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Original Article

Dentistry Section

Comparision of Shear Bond Strength of Stainless Steel and Ceramic Brackets at 24 Hours after Etching Enamel with Different Proportions of Acidulated Phosphate Fluoride

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ABSTRACT

Aims and Objectives: To evaluate and compare the shear bond strength of stainless steel brackets and ceramic brackets at 24h after etching the enamel with acidulated phosphate fluoride gel (1.23% APF) at different proportions (40%,30%,20%) incorporated in conventional etchant (37% phosphoric acid).

Materials and Methods: Eighty premolars (maxillary and mandibular first and second premolars) extracted for orthodontic purpose has been selected for the study and samples were divided into 4 groups containing 10 teeth each. Comprised of teeth etched Group 1 with 40% of APF gel etchant is Group 2 teeth etched with 30% of APF gel in Group 3 teeth etched with 20% of APF gel etchant and Group 4 teeth were etched with conventional etchant (37% phosphoric acid).

Results: The experimental group of Acidulated Phosphate Fluoride (APF) at different proportion (40%, 30%, 20%) incorporated with etchant application for 40s on the enamel surface at 24h indicated that group 4 showed the higher bond strength of all other remaining groups and the groups 1, 2 and 3 showed satisfactory bond strength. The statistical evaluation also revealed that the bond strength of control group (37% phosphoric acid) was greater than those of experimental groups.

Conclusion: The present study results shows that the ceramic brackets have higher bond strength than stainless steel brackets (material wise).

Keywords: APF, Bond strength, Ceramic brackets, Phosphoric acid, Stainless steel brackets

INTRODUCTION

Precise bracket positioning and efficient bond strength is mandatory in orthodontic treatment as the orthodontic force is generally applied to teeth through bracket. In 1955, Buonocore [1] first introduced the phosphoric acid for enamel etching. Acid etching can cause loss of enamel upto 5 micrometer [2,3] so, the surface of enamel becomes more susceptible to demineralisation. Acid etching technique has several undesirable sequelae including loss of enamel due to prophylaxis, etching and debonding; following that enamel cracks and scratches. The retention of resin tags are a major clinical problem.

Hence, the use of a new technique is needed to etch other than with conventional phosphoric acid to minimize enamel loss and enamel demineralization during orthodontic treatment. Other alternative approaches are investigated such as different enamel proportions and adhesive system [4,5] Phosphoric acid etching still seems to be the most widely used method for enamel etching. When 37% phosphoric acid is applied it causes the opening of microscopic pores, producing the irregular enamel surface that facilitates the retention of brackets.

APF gel is found to be good and efficient in enamel remineralization [6]. The purpose of present study is to evaluate the shear bond strength of two different brackets (ceramic and stainless steel) that were bonded after etching the enamel with APF at different proportion (40%, 30%, 20%) incorporated in conventional phosphoric acid.

MATERIALS AND METHODS

Materials: Extracted premolars, Conventional etchant, phosphoric acid 37% (3M UNITEX), Acidulated phosphate fluoride gel (1.23% APF) and etchant mix 40%,30%.20%,Stainless steel standard premolar bracket (0.022 inch ormco), Ceramic standard premolar bracket (0.022 inch ormco), PRIMER (3M UNITEK), Adhesive (3M UNITEK), Light curing unit, FIE made universal testing machine (UNITEX – 94100).

Eighty premolars (maxillary and mandibular first and second premolars) were collected immediately after extraction and stored in saline. Teeth without any morphologic anomalies, enamel defects and without decalcifications were selected for the study. These collected teeth were randomly assigned into 4 groups of 2 subgroups, each containing 10 teeth. The collected teeth were mounted vertically in self cure acrylic jig and long axis of tooth perpendicular to the bottom of mould so that crowns of teeth were exposed. The grouping of the samples is indicated in [Table/Fig-1].

