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The Effect of Enamel Roughness with Different Burs Preparation on The Adhesion of Resin Composite by Eighth-Generation Bonding Agent

Sattar Jabbar Abdul-Zahra Al Hmedat

Department of Conservative Dentistry, College of Dentistry, University of Kufa, Najaf, Iraq.

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ABSTRACT

OBJECTIVE The aim study to evaluates the effect of different diamond bur roughness on the shear bond strength of resin-based composite to the enamel superficial microroughness This may affect adhesion by modifying the substrates' characteristics when using an eighth-generation bonding agent adhesive. **MATERIALS AND METHODS** The 40 premolars were embedded in acrylic resin blocks, Samples were distributed 10 Samples into 4 groups according to burs: black, white, yellow burs, and polishing (control) prepared buccally with in the enamel flat surface, followed applied by eighth-generation bonding agent and A heavy-body silicone mold was used to form an accurate template for composite application, applied with composite resin restoration and polymerization. Shear bond strength (SBS) was tested using a Zwick Roell universal testing machine, and failure modes were analyzed. **RESULTS** showed white bur group exhibited the highest shear bond strength (SBS), with a mean value of 0.80 ± 0.118 MPa followed by yellow bur group 0.54 ± 0.119 MPa, followed by black bur group showed of 0.40 ± 0.071 MPa, followed by pumice polishing group had the lowest bond strength, at 0.34 ± 0.053 MPa, significant differences between the 4 uses groups (P value < 0.001). **CONCLUSION.** enamel surface roughness created by white diamond burs considerably influences the shear bond strength of resin bonded restorations.

Keywords: Enamel; veneer; Bonding; Shear strength; Dental instruments.

1.INTRODUCTION

With the development of dental materials and technologies, in order to extend the life of dental work, especially cosmetic composite materials such as space closure, direct and indirect veneers, all of which are mostly adhered to enamel to achieve optimal adhesion compared to dentin. Enamel and dentin are the main substrates for restoration adhesion, and their structures and compositions vary greatly. Enamel is highly mineralized, has a uniform texture, and has low permeability, so it is less affected by the choice of polishing technology. Dentin, on the other hand, is composed of 70% hydroxyapatite, 10% water, and 20% collagen, and its composition varies with depth1. Shallow dentin is characterized by a higher proportion of intertubular dentin, which is essential for the formation of the hybrid layer and the retention of the resin. On the other hand, deeper dentin has a higher tubule

density and less intertubular dentin, which complicates adhesion and may compromise the bond strength of the restorative material 2,3.

Increasing the contact area between the adhesive and the tooth by controlling the surface roughness is a method to improve retention. However, few studies have investigated the effect of roughness produced by rotary instruments on complete restoration success. Ayad et al. investigated the surface roughness of various diamond (coarse-grain) and finish-grained burs and found that diamond burs added more surface area than carbide burs. 4 In another study, Ayad et al. found that cross-cut carbide burs increased retention rates of zinc polycarboxylate-bonded complete restorations by 46–55%. If a smooth surface is desired, the study recommends considering retention measures during preparation design. Roughening the preparation surface with rotary instruments enhances the cement-tooth locking mechanism and improves retention; therefore, the need for additional retention measures is reduced.

Diamond burs can be cleaned, sterilized, and reused multiple times. There is no consensus in the scientific literature regarding the maximum number of applications that clinicians are advised to perform with dental burs. Therefore, the cutting performance of these instruments cannot be evaluated with certainty. Often, one must rely on the appearance of the bur to determine if it is still safe to use after repeated use to avoid adverse side effects such as increased heat production that could damage the pulp or incomplete removal of infected or affected tissue. **(fig.1)**.

The 8th generation bonding agent contains nanosized fillers. Nano-fillers with an approximate particle size of 12 nm are incorporated in these new systems and the content with more than 1.0% by weight may increase the viscosity of the adhesives and also results in agglomeration of the fillers on the moistened surface. These nano-fillers facilitate increased penetration of resin monomers and the thickness of the hybrid layer that, in turn, results in improving the mechanical properties of the bonding systems.

