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Original Article

Comparative Assessment and Evaluation of Shear Bond Strength of Resin-Bonded Fixed Partial Restorations as affected by Diamond Rotary Burs with Different Grit Sizes- An in vitro study

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***ABSTRACT*:**
Aim: The resistance and retention forms as the determining factors affecting the success of retention of resin-bonded restorations. The present study was conducted to compare the effects of diamond rotary burs with different grit sizes on retention of resin-bonded restorations. **Materials & Methods:** 80 maxillary central incisors was removed and polished surfaces of the teeth were prepared with four groups of rotary diamond burs with super-coarse, coarse, medium, and fine grit sizes. 80 restorations were casted with nickel-chromium alloy and bonded with Panavia cement. The samples were mounted on a universal testing machine and an axial load was applied along the cement-restoration interface at the crosshead speed of 0.5 mm/min to assess the shear bond strength. **Results:** Statistical analysis and interpretations were quite interesting and revealed that the differences was non- significant (P> 0.05). Group I, group II and group IV showed 15% and group III showed 10% of type I debonding. Most commonly type II debonding was seen and it was 75% in group IV, 70% in group III, 60% in group II and 50% in group I. Type III debonding was seen 35% in group I, 25% in group II, 20% in group III and 10% in group IV. **Conclusion:** The shear bond strength in samples prepared by super course diamond burs were significantly higher than course, medium and fine burs. The success of retention of resin-bonded restorations depends on retention, resistance and roughness of abutment teeth. **Clinical significance:** With the advent of resin bonded restoration, the replacement of missing teeth has become easy and effective management may be done in the benefit of the patient. However, for the success of resin bonded restoration, factors such as retention form, resistance for, grit size, surface roughness plays important role. Thus by this study, factors affecting failures can be determined.
Key words: Nickel-chromium, Resin bonded restoration, Shear strength.

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INTRODUCTION

The replacement of missing teeth by removable partial denture, implant or fixed partial denture is well documented. Several materials are available for fixing the crown to the tooth. Resin bonded restoration has gained significant attention in this regard.[1] Over the time, resin bonded restorations has undergone various modifications which has increased its popularity. However, it has few drawbacks and shortcomings too, one of which is debonding. It is considered to be the main drawback. The weak bond of cement to metal was the main cause of debonding in resin-bonded prostheses.[2]

Several modifications has been done like etching of the casting surface by chemical or electrolytical method, adding retention in form of macro-mechanical phenomenon, application of silicoater, and air abrasion with aluminum oxide particles.[3] All these changes led to enhance retention of resin bonded restoration by creating strong bond with base metal alloys. Even with all these, there is no the satisfactory retention rate.[4]

Various authors in their studies emphasized the resistance and retention forms as the determining factors affecting the success of retention of resin-bonded restorations. Adding additional retentive measures such as boxes and grooves or occlusal rest seats improved the retention. But there is increased loss of tooth structure with all these modifications ultimately affecting retention.[5,6,7]

In a study conducted by Ayad et al.[8] found that surface area of the tooth can be increased to significant level using diamond burs as compared to tungsten carbide and tungsten carbide finishing burs. Ayad suggested that there is 46-55% increase in retention of full coverage restoration cemented with zinc polycarboxylate by crosscut carbide burs. Thus, by increasing the adhesive-tooth contact surface through managing the surface roughness, the retention may be improved.

Roughening the preparation surface with rotary instruments increases the cement-tooth interlocking mechanism and improves the retention; consequently, the need for extra retentive measures declines.[9] There are insufficient studies about the effect of dentin roughness on the retention of crowns and effect of roughness created by different rotary instruments on the success of full coverage restorations.[10] Hence, this study was conducted to compare the effects of diamond rotary burs with different grit sizes on retention of resin-bonded restorations.

MATERIALS & METHODS

This study was conducted on freshly extracted 80 maxillary central incisors which were periodontically weak. All teeth were stored in solution chloramine- T at the temperature of 4° for 1 month. After, 1 month each tooth was implanted in a polymeric tube filled with auto-polymerizing acrylic resin and was aligned parallel with the tube wall. Incisal enamel of each tooth was cut down for resin bonded restoration. Following, labial and proximal enamel surfaces of the teeth were cut with diamond saw and the buccal dentin was prepared in the shape of 4 × 4mm rectangle. In all, buccal dentin was ground with wet silicon carbide paper. 420, 600, 1000, and 1200 grit sizes of silicon carbide papers were used for 20 seconds each. Samples were then classified into 4 groups such as group I (Super course), group II (Course), group III (Medium) and group IV (Fine) and diamond rotary burs were used for polishing surfaces of each specimen. After preparing the dentin surface, a custom acrylic resin tray was constructed for each sample, and the final impression was made with polyether impression material.