PREPARATION OF APF ETCHANT

To achieve different concentrations of APF (40%, 30%, 20%) incorporated in 37% phosphoric acid, following ratios of APF and 37% phosphoric acid were mixed (for 5ml of etchant mix). The [Table/Fig-2] shows the ratio of APF mixed with the etchant (37% phosphoric acid). That is, for group 1 ratio of APF to etchant is 2:3 and for group 2, it is 1.5 : 3.5 and for group 3 it is 1:4 and for group 4 it is 0:5.

The brackets were bonded to teeth by the following method [7]. The teeth were rinsed with water and then dried in air stream. The enamel appeared as uniform, dull and frosty white. After the application of primer on the etched enamel surface with applicator tip, stainless steel bracket and ceramic brackets were bonded. A thin coat of primer was applied on to the etched surface and on the bracket surface. After the application of composite (TRANSBOND XT UNITEK), the bracket was placed on tooth surface and pressed

G1-S24,C24	Indicates 40% APF with steel 24 hours , ceramic 24 hours.
G2-S24,C24	Indicates 30% APF with steel 24 hours, ceramic 24 hours.
G3-S24, C24	Indicates 20% APF with steel 24 hours , ceramic 24 hours.
G4,S24, C24	Indicates control group (37% phosphoric acid)with out APF steel 24 hour , ceramic 24 hour.

[Table/Fig-1]: Different groups

GROUP	APF (1.23%) ml	Phosphoric acid 37% (ml)
G1	2	3
G2	1.5	3.5
G3	1	4
G4	0	5

[Table/Fig-2]: Different proportions of APF

Group	n	Mean in Mpa	Std. Deviation	p-value
S24	10	3.78	0.35	0.001
C24	10	4.45	0.18	0.001
Mean value indicated in the table is the average bond strength of samples in the subgroup				

[Table/Fig-3]: Group 1,APF 40%

Group	n	Mean in Mpa	Std.Deviation	p-Value
S24	10	4.86	0.18	0.001
C24	10	4.99	0.23	0.001

[Table/Fig-4]: Group 2, APF 30%

Group	n	Mean in Mpa	Std.Deviation	p-Value
10	5.02	0.36	0.001 significant	0.001
10	5.56	0.42	0.001 significant	0.001

[Table/Fig-5]: Group 3, APF 20%

Group	n	Mean in Mpa	Std.Deviation	p-Value
10	10	6.34	0.21	Not significant
10	10	6.56	0.22	Not significant

[Table/Fig-6]: Group 4, control group (37% Phosphoric Acid)

firmly; excessive sealant and adhesive was removed and the teeth was light cured for 40s totally, 10s for each side (mesial, distal, occlusal and gingival) hence the etching time was standardized for 40s [8,9].

Group 1: Teeth etched with 40 % of APF gel etchant.

Group 2: Teeth etched with 30 % of APF gel etchant.

Group 3: Teeth etched with 20 % of APF gel etchant.

Group 4:. Teeth etched with conventional etchant (37% phosphoric acid).

After bonding the specimen were kept at room temperature for 10mins and 80 samples were stored in water bath, 24h before debonding.

DEBONDING PROCEDURES

The FIE universal testing machine UNITEX, model (94100) was used to test the shear bond strength of each tooth. Each sample was mounted in lower arm of instron testing machine, a chisel edge plunger was mounted to the movable crosshead of testing machine and positioned so that the leading edge was aimed at the enamel-adhesive interface at a cross speed of 1mm/min. The applied force was parallel to the tooth surface.

Subgroup	Group	n	Mean	Std.Deviation	p-value
	G1	10	6.6614	.7021	
	G2	10	7.5263	.3845	0.001
S24	G3	10	9.7110	.4744	
	G4	10	12.2357	.4370	

[Table/Fig-7]: For a given subgroup APF % wise comparision with in the group

Subgroup	Group	n	Mean	Std.Deviation	p-value
	G1	10	8.856	.312	
	G2	10	8.874	.453	0.001
C24	G3	10	10.442	.639	
	G4	10	12.435	.438	

[Table/Fig-8]: For a given subgroup APF % wise comparision with in the group

$$\text{Bond Strength} = \frac{\text{Dislodgement Load of Bracket (Kg)}}{\text{Surface Area of Bracket}}$$

Statistical evaluation of the results was done using t-test.

