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Evaluation of the Effect of Two Different Bonding Systems on Shear Bond Strength to Dentin

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Abstract

Objectives: this study was carried out to evaluate two different bonding systems on Shear bond strength to dentine and Fracture mode analysis of the fractured specimens. **Material and Methods**: A total of 40 molars were used. They were divided into two groups (20 each) according to the application modes. The two groups were further subdivided into two subgroups (10 each). The first subgroup was stored, and the second subgroup was subjected to thermocycling. After the bonding procedure, a nanofilled composite was applied incrementally. **Results:** As regards non-thermocycled and thermocycled specimens; there was no statistically significant difference between the values of the two application modes with effect size = 0.780 and 0.780, respectively. With etch and rinse and self-etch application modes; there was no statistically significant difference between the values of both subgroups with effect size 0.475 and 0.951, respectively. **Conclusion:** The shear bond strength values of both bonding protocols showed no statistically significant difference regarding both thermocycled and non-thermocyled specimens. Adhesive fracture was predominant in both groups.

Keywords*: shear bond strength, universal adhesive, etch and rinse, self-etch*

1. Introduction

In an attempt to overcome the shortcomings of the etch-and-rinse adhesives, self-etching adhesives were introduced to restorative dentistry which showed unique advantage of being able to diffuse deeper to the fully decalcified depth[1], enhancing the sealing ability preventing the gap formed due to the inconsistent decalcification and penetration of the etch-and-rinse adhesives[2].

Self-etching adhesives also show some shortcomings. Most important of which is the inability to decalcify uncut enamel as same as acid etching using phosphoric acid pretreatment due to their high pH levels[3].
Universal adhesives have been then introduced achieving the advantages of simplifying the application process, saving time, and eliminating errors that may arise from multiple steps involved in other dental adhesives[4].

Thermal cycling tends to produce stresses at the resin/tooth interface thus can have an impact on the bond strength of different adhesive systems[5].

The effectiveness of an adhesive system to bond to dental substrates is mostly tested with bond strength tests. There are several bond strength tests that are advocated in testing bond effectiveness and durability such as shear bond strength test, microtensile, microshear push-out and fracture toughness tests[6].

Macro Shear Bond Strength (SBS) remains the most widely used method to test bond effectiveness of new adhesive formulations and has gained its popularity in dentistry since no further specimen processing is needed after the bonding procedure, allowing a reliable method to test bond performance[7].

Hence, the studying of the effects of one universal adhesive on shear bond strength used in different application methods; etch-and-rinse and self-etching modes might be of value.

2. Material and Methods

2.1. Selection of the Specimens:

A total of forty molars were collected from the outpatient dental clinic. The molars were cleaned from blood and the soft tissue was removed using a hand scaler and hard deposits were removed using an ultrasonic scaler[8]. The molars were then stored in distilled water at room temperature which was replenished every 24 hours[9]. Molars were selected according to the following criteria:- Inclusion criteria: sound molars, permanent molars and age group: 25-40 years old. Exclusion criteria: carious teeth, deciduous teeth, fractured or cracked teeth, teeth with congenital dental anomalies, teeth with acquired defects and restored molars.

2.2 Grouping of the specimens:

A total of forty human extracted molar were used in this study. They were divided into two groups (20 each) according to the application mode of two different bonding systems, namely etch and rinse and self-etch, respectively (Table 1). The two groups were further subdivided into two subgroups (10 each) (Table 2). The first subgroup was stored in distilled water at room temperature in incubators, while the second subgroup was subjected to thermocycling (5˚C to 55˚C - 500 cycles)10.

Table (1): Factorial Design

Factor	Symbol		Description
Application mode	**A**	A_1	Etch and rinse mode
		A2	Self-etch mode
Thermocycling	**T**	T1	No thermocycling
		T2	Thermocycling

Table (2): Interactions between variables

A1			A2		Total
T1	**A1T1**	**10**	**A2T1**	**10**	**40 specimens**
T2	**A1T2**	**10**	**A2T2**	**10**	

2.3 Procedure:

The coronal portion was sectioned by diamond disc using a straight hand piece under copious amount of distilled water to a level 3 mm above the CEJ horizontally in a buccolingual direction exposing only dentin. The exposed dentin surfaces were wet ground under copious amount of water using #600 grit SiC for 30 seconds to create standardized smear layers11. Each tooth was placed in self-cured acrylic block from the root side, till the cemento-enamel junction (CEJ).

In etch-and-rinse technique, the dentin surface was acid etched using phosphoric acid 37% etchant gel for 15 seconds, rinsed with air/water spray for 20 seconds and blot dried using cotton pellet to keep dentin visibly moist.

