Original Article

Evaluation and Comparison of Micro Shear of 5th, 7th and 8th Generation Bonding Agents in Dentin (In Vitro Study)

Elnaz Shafigh [1]*, Mohammad Reza Mahdavi [2], Rezvan Nasiri [1]

[1] Assistant Professor, Operative dentistry department, Faculty of Dentistry, Aja University of Medical Sciences, Tehran, Iran. [2] Dentistry Student, Faculty of Dentistry, Aja University of Medical Sciences, Tehran, Iran.

Abstract

Introduction: Today various bonding systems are introduced in the market which increase the quality of restoration and durability. The purpose of this study was to compare the shear strength of dentin in three different generations of bonding materials in the market. **Methods and Materials:** In this study, 60 healthy premolars tooth that were extracted for orthodontic reasons were disinfected and exposed of their dentin with a diamond bur. 3 M Z100 (USA, ESPE) composite were used. Three different generations of bonding materials were used. The 8th Generation (group A) Dentin Bonding Agents was (USA, Scotchbond Universal, 3M ESPE) and 7th generation (group B) was (USA, Adper Easy one, 3M ESPE) and finally 5th generation (group c) was (Germany, Single Bond 2, 3M ESPE) which apply to the dentin surface according to the manufacture instructions. The specimens were thermocycled 1000 times. The shear bond strength was evaluated at a universal testing machine by speed of 0.5 m / min. **Results:** The mean shear bond strength in Scotchbond Universal group was 15.8 ± 6.08 MPa and in Adper Easy one was 11.24 ± 3.75 MPa and in Single Bond 2 group was 15.24 ± 4.6 MPa.). The mean shear bond strength of group A was significantly different from that of group B (P <0.05). The mean shear bond strength of group A was not significantly different from that of group C (P> 0.05). The mean shear bond strength of group B was not significantly different from that of group C shear bond strength. (P> 0.05). **Conclusion:** The present study showed that eight-generation bonding systems (Scotchbond Universal, USA, 3M ESPE) has the same shear bond strength as single bond 2 generation has. Also, the shear bond strength of Seventh-generation Adper Easy One is less than the fifth-generation (AdperSingle Bond 2), although this difference was not significant. On the other hand, this generation of bonding is user friendlier due to its ease of use and lower clinical time for use in pediatric dentistry, where isolation and collaboration is a major challenge.

Keywords: Shear Bond Strength, Dentin, 5th Generation Bonding, 8th Generation Bonding, 7th Generation Bonding, Self-etching, Total Etching

Introduction

Dentin bonding systems are used to bond the composite to the teeth and poor bonding systems is one of the problems in dentistry, especially in prosthetic and restorative treatments, which results in weak restorations. The clinical success of composite restorations is largely dependent on the efficiency and quality of the bonding system used, which makes a long lasting and effective bond between the composite and the tooth structure as well as reducing micro leakage subsequently reducing caries, pulpal sensitivity and inflammation. [1] Shear bond strength and microleakage are two important properties of dentin bonding systems that are effective in the durability of composite restorations. According to research, the bonding rate in multi-stage systems (4th and 5th generation) is 5-32 MPa and in single-stage systems (6th, 7th and 8th generation) is 26-27 MPa. [1, 2]

Self-etch systems do not need to remove the smear layer, and simultaneously decalcification and resin penetration occurs between enamel and collagen fibers of dentin. This clinical process is less complex and is less sensitive to degradation due to no need for rinsing and no dependence on dentin moisture. [1]

In the self-etching system (6th, 7th and 8th generation), the conditioner, primer and resin are in a solution, used simultaneously on enamel and dentine. The marginal seals obtained from these materials are suitable and similar to conventional systems. [3]

Address for correspondence: Elnaz Shafigh, Operative dentistry department, Faculty of Dentistry, Army University of Medical Sciences 13th street, sabari street, Ajoudanye, Tehran, Iran.
Email: shafighelnaz@gmail.com

