Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2022 Apr 28; 10(D):205-209.
https://doi.org/10.3889/oamjms.2022.9542
eISSN: 1857-9655
Category: *D - Dental Sciences*
Section: *Dental Pathology and Endodontics*

The Effect of Desensitizing Agent on Shear Bond Strength to Dentin using Three Self-etching Bonding Systems at Different Time Intervals. An *In Vitro* Study

Ashraf S. Al-Chalabi*, Rajaa Taher, Makdad Chakmakchi

Department of Conservative Dentistry, College of Dentistry, University of Mosul, Mosul, Iraq

Edited by: Katerina Spiroska
Citation: Al-Chalabi AS, Taher R, Chakmakchi M. The Effect of Desensitizing Agent on Shear Bond Strength to Dentin using Three Self-etching Bonding Systems at Different Time Intervals. An *In Vitro* Study. Open Access Maced J Med Sci. 2022 Apr 28; 10(D):205-209. https://doi.org/10.3889/oamjms.2022.9542
Keywords: Desensitizing agent; Quadrant FiniSense; G-Premio bonding; Shear bond strength; i bond; Clearfil S3 bound plus
***Correspondence:** Ashraf S. Al-Chalabi, Department of Conservative Dentistry, College of Dentistry, University of Mosul, Mosul, Iraq. E-mail: drashraf8@uomosul.edu.iq
Received: 25-Mar-2022
Revised: 11-Apr-2022
Accepted: 18-Apr-2022

Funding: This research did not receive any financial support
Competing Interests: The authors have declared that no competing interests exist

Abstract

AIM: The aim of the study was to investigate the shear bond strength of dentin surfaces using different self-etching bonding systems after treating with a desensitizing agent at different time intervals.

MATERIALS AND METHODS: Sixty-three sound upper premolars were used, and each tooth was sectioned mesiodistally into buccal and palatal halves (n = 126). Each half was mounted into an acrylic block and a flat dentin surface was prepared at the middle third of the buccal and palatal surface of the specimens. Half of the specimens (n = 63) were treated with desensitizing agent Quadrant FiniSense and the other half acted as control then all specimens were bonded with one of the three self-etching bonding systems (n = 42 for each boding system) (G-Premio bonding, i Bond, Clearfil S3 bond plus). After adhesive procedures, a composite resin was applied against the tooth to form a cylinder (2 mm × 4 mm) and cured. From each bonding system, 14 specimens (seven desensitized specimens and seven without treatment) were stored in distilled water at 37°C for 24 h, 7 days, and 72 days. At the end of each interval, the samples were tested for the shear bond strength using the Instron testing machine. Statistical analysis was done using the Independent t-test and One-way analysis of variance Test and Duncan's Multiple Range Test.

RESULTS: All bonding systems showed lower bonding strength when samples were treated with desensitizer with a significant difference at all time intervals except for the i bond group which showed no significant difference in bond strength at a period of 7 and 72 days in treated and without desensitizer treated samples.

CONCLUSION: Treatment of dentin hypersensitivity using Quadrant FiniSense Desensitizer may have a negative effect on the bonding strength of some self-etching bonding systems.

Introduction

Dentin hypersensitivity (DH) is one of the most common problems that may cause discomfort to the patient and requires treatment at the dental office [1]. In the clinic, areas of DH may result from the exposed root surface, erosion or abrasion, and sometimes it may occur after full crown preparation on vital abutment teeth [2]. DH is manifested as a short sharp pain to some external stimuli such as chemical, thermal, evaporative, osmotic, or tactile stimuli [3].

Many theories explained DH such as neural theory, transduction theory, and hydrodynamic theory but the most accepted one is the hydrodynamic theory, which states that external stimuli lead to the sudden flow of liquids within the dentin tubules, and the fluid movement excites nerve endings in the pulp, inducing pain or sensitivity [4].

