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Shear bond strength of orthodontic brackets using different types of bonding materials

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Abstract

Aim: the shear bond strength testing has been accomplished to lead orthodontists in selection of adhesives and brackets. The current research was conducted to assess the effect of using different types of bonding material on the shear bond strength of plastic brackets.

Materials and methods: Thirty upper first premolar teeth were utilized. There were 3 groups: - chemical composite, no mix chemical composite and light cure composite. Samples were then subjected to shear bond test using Instron testing machine. Samples data were then analyzed and compared using ANOVA and LSD tests.

Results: The results indicated that the chemical composite presented the greatest value of mean shear bond strength. On the other hand, the light cure gave the least mean shear bond strength. Highly significant differences between two groups ($P \leq 0.01$) ;and among all groups($P \leq 0.01$)were obtained.

Conclusion: Chemical composites provided a greater shear bond strength than other types of composite (no mix and light cure).

Keywords: shear, adhesive, brackets, orthodontics.

Introduction

Fixed orthodontic appliance is a contemporary bonded appliance, which can improve oral hygiene, design and esthetic. The purposes of using such appliances are to eliminate the tooth separation at the beginning of treatment and to close of band Spaces at the end of treatment [1]. Fixed orthodontic appliances generally comprise bands and arch wires, and brackets, which are fabricated from various materials (i.e. plastic, ceramic or metal) to increase the demand for esthetic appliance[2]. Plastic brackets were first introduced into market since 1970 and were made from resins and polycarbonate. The lack of strength and stiffness, staining and odor leading to tie wing fractures, permanent deformation and bonding problems after subjecting to the load over an extended period of time were the main disadvantages of metal brackets. For clinical application, plastic brackets are only suitable if they have metal slot. The adhesives are materials which are able to hold the materials together and have been utilized in dentistry [3,4]. Nowadays, numerous kinds of bonding material are now available for bonding orthodontic attachments and they are light or chemically. The shear strength test is the most common test used; on the other hand, it is sensitive method as

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the bond strength measurements were influenced significantly via the direction of debonding force[5 -6]. The bond strengths must be great sufficient to control the tooth movement in all planes. As well, the bond strength of adhesive and attachments should be adequate to tolerate stresses exerted by arch wires, patient misuse and forces of mastication, Likewise, the bond strengths should be low enough to debond without producing any harm to the surface of enamel [7-8.] The purpose of current research was to evaluate the effect of the shear bond strength of orthodontic plastic brackets using different types of the adhesive bonding material.

Materials and methods

1. Samples preparation

In total, thirty upper first premolar teeth, which have been collected from the department of surgery at Baghdad University Dentistry College; and from private clinics. The plastic brackets for upper first premolar were bonded by different types of bonding material. In the current study, three groups with each group had 10 samples and these include:

Group A. Ten plastic brackets were bonded by chemical composite,

Group B. Ten plastic brackets were bonded by no mix chemical composite,

Group C. Ten plastic brackets were bonded by light-cure composite.

2 Mounting of the teeth

All the collected teeth followed the same procedure of mounting.

A. Preparation of the mould

The long plastic tube was cut into 30 plastic piece (3cm length) using sharp knife

B. Fitting the teeth inside the mould

Acrylic powder and liquid were mixed in a proper amount in a glass dish according to the manufacturer instructions; and poured in its fluid phase into the plastic mould. The tooth was then carried by artery forceps and fitted inside the acrylic resin before converting into plastic phase. The crown of each tooth was only exposed where the long axis of the tooth must be parallel to the long axis of the plastic mould. Following complete set of the acrylic, the plastic mould was split into two pieces by sharp knife and the acrylic block was taken out.

3. Bonding Procedure

1. Teeth Preparation

The surface of the crown to be bonded was polished with pumice powder and water for a duration of 10 seconds. Then teeth were washed, and water- sprayed for ten seconds and air dried[9]. The tooth surface was then etched for thirty seconds by use of 37% liquid of phosphoric acid (Alpha dent company) with a brush and water - sprayed (for thirty second), and air sprayed (ten seconds) [10].

