ORIGINAL ARTICLE

SHEAR BOND STRENGTH OF BRACKETS ON BONDING TO TREATED AMALGAM SURFACES

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ABSTRACT

The field of orthodontics has improved many folds since its advent in 1900 century. Orthodontic bonding to enamel surface has massively improved the control of clinician in an effort to settle teeth in an ideal occlusion. Amalgam fillings have been in use since the development of the field of dentistry. Orthodontist more often than not comes across amalgam as a surface to bond bracket in term of fixed orthodontic therapy. The strength of bond between orthodontic bracket and amalgam has to improve, in order to insure the most important phase of orthodontic treatment that is orthodontic bonding.

The aim of this study was to compare mean shear bond strength of orthodontic brackets on sand-blasted versus diamond bur roughened amalgam surfaces.

This randomized control trial was performed in the Department of Orthodontics, FMH College of Medicine and Dentistry Lahore. Sixty extracted human maxillary premolars and molars were used. They were randomly divided into two study groups of 30 teeth. In group-I, brackets were bonded to amalgam using sandblasting with 50 um alumina particles. In group-II, brackets were bonded after amalgam surface was roughened with a diamond bur. Brackets were debonded using AGS-J SHI-MADZU 5 KN universal testing machine with cross head speed of 1mm / min and shear bond strength was measured along with it.

Shear bond strength of sandblasted group was higher than the diamond roughened group.

In this in vitro study, it was concluded that the shear bond strength of sandblasted group on bonding stainless steel brackets to amalgam surface was significantly higher than that obtained with diamond bur roughening.

Key Words: *Self etching primer, Shear bond strength.*

INTRODUCTION

There is an increase in the number of young female patients seen at the orthodontic department.[1] The skeletal class II and class II molar relation being found more prevalent in Pakistani population allow us to better review and customize our treatment modalities in that respect. [2] The technical advancements in orthodontic bonding have reduced the use of banding on posterior teeth. Currently bonding is preferred over banding as latter deteriorates the periodontal status of teeth.[3] Plaque index, pocket depth and gingival changes all seem to worsen with banding as compared to bonding on tooth surfaces.[4] Successful orthodontic treatment not only corrects the malocclusion but also help improve periodontal conditions of the patients.[5] Amalgam restorations are still preferred in adults having large cavities and located posteriorly requiring more isolation.[6] Mostly patients undergoing orthodontic treatment have large amalgam restorations on their posterior teeth. This clinical predicament demands the requirement of different procedures to improve bonding between amalgam restoration and bracket by special surface preparation e.g. sandblasting, diamond bur roughening, use of intermediate resins and adhesive, Er,Cr:YSGG laser and Ga-Sn liquid application.[7]

Amalgam surfaces treated with laser produced higher shear bond strength compared to sandblasting technique.[8] Use of different intermediate resins and adhesive does not increase the mean shear bond strength of orthodontic brackets as compared to etched enamel even with different surface treatments. However, temperature variations were not affecting bond strength of composite to amalgam.[7] Compared to green stone, sandblasting resulted in twofold increase in shear bond strength.[9] It has been reported that 4-META used as primer increases the shear bond strength closer to etched enamel teeth with amalgam surfaces roughened with air-borne particle abrasion.[10] Sandblasting is used successfully to bond stainless steel brackets on porcelain surfaces being safe than hydrofluoric acid

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etching.[11] Resin composite masking is said to give increased shear bond strength with standard deviation of 15.54/6.41 with sandblasting of amalgam surface. Bur roughened amalgam surface showed shear bond strength with standard deviation of 15.26/3.90 in an aging amalgam with $p<0.0001$ showing significant difference.[10] Insignificant difference was found with $p>0.05$ when shear bond strength between two amalgam bonding groups were observed. [7] While in another study, shear bond strength for diamond bur roughened group and sandblasted group was comparable and clinically significant

Dearth of local data and variability in results suggests the need to determine the best method for roughening of amalgam surface to get maximum shear bond strength.[7] Conditions like temperature be controlled and type of primer used can significantly increase the bond strength closer to those of etched enamel. Inferences may help clinicians for quality orthodontic practice with less bond failures on amalgam surfaces.

