Shear Bond Strength of Acidic Primer, Light-Cure Glass Ionomer, Light-Cure and Self Cure Composite Adhesive Systems - An In Vitro Study

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ABSTRACT

Background: The purpose of this study was to determine shear bond strength and the effect on the bracket/ adhesive failure mode when an acidic primer and other etchants were used to condition the enamel surface before bonding.

Materials & Methods: Group I: Brackets bonded with Ultimate cure-on-light Light-cure composite adhesive system. Group II: Brackets bonded with Ortho-one no-mix. Self-cure composite adhesive system. Group III: Brackets bonded with Light-cure glass ionomer adhesive system. Group IV: Brackets bonded with Transbond plus self etching primer.

Results: The results of this study indicated that the shear bond strength when using Transbond plus self etching primer showed the highest bond strength Group- IV(8.69 ± 2.54 MPa) followed by Ultimate cure-on-light Group-I (8.62 ± 1.84 MPa), Ortho-one no-mix (Bisco Inc. USA)Group-II (8.07 ± 1.72 MPa), and least bond strength was seen in G.C. Fuji Ortho L.C. Group-III (6.01 ± 1.6) MPa

Conclusion: Use of self etching primer saves chairside time and satisfactory high bond strength was obtained. Care should be taken during debonding of ceramic brackets

Key Words: shear bond strength, self etching primers, acid etching.

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Introduction

Bonding of brackets is an essential step in routine orthodontic procedure in fixed appliance therapy. Various bonding agents were developed after the introduction of the acid-etch technique by Buonocore[1] in 1955. These included primarily the acrylic (methylmethacrylic) and the diacrylic (bis-GMA) systems, which are widely used for bonding of brackets.

Glass ionomer cements are class of dental materials which possess a unique combination of properties. They adhere to the enamel surface without the need of acid etching or enamel surface conditioning. They serve as a reservoir of fluoride ions that protect against decalcification of the

surrounding tooth structure[2-4]. The glass ionomer cements are also easier to remove from enamel than composite resins since the adhesion of the cement does not involve the acid etching of enamel. These characteristics of the glass ionomer cement may reduce the amount of enamel surface loss often associated with bonding procedures that use composite resins.

Conventional adhesive systems use three different agents when bonding orthodontic brackets to the tooth, namely an enamel conditioner, a primer solution, and an adhesive resin. A unique characteristic of some new etching systems is that they combine the conditioning and priming agents into a single acidic primer solution that can be used on enamel and dentin.[5] Combining, conditioning and priming into a single treatment step also saves time.

The purpose of this study was to determine and compare the shear bond strengths of orthodontic brackets bonded with the following bonding agents i.e. A) Light-cure composite adhesive systems. B) Self-cure composite adhesive systems. C) Light-cure Glass Ionomer adhesive systems. D) Acidic primer adhesive systems.

Also to find out the amount of the residual bonding material present on surface of the enamel after de-bonding.

Fig. 1: Materials used for the study

Materials and Methods:

The study was conducted at Department of Orthodontics, Bapuji Dental college and Hospital, Davangere with the help of instruments depicted in (Fig no. 1).

Teeth

Forty eight, sound non-carious premolar teeth which were extracted for orthodontic purpose were selected for this in vitro study. The extracted teeth had to meet the following criteria for

inclusion in the study - perfect on buccal surface, devoid of cracks from extraction forceps tip, be free of caries and have had no pretreatment with a chemical agent, such as Alcohol, Formalin (or) Hydrogen peroxide. These teeth were thoroughly cleaned of any soft tissue and blood and stored immediately in distilled water to prevent dehydration.

Brackets

80 pre-adjusted edgewise brackets of .022" slot having bracket base area of 9.9120 mm^2 with 100 pore mesh base (American Orthodontics, Roth prescription) were used in this study.

Bonding procedure:

The teeth were randomly divided into four groups.

1. **Group I:** Brackets bonded with Ultimate cure-on-light (Shuffle Marketing, Pondicherry) Light-cure composite adhesive system.
2. **Group II:** Brackets bonded with Ortho-one no-mix (Bisco Inc. USA).
   Self-cure composite adhesive system.
3. **Group III:** Brackets bonded with G.C. Fuji Ortho L.C. Japan Light-cure glass ionomer adhesive system.
4. **Group IV:** Brackets bonded with Transbond plus self etching primer (3M Unitek) Acidic primer adhesive system with Light-cure composite.

Teeth in each group were mounted vertically on different colour coded acrylic blocks for subsequent identification. The acrylic bases were covered upto usual level of alveolar bone around each premolar tooth. The teeth were stored in distilled water to prevent any dehydration.

The teeth were then polished by means of rubber cup with non-fluoridated pumice for 15 seconds. The teeth were then rinsed thoroughly with distilled water and dried with oil free air stream. Care was taken not to desiccate the teeth. The buccal surface of teeth in group I and II were conditioned by 37% phosphoric acid for 60 seconds, and teeth were rinsed with distilled water. The buccal surface of teeth in group III were conditioned by using 20% polyacrylic acid for 20 seconds and teeth were rinsed with distilled water. After rinsing the buccal surfaces, etched surfaces were dried with oil and moisture free air stream. The teeth in group IV were applied with acidic primer system for 5 seconds, and brackets were placed immediately after 15 seconds without rinsing with distilled water.

