EVALUATION OF THE ENAMEL SURFACE WITH SCANNING ELECTRON MICROSCOPE AN IN-VITRO STUDY

Sandhya C A. Shyam Lohakare, Pushpa Vinay Hazarey

ABSTRACT

Amis and Objectives: To evaluate the mode of bond failure of brackets bonded with self-cure resin reinforced glass inomer cement GC Fuji Ortho and composite resin (Medicept). To record and compare the site of bond failure and to study the enamel surface and bracket surface following debonding by using Scanning Electron Microscope (SEM). Materials and method: Brackets used in this study were stainless steel mesh backed beggs flat and curved brackets. Adhesive resin used for orthodontic bonding were no–mix composite resin, self-cure resin reinforced glass ionomer cement. Housefield tensometer machine was used to measure shear bond strength after debonding of bracket from tooth. The site of bond failure was determined as cohesive and adhesive. The specimen were then examined under a scanning electron microscope to study the enamel surface. Results: The site of bond failure of composite resin was cohesive and the site of bond failure for self cure resin reinforced glass ionomer cement was mainly adhesive. Scanning electron microscope study for composite resin showed the presence of material on tooth surface after debonding with enamel loss in the form of cracks or voids. SEM study for glass inomer cement shows absence of material on tooth surface with no enamel loss. Conclusion: Self-cure resin reinforced glass ionomer cement is better than composite resin due to its chemical adhesive properties than mechanical retentive property of composite.

Keywords: Adhesives; Bond failure site; Cohesive; Debonding; Enamel surface.

Introduction

The development of adhesives, which bond orthodontic attachments, directly to enamel has been greatly influenced by the research work in conservative dentistry. The resin reinforced glass ionomer cement has recently been developed for orthodontic bracket bonding procedures. This in vitro study was conducted to evaluate the mode of bond failure of brackets bonded with self-cure resin reinforced glass inomer cement (GC Fuji Ortho) and composite resin (Medicept). The main objective of this study was to record and compare the site of bond failure and to study the enamel surface and bracket surface following debonding by using Scanning Electron Microscope (SEM).

Materials and Method

The present invitro study sample consists of 60 young healthy premolar teeth extracted for orthodontic treatment purpose at Government Dental College and Hospital, Nagpur. The teeth were collected and stored in distilled water so as to prevent them from becoming brittle. Inclusion criteria for the specimen selection for the present in–vitro study includes, anatomically sound teeth, teeth having visibly perfect enamel on the buccal aspect, no history of any pre-treatment with chemical agents such as alcohol, H_2O_2, or fluoride, teeth that were non-caries and having no restoration, without enamel defects, and no history of previous orthodontic treatment and non hypoplastic or hyperplastic teeth.

The root of all teeth were embedded in self-cure acrylic resin blocks which were colour coded for each group to permit subsequent identification. Polishing was done with a prophylactic brush and a slurry of pumice and water with a rotary slow handpiece (15000 RPM Made in Japan) on the buccal surface of all the mounted bicuspids. After polishing teeth were rinsed with ample amount of water from a three way syringe. The same operator performed a standard technique for bonding of all the brackets.

The materials used in this study were as follows: Brackets (stainless steel mesh backed beggs flat and curved Brackets) and adhesives (no–mix composite resin - Medicept, self-cure resin reinforced glass ionomer cement - GC Fuji Ortho). The tooth which showed any evidence of macroscopic damage to the enamel during extraction procedure were not considered for the study. The specimens were divided into two groups with 30 bicuspidis in each.

Group A consisted of 30 bicuspidis used for the evaluation of the shear bond strength of brackets bonded with a no-mix composite resin (Medicept). Mounted teeth were dried with a hair dryer. The buccal surface of each tooth were etched for 60 seconds with 37% phosphoric acid, rinsed with copious amount of water and dried with a hair dryer. Brackets were then bonded with a no-mix composite to bench cure for 5 minutes and was then stored in distilled water for 24 hours.

Group B consisted of 30 bicuspidis used for the evaluation of the shear bond–strength of brackets bonded with self-cure resin reinforced glass ionomer cement (GC Fuji Ortho). Teeth were kept moist. GC Fuji Ortho powder and liquid were dispensed on a mixing pad and mixed according to the manufacturer's recommendations. Small amount of material was placed over the mesh pad of brackets and positioned on the buccal enamel surface of tooth with a firm pressure. Brackets were placed with each mix using a reverse action and the excess removed from the margins with a straight probe. Immediately after this tooth was cured, the mounted teeth were stored in distilled water for 24 hours.

Shear bond strength measurement: Hounsfield tensometer machine was used to measure shear force. The brackets were placed under a continual load rate of 5mm per minute until a breaking Point (debonding points) was reached. A special harness was fabricated which consist of an oval loop of round stainless steel, 22 gauge wire measuring 4mm x 6mm in di-
ameter. The harness was fixed in the crosshead grip and loop was engaged in the bracket slot (Figure 6). A shear was performed on each sample with the pull of cross head parallel to the bracket enamel interface. The point of breakage for each sample was recorded in kilograms. The diameter of the mesh-pad of the bracket was measured with a Vernier caliper and the surface area was calculated in square mm. The surface area of the mesh-pad was 3mm x 3mm = 9mm².