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Various systems have been introduced so far that newer one have always tried to simplify the clinical process, but due to the enamel and dentin structure are different, the simplification of the clinical process can decrease bond strength and increased micro leakage. But if a dentin bonding system that has simplified the clinical application process can have a shear bond strength equal to or greater than the older system, it seems reasonable for the dentist to use a newer system. Many researches are currently hold to increase bonding strengths. Weak bonding strengths and difficulty in applying dentin bonding systems have adverse consequences such as increased technical sensitivity, increased number of steps resulting in increased error during work, wasting time of the dentist and the patient, discoloration due to recurrence of caries around the restorations And finally results in loss of restoration. [4]

Method and Material:

This experimental and in vitro study was performed on 60 healthy and without decay human premolar teeth that were extracted due to orthodontic procedures and stored in normal saline at room temperature.

All teeth were cleaned with rubber cap and pumice. Sixty teeth were used to measure shear bond strength. Samples were stored in 0.2% thymol solution for 24 hours before starting.

To evaluate the shear bond strength, each specimen was mounted individually in self-cured acrylic (Bayer, Germany) in a PVC ring with a diameter of 1.5 cm, the occlusal surface of each specimen was cut and completely exposed to the dentin with a diamond bur (Germany,Diatec). And cooled continuously by water spray to prevent heat. Specimens were examined and specimens with pulpal exposure were excluded. After that, the dentin surfaces of each specimen abraded for about 20 seconds with silicone paper discs grit 600 to create a uniform smear layer. After preparation, the samples were randomly divided into three groups of twenty and each group was treated with a different bonding agent. All bonding was applied to the dentin surfaces according to the manufacturer's instructions.

In group A, 20 specimens were treated by (Scotchbond Universal USA, 3M ESPE) according to the manufacturer's instructions. In this group, 20 seconds of bonding was applied to the dentin surface by micro brush and then air spray was taken gently and then cured for 20 seconds.

In Group B, 20 samples were treated as recommended by the manufacturer of bonding (USA, Adper Easy one, 3M ESPE) as a representative of the seventh generation , the bonding was rubbed onto the dentin surface by micro brush for 20 seconds, then gently get air and dried for 5 seconds and then cured for 20 seconds.

In group C, which consisted of 20 teeth prepared initially, the teeth get air spray and dried and etched on 37% phosphoric acid gel (Iran, Morvabon) on the dentine for 15 seconds. Then, the tooth was rinsed for 20 seconds with a spray of air after drying, the bonding agent (Germany, Single Bond 2, 3M ESPE) was used as the 5th generation and rub for 15 seconds according to the manufacturer's instructions, and the solvent was evaporated by air spray for five seconds and light-cured (China, pengiun LED lightcure, COXO) at a light intensity of 500 mW / cm2. Cured for 20 seconds.

Following these steps, in three groups A, B and C, a transparent plastic tube 2.5 mm in diameter and 3 mm high filled with A2, 3M Z100 (USA, ESPE) composite was applied to each sample and 40 Seconds were cured in each side, totally 120 seconds and stored for one day in 37 ° C water and then thermocycled for 1000 rpm between + 5 ° C and + 55 ° C.

To measure the shear bond strength of the specimens, the zwick (Germany, Roell) machine was used in such a way that each specimen was placed in a special place. This chisel touched with the specimen and gradually applied force to the specimen at a velocity of 0.5 mm / min and until it fractured. The amount of force was recorded. The shear bond strength of the specimens was first recorded in Newton and then divided by the cross-sectional area of the composite cylinder to a diameter of 2.5 mm to convert in Mega Pascal.

In order to evaluate the results of each experimental group, ANOVA test were used which investigates the significance of the effects of 8 and 5 and 7 generation bonding on shear bond strength. Tukey test was used to compare the means of the groups. Statistical analysis was performed using SPSS 25 software.

