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ORIGINAL RESEARCH

Comparison of Shear Bond Strength of Resin Reinforced Chemical Cure Glass Ionomer, Conventional Chemical Cure Glass Ionomer and Chemical Cure Composite Resin in Direct Bonding Systems: An *in vitro* Study

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ABSTRACT

The acid pretreatment and use of composite resins as the bonding medium has disadvantages like scratching and loss of surface enamel, decalcification, etc. To overcome disadvantages of composite resins, glass ionomers and its modifications are being used for bonding. The study was conducted to evaluate the efficiency of resin reinforced glass ionomer as a direct bonding system with conventional glass ionomer cement and composite resin. The study showed that shear bond strength of composite resin has the higher value than both resin reinforced glass ionomer and conventional glass ionomer cement in both 1 and 24 hours duration and it increased from 1 to 24 hours in all groups. The shear bond strength of resin reinforced glass ionomer cement was higher than the conventional glass ionomer cement in both 1 and 24 hours duration. Conditioning with polyacrylic acid improved the bond strength of resin reinforced glass ionomer cement significantly but not statistically significant in the case of conventional glass ionomer cement.

Keywords: Resin reinforced glass ionomer, Conventional glass ionomer, Composite resin.

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INTRODUCTION

With the introduction of the acid etching[1] as an adjunct to bonding and BISGMA[2] (Bisphenol A glycidyl dimethacrylate) by, composite resins are widely accepted as a medium for cementing orthodontic brackets to the teeth.

In 1965, with the advent of epoxy resin bonding, used acid etch technique for direct bonding of orthodontic attachments. However, the acid pretreatment and use of composite resins as the bonding medium has disadvantages like scratching and loss of surface enamel, decalcification during prophylaxis, during debonding and rebonding.[3]

Efforts to overcome disadvantages of composite resin led to usage of glass ionomers and its modifications for orthodontic bonding. Glass ionomer cements were introduced,[4] primarily luting agents and direct restorative materials, currently used for cementing orthodontic bands with unique properties of bonding chemically to enamel and dentin as well as to stainless steel.

Glass ionomers release fluoride thereby prevents decalcification, can be removed more easily than composite resin. Good handling properties, biocompatibility with surrounding oral structures, anticariogenic properties are other significant advantages of glass ionomers. Conventional glass ionomer cements exhibits prolonged setting, gains strength lately and are sensitive to moisture contamination and later to dehydration.[5]

Resin modified glass ionomer cements are anticariogenic, gains strength and hardness at a faster rate, low sensitivity to moisture contamination and dehydration ensured for use an orthodontic bonding agent. They have a dual setting reaction consisting of an acid base reaction, supplemented by a polymerization reaction either chemically or by visible light.[6]

Among the developments in glass ionomer cements are, Fuji Ortho, a self curing, resin reinforced glass ionomer cement with improved bond strength for the direct bonding

of orthodontic brackets with an additional advantage of being suitable for cementing bands, palatal expanders and other appliances for which light curing is not possible.

The study was aimed to evaluate the efficiency of Fuji Ortho as a direct bonding system with conventional glass ionomer cement and composite resin.

AIMS AND OBJECTIVES

To evaluate the shear bond strength of resin reinforced chemical cure glass ionomer cement with conditioning and without conditioning after 1 and 24 hour duration.

To evaluate the shear bond strength of conventional chemical cure glass ionomer cement with conditioning and without conditioning after 1 and 24 hours duration.

Comparison of shear bond strength of resin reinforced chemical cure glass ionomer cement with that of conventional chemical cure glass ionomer and chemical cure composite.

MATERIALS AND METHODS

This *in vitro* study was carried out with 150, sound premolar teeth which were extracted for orthodontic purpose. Criteria of extracted teeth are, grossly perfect on buccal surface, without cracks from extraction forceps, free of caries and no pretreatment with chemical agents. Teeth were thoroughly cleaned off any soft tissues, blood and stored immediately in distilled water to prevent dehydration. Teeth were randomly divided into five major groups of thirty each and each group was further divided into two sub groups of fifteen each for 1 and 24 hours duration.

Group I: Chemical cure composite resin tested at the end of 1 hour (CC with etching), 24 hours (CC with etching).

Group II: Resin reinforced chemical cure glass ionomer conditioned with polyacrylic acid, at the end of 1 hour (RRCCGIC with PAA), 24 hours (RRCCGIC with PAA).

Group III: Resin reinforced chemical cure glass ionomer with out conditioning with polyacrylic acid, at the end of 1 hour (RRCCGIC without PAA), 24 hours (RRCCGIC with out PAA).

Group IV: Chemical cure glass ionomer (conventional) conditioned with polyacrylic acid, at the end of 1 hour (CCGIC with PAA), 24 hours (CCGIC with PAA).

Group V: Chemical cure glass ionomer (conventional) without conditioning with polyacrylic acid, at the end of 1 hour (CCGIC without PAA), 24 hours (CCGIC without PAA).

The adhesives chosen for study are Rely-a-bond chemical cure composite resin, Fuji Ortho chemical cure glass ionomer resin cement and Fuji I glass ionomer cement.

