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Effects of Fluorosis and Self Etching Primers on Shear Bond Strengths of Orthodontic Brackets

Ahmet Yalcin Gungor[a]
Hakan Turkkahraman[b]
Necdet Adanir[c]
Huseyin Alkis[a]

ABSTRACT

Objectives: To evaluate the effects fluorosis and self etching primers (SEP) on shear bond strengths (SBS) of orthodontic brackets.

Methods: A total of 48 (24 fluorosed and 24 non-fluorosed) non-carious freshly extracted human permanent premolar teeth were used in this study. Fluorosed teeth were selected according to the modified Thylstrup and Fejerskov index (TFI), which is based on the clinical changes in fluorosed teeth. Fluorosed and non-fluorosed teeth were randomly assigned to 4 groups of 12 each. In groups I (non-fluorosed teeth) and II (fluorosed teeth), standard etching protocol was used and brackets were bonded with Light Bond. In groups III (non-fluorosed teeth) and IV (fluorosed teeth), Transbond Plus SEP was used and brackets were bonded with Transbond XT Light Cure Adhesive. All specimens were cured with a halogen light. After bonding, SBS of the brackets were tested with Universal testing machine. After debonding, all teeth and brackets in the test groups were examined under 10x magnifications. Any adhesive remained after debonding was assessed and scored according to the modified Adhesive Remnant Index (ARI).

Results: ANOVA indicated a significant difference between groups ($P<.001$). SBS in group II (Light Bond+Fluorosis) were significantly lower than other groups. ARI scores of the groups were also significantly different ($P<.001$). There was a greater frequency of ARI scores of 1,2 and 3 in group II (Light Bond+Fluorosis).

Conclusions: When standard etching protocol was used enamel fluorosis significantly decreased the bond strength of orthodontic brackets. Satisfactory bond strengths were obtained when SEP was used for bonding brackets to the fluorosed teeth. (Eur J Dent 2009;3:173-177)

Key words: Fluorosis; Acid etching; Self etching primers; Shear bond strength; Adhesive remnant index.

[a] Research Assistant, Department of Orthodontics, Faculty of Dentistry, Suleyman Demirel University, Isparta, Turkey.
[b] Associate Professor, Department of Orthodontics, Faculty of Dentistry, Suleyman Demirel University, Isparta, Turkey.
[c] Associate Professor, Department of Endodontics, Faculty of Dentistry, Suleyman Demirel University, Isparta, Turkey.

Corresponding author:
Dr. Hakan Turkkahraman
SDU Dishekimligi Fakultesi
Ortodonti Anabilim Dalı, Dogu Kampusu,
32260, Isparta, Turkey.
Phone: +90 246 211 33 14
Fax: +90 246 237 06 07
E-mail: kahraman@med.sdu.edu.tr

INTRODUCTION

Dental fluorosis can influence esthetic perceptions, and its prevalence has increased over the past 50 years.[1] Excessive fluoride in drinking water, greater than 1 to 2 ppm, can cause metabolic alteration in the ameloblasts, resulting in a defective matrix and improper calcification of teeth.[2] Dental fluorosis can also influence shear bond strength (SBS) of the orthodontic brackets. A significant decrease in SBS was reported when orthodontic brackets were bonded on fluorosed teeth.[3]

Effects of self etching primers (SEP) on SBS of orthodontic brackets are well documented.[4-6] Several authors reported that there was no difference between self etching and standard etching protocol on bond strengths.[7-12] On the other hand, lower bond strengths with SEP were also reported.[13,14]

To our knowledge, no study evaluated the efficiency of SEP when used for orthodontic bonding on fluorosed teeth. Therefore, the aim of this in vitro study was to evaluate the effects fluorosis and SEP on SBS of orthodontic brackets. Our null hypothesis was that fluorosis and SEP do not affect SBS of orthodontic brackets.

MATERIALS AND METHODS

A total of 48 (24 fluorosed and 24 non-fluorosed) non-carious freshly extracted human permanent premolar teeth were used in this study. Fluorosed teeth were selected according to the modified Thylstrup and Fejerskov index (TFI), which is based on the clinical changes in fluorosed teeth. Each tooth was individually embedded in auto polymerizing acrylic resin (Meliodent, Herause Kulzer, Hanau, Germany). The specimens were kept in distilled water except during bonding and testing procedures. 48 fluorosed and non-fluorosed teeth were randomly assigned to 4 groups of 12 each.

Before bonding, the facial surfaces of the teeth were cleaned with a mixture of water and pumice. The teeth were rinsed thoroughly with water and dried with oil and moisture-free compressed air. Ormco Mini 2000 (Ormco Corp, Glendora, Calif) bicuspid metal brackets with 9.63 mm^2 surface area were used.