Results:

The descriptive parameters of the three experimental groups are presented in Table 2. The lowest mean shear bond strength was obtained in group B with a mean of 11.24 ± 3.75 MPa and the highest mean shear bond strength was obtained in group A with mean of 15.8 ± 6.08 MPa. The mean band shear strength of group C was also 15.24 ± 4.6 MPa (Figure 1).

One-way ANOVA test was used to determine the significant differences between the groups (Table 3). The mean shear bond strength of the three groups was statistically significant ($P < 0.05$).

The means were compared using the t-test method (Tables 2 and 3). Mean shear bond strength of group A with group B had a significant difference ($P < 0.05$). The mean shear bond strength of group A was not significantly different from that of group C ($P > 0.05$). The mean shear bond strength of group B was not significantly different from that of group C shear bond strength. ($P > 0.05$)

Discussion:

Shear bond strength is an important feature of dentin bonding systems that is very effective on the durability of composite restorations. Dentin bonding systems are used to bond the composite to the teeth, and poor bonding systems are one of the problems in dentistry, especially prosthetic and restorative treatments, which result in failures. The poor bonding and the difficulty of applying dentin bonding systems have adverse consequences such as discoloration of the teeth due to recurrent caries around the restoration and ultimately loss of repair. [5]

In modern dentistry, bonding systems are moving toward simplification. Today, an ideal bonding must have features such as biocompatibility, long durability and simple steps. Hence, the 6th and 7th generation bonds were invented, in the 6th Generation etch and Primer is in one bottle and the bonding in a separate bottle. The advantage of the 6th generation is that the bonding is hydrophobic and therefore it is less soluble in water due to dentin water or micro leakage.

But the 7th generation came up with the simplification of the 6th generation so that all the materials are in one bottle and its enamel bond is desirable but because of the hydrophilic bonding process it dissolves faster and does not have the proper dentin bonding. [6]

Hence the eighth generation have recently introduced to the market with the seventh generation advantage (no need for separate etching and reduced working time which is etch, Bond and Primer in a bottle) has high bond strength. It is claimed by manufacturers that their shear bond strength is equal to 4 and 5 generation two- and three-stage systems. [7]

It is estimated that the 8th generation of bonding techniques is based on nanotechnology and dual curing. The fillers in the 8th generation bonds are SiO_2 nano-sized fillers (below 20 nm) that are chemically cured while they are cured by light. As a result, the cross links are stronger with the acidic and hydrophilic components inside the smear layer. It is claimed that some of these nano-fillers are even capable of releasing fluoride. [8]

Since the eighth generation bonding has just been introduced recently and there are few studies about it, with the aim of introducing this generation of bonding to our country's dentists and investigating the manufacturer's claim in this research, we aim to determine the shear bond strength of three types of systems. Compare single-step self-etch bonding (8 th generation Universal) and 2-steps (5th generation) single-step self-etching system (7th generation).

Based on Kamble's research, they examined three types of 6th, 7th and 8th generation bonding. The 8th generation had the highest tensile strength, followed by the 6th generation and the lowest in the 7th generation. Which was approved with our study. [7]

Shekhar et al. found in their study that shear bond of the 5th generation is stronger than the 6th and 7th generation.[7]

The result of Okada et al.'s study to evaluate the shear bond strength bonding two types of one-step adhesive (Clearfil Tri-S and G-Bond) and two types of two-steps adhesive including self-etch adhesive (Clearfil SE Bond) and total adhesive etch (Adper Single Bond) was similar with the results of the present study. [9]

In the study of Mortazavi et al., in order to measure the shear strength of three dentin bonding systems, , the shear bond strength of Clearfil SE Bond was higher than Single Bond in contrast to the present study. [10]

Yaseen and Subba Reddy in their study stated that the 7th generation has higher shear bonds than the 6th generation in primary teeth. [11]

Various factors can be effective in the results of shear bond strength test such as the stages and conditions of the test, the type of tooth examined, and the way teeth are collected and stored, the depth of dentin and enamel examined, the type of measuring device and type of manufacturer adhesive. Various systems have been introduced so far that have always sought to simplify the clinical process by manufacturers in the newer types, but due to the importance of enamel and dentin differences, the simplification of the clinical procedure can result in reduced dentin bond strength and increased micro leakage. This is clearly occurred in the 7th generation bondings, which reduces dentists' interest in self-etching techniques.