Dentin desensitizers are used commonly for the management of post-operative sensitivity. Treatment of DH can be done by two main mechanisms: Either blocking of the dentinal tubules or interference with the mechanoreceptor sensitivity but the main treatment utilized is through occlusion of the dentinal tubules, thereby reducing hypersensitivity [5]. This is done by many methods such as tubular obliterating procedures, anti-inflammatory agents, dental adhesives, varnishes, and lasers [6]. One of these desensitizers is Quadrant FiniSense (Cavex, Holland) which causes coagulation of the proteins in the dentine liquid that results in intradentinal closing of the tubuli, which prevents movement of the liquid in them – preventing the cause of the sensitivity.

The post-operative sensitivity with composite restorations may be reduced by the combined use of dentin desensitizer before the application of a bonding agent [7]. However, the effect of dentin desensitizer on the strength of bonding of the composite to dentin may differ from one bonding agent to another and needed to be evaluated as the desensitized treated dentin may have an adverse effect on bonding strength [8].

The aim of this *in vitro* study was to investigate the shear bond strength of composite to dentin surface using different self-etching bonding systems after treating with a desensitizing agent at different time intervals.

Materials and Methods

The study protocol was approved by the Ethical Committee of the Institutional Review Board at the College of Dentistry at the University of Mosul.

Samples grouping

This *in-vitro* study was conducted to evaluate the effect of a desensitizing agent on the bonding strength of three self-etching bonding agents at different times. Half of the samples were treated with a desensitizing agent whereas the other half were left without treatment and served as a control. All specimens were treated with one of three self-etching bonding systems then samples were stored for 24 h, 7 days, and 72 days (Flowchart 1).