Further, nano-bonding agent solutions with nano-fillers produce better enamel and dentin bond strength, stress absorption, and longer shelf life, These new agents from self-etch generations have acidic hydrophilic monomers which can be easily applied on the moistened and etched enamel. Numerous studies reported more shear bond strength compared to previous generation bonding agents[7].

Composition of eight-generation bonding agents includes; a unique combination of three functional monomers (4-META, MDP, and MDTP), notably excluding HEMA, ensures excellent stability and exceptional bond strengths not just to tooth tissue but to all indirect substrates, including composites, direct and indirect cosmatic restoration[8].

The null hypotheses tested were: All the different *diamond* burs would none significantly different on the shear bond strength of resin-based composite and cosmetic restoration to the enamel.

Bur abrasivity	Approximate grit size (μm)	Bur colour
Super-coarse	180	Black
Coarse	150	Green
Medium	100	Blue
Fine	50	Red
Extrafine	25	Yellow
Superfine	20	White

figure (1) Diamond bur color and degree of abrasive and grit.

2.Material and methods.

2.1 material and study design:

Prepear four groups was made each group compose of 10 sample to made the shear bond strength measuring, the bond used during this study (shofu) eight edition Single Bond Universal adhesive that Combined total-etch and self-etch bonding capability. the teeth used 40 premolar that extracted for orthodontic purpose which be examined for free from caries, crack or any other defect. the teeth were cleaned and placed in distal water to prevent dehydration until the day of practical part, then the 40 teeth divided randomly into 4 groups, each tooth was evaluated by transillumination method for enamel cracks all the teeth fattening from labial surface to applying the composite.

All sample should be containing base this done by immerge the root of the premolar in the heavy body silicone impression materials mold filled with the self-cure acrylic the base for stabilization **(fig.2).**

figure (2) sample containing base from self-cure acrylic

after complete sample preparation do a mold for composite placed on labial surface of the tooth the mold diameter 3mm and 2mm thickness cylindric shape

The general description (brand, type, manufacturer, and rotational speed) of the materials used in this study is listed in **Tab.1**.

Brand	Type of bur	Manufacturer	Rotational per minute (RPM)
TF-11EF	White Diamond (Fine Grit)	Mani Inc., Japan	**300,000**
TF-12F	Yellow Diamond (Medium Grit)	Mani Inc., Japan	**300,000**
TF-13C	Black Diamond (Coarse Grit)	Mani Inc., Japan	**300,000**

Tab.1: The brands, types of burs, manufacturers, and the respective R per minute of the burs.

2.2 Groups preparation:

40 Teeth were divided into four groups, with each group containing 10 teeth as fallowing, each tooth was numbered distinctly according each group **(fig.3)**.

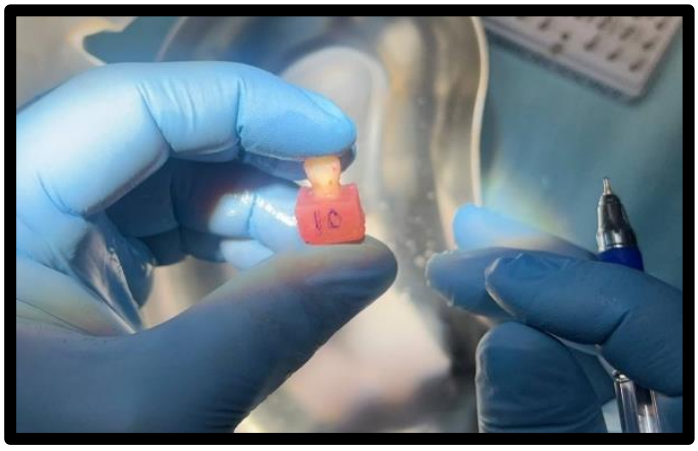


figure (3) each tooth was numbered

1- Group No.1 ten teeth was A prophylaxis paste (Sprectra, PREVEST DentPro) was used on the controlling group only**.**
2- Group No.2 ten teeth was prepared using White bur.
3- Group No.3 ten teeth was prepared using Yellow bur.
4- Group No.4 ten teeth was prepared using Black bur.

• Preparation on the flattening area of the buccal surfaces was performed using a high-speed turbine and specific burs, ensuring a 2.0 mm depth reduction **(fig.4)**.

