

Effects of Diamond and Carbide Burs on Dentin Bond Strengths of Self – Etch Bonding Systems

A. Kaviani¹, A. Ahmadzadeh², J. Shahroie³, Z. Ghasemi⁴

¹Assistant Professor, Operative Dentistry, School of Dentistry, Jundishapour University of Medical Sciences, Ahvaz, Iran

²Assistant Professor, Department of Prosthodontics, School of Dentistry, Jundishapour University of Medical Sciences, Ahvaz, Iran

³Dentist, Ahvaz, Iran

⁴Post- graduate student of prosthodontics, Dental School, Jundi Shapur University of Medical Sciences, Ahwaz, Iran

Abstract

Background and Aim: Nowadays, with regard to the quantitative and qualitative development of dental esthetic services and qualitative advances made in tooth-colored restorations, there is a great rise of demands for use of composite resins. The aim of this study was to assess the efficiency of diamond and carbide burs on bond strength of a self-etch adhesive to dentin.

Materials and Methods: In this in vitro experimental study sixty sound extracted human third molars were mounted in self cure acrylic resin. The teeth were randomly assigned to two groups (n=30 each). In the first group, the teeth were ground with high-speed medium grit diamond bur and in the second group the teeth were ground with high-speed carbide burs. A composite cylinder with a 3 mm diameter was bonded to each specimen with a self-etch adhesive system and the shear bond test was performed using a universal testing machine. The results were expressed in MPas and were subjected to and Tukey's test.

Results: The mean shear bond strength in diamond and carbide burs were 17.67 MPa (SD=±4.41) and 14.51 MPa (SD=±5.18), respectively. There was a significant difference in dentin bond strength between two groups. (p< 0.05).

Conclusion: The use of different burs affect the shear bond strength of the self-etch adhesives to dentin. This adhesive performed significantly better when a diamond bur was used to prepared dentin surface.

Key Words: Diamond bur , carbide bur , self etch adhesive

 Corresponding author:
A. Kaviani, Assistant Professor,
Operative Dentistry, School of
Dentistry, Jundishapour
University of Medical Sciences,
Ahvaz, Iran
azita_kaviani@yahoo.com

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Introduction

Nowadays, composite fillings are largely demanded due to the qualitative and quantitative development of operative dentistry services and also qualitative progresses in use of tooth-colored fillings. Furthermore, due to the high technical sensitivity of these materials and also the need for promoting the quality of composite fillings and promoting patient satisfaction in all aspects of

health service system, studying the factors effective in the success of dental fillings especially composite fillings is obviously necessary.

Previous studies referred to high bond strength as one of the highly effective factors in success and strength of composite fillings. Undoubtedly, one of the effective factors in dental adhesion is the mechanical preparation of teeth. After mechanical preparation of the tooth cavity with required in-

struments such as burs, an amorphous layer of organic and inorganic debris called smear layer covers the cavity surface. Today, it has been shown that the quality and quantity of the smear layer depend mostly on the way it is created and that it has distinct characteristics under different conditions. A few differences have been reported to occur in the smear layer of teeth prepared using different dental instruments that undoubtedly influences bond strength of composite resin to teeth [1].

Self-etching primers which include an acidic monomer dissolve the smear layer. Actually, their success is due to their capability to dissolve and transform the smear layer and also penetration of resin to underlying layers [2].

Due to the correlation between thickness and quality of the smear layer in different methods for mechanical preparation of the cavity, the preparation method and instruments obviously correlate with the quality and thickness of the smear layer and consequently with the bond strength. Previous studies in this regard suggested that the bond strength of self-etching primers in teeth prepared using burs was lower than that of teeth prepared using silicon carbide or abrasive paper discs [3]. Moreover, the type and specifications of the burs used for cavity preparation, largely affect the smear layer and its characteristics [3].

Koibuchi et al showed that the tensile bond strength of composite to dentin using clearfil liner bond II in a group of teeth prepared by 6000 grit silicon carbide paper disks was significantly higher than that in a group of teeth prepared by 180 grit silicon carbide paper disks. They also showed that rougher smear layers had an adverse effect on the bond and thinner smear layers created more acceptable bonds [4].