It is obviously clear that if a dentin bonding system that has been simplified by clinical application can show shear bond strengths equal to or greater than the older systems, it is reasonable for the dentist to use a newer system.

Conclusion:

Since, the reduction in the technique sensitivity of any bonding system would always be a preferred factor in restorative dentistry; further studies should be hold keeping to develop the universal bonding system [12].

The review of literature and the study conducted with its limitations, it appears self-etching bonding system such as 8th generations are candid recommendation for the use of any resin restoration in operative dentistry.

References

1. Silveira de Araújo C, Incerti da Silva T, Ogliari F, Meireles S, Piva E, Demarco F. Microleakage of seven adhesive systems in enamel and dentin. J Contemp Dent Pract. 2006;7(5):26-33.
2. Beech D, Hardwick J. Mechanism of adhesion of polymers to acid-etched enamel: Effect of acid concentration and washing on bond strength. Journal of oral rehabilitation. 1978;5(1):69-80.
3. Davari A, DaneshKazemi A, Modaresi J, Mohammadi Z, Akbarian L. The Effect of Light-Curing Time to Adhesive Layer on Shear Bond

Strength of Composite to Dentin. Journal of Dentistry. 2007;8(1):10-8.
4. Hormati AA, Fuller JL, Denehy GE. Effects of contamination and mechanical disturbance on the quality of acid-etched enamel. The Journal of the American Dental Association. 1980;100(1):34-8.
5. Reifeis P, Cochran M, Moore B. An in vitro shear bond strength study of enamel/dentin bonding systems on enamel. Operative dentistry. 1995;20:174-.
6. Nirwan M, Nigam AG, Marwah N, Nayak UA, Bansal A, Gahlot MS. A comparative evaluation of retention of pit and fissure sealant bonded using sixth-, seventh-, and eighth-generation adhesives: An in vivo study. Journal of Indian Society of Pedodontics and Preventive Dentistry. 2017;35(4):359.
7. Kamble SS, Kandasamy B, Thillaigovindan R, Goyal NK, Talukdar P, Seal M. In vitro comparative evaluation of tensile bond strength of 6th, 7th and 8th generation dentin bonding agents. Journal of international oral health: JIOH. 2015;7(5):41.
8. Pashley EL, Agee KA, Pashley DH, Tay FR. Effects of one versus two applications of an unfilled, all-in-one adhesive on dentine bonding. Journal of Dentistry. 2002;30(2-3):83-90.
9. Okada H, Sadr A, Shimada Y, Tagami J. Micro-shear bond strength of current one-step adhesives to cementum and dentin. American journal of dentistry. 2009;22(5):259-63.
10. Mortazavi V, Fathi M, Ataei E, Khodaeian N, Askari N. Shear bond strengths and morphological evaluation of filled and unfilled adhesive interfaces to enamel and dentine. International journal of dentistry. 2012;2012.
11. Yaseen S, Reddy VS. Comparative evaluation of shear bond strength of two self-etching adhesives (sixth and seventh generation) on dentin of primary and permanent teeth: An in vitro study. Journal of Indian Society of Pedodontics and Preventive Dentistry. 2009;27(1):33.
12. Mithiborwala SH, Chaugule V, Munshi A, Patil V. Comparative Evaluation of the Adhesive Properties of Two Generations of Dentin Bonding Agents by Checking the Microleakage in the Primary Teeth: An in vitro Study. International journal of clinical pediatric dentistry. 2011;4(3):195.