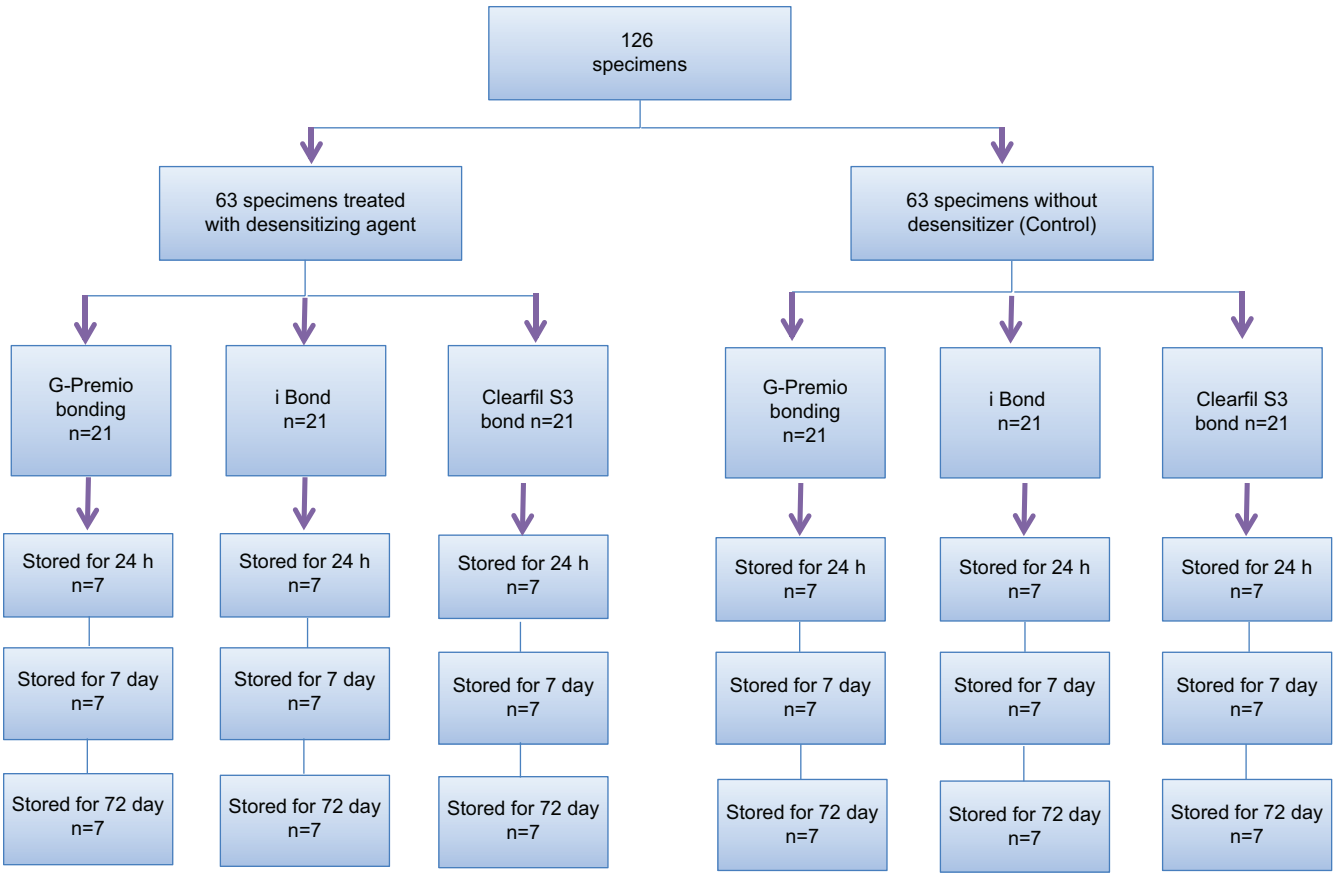
Sample preparation

In this *in vitro* study, 63 sound extracted human upper premolars stored in 0.1% thymol solution were used. Each tooth was sectioned mesiodistally into buccal and palatal halves (n = 126) using a low-speed cutting disc with copious water cooling and stored in distilled water to prevent dehydration. Each specimen was mounted in an acrylic resin block just below the cementoenamel junction and a flat dentin surface was prepared at the middle third of the uncut surface (buccally or palatally) for each specimen approximately 5 mm × 10 mm using a fine diamond bur with a high-speed handpiece mounted on an articulator to ensure a flat surface for all samples. All samples were cleaned using an ultrasonic cleaner for 5 min then polished using #600 waterproof polishing paper under flowing water to ensure a flat surface for all specimens then cleaned again using an ultrasonic cleaner for 5 min. Half of the specimens (n = 63) were treated with desensitizing agent Quadrant FiniSense (Cavex, Holland) according to the manufacturer instructions while the other 63 specimens were left without any pretreatment and served as control.

All specimens (n = 126) were bonded with one of the three self-etching bonding systems. The self-itching bonding agents used in this study were:

1. G-Premio bonding (GC America) n = 21 for desensitizer treated specimens and n = 21 for control
2. i Bond (Heraeus Kulzer) n = 21 for desensitizer treated specimens and n = 21 for control
3. Clearfil S3 bond plus (Kuraray) n = 21 for desensitizer treated specimens and n = 21 for control.

After the application of the self-etching bonding agent, a vinyl tube with a length of 2 mm and a 4 mm internal diameter was placed onto the prepared dentin substrate. A composite resin (Clearfil Majesty esthetic,



Flowchart 1: Samples grouping

Kuraray, Japan) was placed into the vinyl tube and compressed against the tooth to form a cylinder (2 mm height and 4mm diameter) and cured for 40 s.

Testing procedure

Fourteen specimens from each bonding system applied samples (seven desensitizing treated specimens and seven control) were stored in distilled water at 37°C for 24 h, another 14 samples were stored for 7 days and the remaining 14 samples were stored for 72 days. At the end of each interval, the shear bond strength of each sample was tested using an Instron universal testing machine (TH-8203S, China) (Figure 1). During testing, the long axis of applied force direction was perpendicular to the composite cylinder with the knife-edge being located at the composite-dentin interface, the strength of bonding will be measured in shear mode at across –head speed of 0.5 mm/min until failure occurs. Data were analyzed using the Independent t-test, One-way analysis of variance (ANOVA) Test, and Duncan's Multiple Range Test. The statistical procedures were analyzed with a significance level at $p < 0.05$ using "IBM SPSS Statistics 23 Software."

Figure 1: Photo of the Instron testing machine used to measure the shear bond strength of the prepared samples

Results

Within each one of the three groups, we compared the shear bond strength in MPa with and without using desensitizers at each time interval 24 h, 7 days, and 72 days (Tables 1-3).

All bonding systems showed lower bonding strength when samples were treated with desensitizer with a significant difference at all time intervals except for i bond group which revealed no significant difference in bond strength at a period of 7 and 72 days in treated and without treated samples.