The adhesive was then applied and cured for 10 seconds according to manufacturer instructions. In self-etching technique, the adhesive layer was applied using a microbrush directly over dentin surfaces and cured for 10 seconds according to its manufacturer instructions.

Teflon mold was constructed 2 x 4 mm in dimensions and adjusted over the treated dentin surface. A 2 mm resin composite increment was packed inside the mold and cured for 20 seconds according to manufacturer instructions. The second increment was added, covered with Mylar strip, gently pressed over a glass slab, and light cured for 20 seconds according to manufacturer instructions. The mold was separated and excess resin composite was scrapped and the specimens were subjected to storage in distilled water at room temperature for testing machine.

Stereomicroscope was then used to evaluate and analyze the fracture mode: the fracture mode analysis was adhesive failure at the adhesive/dentin interface, cohesive failure within resin composite or dentin and mixed failure in dentin and resin composite.

3. Results

As regards non-thermocycled and thermocycled specimens; there was no statistically significant difference between the values of the two application modes with effect size = 0.780 and 0.780 respectively and *P*-value = 0.251 and 0.251 as shown in figure 1.

With etch and rinse and self-etch application modes; there was no statistically significant difference between the values of both subgroups with effect size 0.475 and 0.951 respectively and *P*-value = 0.465 and 0.175 as shown in figure 2.

Regarding the etch and rinse bonding system, the following fracture modes were observed: 16 out of the 20 specimens showed adhesive fracture; 8 of which were non-thermocycled and 8 were thermocycled specimens, 4 out of the 20 specimens showed adhesive/cohesive fracture; two of which were non-thermocyled and two were thermocycled specimens. None of the specimens showed cohesive fracture. Whereas in self-etch bonding system (20 specimens), the following fracture modes were observed: 15 out of the twenty specimens showed adhesive fracture; 6 of which were non-thermocycled and 9 were thermocyled specimens. 4 out of the 20 specimens showed adhesive/cohesive fracture; all were among the non-thermocycled specimens. 1 out of the 20 specimens showed cohesive fracture in dentin; it was a thermocycled specimen.

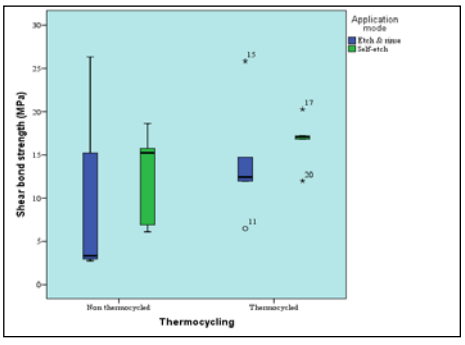

Figure 1

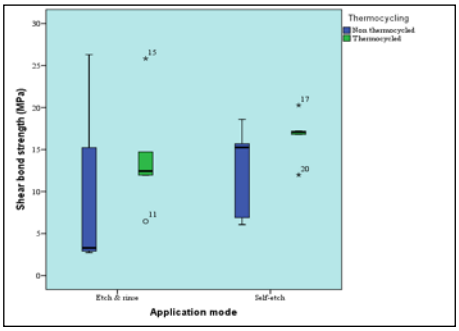

Figure 2

4. Discussion

This study showed that the bond strength of the universal adhesive to permanent tooth dentin was not affected by the different bonding systems used, namely etch and rinse and self-etch bonding systems, which is in agreement with some researchers12,13, who found no differences in bond strength values between either application of Single Bond Universal (SBU) and permanent sound dentin.

However, it was shown in a study that different results were obtained as they used caries-affected dentin (CAD) and found that the bond strength was reduced when the bonding substrate was caries affected dentin lesions, in both adhesive systems (Etch-and-rinse and Self-etch modes) used[14]. But they agreed that there is absence of statistically significant difference of bonding performance between different application modes of the universal adhesive used (Scotchbond Universal-SBU) confirmed by its ability to promote micromechanical retention by diffusion of resin monomers and chemical adhesion, regardless the application mode used.

Another study evaluating the microshear bond strength of different universal adhesives with different application modes on sound human dentin confirmed the results of this study. They stated that Single Bond Universal (SBU) did not show any significant difference in μSBS value between both etching modes which is confirmed in this study[10]. This is explained by its ability to bond micromechanically creating dentin–resin interaction zone with stable resin tags as well as their strong chemical interaction of its functional monomer, 10‐MDP, with residual hydroxyapatite of the tooth structure forming a stable nanolayer that is considered a strong phase at the adhesive interface, irrespective of the application system used. Also, it was stated that self-etch adhesive systems might be preferable for application on dentin due to shallower demineralization eliminating the need for etching and rinsing steps which are crucial steps in etch and rinse bonding systems[15].