A study by Al-Omar et al indicated that surface roughness did not make any significant difference in contact angle values of distilled water with different levels of the preparation [5].

In Ogata et al's study in 2002, it was shown that the effect of the method used for dentin preparation on shear bond strength was influenced by the adhesive system [6].

Vaysman et al found that if a uniform roughness can be made on the bottom surface of the cavity, the initial sealing ability of the existing bondings may increase [7].

Hosoya et al's study indicated that the dentin surface of the teeth prepared using very soft and soft diamond burs was rougher than that prepared using 600 grit silicon carbide paper disks. Moreover, shear bond strength of the groups using SE bond was significantly higher than that of groups using single bond [8].

In Barros et al's study, it was found that carbide burs left a surface which was more suitable for bonding than the surface left by diamond burs [9].

Materials and Methods

In this experimental in vitro investigation, 60 extracted healthy third molars were collected and maintained in normal saline.

Samples were selected through convenience sampling. Teeth which were healthy and free of decay and cracks were selected.

Before beginning the study, the teeth were taken out of normal saline. Then, they were cleaned with a scalpel, any extra tissue was removed, and they were completely cleaned with abrasive paper. The samples were mounted in acrylic resin blocks. In order to reach the dentin surface, the tooth crowns were cut off parallel to the occlusal surface, from occlusal and middle one-thirds using a dental cutting machine, as the occlusal surface dentin appeared. Then, the dentin cuts were polished using silicon carbide abrasive paper. The teeth were then divided into two groups, each containing 30 teeth. The dentin surface of each sample was prepared using medium fissure diamond burs (D&Z, Germany) for one group and fissure carbide burs (SS White, USA) for the other group. For preparation of each group, a separate bur was placed onto a high-speed handpiece with air-water spray with a maximum speed of 340,000 rpm, and air pressure of 27 psi. The preparation was carried out through 10 sweeps of the bur and a constant pressure of hand on the dentin.

The self-etching bonding agent (Prompt-l-pop 3M-

USA) was smeared on the dentin surface with a specific brush according to the manufacturer's instructions, and was thinned after 20 seconds, using a weak stream of air so that the appropriate thickness was achieved. Curing was carried out using a blue light and a quartz-tungsten-halogen device (Coltolux, Colten, Germany) at the wavelength of 460-470 nm for 10 seconds.

After preparation of the dentin surface and application of the self-etching bonding, the composite was applied using a plastic tube with inner diameter of 3 mm and length of 4 mm. Two-millimeter layers of A₂ shade composite (Point₄, Kerr, Germany) was placed into the tube and cured from a distance of 1 mm up for 40 seconds until the tube was completely filled with composite.

Then, the cylinders around the composite were removed using a scalpel and the composite was again cured with light for 40 seconds. After the above procedures, the samples were incubated at 37°C.

The fracture resistance test of samples was performed using DARTEC device (NCIO-England) with collaboration of the Biophysics Department of the School of Medicine in Isfahan University of Medical Sciences. All samples were fixed in the device one by one and the force required for the fracture of composite cylinders was measured using a crosshead on a movable jaw of the device that moved at the speed of 0.5 mm/min.

The forces were recorded by the device in Newtons. The shear bond strength was calculated in MPas through dividing the force by the surface area of the composite [10].

Results

The average of shear – bonding strength in diamond burs was 14.51 Mpa with a variance of 5.18 and the average of shear-bonding strength in carbide burs was 17.67 Mpa with a variance of 4.41. ($p < 0.05$)

There was a significant difference in dentin bond strength between two groups. ($\alpha < 0.05$)

Discussion

While the bond strength of enamel bonding agent

Table 1. Bond strength values (MPa) in experimental groups

Group	N	Minimum	Maximum	Mean	Std. Deviation	Std. Error Mean
Carbide burs	30	8/30	30/60	14/5110	5/18896	26/925
Diamond burs	30	10	26/60	17/6767	4/41492	19/492

is predictable and stable, bonding to dentin is quite challenging. The difference is mainly due to the intrinsic properties of dentin including high organic content, changes in its internal structure, the presence of fluid and odontoblastic processes in tubules, and the presence of the smear layer. With the growing popularity of self-etching systems, concerns about preparation of substrate have increased due to their relatively mild nature. One of the current concerns is buffering and blocking the smear layer with different thicknesses and compositions [11].