2. Bonding of orthodontic Brackets

A. Plastic bracket bonded by chemical composite:

The equal amounts (base and catalyst) of bonding material were mixed using a plastic spatula. One end of the spatula was used for each paste to avoid cross contamination. the primer was used according to the manufacturer instruction and a thin layer was applied on the tooth surface. The equal amount of chemical composite (base and catalyst) were mixed and then added on the bracket, which positioned occluso-gingivally at the highest contour mesio-distally. Any excess of bonding material was

carefully removed from around the bracket base using dental probe before the material was set. the specimens were allowed for bench cure for 10 minutes as shown in figure 1[11-12].

B. Plastic bracket bonded by no mix chemical composite:

A thin layer of primer was put on the tooth area to be bonded, and mesh surface of each bracket using a small brush and left to dry for 45 second. A small amount of adhesive paste was then applied to the mesh surface of the bracket and placed on tooth surface; and press firmly. The initial set occurs with 45 second and the excess adhesive paste was carefully removed from of the brackets using dental probe before the material was set.

C. Plastic bracket bonded by light-cure composite

A small amount of the light composite paste was applied on the bracket, which located correctly on each tooth. Before the material was set, the excess was carefully taken away using dental probe [13-14.] The light cure unit (SDI limited, Bayswater, Australia) was utilized to cure samples for 10-20 seconds.

4. Shear bond test

The Instron machine (Zwick l, Germany) (Figure 2) with cross head speed of 0.5 mm/minute was used for shear bond strength[15]. Each specimen was positioned correctly in the machine base by special clamping device, where bracket base was in parallel to load direction. The chisel end rod located down, and fixed within the upper arm of the testing machine. The load was applied an occluso-gingivally at the bracket tooth interface and recorded in Newton(figure 3)[16]. The strength values which were measured in megapascal (Mpa)were obtained from this formula: Force/surface area.

Samples data were analyzed by SPSS 16 software. The mean, standard deviation, minimum, and maximum values were summarized. Among all groups, comparisons were obtained using ANOVA, F-test and LSD test.

Results

The results of the study showed that the shear bond strength was significantly affected by the type of adhesive material. All values of mean, standard deviation and min and maximum are demonstrated in table 1. The results demonstrated that the chemical composite presented the greatest mean of bond strength. The light cure composite, on the other hand, had the least mean shear bond strength as shown in table 1 and figure 4. In addition, significant differences between all groups($P \leq 0.01$) as displayed in the ANOVA test (table 2).Furthermore, The LSD test indicated that there were significant differences between two groups as illustrated in table 3($P \leq 0.01$).

Discussion

Group A: plastic bracket bonded by chemical composite.

In the current study, the shear bond strength was the greatest when the chemical composite was utilized since the reaction and polymerization started before applying it on the base of the bracket, which led to increase in the viscosity of the chemical composite, subsequently increase in contact angle; and decrease in surface energy (surface tension)[17]. This result agrees with Pender et al, (1988)[18] who reported

that the two- paste composite adhesives could be used for bonding the orthodontic attachments to molars since they provide a bond strength which could afford mastication forces. Similarly, Raid (1999)[19] indicated that the two-paste chemical composite adhesives made a higher shear bond strength compared to no-mix adhesive. However, the present study disagrees the results of Odegaard and Segner (1988) [20] who assessed another two-paste adhesive and they found that there were no significant differences in shear bond strength. Furthermore, Smith and Shivapuja (1993)[21] compared the bond strength of various types of adhesive materials. They found that the no-mix composite adhesive formed a greater shear bond strength in comparison to the two-paste composite adhesive.

Group B: plastic bracket bonded by no mix chemical composite.

The current study found that the no mix composite provided a lower mean of bond strength compared to chemical composite. This finding agrees with Pender et al (1988) [18] who found that chemical composite created a higher shear bond strength than no mix adhesives since the no mix adhesive is weaker than chemical composite adhesive because the bond between chemical composite adhesive and tooth surface is greater than that of no mix adhesives with tooth surface, subsequently, this would give positive correlation with bond strength. This finding come agrees with Briton et al(1990)[21] and Sheen et al,(1993)[22.] On the other hand, the present results disagree with smith and shivapuja (1993)[23] who found that no mix chemical composite produced a higher shear bond strength than chemical composite.

Group C: plastic bracket bonded by light-cure composite.

