ORIGINAL ARTICLE

Comparison of Surface Conditioning Protocols on The Shear Bond Strength of Metal Brackets Bonded To Amalgam Surface

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OBJECTIVE: Orthodontists more often comes across amalgam restoration as a surface to bond brackets. The objective of current study was to compare the mean shear bond strength of orthodontic metal brackets bonded on sandblasted versus diamond bur roughened amalgam surfaces.

METHODOLOGY: Current In-vitro, comparative study was conducted at Orthodontic department of Faisalabad medical university from 17.2.2017 to 17.8.2017. Sixty extracted human maxillary molars were included in the study as per inclusion criteria. They were randomly divided into two groups. In group-A, metal brackets were bonded to amalgam using sandblasting with 50 ?m alumina particles. In group-B, brackets were bonded after roughening the amalgam surface with diamond bur. Shear bond strength (SB) was measured and compared using universal testing machine, in both the groups.

RESULTS: SB of metal brackets bonded with sandblasting (17.05±5.9 MPa) was significantly higher than diamond bur roughened group (11.08±4.0 MPa).

CONCLUSION: Amalgam surface treatment with sandblasting increased the shear bond strength of metal orthodontic brackets significantly higher than the diamond bur roughening.

KEY WORDS: Brackets; Amalgam; Sandblast; Shear bond strength.

HOW TO CITE: Azeem M, Haq AU, Qadir S. Comparison of Surface Conditioning Protocols on The Shear Bond Strength of Metal Brackets Bonded To Amalgam Surface. J Pak Dent Assoc 2018;27(1):32-36.

DOI: https://doi.org/10.25301/JPDA.271.32

Received: 16 October, 2017, Accepted: 06 December, 2017

INTRODUCTION

One third of the children population needs some sort of orthodontic treatment.[1,2] The recent advancements in the area of orthodontic bonding have suggested the replacement of molar banding with bonding, as banding deteriorates the periodontal status of dentition.[3,4] Successful orthodontic treatment should not only corrects the malocclusion but should also keep the attachment apparatus sound and healthy.[5]

Many patients undergoing orthodontic therapy have large amalgam restorations on their posterior teeth as amalgams are still preferred over composite restorations in teeth having large carious defects.[6] This clinical predicament demand requirement of different techniques to improve the bonding between amalgam restoration and bracket surface by special surface preparation methods such as; sandblasting, diamond bur roughening, use of intermediate resins, and intraoral laser.[7]

Results from previous study showed that amalgam surfaces treated with laser produced higher shear bond strength (SB) compared to the sandblasting technique.[8] Compared to the green stone, sandblasting resulted in 2-fold increase in the SB.[9] 4-META used as primer is also found to increase the SB closer to etched enamel teeth with amalgam surfaces roughened with air-borne particle abrasion.[10]

Sandblasting is used successfully to bond metal brackets on porcelain surfaces being safer than hydrofluoric acid etching.[11] Resin composite masking with sandblasting of amalgam surface, was found to provide the increased SB with value of 15.54/6.41 MPa. Bur roughened amalgam surface showed SB of 15.26/3.90 MPa.10 Insignificant difference was found when SB between sandblasted and diamond rough amalgam bonding surfaces were compared.[12] In another study SB for diamond bur roughened group was 6.44 ± 0.12 MPa and for sandblasted group 6.01 ± 0.02 MPa.[13]

The variability in literature suggests the need to determine the best surface treatment method for amalgam surfaces to get maximum SB while orthodontic bonding.[12] Results of present study will guide the orthodontists for successful orthodontic bonding with lesser bond failures on amalgam surfaces. Therefore the objective of our study was to compare

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the mean shear bond strength of metal brackets bonded on sandblasted versus diamond bur roughened amalgam surfaces. Our hypothesis was that the mean SB on amalgam surface is significantly higher with sand blasting than diamond bur roughening.

METHODOLOGY

Current In-vitro, comparative study was conducted after ethical board approval (110-D/2017) at Orthodontic department of Faisalabad medical university from 17.2.2017 to 17.8.2017. Sample size of 60 was estimated using 95% confidence level, 80% power of test.[13]

Selection criteria consisted of: (1): Extracted maxillary posteriors because of orthodontic reasons,(2): Intact buccal surfaces,(3): Extracted teeth with fracture, caries, enamel hypoplasia, etc were excluded.