Numerous studies have reported the high bonding strength of modern bonding systems like self-etching primer systems. Many of these studies prepared the teeth using silicon carbide abrasive disks, whereas, many clinics use different instruments such as steel, carbide, and/or diamond burs. Various rotary instruments affect the mineralized tissue differently and this may influence the relationship between the adhesive and dentin. Therefore, being aware of the effect of preparation methods on the bonding between resin and dentin is of special importance clinically [11].

In Ogata et al.'s study in 2002, the effect of self-etching primers on tensile bond strength of composite to dentin prepared with various burs was compared to that of phosphoric acid etching solutions. They found that for achieving a favorable bonding to dentin in adhesive systems; the smear layer must be removed completely using a conditioner. In the above study, the tensile bond strength of composite to dentin prepared with various burs was measured using both self-etching system (Mac-Bond II) and total-etching system (single bond).

Microtensile testing and fracture of the samples showed that fracture strength of the teeth prepared

with diamond bur had the lowest strength in their self-etching group. In the single bond group, shear bond strength of carbide burs was higher than that of others, while other groups did not show any significant difference [12].

It seems that due to the thick smear layer which was prepared by the diamond bur and was not removed totally by the weak acid, probably the shear bond strength of carbide burs was more favorable than that of others [13]. However, in the present study, probably the use of a stronger acid (Polyalkenoic acid) in prompt-l-pop bonding led to a more complete removal of the smear layer. It has been shown that the bond strength of diamond burs was higher than that of others [14].

Koase et al studied the effect of preparing dentin with a variety of medium and very soft diamond bur on the tensile bond strength of composite to dentin using one-step prompt-l-pop adhesive systems and 2-step self-etching systems. The results indicated that in all adhesive systems, the teeth prepared with very soft diamond bur had a stronger bonding. The difference between two types of diamond bur seemed significant in total-etching systems while it was not significant in 2-step self-etching systems. The researchers emphasized that the surface of the prepared dentin correlated with the bond strength and the type of bur was significantly influential. It can be stated that that softer diamond burs make thinner smear layers which are easily removed by self-etching bonding agents and consequently create stronger bonds [15].

However, the opposite was proved by the present study, and this can be probably due to the use of the stronger polyalkenoic acid in bonding for removal of the smear layer. Furthermore, it has been shown that the use of diamond burs has established stronger micromechanical retention due to deeper irregularities [14].

The study by Barros et al. in 2005 on the effect of the type of bur and conditioner on dentin surface showed that surfaces prepared with carbide burs had less smear plugs than those prepared with diamond burs. They examined the prepared surfaces in both total-etch bonding system (single bond)

and 2-step self-etching bonding system (SE bond) and showed that carbide burs left a more suitable surface than did diamond burs [9].

Moreover, it seemed that due to the thicker smear layer created by diamond burs, making changes in the smear layer and reaching the underlying dentin requires a stronger acid like phosphoric acid. However, regarding the point that self-etch bondings have weaker acids, they probably have less ability to remove the smear layer, thereby less strong shear bonds are established. Actually, the quality and quantity of the smear layer are effective in bond strength. However, the opposite was proved by the present study that may be attributed to the presence of an appropriate acid in the prompt-l-pop bonding [14]. The use of diamond burs for preparation of dentin results in establishment of thicker smear layers, deeper roughness, and more uniform grooves, therefore, when the bonding agent penetrates into the roughnesses and grooves, higher bond strength will be obtained and this conforms to the results of the present study [14,16].

In this respect, higher bond strength after the use of diamond burs reduces the microleakage and increases the stability of filling in clinics. Considering the cost effectiveness and longer durability of diamond burs than carbide burs, dentists may be interested in the above results.