In the present study, the light cure composite provided the lowest mean value of shear bond strength among all groups (A&B). These results were due to different methods applied by different authors, or due to different types of materials supplied by Manufacturers. In addition, the morphology of the brackets could affect the bond strength by resin tags, stress distribution at the bracket cement interface, and geometry depth[24]. These findings agree with Bishara et al (2005)[25] and Sadiq et al (2007)[26] and disagree with the Siderholm et al (2008)[27]. The null hypothesis was, therefore, refused as significant differences between all groups were observed. The current study concluded that the chemical composite had a significant effect on shear bond strength of plastic brackets. Further investigation of other types of bonding agents and different orthodontic brackets is required.

References

1- Fields HW. bonded resin in orthodontics. Pediatric Dent. 1982; 4:51:60.
2- Merguro D, Hayakawa T, Kawasaki M, Kasai K. Shear bond strength of calciu phosphate ceramic brackets to human enamel. Angle Ortho J. 2006; 76(2):301-305.
3- McCabe J. Anderson's applied dental materials. 6th ed. Blackwell scientific publications. 1985,5-26.
4- Kugel G, Ferrarri M. The science of bonding: from fist to sixth generation. J AM Dent Assoc. 2000; 131 Suppl:20S-5.
5- Stanford SK, Wozniak WT, Fan PL. The need for standardization of test protocols. Semin Orthod. 1997;3(3)206-9.
6- Klocke A, Kahl-Nieket B. the effect of debonding force direction on orthodontic shear bond strength. Am J orthod Dentofacial Orthop. 2006; 129(2):261-5.
7- Pickett KL, Sadowsky PL, Jacobson a, Lacefield W. Orthodontic in vivo bond strength: comparison with in vitro results. Angle Orthod. 2001;71(2):141-8.

8- Ozcan M, Vallittu PK, Peltomaki T, Huysamans MC, Kalk W. Bonding polycarbonate brackets to ceramic: effects of substrate treatment on bond strength. Am J orthod Dentofacial Orthop.2004; 126(2):220-7
9- Wang WN, Meng CL, Tarng TH. Bond strength: A comparison between chemical coated and mechanical interlock bases of ceramic and metal brackets. Am J orthod Dentofacial Orthop. 1997; 111:374-81.
10- Bishara SE, Olsen M, VonWald L. Comparisons of shear bond strength of precoated and uncoated brackets. Am J orthod Dentofacial Orthop. 1997; 112(6):617-21.
11- Jones SP, Geldhil JR, Davis EH. The crystal growth techniques: a laboratory evaluation of bond strengths. Eur J Orthod.1999; 21:89-93.
12- Khayyat NA. Shear bond strength of bonded buccal and lingual brackets for three orthodontics composite: an in vitro study. Master thesis. University of Mosel, 2000.
13- Bishara JC, Oonosombat C, Solimann MM , Laffon JF, Warren JF, Ajlouni R. Comparison of bonding time and shear bond strength between conventional and a new integrated bonding system. Angle Orthod J. 2005; 75(2) 237-242.
14- Bishara JC, Ostby AW, Laffon JF, Warren JF. The effect of modifying the self-etchant bonding protocol on the shear bond strength of orthodontic brackets. Angle Orthod J. 2007; 77(3) 504-508.
15- Martina R, Laino A, Cacciafesta V, Cantiello P.Recycling effects on ceramic brackets: a dimensional , weight and shear bond strength analysis. Eur J Orthodont. 1997; 19:629-36.
16- Lipppitz SJ, Staley RN, jakobsen jr. . in vitro study of 24 hour and 30 day shear bond strength of three resin glass ionmer cements used to bond orthodontic brackets. Am J orthod Dentofacial Orthop.1998; 113:260-4.
17- William and Gunnar,1978. An outline of dental materials and other selections 9th ed.
18- Pender N, Dresener E, Wilson S, Vowles R. Shear bond strength of orthodontic bounding agent. Eur. J. Orthodontic. 1988; 10:374-379.
19- Raid K. Shear bond strength of four composite adhesive systems: an in vitro study. Master thesis. College of Dentistry University of Baghdad,1999.
20- Odegaard J, Segner D. Shear bond strength of metal brackets compared with new ceramic brackets. Am J orthod Dentofacial Orthop.1988; 94:201-206.
21- Briton JC, Mcinnes P , Weinbery R, Ledoux WR, Retief DH. Shear bond strength of ceramic orthodontic brackets to enamel. Am J orthod Dentofacial Orthop.1990;98:348-53.
22- Sheen DH, Wang WN, Tarng TH. The bond strength of younger and older permanent teeth with various etching times. Angle Orthod.1993; 63:225-30.
23- Smith RT, Shivapuja PK. the evaluation of dual cement resins in orthodontic bonding. Am J orthod Dentofacial Orthop.1993;103(5)448-51.
24- Knox J, Hubsch P, Jones ML, Middleton J. the influence of bracket base design on the strength of the bracket cement interface. J Orthod. 2000;27(3): 249-54.
25- Bishara SE, Oonsombat C, Solimann MM, Warren JJ, Laffoon JF, Ajlouni R. Comparison of bonding time and shear bond strength between conventional and a new integrated bonding system. Angle Orthod. 2005; 75(2):237-242.
26- Sadiq SMA. Comparison the bond strength of metal orthodontic brackets bases using three types of adhesives generations. M Dent J. 2007; 4(1): 61-9.
27- Soderholm KJ, Soares F, Argumosa M, Loverland C, Bimstein E, Guelmann M. shear bond strength of one etch and rinse and five self-etching dental adhesives when used by six operators. Acta Odontol Scand. 2008; 66(4): 243-9.