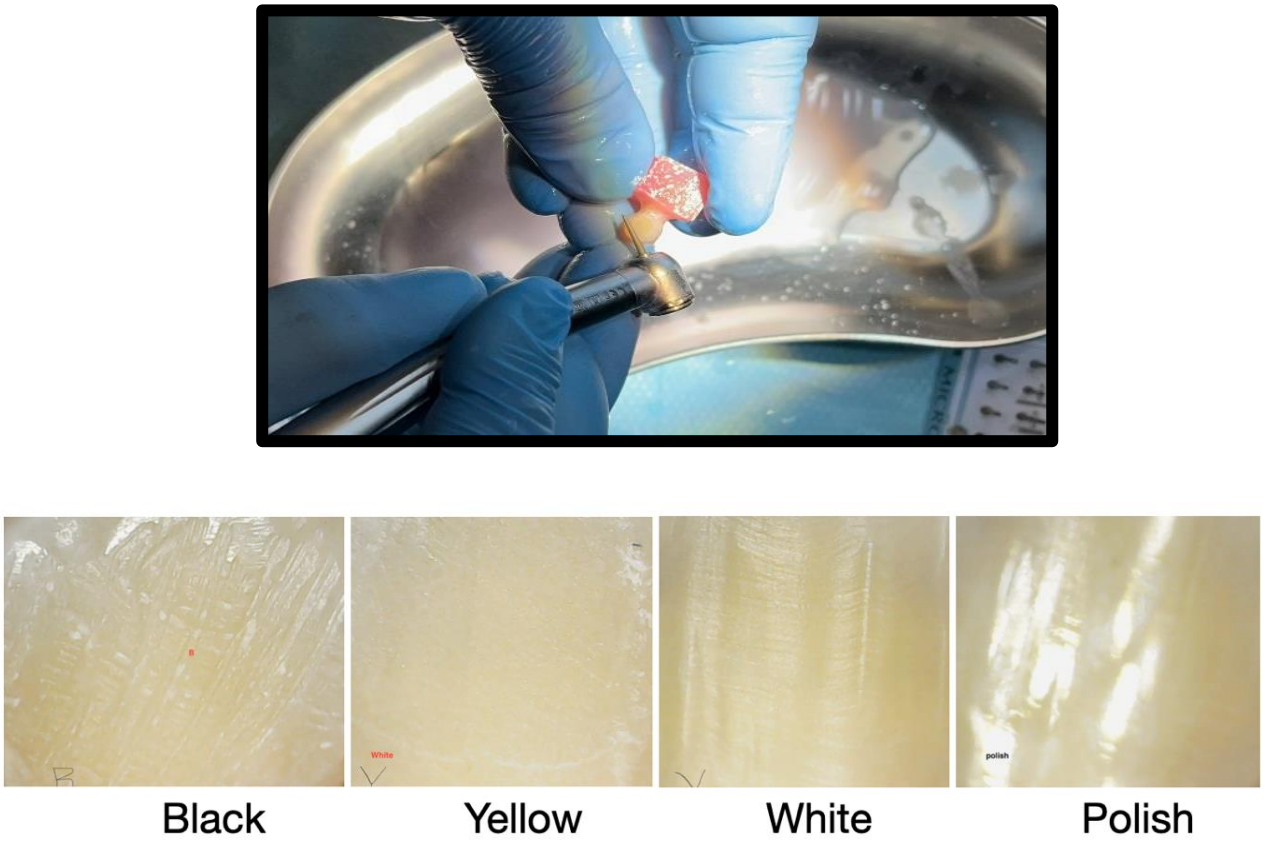


figure (4) Preparation of groups sample

all the groups undergo same procedures applying the bond Eighth-Generation bonding agent was used (SHUFO INC. kyoto 605-0983, Japan) to enhance composite adhesion to the tooth surface, with Resin based composite restoration (SHUFO PN1117-Beautifill II) (fig5).

figure (5) (SHUFO INC. kyoto 605-0983, Japan) and (SHUFO PN1117-Beautifill II)

Applying to the buccal tooth surface by bond brush robbing for 15 sec., then leaving it without dryness on tooth surface for 15 sec., then dryness for 10 sec. using air syringe **(fig6)**.