METHODOLOGY

The study design was randomized controlled trial. The study was carried out in Orthodontics department, FMH College of Medicine and Dentistry Lahore. The duration of study was six months (February 2014-August 2014). Sample size of 60 cases (30 each) was estimated using 95% confidence level, 80% power of test with expected mean bond strength 6.44±0.12 in diamond bur group and 6.01±0.02 in sandblast group.[12] The sampling technique was Non-probability purposive sampling. Sample selection was done through respective inclusion criteria: extracted premolar and molar teeth with intact buccal surfaces and exclusion criteria: 1) Extracted teeth with surface anomaly e.g. caries, enamel hypoplasia etc. 2) Extracted teeth with any conservative treatment. Extracted teeth were selected from the oral surgical OPD of Fatima Memorial dental hospital surgery outpatient department after taking the inform consent from the patients and were kept in 0.1% (wt/vol) thymol solution. The buccal surfaces of teeth were then cleaned with pumice power and rubber cups. The teeth were then embedded in self cure acrylic moulds so that the buccal surfaces are kept perpendicular to the applied shear force. Teeth were randomly allocated into two groups following lottery method. A cavity (width 6 mm, length 7 mm, axial depth 2 mm) with retention grooves at the base were prepared in sixty teeth. Thirty treated teeth were sandblasted with 50 micrometer alumina particles (Korkox 50; Bego, Bremen, Germany) and another thirty teeth were roughened with a diamond bur (MANI TF-12). Orthodontic brackets were bonded to each tooth with Transbond composite (3m unitek) and a metal primer (4-META, Reliance orthodontic products). Whole sample was stored in normal saline for 72 hours, thermo cycled from 5 -55 degrees for 24 hours .The bonded teeth were then tested on universal testing machine AGS-J SHIMADZU 5 KN universal testing machine with cross head speed of 1mm/min. The debonding blade of the machine was kept absolutely perpendicular to the buccal surface of each tooth. Before testing the teeth were secured firmly in the jig. The force at which the bracket dislodged was calculated and noted.

The force 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 I N/mm.[7] The bracket base area was (10.3 mm^2) for all sample. Data collected was analyzed by using computer software SPSS version 17.0. The shear bond strength was presented in the form of mean, standard deviation and t-test was applied for comparison of shear bond strength between the two groups. p value less than and equal to 0.05 was considered significant.

RESULTS

The descriptive statistics, including the mean and standard deviation values for the shear bond strengths of sandblasted and diamond bur roughened group are presented in the Table I . The mean shear bond strength of sandblasted group is 16.30 Mpa, with a standard deviation of 6.01Mpa (table I). Meanwhile, the mean shear bond strength of the diamond bur roughened group is 10.04Mpa with a standard deviation of 4.066Mpa (Table I). The t-test comparison indicates that there is a significant difference between the two means ($P<0.05$). The sandblasted group has significantly higher shear bond strength than the diamond bur roughened group (Table II).

DISCUSSION

The study conducted assessed the shear bond strength of stainless steel brackets on bonding to amalgam surface treated with two different methods;

TABLE 1: DESCRIPTIVE STATISTICS OF SHEAR BOND STRENGTH OF SANDBLASTED AND DIAMOND BUR ROUGHENED GROUP

Shear bond strength (Mpa) sandblasted group	**n***	**Mean**	**Standard deviation**
	30	16.3073	6.01042
Shear bond strength (Mpa) sandblasted group	**n***	**Mean**	**Standard deviation**
	30	10.0423	4.06625

- n*= number of teeth

TABLE 2: INDEPENDENT SAMPLE TEST

	t-test for equality of Means					
					95% Confidence interval of the Difference	
	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Shear bond strength in MPa	4.729	.000	6.26600	1.32488	3.61296	8.91704

sandblasting and diamond bur roughening. The hypothesis was supported as the shear bond strength of stainless steel brackets bonded with sandblasting was significantly higher than diamond bur roughened group. Results support the hypothesis. Results showed the sandblasting measurements is clinically acceptable and is the suggested method to bond stainless steel brackets to amalgam surface in clinical practice.