Table 1: Independent t-test for G-premio bond group with and without desensitizer at different intervals

Time	Group	n	Mean	t-value	sig	Std.Deviation	Std. Error Mean
24 h	With	7	7.8914	-4.791-	0.000	0.24382	0.09215
	without	7	9.5671	-4.791-		0.89261	0.33738
7 days	With	7	7.2486	-2.717-	0.019	0.38779	0.14657
	without	7	7.9643	-2.717-		0.57925	0.21894
72 days	With	7	5.7814	-4.401-	0.001	0.57621	0.21779
	Without	7	6.9486	-4.401-		0.40048	0.15137

Both "One-way ANOVA Test And Duncan's Multiple Range Test" were used to compare the three groups at different time intervals as shown in Tables 4 and 5.

Table 2: Independent t-test for i Bond group with and without desensitizer at different intervals

Time	Group	n	Mean	t-value	sig	Std.Deviation	Std. Error Mean
24 h	With	7	8.1043	-3.781-	0.003	0.36276	0.13711
	without	7	9.1043	-3.781-		0.59827	0.22613
7 days	With	7	6.9257	-1.619-	0.131	0.22824	0.08627
	without	7	7.4771	-1.619-		0.87181	0.32951
72 days	With	7	5.8443	-1.840-	0.091	0.39614	0.14973
	without	7	6.6697	-1.840-		0.1.1187	0.42283

Results showed that there was no significant difference at 24 h between G-Premio-bond and i bond but both significantly differ from clearfil S3 bond in both with and without treated samples while after 7 days, tested groups showed a significant difference between G-Premio-bond which showed higher bond strength compared to clearfil S3 bond in both sensitizers treated with untreated samples while iBond showed no significant difference from other two groups (G-Premio-bond and clearfil S3 bond). At 72 days period, all the tested groups showed no significant difference in shear bond strength in both treated and untreated samples.

Table 3: Independent t-test of Clearfil S3 bound plus group with and without desensitizer at different intervals

Time	Group	n	Mean	t-value	sig	Std.Deviation	Std. Error Mean
24 h	With	7	7.2529	-2.937-	0.012	0.52188	0.19725
	without	7	7.9100	-2.937-		0.27958	0.10567
7 days	With	7	6.7029	-2.868-	0.014	0.24615	0.09304
	without	7	7.1400	-2.868-		0.31937	0.12071
72 days	With	7	6.0900	-4.075-	0.002	0.27172	0.10270
	without	7	6.9000	-4.075-		0.45022	0.17017

Discussion

DH is a common and chronic disease that can happen during exposure of dentinal tubules or

Table 4: One-way ANOVA test for three groups at different times

Time	Desensitizer	Group	Sum of Squares	df	Mean Square	F	Sig.
24 h	With	Between Groups	2.749	2	1.374	8.897	0.002
		Within Groups	2.780	18	0.154		
		Total	5.529	20			
	Without	Between Groups	10.236	2	5.118	12.454	0.000
		Within Groups	7.397	18	0.411		
		Total	17.633	20			
7 days	With	Between Groups	1.054	2	0.527	6.010	0.010
		Within Groups	1.578	18	0.088		
		Total	2.632	20			
	Without	Between Groups	2.404	2	1.202	3.011	0.074
		Within Groups	7.186	18	0.399		
		Total	9.590	20			
72 days	With	Between Groups	0.372	2	0.186	0.992	0.390
		Within Groups	3.377	18	0.188		
		Total	3.749	20			
	Without	Between Groups	0.311	2	0.155	0.289	0.753
		Within Groups	9.687	18	0.538		
		Total	9.998	20			

the loss of enamel and cementum [9]. Many materials and techniques have been suggested to minimize or eliminate the sensitivity including potassium salts containing toothpaste, fluoride-releasing composites, resins, laser, bioglass, and others [10].

Desensitizing agents mainly function by precipitating within dentinal tubules or at the tubular orifice thus occluding the dentinal tubules, preventing the fluid movement inside tubules and reducing pain sensation by inhibiting the hydrodynamic mechanism of DH, however, studies have been shown that these desensitizing agents may inhibit the penetration of the adhesive system into dentinal tubules and leading to lower bond strength, producing spaces at the bonded interface when stress occurs [11].