RESULTS

An FIE universal testing machine was used for evaluating the shear bond strength and readings were recorded in Newton and converted to Mega Pascal (Mpa). The shear bond strength was evaluated for all the groups.

The material comparisons for a given % of APF is shown in [Table/Fig-3-6].

In APF 40%, 30% and 20% there is a significant difference, ($p<0.01$) between steel and ceramic in 24h [Table/Fig-3-5].

Regarding control group, there is no significant difference ($p>0.01$) [Table/Fig-6].

For a given sub group APF % wise comparison with in the group is shown in [Table/Fig-7,8].

The inference is that, there is a significant difference for 40%,30%,20% APF and control group. In the present study the statistical evaluation of data from experimental results reveals bond strength of control group (37% phosphoric acid) was greater than those experimental groups. The present study results shows that according to stainless steel and ceramic bracket (material wise) the ceramic brackets show higher bond strength than the stainless steel brackets.

DISCUSSION

There are many studies [10-13] that have been undertaken to prevent and reduce the enamel loss during direct bonding technique. In order to prevent enamel loss, topical flovride application is effective in increasing the resistance to dental caries and demineralization [14,15]. The results of present study was in accordance with Thronton et al., in which the shear bond strength of 0.05% NaF concentration with etchant 37% phosphoric acid application resulted in increase in fluoride content in enamel surface without decreasing the bond strength [16]. Flouride reacts with enamel forming calcium fluoride and fluoroapatite, which act as a slow-releasing agent enhancing the remineralisation of etched enamel and making it more resistant to acid dissolution. There are many studies that have been undertaken to prevent and reduce the enamel loss during direct bonding technique. Although, clinically 37% phosphoric acid is routinely used as an enamel conditioner, mild acid concentration can lead to less enamel loss and demineralization. In order to prevent the enamel loss, ching liang meng and tatiana kelly have demonstrated the topical fluoride application is effective in increasing the resistance to dental caries or demineralization. The present study was contrary with Ching Liang Meng et al., as it reported unsatisfactory bond strength with application of 1.23% APF to etched enamel for 4mins, after 37%

of phosphoric acid etching and before bonding. Currently, there is no universally accepted minimum clinical bond strength. However, Reynolds IR [17,18] suggested that bond strengths of 6-10 Mpa are sufficient for orthodontic bonding. The statistical evaluation of data from experimental results reveals that the bond strength of control group (37% phosphoric acid) was greater than that of experimental groups. The experimental group of APF at different proportions (40%, 30%, 20%) incorporated with etchant application for 40s on the enamel surface at 24h, indicates

- Group 1 (APF 40%) shows satisfactory bond strength.
- Group 2 (APF 30%) shows satisfactory bond strength and also higher bond strength than group 1.
- Group 3 (APF 20%) shows satisfactory bond strength and also higher bond strength than group 2.
- Group 4 (37% phosphoric acid) shows higher bond strength than all other remaining groups. 37% phosphoric acid is used as enamel conditioner, mild acid concentration can lead to minimal loss of enamel so, and it is beneficial and shows higher bond strength.

According to material wise, the order of ranking of higher bond strength is

- Ceramic bracket.
- Stainless steel bracket.

The statistical evaluation of data from experimental results revealed that the ceramic bracket showed higher bond strength than Stainless steel bracket.

SUMMARY AND CONCLUSION

When compared in terms of different concentrations of APF incorporated in 37% phosphoric acid resulted in the following.

- 37% of phosphoric acid (conventional etchant) shows higher bond strength when compared with all other remaining groups.
- 20% of APF shows satisfactory bond strength and also higher bond strength than 30% of APF, but lower than conventional etchant.
- 30% of APF shows acceptable bond strength, but compared to 40% of APF there was definitely higher bond strength.
- 40% of APF shows satisfactory bond strength but lesser bond strength than 20% and 30% phosphoric acid and much lesser bond strength than control group.

When compared in terms of bracket materials, ceramic brackets expressed more shear bond strength than stainless steel brackets.

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