Mode of Failure: Followed by debonding each specimen’s failure interference was identified visually. The failed specimens were prepared and micrographs were taken using scanning electron microscope to confirm the site of failure to study effect of debonding on enamel. The failure site was determined subjectively as a) cohesive failure within the cement, b) adhesive enamel failure within the Enamel or adhesive bracket failure between cement and bracket. A total of ten microphotographs were taken including a photograph of normal enamel surface. (Figure 4) SPSS V.16 was used for the statistical analysis to compare the mean and difference between the groups.

Results

Site of Bond Failure: The study results were tabulated to show the frequency of failure sites based on different bonding materials. It was observed that more number of bond failures occurred at adhesive enamel interface in group B (self-cure resin reinforced glass ionomer cement, GC Fuji Ortho), whereas in Group A (no – mix composite resin – medicpekt) the failure site were more of cohesive nature i.e. the failures were within bonding material.

It has been observed that out of 30 brackets in Group A, 24 bracket failure was of cohesive nature which showed that the bonding material adheres to the enamel surface more as compared to the bracket base and thus it leaves more material on the tooth surface after debonding. In group B- 27 bracket failure is between adhesive enamel and 3 bracket failure is between adhesive bracket (Table 1).

Mode of Bond Failure: Following debonding the failure interface was identified visually. The debonded samples of tooth and failed orthodontic brackets were prepared for scanning under a scanning electron microscope to find out the effect of debonding on enamel surface and to confirm the site of failure. The clinical finding were substantiated by the scanning electron micrographs (SEM) photograph showing normal enamel surface which is unetched.

In group A with no – mix composite resins the adhesive remnants were seen on the tooth surface following debonding of bracket. Several vertical and horizontal cracks were evident on the enamel following debonding the brackets bonded with composite resin.

In group B - GC Fuji Ortho- no cement remnants were seen following debonding of brackets and the tooth surface shows normal enamel structure after debonding. Debonding of this material shows failure at adhesive enamel interface and the bracket was covered with material. The tooth surface shows etched enamel appearance with 37% ortho phosphoric acid before application of primer which shows loss of normal enamel structure.

Discussion

This study results suggest a potential clinical benefits of glass ionomer cement in comparison with potential hazards of composite resins in the direct bonding of orthodontic brackets. Glass ionomer cement can be scrapped off with curette with no evidence of adverse effects on enamel, quiet unlike that of composite resins as use of diamond burs can have detrimental effects on enamel surface. The result of the present study showed that the site of failure for composite was mainly cohesive i.e. failure occured within the body of cement and is similar to previous observations in literature.3,4

The site of failure for self-cure resin reinforced glass ionomer cement (GC Fuji Ortho) was mainly adhesive in nature. Failure occurred between the adhesive enamel i.e., the bonding material adheres to the bracket surface and enamel surface remains clean after debonding. Studies by various authors showed that composite resin bonded very well to the tooth surface compared to the bracket, whilst the glass ionomer adhered significantly better to the bracket base than to the tooth surface.3,4 There was a highly significant difference in amount of adhesive retained on tooth and on bracket base between composite resin and glass ionomer cement groups. The clinical implication this observation was that following debonding large amount of composite remains on the tooth as compared to that of glass ionomer cement remaining on the tooth. The cement retained on the tooth surface creates problems after debonding. Glass ionomer cements are comparatively easier to remove from the tooth surface compared to composite resin. All samples were studied under the scanning electron microscope after debonding. In non mix composite group scanning electron micrographs showed adhesive remnants or islands on the tooth surface after debonding. The bracket surface after debonding shows adhesive material remnants and partial mesh of bracket. The enamel was the marked by vertical and horizontal cracks in micrographs. The cracks were due to iatrogenic damage inflicted at the time of bracket removal.

<table>
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<tr>
<th>Group</th>
<th>Material</th>
<th>Failure Site</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Cohesive</td>
</tr>
<tr>
<td>A</td>
<td>No MixComposite</td>
<td>24</td>
</tr>
<tr>
<td>B</td>
<td>Self cure Reinforced Glass Inomer Cement</td>
<td>-</td>
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</tbody>
</table>

Table 1. Frequency of failure site by bonding material
In self-cure reinforced glass ionomer cement group very little or no cement was remaining on the die tooth surface. The remnants on the tooth surface were easily scrapped off with curette without any adverse effect on enamel surface. Evaluation of bracket surface of glass ionomer shows that complete material is present over there without any mesh.

Bonding and debonding in orthodontics demands the development of a new adhesive, which avoid the acid pretreatment of enamel and render tooth structure more resistant to the caries process to minimize the negative iatrogenic outcomes of orthodontic therapy. Glass ionomer cements go a long way in fulfilling the above requirements, except for lack of adequate bond strength. Efforts are on to improve the bond strength, which has led the development of newer, better cement i.e., self-cure resin reinforced glass ionomer cement.

**Conclusion**

In conclusion, on the basis of this in-vitro evaluation, self-cure resin reinforced glass ionomer cement may well become the method of choice of bonding orthodontic brackets than the non-mix composite.

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**References**


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