Table 5: Duncan's multiple range test between three groups at the same time interval

Group	24 h		7 days		72 days	
	With	Without	With	Without	With	Without
G- Premio-Bond						
Mean	7.8914 a	9.5671 a	7.2486 a	7.9643 a	5.7814 a	6.9486 a
n	7	7	7	7	7	7
Std. Deviation	0.24382	0.89261	0.38779	0.57925	0.57621	0.40048
I-Bond self-etch						
Mean	8.1043 a	9.1043 a	6.9257 ab	7.4771 ab	5.8443 a	6.6697 a
n	7	7	7	7	7	7
Std. Deviation	0.36276	0.59827	0.22824	0.87181	0.39614	1.11870
Clearfil S3 Bond						
Mean	7.2529 b	7.9100 b	6.7029 b	7.1400 b	6.0900 a	6.9000 a
n	7	7	7	7	7	7
Std. Deviation	0.52188	0.27958	0.24615	0.31937	0.27172	0.45022
Total						
Mean	7.7495	8.8605	6.9590	7.5271	5.9052	6.8394
n	21	21	21	21	21	21
Std. Deviation	0.52579	0.93895	0.36279	0.69245	0.43295	0.70704

In this study, we used a different time to evaluate their effect on bonding strength as studies showed that long time intervals have a negative effect on bonding strength [12]. All bonding systems showed lower bonding strength at all times except for i bond group which revealed no significant difference in bond strength at a period of 7 and 72 days. This may be attributed to the i bond system that may have less acidity compared to other self-etching bonding systems and then some "minerals (hydroxyapatite) remain attached to the collagen fibers, which may serve as a receptor for additional intermolecular interaction with specific monomers of the self-etch adhesive, permitting chemical links between the dental substrate and functional groups of the adhesive monomers" [13].

Quadrant FiniSense Desensitizer contains 36% 2-Hydroxyethylmethacrylate (HEMA), 5% glutaraldehyde, and 59% water and is used as desensitizing primer to relieve pain caused by exposed dentin and to prevent or relieve post-operative sensitivity under all restorative materials.

Part of the dentinal fluid protein which is called serum albumin may precipitate by reaction with glutaraldehyde also this reaction may induce the polymerization of HEMA [14]. Studies have shown that HEMA and glutaraldehyde together may cause occlusion of the dentinal tubule to depths of 50–200 μm [15]. The results of this study revealed that the use of desensitizer before the bonding step can reduce the bonding strength of all three bonding systems, the occluded dentinal tubules may limit the penetration of the bonding agent. The results in this study agree with Malkoc *et al*., 2005 [16].

Samples storage in water at different times was used to evaluate the effect of aging on the bonding interface that is why different time intervals were used in this study which might be important for observing the degradation susceptibility of adhesive [17].

Temperature variations can produce a significant changes in the physical and mechanical properties of dental materials and also in the chemical stability of the bonding interface [18]. That is why the limitation of this study was in the temperature which was 37°C for all samples without any fluctuations that does not mimic the normal situation inside the oral cavity also longer time storage might be required to study their effect on bonding strength. The significant reduction in the bond strength results observed for all three adhesive systems after 72 days of storage when compared to 24 h, demonstrates that chemical degradation of components may invariably compromise their bonding ability to dentin [12].

Conclusion

The results of this study revealed that the application of Quadrant FiniSense Desensitizer can significantly decrease bond strength to the dentin surface. Hence, application of such material to reduce sensitivity just before the bonding procedure should be considered because it may compromise bonding strength to dentin.

Acknowledgments

My deepest gratitude and appreciation to the University of Mosul for their continuous support and help. Great thanks to the College of Dentistry, University of Mosul, for providing all facilities and guidance in this study.