Teeth were mounted vertically to the long axis of the tooth up to the level of alveolar bone in different color coded acrylic blocks for identification. The teeth were kept outside the distilled water only for very short time so that dehydration does not occur. The bonding surfaces of the teeth were cleaned and polished with rubber cups with non fluoridated pumice for 15 seconds. The teeth were thoroughly rinsed with water and dried in oil free air stream and care was taken not to desiccate the teeth.

METHODOLOGY

The group I samples were conditioned with 37% phosphoric acid for 30 seconds, rinsed thoroughly with water and dried, chalky appearance of enamel denotes the etching of enamel. Then primer was applied on to tooth as well as on the bracket. With the help of bracket holding forceps, bracket was firmly pressed on to the tooth. Excess adhesive was removed with an explorer and care was taken not to disturb the bracket while setting (Fig. 1).

Groups II and IV group samples were conditioned with 10% polyacrylic acid for 20 seconds, where as III and V group samples were not conditioned with any material and teeth were rinsed with distilled water (Fig. 2).

Groups II and III samples: Resin reinforced chemical cure glass ionomer cement was mixed for 10 seconds and then applied a thin layer over the mesh pad of bracket with a plastic instrument.

For groups IV and V, samples: Chemical cure (conventional) glass ionomer cement was mixed for 10 sec and then applied a thin layer over the mesh pad of bracket with a plastic instrument.

Adhesive coated brackets are positioned with bracket holding forceps on to the tooth. Brackets are pressed firmly

Fig. 1: Adhesives used in the study: Fuji Ortho, Fuji I and Rely-a-bond

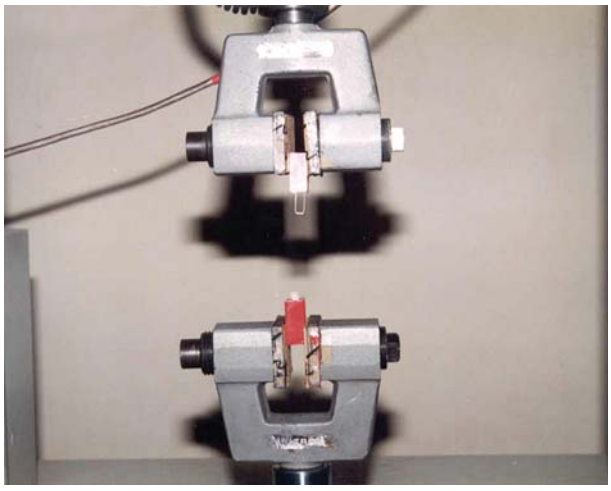


Fig. 2: Sample loaded for testing shear bond strength

against the enamel surface. Excess adhesive is removed carefully without disturbing the bracket before curing of adhesive. Fifteen minutes after bonding, samples were placed in a distilled water bath at 37 °C until ready for testing.

The shear bond strength of each sample were determined with universal testing instrument INSTRON (model 4204). The cross head speed set at the rate of 1mm/minutes and the breaking load at which bracket debonded was recorded in megapascals.

RESULTS

Table 1 showed that mean shear bond strength in 24 hours duration is significantly higher than the mean shear bond strength in 1 hour duration in all five study groups ($p < 0.0001$).

Tables 2 and 3 showed that the mean shear bond strength in group I is significantly higher than groups II, III, IV, V. The mean shear bond strength in group II is significantly higher than groups III, IV, V. Also the mean shear bond strength in group III is significantly higher than groups IV and V and no significant difference between groups IV and V.

DISCUSSION

The setting reaction of Fuji Ortho was dual core due to resin reinforced component of glass ionomer. Resin components include 2 – hydroxyethyl methacrylate (HEMA) as the major constituent along with, di–2 methacryloxethyl –2, 2,4 – trimethylhexamethylene dicarbonate with powder liquid ratio of 3.0 /1.0. Once the powder and liquid are mixed, the acid base reaction of the conventional glass ionomers followed by polymerization of resin monomers occurs to produce a homogenous resin matrix that surrounds glass particles.

The present study indicated that composite resins have a significantly higher bond strength 6.324 ± 0.795 MPa (for I hour) and 9.842 ± 1.058 MPa (for 24 hours) than either of the glass ionomer cements[7,8] Fuji Ortho (conditioned) has recorded bond strengths of 4.774 ± 0.786 MPa (for 1 hour) and 6.993 ± 1.281 MPa (for 24 hours) and Fuji Ortho (unconditioned) recorded a bond strength of 3.092 ± 0.572 Mpa (for 1 hour) and 4.047 ± 0.729 MPa (for 24 hours).[9]

Fuji I (conditioned) has shown a slightly more (but statistically not significant) bond strength of 1.714 ± 0.407 MPa (for 1 hour) and 2.467 ± 0.297 MPa (for 24 hours)

Table 1: In all five study groups, significantly higher mean shear bond strength in 24 hours than 1 hour duration were recorded