There is still debate about the best application mode of universal adhesives on dentin whether it is better applied with prior acid etching procedure or used as self‐etch adhesives. Regarding the mechanical standpoint some studies showed that additional phosphoric acid etching was beneficial for the dentin bond strength when using universal adhesives[16].

In a randomized controlled clinical trial[17], it was found that the dentin sealing ability of universal adhesives was deteriorated when using etch-and-rinse mode possibly due to the prior etching procedure that tends to remove calcium from dentin, which may impede any potential chemical bonding (nano-layering) between calcium and phosphate groups in the adhesive, while when using self-etch mode, the lowest nanoleakage was observed. Thus, they concluded that etching dentin is not recommended to be the first choice for universal adhesives.

Some studies found statistically similar bond strength values of universal adhesives used with both bonding protocols, however they found that upon performing artificial-aging of Universal Adhesives, Self-etch strategy showed more long-term stability of dentin bond, possibly due to the established chemical bond formed by 10-MDP[18].

Dissimilar results were obtained in some studies using superficial dentin that was found to be higher and significantly different when evaluating bond strength of universal adhesives[19].

The effect of thermocycling on the bond strength of both etch-and-rinse and self-etch adhesive modes to coronal dentin was evaluated showing no statistically significant difference in bond strength values whereas self-etch adhesive had higher shear bond strength values than etch-and-rinse to root dentin when thermocycling was performed[20].

Fracture mode analysis was performed in this study which is an important factor to be considered when bond strength is tested. Three modes of failure were evaluated: adhesive failure at the adhesive/dentin interface, cohesive failure in the resin composite and/or dentin, and mixed failure. In adhesive failures, the adhesive layer is usually involved at the interface, whereas in mixed failures, a portion of dentin and/or composite is involved. In cohesive failures, only dentin or resin composite is involved at the fracture site[21].

In this study, the main mode of failure observed in the etch-and-rinse group with or without thermocycling was adhesive fracture, followed by mixed fracture with no cohesive fracture found. This was in agreement with another study[19]. Similarly, in the self-etch group in this study, the mostly found type of failure was adhesive, followed by mixed with one cohesive failure in dentin observed in a thermocycled sample. However, the latter study found that in the self-etch group, the main fracture mode was adhesive, followed by cohesive, and the least mode observed was the mixed failure which is in disagreement to the current study.

Some authors[23] also analyzed the fracture modes of universal adhesives after microshear bond strength test and confirmed the fracture modes resulted in this study; they found that the main failure mode found was adhesive, followed by mixed, and there were almost no cohesive failures found in their study. They stated that the adhesive failures indicate a rupture of the bond at the dentin/composite interface, while mixed fractures indicate cohesive disruption in the composite and adhesive in the dentin. Therefore, the higher prevalence of adhesive fractures pointed out that the bond strength of the specimens was analyzed and not the internal resistance of the material.

5. Conclusion

The shear bond strength values of universal adhesive using self-etch bonding protocol showed no statistically significant difference than the values using the standard etch and rinse protocol. Regarding thermocycling, thermocycled and non-thermocyled specimens had no statistically significant difference in shear bond strength values within each group; etch and rinse and self-etch groups. Fracture mode analysis showed that adhesive failure was predominant in both groups, followed by mixed failure. Only one of the cut specimens in the self-etch group showed cohesive failure in dentin.

