlusion of dentinal tubules was more deeply rooted [Figure 2c and g]. This might be as a result of the action of CPP-ACP, which releases Ca^{2+} and PO_4^{3-} to maintained a supersaturated environment and obturate dentinal tubules with remineralized dentin.[15,16]

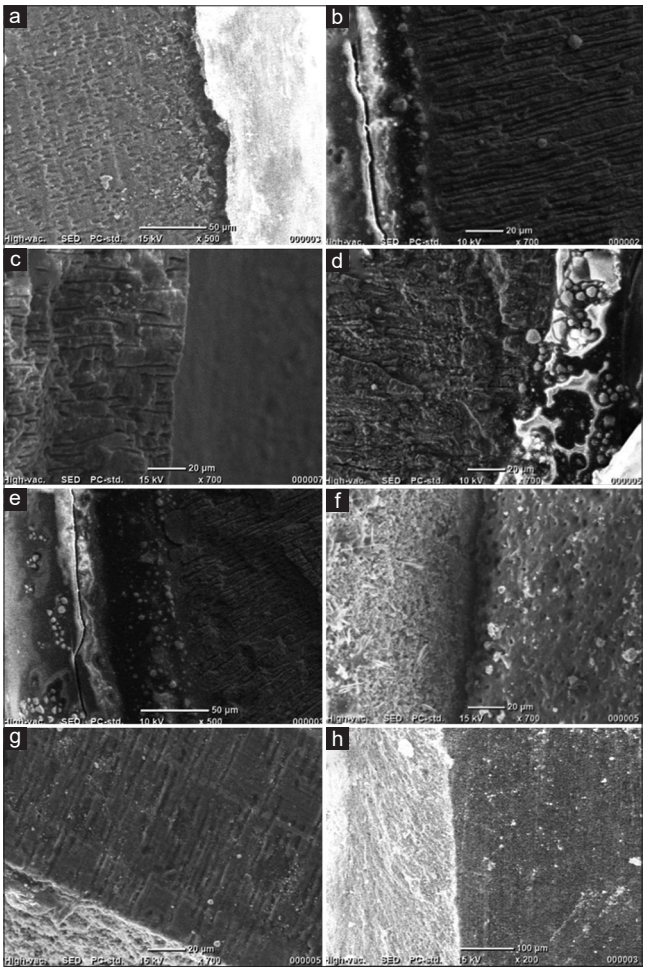

Figure 2: Scanning electron microscope images of etch and rinse adhesive agent applied (a) Control (b) NovaMin (c) GC Tooth Mousse (d) Gluma and self-etch adhesive agent applied (e) Control (f) NovaMin (g) GC tooth Mousse (h) Gluma

According to Pei *et al*.'s[17] explanation, the deposition of nano-hydroxyapatite found in toothpaste can counteract the demineralization of some self-etch adhesives by stifling resin penetration and weakening the bond,[18] which is in accordance with this study that, NovaMin showed better MBS in ERS than SES. Contrary to this, Krithi *et al*.[9,19] observed that dentin which had been remineralized with NovaMin exhibited considerably stronger bond strength under the SES group, even though there was no discernible difference between the remineralizing agents under the ERS. This might be because of the time duration for which the desensitizing agent was applied; in the present investigation, was only 15 days. This is correlated to the dentinal tubules blocked by mineral deposits in SEM images of samples treated with NovaMin toothpaste in both adhesive groups [Figure 2a-b and e-f].

In the current study, there was no significant effect of the desensitizing agent on the MBS on its own. Varying result in the bond strength among the groups is majorly due to the type of adhesive system used. Future research on the aging effects and bond degradation of desensitizer-treated needs to be evaluated.

CONCLUSION

Under the limitations of the present study, it can be etch and rinse adhesive system showed better bond strength when compared to self-etch adhesive system. While little or no difference was seen among the remineralizing agents under the total-etch or self-etch adhesive system.

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Conflicts of interest
There are no conflicts of interest.

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