80 metal castings of size 4 × 4 mm, 1 mm thick were made of nickel-chromium alloy. 50 μm aluminum oxide were used for air-abrading the internal surfaces of castings for 10 seconds. ED primer liquids A and B were mixed equally, applied on dentin surface, and air dried gently. Panavia cement pastes were mixed and applied on the surface of the casting and bonded to the prepared dentin surfaces. Each sample was loaded in the universal testing machine for 5 minutes with a load of 10 N. Samples were cured for 40 seconds by light curing unit. All samples were thermocycled in 5ºC to 55ºC water baths for a total of 1000 cycles with dwell and transfer times of 15 seconds. All samples were mounted on the universal testing machine and an axial load was applied with a chisel-shaped rod at a crosshead speed of 0.5 mm/min along the casting-cement interface until failure occurred. The maximum load that caused debonding was recorded in MPa for each sample. 40 × magnification stereomicroscope was used to see the types of failure which were categorized into three types. Type I indicates adhesive failure with the cement remnant on the prepared dentin surfaces, type shows adhesive failure with the cement remnant on the casting surface, and type III indicates mixed failure with cement remnants on both prepared dentin and casting surfaces. Results were tabulated and subjected to statistical analysis using SPSS software. One way ANOVA test was used to determine the shear strength.

RESULTS

Graph I shows that each group contains 20 samples. The difference was statistical non- significant (P> 0.05). Table I shows the mean shear bond strength values in each group. Group I showed 17.68±1.40 MPa, group II showed 13.80±1.12 MPa, group III showed 10.44±1.40 MPa and group IV showed 7.10±1.20 MPa. It was found to be statistical significant (P< 0.05). Table II shows that group I, group II and group IV showed 15% and group III showed 10% of type I debonding. Most commonly type II debonding was seen and it was 75% in group IV, 70% in group III, 60% in group II and 50% in group I. Type III debonding was seen 35% in group I, 25% in group II, 20% in group III and 10% in group IV.

Graph I Number of teeth sample in each group

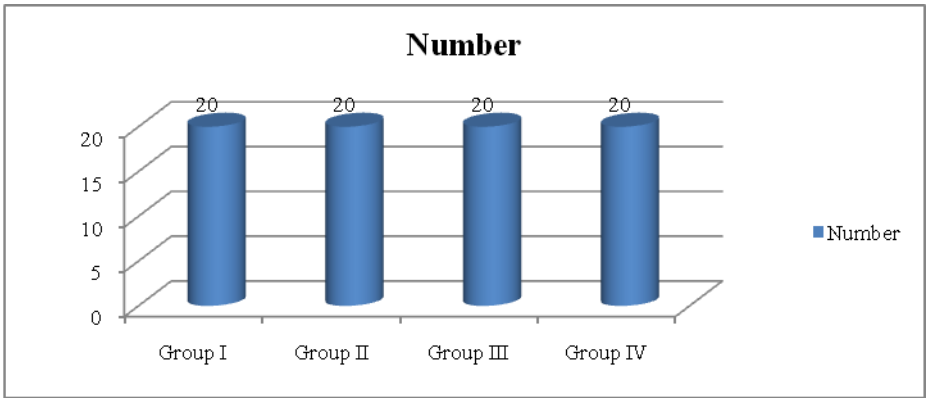

Table I Mean shear bond strength values

Group	Description & grit size	Mean ±S.D	Minimum	Maximum
Group I	Super course (181 µm)	17.68±(1.40)	15.42	20.60
Group II	Course (151 µm)	13.80±(1.12)	11.16	15.68
Group III	Medium (107- 126 µm)	10.44±(1.40)	6.36	12.80
Group IV	Fine (40 µm)	7.10±(1.20)	4.70	8.50

Table II Failure mode after debonding

	Type of debonding		
	Type I	**Type II**	**Type III**
Group	**Cement remnants on dentin**	**Cement remnants on casting**	**Mixed (Cement remnants on dentin and casting)**
Group I	3 (15%)	10 (50%)	7 (35%)
Group II	3 (15%)	12 (60%)	5 (25%)
Group III	2 (10%)	14 (70%)	4 (20%)
Group IV	3 (15%)	15 (75%)	2 (10%)

DISCUSSION

A resin-bonded bridge is cemented with resin composite to an abutment teeth having preparation confined either entirely or almost entirely to enamel. Resin bonded restoration has gained importance over the year. Apart from dental implants, it has one of the best treatment option for missing teeth. It is comparatively cheap than dental implants having additional benefit of limited damage to the surrounding teeth during preparation for placement.[11] Whereas dental implants are expensive. It is one of the best treatment options for patients with partial edentulism. For the success of resin bonded restoration, factors such as retention plays an important role whereas debonding is the commonly encounter drawback with it.[12] This study was conducted to compare the effects of diamond rotary burs with different grit sizes on retention of resin-bonded restorations.

