ORIGINAL ARTICLE

EVALUATION OF MEAN SHEAR BOND STRENGTH OF ORTHODONTIC METAL BRACKETS BONDED WITH FLOWABLE COMPOSITES USED WITH AND WITHOUT INTERMEDIATE BONDING RESIN: AN IN VITRO STUDY

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ABSTRACT

Objectives of this study were to compare the mean shear bond strength (SBS) of orthodontic metal brackets bonded to etched enamel with flowable composites used with and without intermediate bonding resin and compare it's mean bracket debond time on extracted human teeth. This study was randomized controlled trial. The current RCT study was conducted at Orthodontics Department, Armed Forces Institute of Dentistry, Rawalpindi. A total of 60 extracted human acid etched premolars were randomly allocated into two groups. In Group A, bonding resin was applied on etched tooth whereas in Group B application of bonding resin was avoided. After 24 hours storage in water at 37 0C, shear bond test was performed. Results showed that mean SBS for the Group A and Group B was 12.33 MPa and 11.70 MPa respectively. Intergroup comparison between two groups using Independent sample T-test showed no statistically significant difference in mean SBS. (p=0.320) Intergroup comparison also showed no statistically significant difference in time taken for brackets to debond from tooth surface. (p= 0.52) Keeping in view the study results of mean SBS and time required for brackets to debond, flowable composites with no intermediate bonding resin could be effectively applied for orthodontic bracket bonding. Thus reducing the chair side time, chances of contamination with saliva and providing acceptable clinical bond strength.

Key Words: *Orthodontic bonding, Flowable composites, Resin, Shear Bond Strength, Debonding Time.*

INTRODUCTION

Fixed orthodontics appliances were introduced initially as metal bands attached on all the teeth. However with the introduction of acid etching concept by Buonocore in 1955 revolutionized the concept of bonding in dentistry.[1] This technique was used by Newman in 1965 for adhesion of orthodontic brackets using composite resin.[2] This bonding of the brackets directly to the tooth provides improved gingival health condition, improved patient comfort and acceptable aesthetic.[3] Adhesive systems for bonding orthodontic brackets to enamel use three different agents namely etchant, bonding resin and bonding adhesives.

Conventional adhesive bonding is a multi-step procedure involving acid etching of the enamel followed by bonding agent application and placement of orthodontic bracket with composite adhesive on the tooth.[4] Composite adhesive offers the advantages of early high bond strength, improved esthetics, increased working time and shorter setting time.[5,6] Despite various advantages, there are several shortcomings associated with this conventional technique including multi step nature of the procedure resulting in increased chair side time and chances of salivary contamination.[7,8] For this purpose one such product that strives for practical and efficient solution is a new flash-free flowable composite adhesive (low viscosity) for orthodontic bracket bonding. It was introduced to the market in an effort to reduce chair time by modifying the bonding procedure from three to two steps by elimination of use of bonding resin with flowable composites.[9] There is weak evidence that a flowable is likely to result in modest

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time savings when compared with the conventional acid etch technique used composite adhesive (high viscosity).[10,11] Various attempts have been made by manufacturers and researchers to develop composite resin with desired qualities like improve shear bonds strength (SBS) and ease of use. The bond strength has a direct impact on the success of orthodontic treatment. Failure of bracket enamel bond results in inconvenience for both the patient and the dentist and also prolongs the treatment time.[12]

Adhesives with higher filler contents (conventional composites) have improved dimensional stability but may lead to formation of adhesive flash accumulating plaque around the brackets. Flowable composites have lower viscosity which is assumed to spread out and conform to the tooth surface more uniformly therefore decreasing incidence of white spot lesions and gingival irritation.[4,10]

Direct application of flowable composite on the etched enamel without bonding resin reduces the number of steps during bonding, saves the treatment time and procedural errors associated with salivary contamination. Studies comparing the flowable composite with conventional composite resin showed that acceptable shear bond strength greater than 5.9 Mpa, adequate for clinical use can be achieved with flowable composite for orthodontic bracket bonding.[12]

The rationale of this study was to assess shear bond strength (SBS) achieved with flowable composite without intermediate bonding resin which is able to provide adequate bond strength with fewer procedural steps can help in decreased chair side timings and reducing contamination risk as well as stronger bonding between orthodontic metal brackets and tooth structure for longer duration of orthodontic treatment.