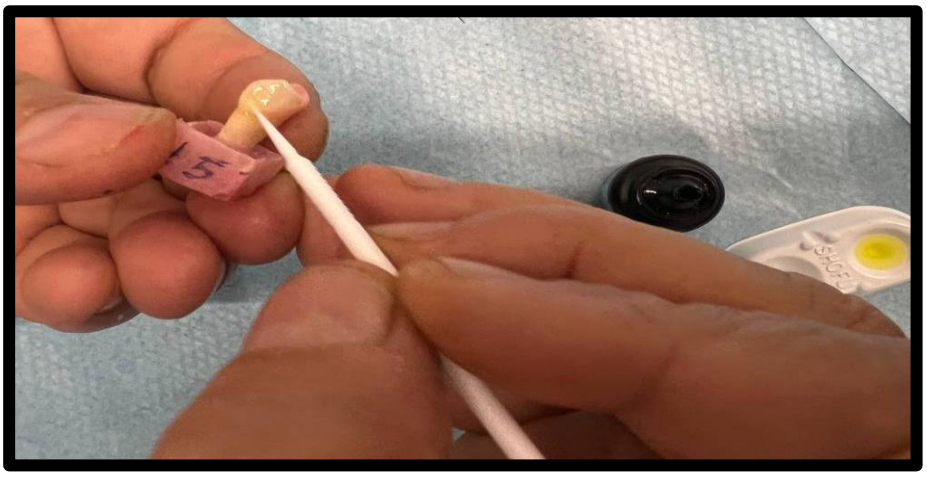


figure (6) Applying to the buccal tooth surface by bond brush

Then the final step curing for 3 sec. using (VALO-cordless) multiwavelength-emitting diode (LED) for producing high-intensity light at (1400mW/cm2) capable of polymerization all light cure dental material, then a layer of composite applied on bond according to manufactured and mold shape to obtain same shape and size for all the samples, the composite applied according to group procedure. **(fig.7)**.

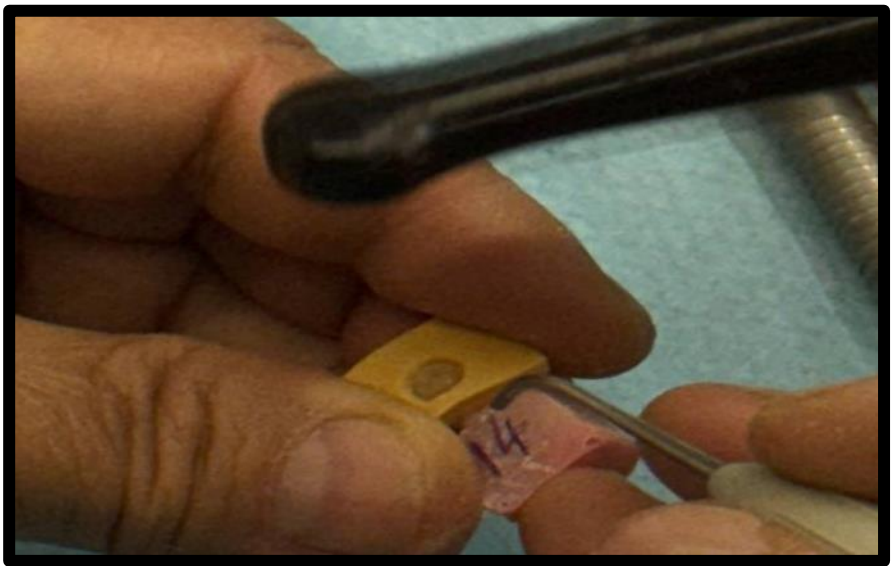


figure (7) Preparation of curing the composite on the mold groups sample

2.3 Shear bond strength (SBS) test

Specimens positioned in acrylic resin were prepared in a way that the composite were perpendicular to the shear blade. All study groups were submitted to the shear bond strength test with placing the tip of active shear blade on the superior portion of the composite base **(Fig 8)**, and the force was directed to the composite –tooth interface by a blade at a cross-head velocity of 0.5mm/minute till the bracket detached. The maximum force applied for de-bonding the bracket from tooth surface was recorded in Newton (N). The readings were gained in kgf (Kilogram-force), changed into N (Newton), then the shear bond strength was determined by dividing the force by bracket surface area, with average surface area of the bracket base was (12.4mm2), so the shear bond strength

measured values in MPa.