References

1. Jacques P, Hebling J. Effect of dentin conditioner on the micro tensile bond strength of a conventional and self-etching primer adhesive system. Dental Materials 2005; 21:103-109.
2. Devarasa G, Reddy V, Chaitra N. Self-etching on intact enamel. Journal of Indian Society of Pedodontics and Preventive Dentistry 2012; 30: 133-138.
3. Cardenas A, Siqueira F, Rocha J, Szesz A, El-askary F, Anwar M, Reis A, Louercio A. Influence of Conditioning Time of Universal Adhesives on Adhesive Properties and Enamel-Etching Pattern. Operative Dentistry 2016; 41(2):000-000.
4. Fatma Dilsad OZ, Esra ERGIN, and Simge CANATAN. Twenty-four-month clinical performance of different universal adhesives in etch-and-rinse, selective etching and self-etch application modes in NCCL – a randomized controlled clinical trial. Journal of Applied Oral Science 2019; 27:e2018035.
5. H.Y. El Sayed, A.I. Abdalla, M.E. Shalby, M.E. Essa, D.M. Amin. Effect of thermocycling on the micro-shear bond strength of solvent free and solvent containing self-etch adhesives to dentin. Tanta Dental Journal 2014; 1e7.
6. Siegward D. Heintze, Valentin Rousson, and Eduardo Mahn. Bond strength tests of dental adhesive systems and their correlation with clinical results – A meta-analysis. Academy of Dental Materials 2015; (4):423-34.
7. Aminah M. El Mourad. Assessment of Bonding Effectiveness of Adhesive Materials to Tooth Structure using Bond Strength Test Methods: A Review of Literature. The open Dentistry Journal 2018; 12, 664-678.
8. Mitsuhiro Takeda, Toshiki Takamizawa, Arisa Imai, Takayuki Suzuki, Akimasa Tsujimoto, Wayne W Barkmeier, Mark A Latta, Masashi Miyazaki. Immediate Enamel Bond Strength of Universal Adhesives to Unground and Ground Surfaces in Different Etching Modes. Eur J Oral Sci 2019 Aug; 127(4):351-360.
9. Antonio José Ortiz-Ruiz, Iban Jesús Muñoz-Gómez, Ana Pérez-Pardo, Concepción Germán-Cecilia, Yolanda Martínez-Beneyto, Ascensión Vicente. Influence of Fluoride Varnish on Shear Bond Strength of a Universal Adhesive on Intact and Demineralized Enamel. Odontology 2018 Oct; 106(4):460-468.
10. Ayad A. Ahmed, Mustafa M. Hassan, Ali I. Abdallab. Microshear bond strength of universal adhesives to dentin used in total‐etch and self‐etch modes. Tanta Dental Journal 2018, 15:91–98.
11. Korkmaz Y, Gurgan S, Firat E, Nathanson D. Effect of adhesives and thermocycling on the shear bond strength of a nano-composite to coronal and root dentin. Operative dentistry 2010; 35-5 522-529.
12. Marchesi G, Frassetto A, Mazzoni A, Apolonio F, Diolosa M, Cadenaro M, Di Lenarda R, Pashley DH, Tay F, Breschi L. Adhesive performance of a multi-mode adhesive system: 1-year in vitro study. Journal of Dentistry 2014; 42: 603-612.
13. Wagner A, Wendler M, Petschelt A, Belli R, Lohbauer U. Bonding performance of universal adhesives in different etching modes. Journal of Dentistry 2014; 42: 800-807.
14. V Hass, AFM Cardenas, FSF Siqueira, RR Pacheco PMW Zago, DO Silva, MC Bandeca, AD Loguercio. Bonding Performance of Universal Adhesive Systems Applied in Etch-and-Rinse and Self-Etch Strategies on Natural Dentin Caries. Operative Dentistry, 2019, 44-5, 510-520.

15. Sara Valizadeh, Aida Moradi, Mansooreh Mirazei, Hooman Amiri, and Mohammad Javad Kharazifard. Microshear Bond Strength of Different Adhesive Systems to Dentin. Front Dent. 2019 Jul-Aug; 16(4): 265–271.
16. Lenzi TL, Raggio DP, Soares FZ. Bonding performance of a multimode adhesive to artificially‐induced caries affected primary dentin. J Adhes Dent 2015; 17:125–131.
17. Loguercio AD, de Paula EA, Hass V. A new universal simplified adhesive: 36‐month randomized double‐blind clinical trial. J Dent 2015; 43:1083–1092.
18. Nagarkar S, Theis-Mahon N, Perdigão J. 2019. Universal dental adhesives: Current status, laboratory testing, and clinical performance. J Biomed Mater Res B Part B. 2019:9999B:9999B:1–11.
19. Pedram Daneshkazemi, Amir Ghasemi, Alireza Daneshkazemi, Fahime Shafiee. Evaluation of micro shear bonding strength of two universal dentin bondings to superficial dentin by self etch and etch-and-rinse strategies. J Clin Exp Dent. 2018 Sep; 10(9): e837–e843.
20. Silke Jacker-Guhr, Johannes Sander, Anne-Katrin Luehrs. How "Universal" Is Adhesion? Shear Bond Strength of Multi-mode Adhesives to Enamel and Dentin. J Adhes Dent 2019; 21(1):87-95.
21. Gabriela Cardoso de Cardoso, Leina Nakanishi, Cristina Pereira Isolan, Patrícia dos Santos Jardim, Rafael Ratto de Moraes. Bond Stability of Universal Adhesives Applied To Dentin Using Etch-And-Rinse or Self-Etch Strategies. Brazilian Dental Journal 2019; 30(5): 467-475
22.Costa FV, Campos LMP, Ayala MD. Comparison of different adhesive techniques using a universal adhesive system. Appl Adhes Sci. 2017; 5(1).