The cost of chair side sandblaster and its availability in dental practice is not common and clinicians might not find it easily accessible. The sandblasting also needs proper training and isolation to protect the surrounding tissue. But the results suggest it yields clinically significant Shear bond strength. Diamond bur is easily available in practice and may be the more preferable procedure by the clinicians. But the sandblasting is superior in terms of generating higher bond strength and it's highly supported by the current study. Diamond bur roughening and sandblasting techniques are also used on surfaces like porcelain to increase the mechanical bond between the bracket and the surface.[13] In 2007, Machado et al studied the effect of different surface treatments like diamond bur roughening and sandblasting on amalgam-composite interface. Sandblasted group showed shear bond strength of 16.28 MPa and bur roughening showed Shear bond stregth of 9.27 MPa.[14] The shear bond strength results in our study is comparable to the study undertaken by Machado et al with sandblasted group showing 16.3 MPa of mean SBS and diamond bur roughening showing 10.02 MPa of mean shear bond strength. Shear bond strength (SBS) in this study was measured through stainless steel bracket interface with enamel rather than directly testing the amalgam-composite interface. Sandblasting was found superior to diamond bur roughening technique but results showed were clinically insignificant 3.4-6.4 MPa less than that of the controls 13.2 MPa. In this study different metal bonding adhesives were used 4-Meta, Panavia and Geristone.[15]

It was found that sandblasting amalgam surface generated superior SBS than green stone. Scotch bond 1 or All-Bond 2 and Amalgam bond were the different adhesives used. Instron Universal testing machine was used with a cross head speed of 1mm/minute to test shear bond strength. Scotch bond 1 showed the highest shear bond strength with sandblasting technique.[16] It was previously studied that water storage has deleterious effects on SBS with a mean of 10.7 MPa and cross head speed increased the SBS by 0.77 and 1.3 MPa respectively. [17] The samples in our study were not stored in water after bonding brackets to amalgam and might have decreased the measurments in our study. In another study the shear bond strength of mandibular incisor bracket bond to amalgam surface using different intermediate resins and dental adhesives. No significant difference was found in amalgam bonded groups $p>0.05$. [7] In present study the sandblasted amalgam surface group showed mean shear bond strength of 16.3±6.01 S.D which is clinically acceptable and significant $p<0.05$. In 2012, Er,Cr:YSGG LASER and sandblasting technique was used to bond stainless steel brackets on amalgam. Laser group showed higher shear bonds strength on debonding (6.30 MPa) than sandblasting group.[8] Sandblasting was found superior to diamond bur roughening on bonding to amalgam surfaces in a previous study.[18] This study also supports our hypothesis and infers strong evidence towards sandblasting as the method to use for bonding orthodontic brackets to amalgam.

In previous literature the use of dual cure resin when bonding to metal surfaces was done. It was found a new universal bonding agent Scotch bond Universal providing clinically significant bond strength on all the bonding surfaces (metal, composite, porcelain) [19]. In was found recently that Assure plus resin produced clinically significant (7.70, 7.97) MPa bond strength on amalgam surface with pretreatment sandblasting.[20] On the contrary, Transbond XT performed better than Assure Universal Bonding resin in terms of shear bond strength after amalgam surface treatment (7.2-10.12) MPa [21]. It should be noted that this study was conducted in vitro and factors like salivary contamination should be kept in mind when evaluating the results of the study. The effect of saliva and moisture on bond strength has been discussed and is detrimental to the bond between interface of composite and amalgam. The predictable size and form of amalgam filling might not be possible clinically. In vivo studies in future should be carried out to give more accurate results. The availability of sandblaster for clinical use inside the oral cavity should be valued more and its application should be enlightened more in clinical practice.

CONCLUSION

The study made a comparison between sandblasted and diamond bur roughened amalgam surfaces on

bonding stainless steel brackets and shear bond strength was tested. The results inferred by this in vitro study with its limitations are concluded as follows:

The shear bond strength of sandblasted amalgam group is higher than the diamond bur roughened groups on bonding stainless steel brackets.

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