METHODOLOGY

An in vitro study was conducted in Orthodontic Department, AFID. Approval was taken from the Ethical Review Committee of Armed Force Institute of Dentistry (AFID). Premolar teeth with fully developed roots and closed apexes, extracted for reasons other than this study, were collected from Oral Surgery Department, AFID, Rawalpindi. Non probability consecutive sampling technique was used. Teeth with hypoplastic enamel defects and cracks were excluded from study.

Extracted teeth were stored in distilled water at room temperature till the completion of the sample of sixty teeth. Each tooth was mounted in self-cure acrylic resin and the buccal crown surface of each premolar were rinsed and dried. After 15-seconds, polished with fluoride-free pumice slurry. The buccal enamel surface was etched with 37% phosphoric acid gel for 30 seconds following by 15 seconds rinse and drying until the enamel have faintly white appearance. At this stage all teeth were randomly allocated through computer generated number by primary investigator into two groups. Group A and Group B with 30 teeth in each group. Group A (Control Group) consisted of teeth on which flowable composite with bonding resin was used whereas Group B (Experimental Group) included teeth with flowable composite without the use of intermediate bonding resin.

The bracket bonded specimens were stored in water for 24 hours at 37 OC and an SBS test was performed. A 0.017" X 0.025" stainless steel wire was ligated into each bracket slot to reduce any deformation of bracket during debonding. The specimens were secured in a jig attached to the base plate of a universal testing machine. A chisel edge plunger was mounted in the movable crosshead of the testing machine and was positioned so that the leading edge was aimed at the enamel –composite interface before being bought into contact. The crosshead speed was set at 0.1 mm per minute. The load was applied till the bracket was debonded from the tooth. The load was measured in kilogram (Kg) and then converted into mega Pascal (MPa). Time taken for the brackets to debond was also calculated in seconds for each tooth with the help of stopwatch.

SPSS version 18.0 (IBM SPSS, Statistic version 18.0 IBM Data Collection, New York, USA) was used for data analysis. Mean and standard deviation was calculated for age, shear bond strength (SBS) and frequencies was described for gender distribution. Independent sample t-test was used to compare mean shear bond strength (SBS) and time taken for brackets to debond between the two groups. P value of less than 0.05 was significant.

RESULTS

The mean age of the participants whose teeth were included in this study was 26.2 years (S.D 7.93) in Group A and 23.96 years (S.D 5.98) in Group B. In Group A out of 30, 16 premolars belonged to female participants and 14 from male. Whereas in Group B, out of 30, 15 premolars belonged to male participants and 15 from female participants.

The mean SBS for the group A and Group B was 12.33 MPa and 11.70 MPa respectively (Table 1). The descriptive statistics, including the mean, standard deviation, minimum and maximum and range values of SBS in MPa for both groups are presented in (Table 2). Intergroup comparison using Independent sample t-test showed no statistically significant difference in mean SBS between two groups. (p=0.320) (Table 3)

Time taken for brackets to debond from the teeth was also recorded for each tooth in both group. The descriptive statistics, including the mean time and

TABLE 1: SHEAR BOND STRENGTHS (MPA) IN GROUP A AND GROUP B

Sr. No.	Group A Shear bond strength (MPa)	Group B Shear bond strength (MPa)
1	10.00	10.00
2	12.20	11.00
3	13.00	12.30
4	12.40	10.40
5	11.00	11.30
6	13.10	13.21
7	13.00	13.00
8	12.00	11.90
9	10.20	12.80
10	11.30	11.30
11	14.20	11.20
12	13.00	13.20
13	13.00	11.40
14	13.90	10.30
15	15.60	10.90
16	12.00	13.90
17	13.50	12.50
18	10.00	11.30
19	12.00	10.90
20	14.20	11.00
21	12.00	10.00
22	13.40	10.70
23	12.00	11.90
24	13.00	12.70
25	12.40	12.30
26	11.00	10.70
27	10.50	11.80
28	13.00	13.00
29	10.00	11.90
30	13.00	12.30

standard deviation, recorded for both groups is presented in (Table 4). Intergroup comparison showed no statistically significant difference in time taken for brackets to debond from tooth surface between both groups. (p= 0.52) (Table 5).