According to the selection criteria, 60 extracted teeth were included from the Exodontia department and were kept in 0.1% (wt/vol) thymol solution, at room temperature for 24 h. Class V buccal amalgam restorations with axial wall depth of 2.0 mm, were prepared by one expert operator on all the selected premolar teeth. The shape of cavity was rectangular and preparations were extended beyond the dimensions of the orthodontic attachments. To increase the retention, undercuts were placed at the coronal and gingival walls of class V cavity with a No.35 diamond bur. The cavities were filled with the non- gamma 2 amalgam (Nordiska Dental AB, Angelholm, Sweden) and hand burnished. For standardization, each amalgam surface was polished with a green stone, after allowing amalgam 24 hours to set. Mixing time, condensation time, and force were carefully standardized to rule out any amalgam variation in all the samples. After polishing but before bonding brackets, all amalgam surfaces were cleaned with distilled water ultrasonically to dislodge any impurities and dried with the oil-free air.

Teeth were randomly allocated into the 2 groups following random number table method. Group A 30 teeth were sandblasted with 50 µm alumina particles at right angle from the distance of 10 mm for 3 s at the pressure of 90 psi using the microetcher model II (Danville Engenieering) and Group B 30 teeth were diamond bur roughened with medium grit (100 µm) cylindrical diamond bur (Lemgo, Germany) with their shafts parallel to the amalgam surfaces, in a high-speed hand piece at the speed of 40,000 rpm at the force of 1 N, under the water spray. In the present study, the rpm were calibrated with an optical tachometer mounted on the high speed hand piece head, while the bur force was standardized using an electric balance, adjusted using sash weights before each experiment. Metal brackets (Discovery, Dentaurum, Germany) with bracket base area of 10.3 mm^2 were bonded as per manufacturer's directions to each tooth buccal amalgam surface with adhesive (Transbond XT, 3M Unitek, Monrovia, USA) and 4-META metal primer, at a room temperature. Samples were stored in normal saline for 72 h at 37°C temperature. All amalgam surfaces were thermocycled (Thermocycler, Dorsa, Iran) 1000 cycles, between 5°C and 55°C in each bath, with an overall dwelling time of 30 s and transfer time of 10 s at room temperature.

The samples were removed and embedded in type III gypsum in a PVC ring. The mounted specimens were kept wet while gypsum was setting and then placed in a gypsum-saturated water bath at 37°C for 60 hours. The samples were removed from wet bath and mounted in a custom made holding jig fitted with the brackets positioned vertically. The bonded teeth were then tested on a universal testing machine (Instron 5544, Instron Corp) at a cross head speed of 1mm/min and 50 kg load/tension cell. The force was placed to the bonding site while the bracket base was parallel to the direction of force. A mounted chisel-edge plunger with tip dimension of 1.0 mm was positioned so that the leading edge of the testing machine was aimed at the tooth-resin junction before being brought into the contact. The SB was measured in Newton's and then converted in MPa using the formula: Shear strength (MPa) = Debonding force (N)/bracket base area (mm^2) and 1 N/mm^2.[12]

Data collected was analyzed by using computer software SPSS version 20.0. The SB was presented in the form of mean, standard deviation and t-test was applied for comparison of SB between the two groups. Statistical significance was defined at <0.05.

RESULTS

The mean and standard deviation values for the SB of sandblasted and diamond bur roughened group are presented in the table 1 and 2.

