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Shear bond strength of ceramic brackets bonded to differently conditioned amalgam

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Abstract

Introduction: Because adults often request more esthetic ceramic brackets, it is important to conduct a study with aim of evaluating mean shear bond strength (BS) of ceramic brackets on sandblasted versus diamond bur roughened amalgam surfaces.

Material and methods: This In-Vitro, Comparative study involved 60 extracted human maxillary molars randomly divided into 2 groups. In group-I ceramic brackets were bonded to amalgam using sandblasting with 50 µm alumina particles. In group-II, brackets were bonded after roughening the amalgam surface with diamond bur. Mean BS was measured using universal testing machine.

Results: BS of ceramic brackets bonded with sandblasting was significantly higher than diamond bur roughened group.

Conclusions: Amalgam surface treatment with sandblasting increased shear bond strength of ceramic brackets.

Keywords: Ceramic; amalgam; sandblast; shear bond strength

Introduction

The technical advancements in orthodontics have lead to a decrease in banding of buccal teeth and introduction of ceramic brackets in orthodontic market.[1,2] The ceramic brackets are mainly composed of aluminium oxides[3] and are of two types i.e. polycrystalline and monocrystalline.[4]

Even today, orthodontic patients, especially adults, often have buccal amalgam restorations on their molars. Bonding of metal attachments to these amalgam surfaces has already been investigated in various clinical and in vitro studies, using various methods, such as surface treatment by sandblasting, diamond bur roughening, lasers and the use of special intermediate resins and adhesives.[5-9] Unfortunately, little is known about the bond strength (BS) of ceramic brackets when bonded to amalgam surfaces. This lacking of literature suggests the need to determine the best surface treatment method for amalgam to get maximum BS with bonding of ceramic brackets. Results of the present study will guide orthodontists regarding best protocol for bonding ceramic attachments securely on amalgam surfaces.

The aim of this study was to compare, in-vitro mean shear bond strength of ceramic brackets bonded on sandblasted versus diamond bur roughened amalgam surfaces. Our null hypothesis was that, there was no difference in the BS of ceramic brackets bonded to amalgam surface by diamond bur roughening or sandblasting.

Material and Methods

This In-vitro study was conducted after ethics approval, at Orthodontic Department, Faisalabad Medical University and de'Montmorency College of Dentistry, between January to September 2017. In order to calculate estimated sample size, power analysis was performed using G*-power

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(version 3.0.10), to reach a power of 0.80 and using 95% confidence level. Extracted maxillary first molars having intact buccal surface were used for this study. Extracted teeth without buccal fracture or caries were excluded from the sample. 60 caries free extracted teeth were collected from Oral Surgery Department were kept in 0.5% thymol solution. The teeth were cleaned and polished with pumice.

Amalgam restoration of standard dimension (width 6 mm, length 7 mm, axial depth 2 mm) was done on bucco-occlusal surface of each extracted molar, with a standardized protocol. One operator prepared all the cavities to ensure consistent dimensions. Seventy-two hours later, the restorations were polished, followed by storing in saline solution at 37°C and thermal cycling.

The teeth were later embedded perpendicularly in acrylic moulds and pumice polished. 60 teeth were randomly allocated into 2 groups using random number table method. Group I comprised of 30 teeth, that were sandblasted with 50 um alumina particles for 3 seconds and Group II comprised of 30 teeth that were diamond bur roughened.

Prior to ceramic bracket placement, with bracket base area of 10.3 $mm^{2,}$ all the sample surfaces were etched with 37% phosphoric acid for 60 seconds, rinsed, and then air dried. The 4-META metal primer (3M Unitek) was applied to the amalgam surface followed by ceramic bracket bonding using light cure adhesive (Transbond XT, 3M Unitek, Monrovia, USA), cured for 40 seconds. Samples were stored in normal saline for 72 hours, and thermo-cycled. The bonded teeth were then tested on universal testing machine fitted with a debonding instrument, at speed of 1mm/min.

The BS 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.[8] Collected data was analyzed using SPSS version 21.0. The BS was presented in the form of mean, standard deviation and t-test was applied for comparison of BS between the two groups. Statistical significance was defined at $\alpha=0.05$.

Results

The mean and standard deviation values for the BS of sandblasted and diamond bur roughened group are presented in the table I and II.