Dentists tend to use diamond burs of various efficiencies with different pressures while preparing a tooth. Other investigations should be conducted to examine the effect of different pressure applications while preparing dentin surfaces on probable changes in the quality of the smear layer and bond strength.

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References

- 1- Samimi P, Jafarzadeh M: Effect of eugenol-containing temporary cements on bond strength of

- composite to dentin. [Thesis] Isfahan: Faculty of Dentistry Isfahan Medical Sciences University: Dental School, 2001.
- 2- Ogata, Nacata H, Kavashoji O. Effects of different burs on Dentin bond Strengths of self – etching promoter bonding systems. *Oper Dent*. 2001 Jul-Aug;26(4):375-82.
 - 3- Summit JB, Robbins JW, Hilton TJ, Schwartz RS, Santos JD. *Fundamentals of Operative Dentistry: A Contemporary Approach*, 3rd ed. Chicago: Quintessence Pub; 2006,139-145.
 - 4- Koibuchi H, Yasuda N, Nakabayashi N. Bonding to dentin with a self – etching primer the effect of smear layers. *Dent Mater*. 2001 Mar; 17(2):122-6.
 - 5- AL OMARI W. M. AL, Mitchell C.A, Cunningham GL. Surface roughness and wettability of enamel and dentin surface prepared with different dental burs. *J Oral Rehabil*. 2001 Jul; 28(7):645-50.
 - 6- Ogata M, Harada N, Yamaguichi S, Nakajima M, Tagami J. Effect of self – etching primer vs phosphoric acid etchant on bond to bur – prepared dentin. *Oper Dent*. 2002 Sep-Oct; 27(5):447-54.
 - 7- Vaysman T. Rejan N, Thompson VP. Effect of bur cutting patterns and dentin bonding agents on dentin permeability in a fluid flow model. *Oper Dent*. 2003 Sep-Oct;28(5):522-8.
 - 8- Hosoya Y, Shinkawa H, Suefiji CH, Nozaka K. Effect of diamond bur particle size on dentin bond strength. *Am J Dent*. 2004 Oct;17(5):359-64.
 - 9- Barros J.A, Myaki S.I, Nor J.E, Peters MC. Effect of bur type on conditioning on the surface and interface of dentin. *J Oral Rehabil*. 2005 Nov; 32(11):849-56.
 - 10- Shirani F, Maleki Poor M, Barfar gh. Effect of using time of diamond burs on bond strength between composite and dentin with self etch adhesive. *JIDA* 2009 Summer; 21(2):95-102.
 - 11- Walter R.L, Dias / Patricia N. S, Pereira / Edward J, Swift Jr, Effect of Bur type on microtensile bond strengths of self-etching system to human Dentin. *J Adhes Dent*. 2004 Autumn;6(3):195-203.
 - 12- Ogata M, Harada N, Yamaguichi S, Nakajima M, Tagami J. Effect of self-etching primer vs phosphoric acid etchant on bonding to bur-prepared dentin. *Oper Dent*. 2002 Sep-Oct; 27(5): 447-54.
 - 13- Yiu CK, Hiraishi N, King NM, Tay FR. Effect of dentinal surface preparation on bond strength of self-etching adhesives. *J Adhes Dent*. 2008 Jun; 10(3):173-82.
 - 14- Rocha PI, Broges AB, Rodrigues JR, Arrais CAG, Giannini M. Effect of dentinal surface preparation on bond strength of self-etching adhesive system. *Brazoral Res* 2006 July/Sept; 20(1):52-8.
 - 15- Koas K, Inoue S, Nada Tanaka T, Kawamoto Ch, Takahashi A, Nakaoki Y, Sano H. Effect of bur, cut dentin on bond strength using two all-in-one and one two-step adhesive systems. *J Adhes Dent*. 2004 Summer; 6(2):97-104.
 - 16- Young-Gon Lee, So-Ra Moon and Young-Gon Cho. Effect of cutting instruments on the dentin bond strength of a self-etch adhesive. *J Korean Acad Conserv Dent*. 2010 Jan; 35(1):13-19.