Tables

Table 1. Mean and standard deviation of all tested groups.

	Mean	**Standard deviation**	**Min**	**Max**
Chemical composite	42.6	1.77	40	45
No mix chemical composite	35.7	1.56	34	38
Light cure	33.9	1.28	32	36

Table 2. ANOVA test among all groups

	F test	**P value**	**Significance**
Between groups	87.068	P≤0.01	HS

HS: Highly Significant(P≤0.01)

Table 3. LSD (least significant difference) test between two groups

	P value	Significance
Group A &C	P≤0.01	HS
Group A &B	P≤0.01	HS
Group B &C	P≤0.01	S

HS : Highly Significant(P≤0.01**)**

Figures

Figure 1. Tooth sample with bonded plastic brackets

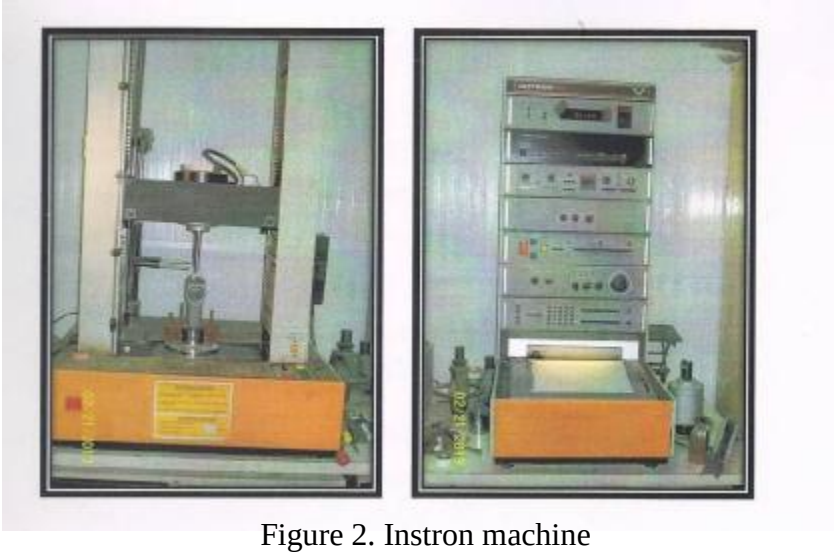

Figure 2. Instron machine

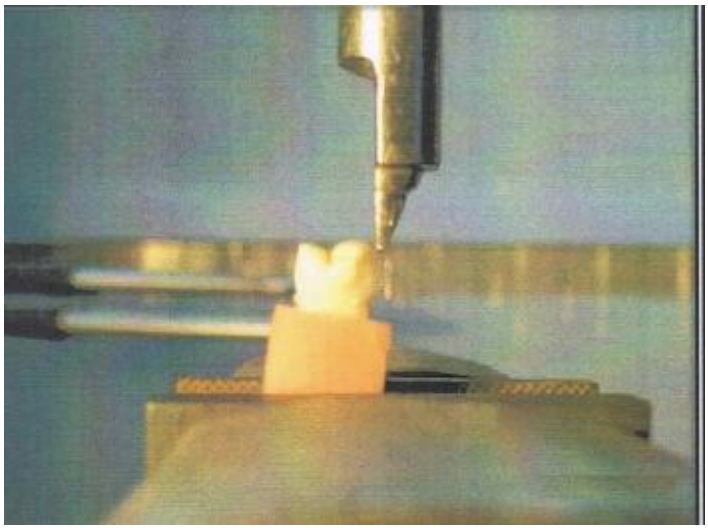

Figure 3. Debonding of plastic brackets by Instron machine

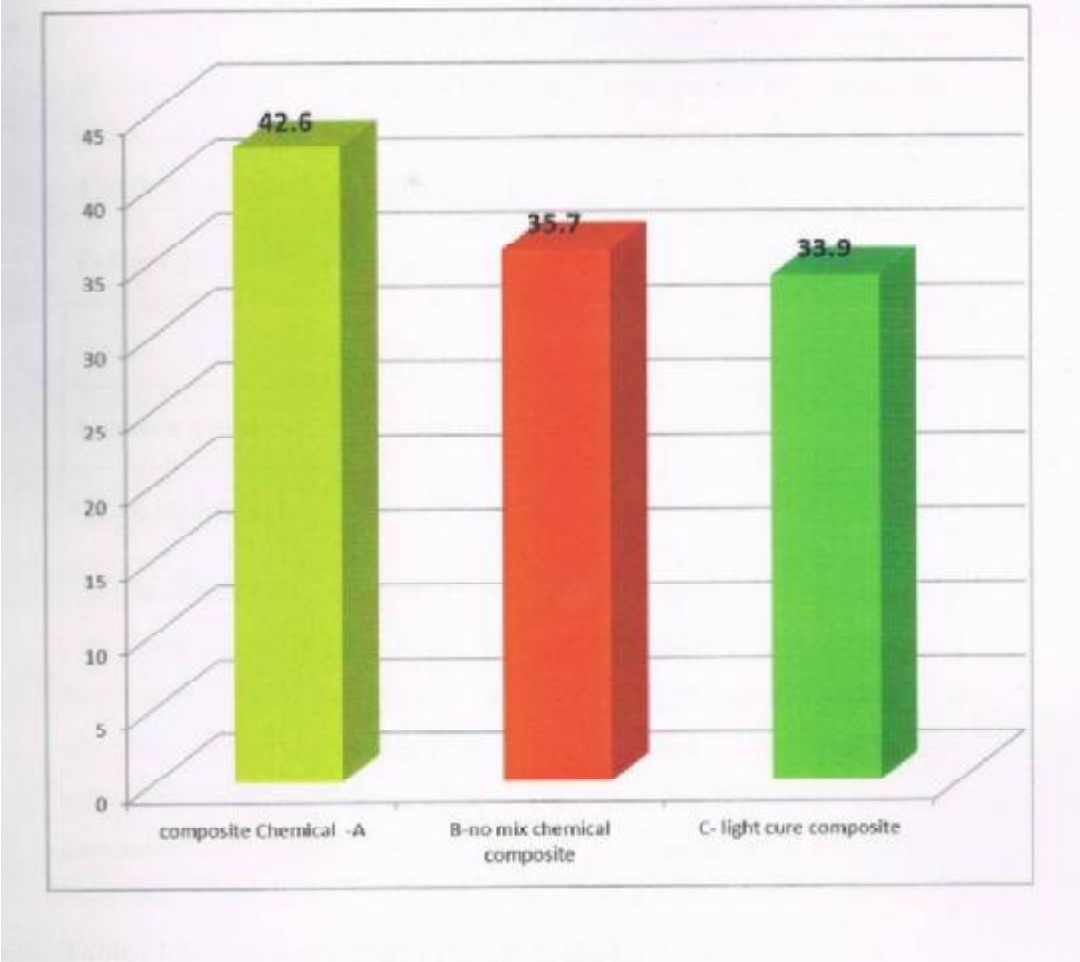

Figure 4. Bar chart represent the mean shear bond strength among all groups