Study groups	*1 hour mean ± SD*	*24 hours mean ± SD*	*t-value*	*DF*	*p-value*
Group I: Rely-a-bond	6.324 ± 0.795	9.842 ± 1.058	10.29	28	<0.0001
Group II: Fuji Ortho (conditioned)	4.744 ± 0.786	6.993 ± 1.281	5.80	28	<0.0001
Group III: Fuji Ortho (unconditioned)	3.092 ± 0.572	4.047 ± 0.729	3.99	28	<0.0001
Group IV: Fuji I (conditioned)	1.714 ± 0.407	2.467 ± 0.297	5.78	28	<0.0001
Group V: Fuji I (unconditioned)	1.529 ± 0.477	2.214 ± 0.454	4.03	28	<0.0001

Table 2: Results of one-way ANOVA in different study groups (1 hour duration)

Source of variation	*DF*	*Sum of squares*	*Mean sum of squares*	*F-ratio*	*p-value*
Between groups	4	251.4	62.9	159.53	<0.0001
Within groups	70	27.6	0.4	–	–
Total	74	279.0			

Table 3: Results of one-way ANOVA (24 hours duration)

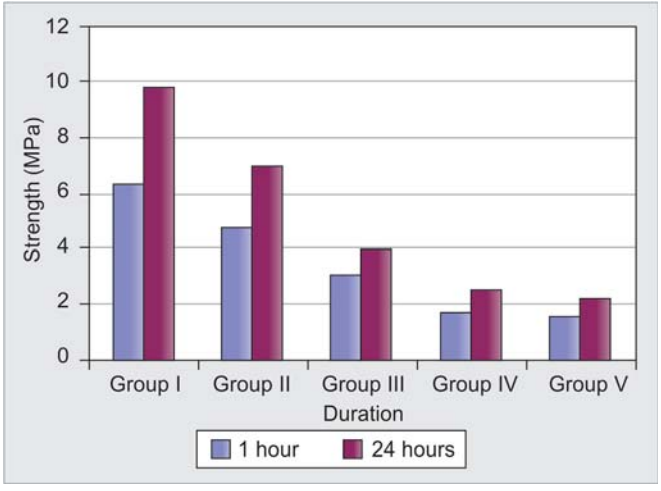
Source of variation	*DF*	*Sum of squares*	*Mean sum of squares*	*F-ratio*	*p-value*
Between groups	4	636.6	159.1	221.8	<0.0001(S)
Within groups	70	50.2	0.7	–	–
Total	74	686.8			

than Fuji I (unconditioned) which recorded a bond strength of 1.529 ± 0.477 MPa (for 1 hour) and 2.214 ± 0.454 MPa (for 24 hours).

Pretreatment of enamel surfaces improved the magnitude of adhesion of glass ionomers,[10,11] though not significantly but the present study is not in agreement with the findings[12,13] who reported pretreatment of enamel with polyacrylic acid did not improve the bond strength of glass ionomers.

The variation in the adhesive strength between Fuji Ortho and Fuji I might be attributed to different setting reaction, composition and physical and chemical properties between two study groups. The study[14] suggested minimum bond strength of 5.9 to 7.8 MPa would appear adequate for most clinical orthodontic needs. In the present study among all the groups tested the Rely-a-bond and Fuji Ortho (conditioned) recorded bond strength of 9.8 and 6.9 MPa which are either within or higher than the ranges (Graph 1).[15,16]

Considering the advantages offered by the glass ionomer cements and the disadvantages of nonfluoride composite resins, it may be presumed that inspite of having weaker bond strength, glass ionomers could be effectively used for direct bonding of brackets.



Graph 1: Higher mean shear bond strength in 24 hours duration than 1 hour duration in all five study groups

SUMMARY AND CONCLUSION

Based on the recorded data from the present study, the following conclusions have been drawn.

Shear bond strength of composite resin has shown the higher value than the both resin reinforced glass ionomer and conventional glass ionomer cement in both 1 and 24 hours duration.

The mean shear bond strength of resin reinforced glass ionomer cement (both conditioned and nonconditioned) was higher than the conventional glass ionomer cement (both conditioned and nonconditioned) in both 1 and 24 hours duration.

The mean shear bond strength of composite resin, resin reinforced glass ionomer and conventional glass ionomer cement increased from 1 to 24 hours.

Conditioning with polyacrylic acid improved the bond strength of resin reinforced glass ionomer cement significantly and it is not statistically significant in the case of conventional glass ionomer cement.

Though the shear bond strength of two glass ionomers used in this study were inferior to the composite resin, advantage of glass ionomer cement overweights the disadvantages of bond failures. Among two glass ionomers used, the new resin reinforced chemical cured glass ionomer cement (with conditioner) have been a material of choice for bonding.

The results of *in vitro* testing of orthodontic bracket bond strengths should be interpreted with care. Because the large number of variables like number of specimens tested, cement consistency and technique employed to apply stress on brackets may affect the quality of the bond to the tooth.

Moreover, wide difference exists between *in vitro* and *in vivo* testing conditions. Considering these factors it is suggested to have further clinical studies to evaluate the bond strength and durability of glass ionomer cementwhen used as an adhesive for direct bonding of orthodontic brackets.

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