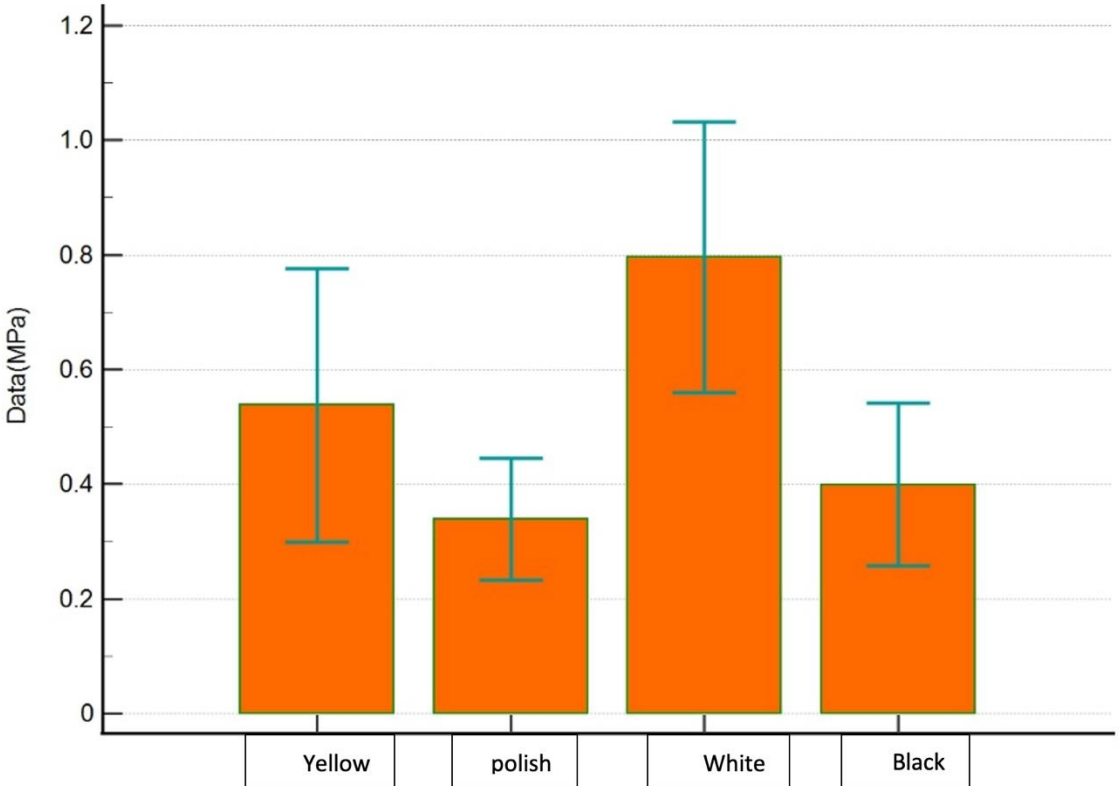
fig.8: Instron machine

3.The results.

Table (2) The white bur group exhibited the highest shear bond strength (SBS), with a mean value of 0.80 ± 0.118 MPa. This suggests that supper fine burs create an optimal surface roughness, facilitating better resin infiltration and bond strength. The yellow bur (extra-fine) group recorded the second-highest bond strength at 0.54 ± 0.119 MPa, indicating that while the surface was rough enough for good adhesion, it didn't create the optimal conditions observed with the white bur group. The black bur (supper-course) group showed a significantly lower bond strength of 0.40 ± 0.071 MPa, which can be attributed to smoother surfaces and increased smear layer formation, reducing the adhesive's ability to penetrate the dentin. The pumice polishing group had the lowest bond strength, at 0.34 ± 0.053 MPa.

Bur abrasivity	Variables	Mean*±SD	P value
extra-fine	**Yellow**	**0.54±0.119b**	**< 0.001**
polished	**polished**	**0.34±0.053a**	
supper fine	**White**	**0.80±0.118c**	
Supper-course	**Black**	**0.40±0.071a**	

Tab.2: Comparison between mean shear bond strength



The readings show variability in bond strength for each group, but the White bur group has the highest bond strengths overall, followed by Yellow and Black, and then Polished, which consistently shows the weakest bond strength.