DISCUSSION

The acceptable bond strength for orthodontic brackets in clinical situations ranges from 2.8 MPa to 10 MPa as documented in various studies.[13,14,15] Traditionally, the use of intermediate bonding resin is considered an essential step as it allows good wetting and penetration of the enamel surface which subsequently increases bond strength of composite with enamel.[16] Composite resins are traditionally loaded with increase amount of filler contents to improve strength and wear resistance. Flowable composite contains smaller filler particle size as traditional hybrid composite but filler loading is decreased in an attempt to improve viscosity of the material. This decreased viscosity of the flowable composite improves the wettability of the enamel surface and can be applied on acid etched enamel without the use of intermediate bonding resin, thus reducing the procedural steps involved in the bracket placement. This not only saves the chair side time but also decreases the chances of contamination of tooth surface with saliva. Thus if flowable composite provides adequate shear bond strength they will clearly provide an advantage over traditional composites for orthodontic bracket bonding.

According to our knowledge there are only nine in vitro orthodontic studies comparing bonding with and without use of intermediate resin layer and they too generate variable results regarding satisfactory bonding without use of intermediate bonding resin layer.[16,17,18]

Results of our study showed that the mean SBS for Group A (brackets bonded with flowable composite using intermediate bonding resin on etched enamel) and Group B (brackets bonded with flowable composite without using intermediate bonding resin on etched enamel) were 12.33 MPa and 11.70 MPa respectively and this result was not statistically significant. The SBS

TABLE 2: DESCRIPTIVE STATISTIC OF SBS FOR GROUP A AND GROUP B

Groups	Sample Size	Mean SBS (MPa)	Min	Max	Std. Error Mean	SD	Range
Group A	30	12.330	10	15.60	0.253	1.386	5.60
Group B	30	11.703	10	13.90	0.189	1.039	3.90

TABLE 3: COMPARISON OF SBS BETWEEN GROUP A AND GROUP B

Groups	Sample size	Mean	S.D	F	P-value *	Sig.
Group A	30	12.330	1.386	1.470	0.230	NS
Group B	30	11.703	1.039			

showed by both groups is well above the SBS required for clinically acceptable bonding.

This result is in accordance with Agha and Tecco et al[16], Agha[19] in his study compared traditional orthodontic composite with two flowable composites, one used with intermediate bonding resin and one without intermediate bonding resin. He found highly significant differences in SBS between traditional orthodontic composite (24.43MPa) and flowable composites but no-significant difference between flowable composites with intermediate resin and without resin (15.38 MPa, 14.66 MPa respectively). Similarly Tecco et al compared a flowable composite product (with and without intermediate bonding resin) and reported a clinically acceptable bond strength for both materials with no significant differences in bond strength among different groups (25.20MPa and 34.80MPa respectively).[16]

Our result was not in agreement with Uysal and colleagues which in their study while comparing traditional orthodontic composite with flowable composite (with and without intermediate bonding resin) showed that fllowable composites with and without intermedate bonding resin (7.75 MPa, 8.53 MPa vs 6.60 MPa, two brands of flowable composite with intermediate layer were used) displayed significantly lower SBS than traditional orthodontic composite.[20] They did not recommend use of flowable composite for routine orthodontic bracket bonding. This low SBS values in their study can be attributed to more technique sensitivity of the products used. Furthermore their study was conducted more than a decade ago (2004). Newer flowable composite have improved handling and flow characteristics as compare to older ones.[21] In short our result implies that flowable composites can simplify the bonding procedure by eliminating the need to apply an intermediate bonding resin without deteriorating the bond strength. Thus saving time, reducing procedural steps and chances of contamination.[6]

Our results showed that the mean (SD) bracket debond time for Group A was 12.70 seconds and for Group B was 11.96 seconds. No statistically significant difference was recorded between two groups for bracket debond time ($p > 0.05$). Although there are studies that have evaluated the other aspects of flowable composites like shear bond strength, Adhesive Remnant Index (ARI), bond failure, scanning electron microscopy analysis and effect of cross head speed on shear bond strength, no other study according to our knowledge has evaluated the effect of use of intermediate bonding agent on time taken for bracket to debond. More research is needed to evaluate the time needed for orthodontic bracket to debond using flowable composite with and without intermediate bonding layer.

CONCLUSION

1 There is no difference in shear bond strength of orthodontic metal brackets bonded to etched enamel with flowable composite with or without intermediate bonding resin.

2 Flowable composites without prior application of intermediate bonding resin on the etched enamel can be effectively applied for orthodontic bracket bonding. Elimination of this step will reduce the chair side time as well as chances of contamination with saliva.

3 There is no difference in time taken for brackets to debond with flowable composite with or without intermediate bonding resin. However more studies are required to evaluate the effect of application of intermediate bonding resin on bracket debonding time.

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