The t-test comparison indicates that there is a significant difference between the two groups ($P<0.05$). The sandblasted group has significantly higher BS than the diamond bur roughened group (Table III)

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

Shear bond strength (Mpa)	n	Mean	Standard deviation	Std. Error Mean
	30	10.0567	3.98780	1.74200

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	5.0865	2.0234	0.52311

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	3.618	58	.000	5.47300	1.60800	3.12321	8.87556

Discussion

Bonding ceramic brackets to restored surfaces is often challenging and requires modified bonding protocols. Various protocols have been suggested to increase bonding of composite adhesives to amalgam restorations. Mechanical techniques include roughening of amalgam surface, preparing undercuts or grooves on amalgam surface, while chemical techniques include special agents that form ionic bonds with metal oxides of amalgam surface.[7,10-12]

Studies exist on amalgam surface treatment with diamond bur roughening and sandblasting techniques to enhance BS between metal brackets and amalgam surface[13] and also on porcelain surface treatment with hydrofluoric acid to increase the BS between porcelain and metal bracket.[14] Unfortunately, little is known about the BS of ceramic brackets when bonded to amalgam surfaces. Current study was conducted to compare shear bond strength of ceramic brackets on bonding to amalgam surface treated with sandblasting or diamond bur roughening. The hypothesis was rejected as the BS of ceramic brackets bonded with sandblasting was significantly higher than diamond bur roughening.

The BS of sandblasted group in this study was significantly higher than diamond bur roughened group. This may be due to surface alteration of amalgam leading to increased energy interaction with adhesive. Sandblasting also increased the surface area of the amalgam surface by increasing porosities, therefore resulting in greater interlocking with the resin. These results are in agreement with other studies,[10,15-20] but in contrast with findings of Fruits and others [21] who found otherwise. Diamond bur roughening in present study did not generate roughness that was required to produce sufficient BS.

Our results are in agreement with findings of Machado,[7] Jamie,[6] and Skilton,[22] as they also concluded that sandblasting is superior to diamond bur roughening when bonding to amalgam surfaces. However, brackets used in these studies [6,7,22] were made of stainless steel, while in the current study, BS of ceramic brackets was evaluated. Zachrisson et al, suggested that change in BS while bonding to amalgam surface with sandblasting does not have a significant effect.[23] Jessup [24] also concluded that diamond bur roughening yielded more BS on amalgam surfaces. These study results are opposed to our results probably because of the different primer that was used in the current study (4-Meta metal primer). Moreover different ceramic brackets were utilized in the current study contrary to the metal ones in the mentioned studies.

Tanaka[25] suggested use of 4-Meta metal primer for bonding adhesive resin to nickel chromium surface to produce superior BS, similar to the present study in which 4-Meta was used as a metal primer to bond ceramic brackets to amalgam surface.

In another study,[26] amalgam specimens were air-abraded for 3 seconds and subsequently bonded with ceramic brackets. Taking 10 MPa as clinically sufficient BS; reliable retention of

ceramic brackets on amalgam surface was obtained. This is in agreement with findings of the present study. According to literature, brackets bonded to the enamel surface must have shear bond strength between 6 and 8 MPa[27-29] in order to achieve successful orthodontic bonding and in the present experimental study, the same was achieved.

A crosshead speed of 1 mm / minute was chosen in the present study and this was in agreement with most of amalgam-bonding studies.[17,18,22,23,26] Furthermore, it has been shown that crosshead speed of 0.1 and 5 mm/minute got no affect in debonding force measurements.

Although sandblasting produces superior BS values, its disadvantages include high chair side cost, proper isolation requirements, training and difficult accessibility. On the other hand, diamond bur is easily available in every dental practice. The study was conducted in vitro and factors like temperature, stress, humidity, acidity and plaque may complicate assessment of best bonding protocol. Therefore, it is suggested that the shear bond strength of ceramic brackets bonded to amalgam be calculated in vivo situations.

Conclusions

Amalgam surface treatment with sandblasting increases the shear bond strength of ceramic orthodontic brackets.