Table I: Descriptive statistics of shear bond strength of sandblasted group

Shear bond strength (Mpa)	n	Mean	Standard deviation	Std. Error Mean
	30	17.0567	5.98780	1.67800

The t-test comparison indicates that there was a significant difference between the two groups (P<0.05). The sandblasted group was having significantly higher SB (17.05±5.98 MPa) than the diamond bur roughened (11.08±4.02 MPa) group (Table 3)

Table II: Descriptive statistics of shear bond strength of diamond bur roughened group

Shear bond strength (Mpa)	n	Mean	Standard deviation	Std. Error Mean
	30	11.0865	4.0234	0.69876

TABLE III: Comparison of both the groups

	t-test						
						95% Confidence interval of the Difference	
	T	Df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Shear bond strength in MPa	4.618	57	.000	6.13300	1.23987	3.56723	8.561009

DISCUSSION

This study was conducted to compare the shear bond strength of metal brackets on bonding to the amalgam surface treated with sandblasting or diamond bur roughening. The hypothesis was accepted as the SB of metal brackets bonded with sandblasting (17.0 MPa) was significantly higher than the diamond bur roughening (11.0 MPa). This can be linked to the fact that sandblasting produced higher surface roughness than the diamond bur roughening and thus resulted in increased bonding surface area by creating the 3-dimensional micro-porous structure. The other mechanism behind increased SB obtained with sandblasting is the removal of unfavourable surface oxides and contaminants from the amalgam by sandblaster thus resulting in increased bonding surface area and mechanical retention of orthodontic brackets having adhesive.

Amalgam surfaces are treated with diamond bur roughening and sandblasting techniques to enhance the SB between metal brackets and amalgam surface.[14] Bourke et al. also suggested the use of 9.6% for 2 minutes hydrofluoric acid to increase the bond between porcelain and stainless steel bracket but use of such acids are not recommended for the amalgam surfaces.[15]

The SB results in our study is comparable to the study by Machado et al.16 with sandblasted group showing 16.3 MPa of mean SB and diamond bur roughening showing 10.02 MPa, similarly in our study the sandblasted group was having 17.0 MPa and diamond bur roughened showed 11.0 MPa. However, SB in our study was measured through metal brackets rather than directly testing the amalgam-composite interface. Results are also in accordance with findings of other studies, where sandblasting was found to be superior method for surface treatment of amalgam surfaces when compared with other groups.[9,17]

Our results are in contrast with Zachrisson et al, who suggested that SB on bonding to amalgam surface with sandblasting is insignificant and 6.8 MPa - 11 MPa less than the controls 16 MPa while in our study the sandblasted group was having SB of 17.0 MPa and diamond bur roughened showed SB of 11.0 MPa.[18] Jessup[19]in 1998 concluded that diamond bur roughening yielded more SB on repaired amalgam surfaces. The study results are opposed to our results probably different because of the primer that is used in current study that is 4-Meta metal primer.

Lingual buttons bonded to the amalgam surfaces also found to yield the higher SB with several resin /conditioner combinations and sandblasting was also done prior to bonding lingual attachments.[20] These results are in agreement with current study as sandblasting and use of metal primer adhesive yielded positive effects. In 1981, Tanaka[21] suggested use of 4-Meta metal primer for bonding adhesive resin to nickel chromium surface to produce superior SB, similarly in our study 4-Meta was used as a metal primer to bond brackets to amalgam surface to yield clinically predictable SB.

In 2010, Katrina concluded that water storage has deleterious effects on mean values of shear bond strength.[22] The samples in our study were stored in water after bonding for 72 hours that might have increased the results obtained in our study.

Although sandblasting got superior SB, but its disadvantages are high chair side cost, need proper isolation and training and difficult accessibility.[23,24] On the other hand, diamond bur is easily available in practice but got inferior SB values as inferred and supported by the results of current study.

There are certain shortcomings of present study. Current research compared only the mean shear bond strength of orthodontic metal brackets bonded on sandblasted versus diamond bur roughened amalgam surfaces, but it was also important to know the surface morphology of amalgam restoration in form of its cohesive or adhesive behaviour by using scanning electron microscope. Information about surface roughness produced with sandblasting and with burs is also missing. Furthermore, current study was conducted in-vitro environment and factors like temperature, stress, humidity, acidity and plaque may complicate assessment of best bonding protocol. Future in-vivo studies with larger sample size are suggested.

CONCLUSION

Amalgam surface treatment with sandblasting increased the shear bond strength of metal orthodontic brackets significantly higher than the diamond bur roughening.

CONFLICT OF INTEREST

None to declare.

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