The primer which was supplied by the manufacturer for light-cure, self-cure were applied on each etched surface of the teeth in their respective(I and II) groups. The primer on each tooth was thinned with a gentle stream of oil and moisture free air. The adhesive paste was applied onto the bracket base, and brackets were placed parallel to the long axis of the tooth and then pressed firmly to obtain a thin film of adhesive on the bracket base. Excess adhesive from around the bracket base was removed with sickle scaler. Each bracket in Group I was exposed to visible light with a 20 second burst to each of mesial, distal, incisal and gingival margin. In addition transillumination was carried out with 20 second exposure from palatal surfaces.

In preparation for bonding the light cured glass ionomer samples (group III), the light-cured cement was dispensed and mixed according to the manufacturer's instructions and applied in a thin layer on the mesh pad of the lingual surface of the bracket with a plastic instrument. The bracket was placed on the enamel surface as previously described and the excess material was removed with an explorer. Each bracket was then exposed to visible light with a Degulux Halogen light unit with a 20 second burst to each of the mesial, distal, incisal and gingival margin. In addition, transillumination was carried out with 20 second

exposure on each tooth from either the palatal (or) lingual surfaces.

Fifteen minutes after bonding, the samples were stored in distilled water bath at 37^{0}C until ready for testing. The shear bond strength of all groups was tested 24 hours after bonding.

Fig. 2: Hounsfield Universal testing instrument

Debonding procedure

The shear bond strength of each sample was determined with a Hounsfield Universal testing instrument (Fig .no 2). The crosshead speed was 1 mm/min. The force values at the point of failure of the bracket were recorded. The ultimate shear strength was recorded in kilograms and converted to megapascals. A minimum of twenty specimens were tested for each experimental group.

Determination of remaining residual adhesive:

After failure, the teeth were examined under 10x magnifications with a stereomicroscope (Leica wild M32). Any adhesive remaining after bracket removal were assessed according to Adhesive Remnant Index (ARI) and scored with respect to the amount of resin material adhering to the enamel surface. The ARI scale has a range between 5 and 1, where 5 indicates that no adhesive remained on the enamel; 4, less than 10% of adhesive remained on the tooth surface; 3, more than 10% but less than 90% of adhesive remained on the tooth; 2, more than 90% of adhesive remained; and 1, all of adhesive remained on the tooth along with the impression of the bracket base. The ARI scores were also used as a more complex means of defining the sites of bond failure between the enamel, the adhesive, and the bracket base.

Results

The results of the analysis of variance indicated that the shear bond strength when using Transbond plus self etching primer showed the highest bond strength Group- IV (8.69 ± 2.54 MPa) followed by Ultimate cure-on-light Group-I (8.62 ± 1.84 MPa), Ortho-one no-mix (Bisco Inc. USA) Group-II (8.07 ± 1.72 MPa), and least bond strength was seen in G.C. Fuji Ortho L.C (Group-

Table 1: One factor ANOVA

Groups	Shear Bond Strength (MPa)				F-ratio*
	Range	Mean	S.D.	S.E.	
I	6.15-12.52	8.62	1.84	0.53	6.11 P<.01
II	6.05-11.79	8.07	1.72	0.50	
III	4.50-9.48	6.01	1.69	0.49	
IV	5.71-12.08	8.69	1.78	0.51	

III) (6.01 ± 1.69 MPa). The adhesive remnant between groups was assessed by Chi-square test and group III showed highest mean score followed by group IV and group I & II.

Discussion

Direct bonding of orthodontic brackets has revolutionized and improved clinical practice of orthodontics. However, there is need to improve our ability to maintain a clinically useful bond strength while minimizing the damage to the tooth during debonding. Traditionally, the use of acid etchant followed by primer materials was an essential part of the bonding procedure in order to allow good wetting and penetration of the adhesive that will bond the brcket to the enamel surface.

In the present study, light cure composite (7.0MPa) and self cure composite (6.52MPa) adhesive systems exhibited higher shear bond strength values to prescribed bond strength required for successful clinical bonding according to Reynolds[6], Lopez.[7]

In the present study light cure glass ionomer group (4.88MPa) showed lesser shear bond strength than the recommended bond strength for successful clinical bonding prescribed by Lopez.[7,12,14]

The present study indicated that the use of acidic primer to bond orthodontic brackets to the enamel surface exhibited higher shear bond strength than studies shown by Bishara.[8,13]

Bishara reported that, adhesive remnant present on the enamel after debonding was least with self etching primer followed by light cure glass ionomer, and light cure composite.[9,11]

In the present study, adhesive present on the enamel was least with light-cure glass ionomer followed by acidic primer, light-cure composite and self-cure composite. This finding was not in accordance with conclusions drawn by Bishara et al[5,8].

The results of the present study indicated that self-etching primer adhesive system showed highest shear bond strength followed by light-cure composite, self-cure composite and light-cure glass ionomer cement. Although all materials have mean shear bond strength suitable for orthodontic bonding, the self-etching adhesives would be preferred because of their ease of handling and time saving procedure.[11]

The drawbacks of the study include:

Some amount of enamel loss during debonding of ceramic brackets.

Comparison of bond strength in relation to fluorosed and non fluorosed teeth could also have been evaluated.

In Future, the study could involve adhesion boosters and its application on Hypo calcified teeth.

Summary and Conclusion

Demineralization of enamel has been one of the iatrogenic effect of fixed orthodontic therapy. Considering these side effects various authors have suggested the use of fluoride to reduce the decalcification and development of white spot lesion. Recently, glass ionomer cement which has fluoride releasing property has been advocated for direct bonding of the orthodontic brackets. The use of self etching primers during bonding increases the bond strength and reduces the chairside time to almost half of that of conventional methods. This study suggests the use of self etching primer along with ceramic brackets to prevent enamel fracture during debonding.

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