References

1. Kafle D, Agarwal A, Shrestha S, Adhikari B. Banding on Adolescents: Is Molar Band Height Different than Clinical Crown Height? Orthodontic Journal of Nepal 2015 Nov; 20-4(2):7-11
2. AlSubaie M, Talic N. Comparison of the static frictional resistance and surface topography of ceramic orthodontic brackets: an in vitro study. Australasian Orthodontic Journal 2017 May;33(1):24
3. Brandão GA, Pereira AC, Brandão AM, de Almeida HA, Motta RH. Does the bracket composition material influence initial biofilm formation? Indian Journal of Dental Research 2015 Mar 1;26(2):148
4. Romano FL, Pessoti G, Galo R, Gomes-Silva JM, Lucisano MP, Borsatto MC, Nelson-Filho P. Does the CO2 laser reduce bond strength in different types of ceramic brackets?. Dental press journal of orthodontics 2017 Apr;22(2):55-60
5. Parnian-Alizadeh O, Mojgan K, Sahand R, Farzaneh F, Elmira-Jafari N. Effect of surface treatment with sandblasting and Er,Cr:YSGG laser on bonding of stainless steel orthodontic brackets to silver amalgam. Med Oral Patol Cir Bucal 2012;17:292-6
6. Portugal J, Marqes P, Jardim L, Leitcio J. Shear Bond Strength of Aged Dental Amalgam Repaired with Composite. Rev Port Estomatol Cir Maxilofac 2008;49:69-74
7. Machado C, Sanchez E , Alapati S, Seghi R, Johnston W. Shear bond strength of amalgam-resin composite interface. Oper Dent 2007;32:341-6
8. Germec D, Cakan U, Ozdemir FI, Arun T, Cakan M. Shear bond strength of brackets bonded to amalgam with different intermediate resins and adhesives. Eur J Orthod 2009;31:207-12
9. Hammad SM, Banna MSE. Effect of surface loading on the shear bond strength of metal orthodontic brackets bonded to resin composite veneer surface using different conditioning protocols. Progress in Orthodontics 2013;14:14
10. Özcan M, Vallittu PK, Huysmans MC, Kalk W, Vahlberg T. Bond strength of resin composite to differently conditioned amalgam. J Mater Sci Mater Med 2006;17:7-13
11. Çehreli SB, Arhun N, Celik C. Amalgam repair: Quantitative evaluation of amalgam-resin and resin-tooth interfaces with different surface treatments. Oper Dent 2010;35:337-44
12. Hadavi F, Hey JH, Ambrose ER, Elbadrawy HE. Effect of different adhesive systems on micro leakage at the amalgam/composite resin interface. Oper Dent 1993;18:2-7
13. Kocadereli I, Canay S, Akca K. Tensile bond strength of ceramic orthodontic brackets bonded to porcelain surfaces. Am J Orthod Dentofacial Orthop 2001; 119:617–20
14. Major PW, Koehler JR, Manning KE. 24-hour shear bond strength of metal orthodontic brackets bonded to porcelain using various adhesion promoters. Am J Orthod Dentofacial Orthop 1995;108:322–9
15. Lubow RM, Cooley RL. Effect of air-powder abrasive instrument on restorative materials. The Journal of prosthetic dentistry 1986 Apr 1;55(4):462-5
16. Al-Jazairy YH. Shear peel bond strength of compomers veneered to amalgam. J Prosth dent. 2001 Apr 30;85(4):396-400
17. Sperber RL, Watson PA, Rossouw PE, Sectakof PA. Adhesion of bonded orthodontic attachments to dental amalgam: In vitro study. Am J Orthod Dentofacial Orthop 1999 Nov 30;116(5):506-13

18. Zachrisson BU, Büyükyilmaz T, Zachrisson Y. Improving orthodontic bonding to silver amalgam. The Angle orthodontist 1995 Feb;65(1):35-42
19. Ruse ND, Sekimoto RT, Feduik D. The effect of amalgam surface preparation on the shear bond strength between composite and amalgam. Operative dentistry 1995 Sep 1;20:180
20. Lacy AM, Rupprecht R, Watanabe L. Use of self-curing composite resins to facilitate amalgam repair. Quintessence international 1992 Jan 1;23(1)
21. Fruits TJ, Duncanson Jr MG, Coury TL. Interfacial bond strengths of amalgam bonded to amalgam and resin composite bonded to amalgam. Quintessence international 1998 May 1;29(5)
22. Skilton JW, Tyas MJ, Woods MG. Effect of surface treatment on orthodontic bonding to amalgam Aus J Orthod 2006; 22:59-66
23. Buyukyilmaz T, Zachrisson BU. Improved orthodontic bonding to silver amalgam. Part 2. Lathe-cut , admixed and spherical amalgams with different intermediate resins. Angle Orthod 1998 ;68: 337-44
24. Jessup JP, Vandewalle KS, Hermesch CB, Buikema DJ. Effects of surface treatments on amalgam repair. Operative dentistry 1998 Jan 1;23:15-20
25. Shiba A, Hayashi T, Yoshida J, Tanaka O. Functionally generated amalgam paths for complete dentures. J Prosth Dent 1981 Nov 1;46(5):494-7
26. Jost-Brinkmann PG, Böhme A. Shear bond strengths attained in vitro with light-cured glass ionomers vs composite adhesives in bonding ceramic brackets to metal or porcelain. The journal of adhesive dentistry 1999;1(3):243-53
27. Powers JM, Kim HB, Turner DS. Orthodontic adhesives and bond strength testing. Semin Orthod. 1997 Sep;3(3):147-56
28. Trimpeneers LM, Verbeeck RH, Dermaut LR, Moors MG. Comparative shear bond strength of some orthodontic bonding resins to enamel. European J Orthod 1996 Jan 1;18(1):89-95
29. Reynolds IR, Von Fraunhofer JA. Direct bonding of orthodontic attachments to teeth: the relation of adhesive bond strength to gauze mesh size. British Journal of Orthodontics 1976 Apr 1;3(2):91-5