4.DISCUSSION.

With limitation of This study was contain the optimal factors such as: 1-Eighth-Generation bonding agent superior bond strength than other generations, 2-Enamel the bond of composite higher than that of dentin, Enamel, the hardest tissue in the human body consists of 95% mineralized inorganic substance, hydroxyapatite arranged in a dense crystalline structure and a small amount of protein and water). To bond to enamel, it is very important to focus on the mineral component (hydroxyapatite) of enamel.[9] and 3- Diamond bur obtain bond strength than other burs. All these factors conducted with composite cosmetic and most common with in the enamel.

In the current study use three different diamond Bur abrasivity the result clearly obtains high significant different in the shear bond strength between the groups, the superior SBS in the white diamond bur (supper fine) fallowed by yellow diamond bur (extra-fine), followed by black diamond bur (Supper-course) and the inferior SBS in polished group (control), The statistical analysis revealed highly significant differences between the tested groups ($P < 0.001$), confirming that the type of bur used during tooth preparation plays a crucial role in determining the quality of the adhesive bond. the null hypothesis must be not accepted because the three diamond burs would obviously high significantly different between it's on the shear bond strength of resin-based composite and cosmetic restoration to the enamel.

The superior results of group White could be attributed to the creation of a surface with favorable roughness and morphology that allowed excellent adhesive infiltration and micromechanical retention. enhances bonding by increasing the available surface area and creating micro-

retentive features that improve resin penetration and hybrid layer formation.

The low surface roughness, or complete enamel rode which facilitate the adhesive monomers from penetrating and fill the enamel substrate and forming a well-integrated hybrid layer.

Additionally partial exposure of the white diamond bur to the enamel its typical Roughness and provided acceptable surface preparation to produce superior interaction of the self-etch eighth-Generation bonding agent, this idea resultant the high SBS with the white diamond bur than other burs Notorious morphology changes were observed on burs' anatomy when used SEM images of burs (Fig.4).

Ayad *et al*. demonstrated that dentin surface treatment affects the adhesive bond strength through changing the surface structure. In a similar study, Ayad *et al*. showed that higher dentin roughness increased the retention of the crowns cemented with zinc phosphate cements while the smooth surfaces of teeth created by finishing burs provided less retention[10].

According to the Ayad *et al*. the increase roughness of the tooth surface lead to increase bond strength of the restoration to the tooth when use ordinary cement but in the risne bond cement the resulte apper oposite as see in current research.

These findings underline the importance of selecting the appropriate bur type and preparation protocol according to the enamel when increase the depth to the dentin and deeper dentin the bond strength weaker. Clinical protocols should consider not only the type of bur but also parameters such as rotational speed, water cooling, and surface cleaning to optimize smear layer characteristics and improve long-term performance.

5.LIMITATIONS.

While this in-vitro study provides valuable data, certain limitations must be acknowledged. The study was performed under controlled laboratory conditions without mechanical loading or dynamic fatigue testing, which may affect long-term clinical outcomes. Additionally, enamel depth and tooth anatomy were standardized, whereas clinical conditions are variable and depend on the practitioner’s technique and patient-specific factors. Future research should focus on evaluating the combined effects of preparation parameters (rotational speed, water cooling), thermomechanical cycling, and different adhesive systems on smear layer morphology, bond strength, and failure patterns. Moreover, histological analysis of the hybrid layer formation in relation to different bur-induced smear layers would add more depth to these findings.

6.CONCLUSION.

1. The type of bur used for enamel preparation has a significant impact on the shear bond strength of composite resin to enamel.

2. Further clinical studies are required to translate these in-vitro findings into clinical recommendations and to explore the effects of other preparation variables on bonding performance.

3- The white diamond bur results superior SBS than other type of diamond bur.

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Group W demonstrated the highest bond strength, indicating that this bur type creates the most favorable dentin surface for bonding.

Groups P and Y exhibited significantly lower bond strength values, emphasizing that these preparation methods are not ideal for achieving durable adhesion.

Failure modes correlated with bond strength, with higher bond strength associated with more cohesive and mixed failures.

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