In this study, 80 freshly extracted periodontally weak teeth were selected and categorized into 4 groups of 20 each. In each group, we estimated the shear bond strength. The mean shear bond strength in group I was 17.68±1.40 MPa which was found to be higher than other 3 groups. group II showed 13.80±1.12 MPa, group III showed 10.44±1.40 MPa and group IV showed 7.10±1.20 MPa. The difference was statistical significant. Mowery et al.[13] conducted a study and found that the rough surface of prepared dentin provided a higher bond strength, which may be due to the increased total surface area involved in the bond. Ayad et al[14] concluded that dentin surface treatment affects the adhesive bond strength through changing the surface structure. Increased roughness of dentin enhance the retention of the crowns cemented with zinc phosphate cements while the smooth surfaces of teeth created by finishing burs provided less retention. Surface roughness provides addition retention in resin bonded restoration. Insufficient retention causes debonding which leads to failure of treatment. Other retentive aids are parallel walls of abutment teeth which guides the parallel guiding grooves. This provides retention against labio- lingual forces. Elimination of undercut also gives retention.

In this study, we used different grit size burs and accordingly classified samples as SC (super-coarse with surface roughness of 181 µm), C (coarse: 151 µm), M (medium: 107-126 µm), and F (fine: 40 µm). Diamond burs provides cleaner cuts and higher polish. These burs are rotated at higher speed. They are effective in cutting enamel and dentin. They are better than carbide burs in terms of providing surface area. Larger the surface area, better is the retention. They are available in different sizes. Grit size affects the smear layer. Greater the grit size, thicker the smear layer. It has been observed that stronger the contact between dentin and cement, stronger the strength of the unit. Viscocity of the cement helps in moistening tooth surface. Factors such as angle between cement and surface of teeth and different sizes of the grit helps in establishing contact between 2 surfaces. Grit size also affects the formation of smear layer on the tooth surface. The formation of smear layer is not beneficial for the success of the restoration. Thinner the grit size, less will be the formation of smear layer.

Smear layer decreases the adhesion between the dentin surface and framework and surface energy. Hence it is recommended to remove the smear layer in order to improve the bond strength.[15] In present study, stereomicroscope was used to evaluate the failure and we observed that most commonly type II debonding was seen and it was 75% in group IV followed by 70% in group III, 60% in group II and 50% in group I. It has been seen that the pressure exerted on indirect restorations during cementation affects resin bonding and determines the efficacy of reaction between adhesive cement and dentin surface covered with smear layer. De Munck et al[16] suggested that viscosity of the material decreases under continuous shear rate.

With resin bonded restoration, management of edentulous area has become easier. Stronger the bond between dentin

surface and undersurface of resin bonded restoration, better is the shear bond strength. Diamond burs of smaller grit sizes provide better retention. The choice of diamond burs decides the strength of restoration. Larger size burs are not efficient in cutting and proving retention to the restoration. Hence nowadays, most of the dentist prefers smaller grit size diamond burs for successful results.

Chieffi et al.[17] conducted a study to evaluate the effect of sustained seating pressure on adhesive luting procedure. They found that constant pressure decreases formation of globule. It was seen that with less globule formation, effective adhesion between restoration and dentin was obtained. It also diminished the water absorption. Bond strength was further affected by choice of luting agent used for adhesion. Better the agent, effective is the bond between two. This in turns affects the shear bond strength. Thus luting agents also affects success of resin bonded restoration.

CONCLUSION

There are many factors affecting the outcome of resin bonded restorations. Amongst all, shear bond strength is one of the contributing factors which is further affected by type of diamond burs used. Debonding is the greatest drawback encounter by the dentists. The shear bond strength in samples prepared by super course diamond burs were significantly higher than course, medium and fine burs. The success of retention of resin-bonded restorations depends on retention, resistance form and surface roughness of abutment teeth.

CLINICAL SIGNIFICANCE: The replacement of missing teeth has become easy due to availability of resin bonded restorations. An effective management may be done in the benefit of the patient. However, for the success of resin bonded restoration, factors such as retention form, resistance for, grit size, surface roughness plays important role.

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