Table 1: materials used in this study

Material	composition	manufacturer
Phosphoric acid gel	Phosphoric acid gel (37%)	Morvabon,Iran
Scotchbond Universal	10-MDP phosphate monomer, methacrylate modified polyalkenoic acid copolymer filler, HEMA, dimethacrylate resins filler, silane, initiators, ethanol, water,	3M ESPE, St. Paul, MN, USA
Adper Easy One	HEMA, Bis-GMA, methacrylated phosphoric esters, 1,6 hexanediol dimethacrylate, methacrylate functionalized polyalkenoic acid (Vitrebond copolymer), finely dispersed bonded silica filler with 7 nm primary particle size, ethanol, water, initiators, based on camphorquinone, stabilizers	3M ESPE, St. Paul, MN, USA
Adper Single Bond 2	Primer: Bis-GMA, HEMA, Adhesive: Water, ethanol, polyalkenoic acid copolymer, photointiator	3M ESPE, St. Paul, MN, USA
Composite resin Z100	Inorganic filler. Zirconiurn/silica with a particle size range of 0/01 to 3.5 µm Organic matrix: Bis-GMA, UDMA, Bis-EMA	3M ESPE, St. Paul, MN, USA

Bis-GMA: Bisphenol A glycidyl methacrylate; HEMA: Hydroxyethyl methacrylate; UDMA: Urethane dimethacrylate: Bis-EMA: Bisphenol A polyethylene glycol dimethacrylate; MDP: Methacryloyloxydecyl dihydrogen phosphate

Table 2: Descriptive Parameters of Micro Shear Bond Strength of Different Groups

Parameter / Group	Maximum (MPa)	Minimum (MPa)	Standard deviation (MPa)	Mean (MPa)
A	26/37	8/05	6/08	**15/8**
B	18/93	6/63	3/75	**11/24**
C	22/38	6/28	4/6	**15/24**

Table 3: Descriptive Parameters of Micro Shear Bond Strength of Different Groups

Source of Change	Sum of squares	Degrees of freedom	Average of squares	Sig.	F
Between groups	252/33	3	84/11	0/015	**3/77**
Within groups (error)	1247/56	56	22/28		
Total	1499/89	59			

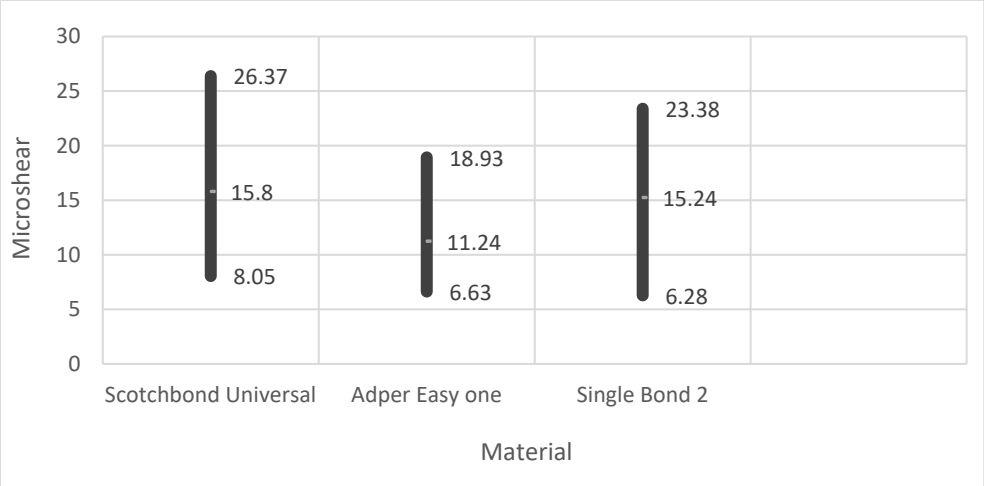

Figure 1: Mean and standard deviation of shear bond strength of the 3 groups studied