References

1. Liu XX, Tenenbaum HC, Wilder RS, Quock R, Hewlett ER, Ren YF. Pathogenesis, diagnosis and management of dentin hypersensitivity: An evidence-based overview for dental practitioners. BMC Oral Health. 2020;20(1):220. https://doi.org/10.1186/s12903-020-01199-z
PMid:32762733
2. Davari A, Ataei E, Assarzadeh H. Dentin hypersensitivity: Etiology, diagnosis and treatment; A literature review. J Dent

(Shiraz). 2013;14(3):136-45.

3. Abed AM, Mahdian M, Seifi M, Ziaei SA, Shamsaei M. Comparative assessment of the sealing ability of Nd: YAG laser versus a new desensitizing agent in human dentinal tubules: A pilot study. Odontology. 2011;99:45-8.
4. Orchardson R, Gillam DG. Managing dentin hypersensitivity. J Am Dent Assoc. 2006;137:990-8. https://doi.org/10.14219/jada.archive.2006.0321
   PMid:16803826
5. Ishihata H, Kanehira M, Finger WJ, Takahashi H, Tomita M, Sasaki K. Effect of two desensitizing agents on dentin permeability *in vitro*. J Appl Oral Sci. 2017;25:34-41. https://doi.org/10.1590/1678-77572016-0228
   PMid:28198974
6. Külünk S, Saraç D, Külünk T, Karakaş 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. https://doi.org/10.1111/j.1708-8240.2011.00415.x
   PMid:22142297
7. Fu B, Shen Y, Wang H, Hannig M. Sealing ability of dentin adhesives/desensitizer. Oper Dent. 2007;32:496-503. https://doi.org/10.2341/06-143
   PMid:17910227
8. Huh JB, Kim JH, Chung MK, Lee HY, Choi YG, Shim JS. The effect of several dentin desensitizers on shear bond strength of adhesive resin luting cement using self-etching primer. J Dent. 2008;36:1025-32. https://doi.org/10.1016/j.jdent.2008.08.012
   PMid:18986747
9. Miglani S, Aggarwal V, Ahuja B. Dentin hypersensitivity: Recent trends in management. J Conserv Dent. 2010;13(4):218-24. https://doi.org/10.4103/0972-0707.73385
   PMid:21217949
10. Chu CH, Lo EC. Dentin hypersensitivity: A review. Hong Kong Dent J. 2010;7:15-22.
11. Awang RA, Masudi SM, Mohd Nor WZ. Effect of desensitizing agent on shear bond strength of an adhesive system. Arch Orofac Sci. 2007;2:32-5.
12. Cardoso SA, Oliveira HL, Münchow EA, Carreño NL, Gonini A Jr., Piva E. Effect of shelf-life simulation on the bond strength of self-etch adhesive systems to dentin. Appl Adhes Sci. 2014;2:26.
13. Nassar AA, El-Sayed HY, Etman WM. Effect of different desensitizing adhesive systems on the shear bond strength of composite resin to dentin surface. Tanta Dent J. 2016;13:109-17.
14. Patil SA, Naik BD, Suma R. Evaluation of three different agents for in-office treatment of dentinal hypersensitivity: A controlled clinical study. Indian J Dent Res. 2015;26(1):38-42. https://doi.org/10.4103/0970-9290.156796
   PMid:25961613
15. Porto IC, Andrade AK, Montes MA. Diagnosis and treatment of dentinal hypersensitivity. J Oral Sci. 2009;51(3):323-32. https://doi.org/10.2334/josnusd.51.323
   PMid:19776498
16. Malkoc S, Demir A, Sengun A, Ozer F. The effect on shear bond strength of different antimicrobial agents after acid etching. Eur J Orthod. 2005;27(5):484-8. https://doi.org/10.1093/ejo/cji032
   PMid:16135539
17. Lima JM, Anami LC, Pereira SM, de Melo RM, Bottino MA, de Miranda LM, *et al*. Dentin/composite bond strength: Effect of aging and experimental unit. J Adhes Sci Technol. 2021;35:536-546. https://doi.org/10.1080/01694243.2020.1816767
18. Iliev G, Hardan L, Kassis C, Bourgi R, Cuevas-Suárez CE, *et al*. Shelf life and storage conditions of universal adhesives: A literature review. Polymers (Basel). 2021;13(16):2708. https://doi.org/10.3390/polym13162708
   PMid:34451245