In groups I and II, each tooth was etched with 37% phosphoric acid gel for 30 seconds. Then, all teeth were rinsed with water/spray combination for 30 seconds and dried until characteristic frosty white etched area is observed. Light Bond (Reliance Orthodontic Products, Inc., Ill, USA) was used as orthodontic adhesive. With a microbrush, a thin uniform layer of sealant was applied on the etched enamel and cured for 20 seconds. A thin coat of sealant was also painted on the metal bracket base and cured for 10 seconds before applying paste. Using a syringe tip, the paste was applied to bracket base. The bracket was then positioned on the tooth and pressed lightly in the desired position. Excess adhesive was removed with a sharp scaler and cured with a Heliolux DLX (Vivadent ETS, Schaan, Liechtenstein) for 40 seconds (20 seconds on the mesial and 20 seconds on the distal surfaces of the brackets).

In groups III and IV, Transbond™ Plus SEP (3M Unitek, USA) was used. With its microbrush, a thin uniform layer of sealant was applied on the enamel. To dry primer into a thin film, a gentle air burst was delivered. Using a syringe tip, the paste (Transbond XT Light Cure Adhesive, 3M Unitek, USA) was applied to bracket base. The bracket was then positioned on the tooth and pressed lightly in the desired position. Excess adhesive was removed with a sharp scaler and cured with a Heliolux DLX (Vivadent ETS, Schaan, Liechtenstein) for 40 seconds (20 seconds on the mesial and 20 seconds on the distal surfaces of the brackets).

All specimens were stored in distilled water at 37°C for 24 hours. Each specimen was loaded into universal testing machine (Lloyd; Fareham, Hants, England) using Nexjen software for testing, with the long axis of the specimen being perpendicular to the direction of the applied force. The standard knife edge was positioned to make contact with the bonded specimen. Bond strength was determined in the shear mode at a crosshead speed of 0.5 mm/min until fracture occurred. Values of failure loads (N) were recorded and converted into megapascals (MPa) by dividing the failure load (N) by the surface area of the bracket base (9.63 mm^2).

After debonding, all teeth and brackets in the test groups were examined under 10x magnification. Any adhesive remained after debonding was assessed and scored according to the modified Adhesive Remnant Index (ARI).[15] The scoring criteria of the index are as follows:

1= All of the composite, with an impression of the bracket base remained on the tooth;

2= More than 90% of the composite remained on the tooth;

3= More than 10% but less than 90% of the composite remained on the tooth;

4= Less than 10%of composite remained on the tooth;

5= No composite remained on the tooth.

Descriptive statistics, including the mean, standard deviation, standard error, minimum and maximum values were calculated for each of the groups tested. One-way analysis of variance (ANOVA) and Tukey multiple comparison tests were used to compare SBS of the groups. The chi-square test was used to determine significant differences in the ARI scores among test groups. Significance for all statistical tests was predetermined at P<.05. All statistics were performed with SPSS version 11.0.0 (SPSS Inc., Chicago, IL, USA).

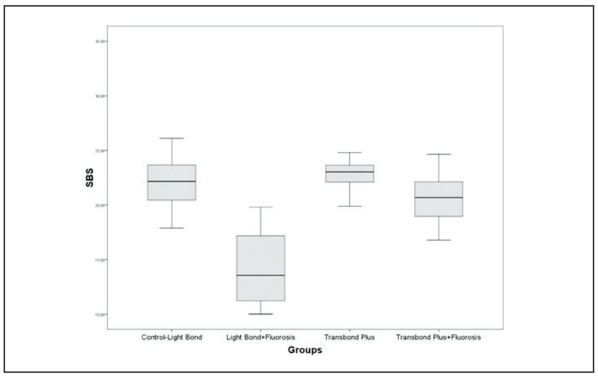

Figure 1. Shear bond strengths (in MPa) of the groups. Results presented as boxplots. Horizontal line in middle of each boxplot shows median value; horizontal lines in box indicate 25% and 75% quartiles; lines outside box indicate 5% and 95% quartiles.

RESULTS

The descriptive statistics of the SBS (in MPa) of the groups are presented as boxplots in Figure 1. All groups displayed clinically acceptable mean bond strengths (over 8 MPa). ANOVA indicated a significant difference between groups (P<.001) (Table 1). Highest values of SBS were measured in group III. SBS in group II were significantly lower than groups I, III and IV (P<.001). No significant difference was found between groups I, III and IV (P<.05).

Frequency distribution of the ARI scores and the chi-square comparison of the test groups are presented in Table 2. There was significant difference between groups. There was a greater frequency of ARI scores of 1,2 and 3 in group II (Light Bond+Fluorosis).

DISCUSSION

This study was designed to evaluate the effects fluorosis and SEP on SBS of orthodontic brackets. For this purpose, fluorosed teeth (TFI score 4) were collected and selected by two examiner's agreement (N.A, H.T). Since fluoride content can vary between different teeth, only fluorosed human maxillary premolar teeth were used in this study.[16]

Fluorosed teeth have the highest concentration of fluoride in the outer 200 µm of enamel

Table 1. The results of the ANOVA comparing the SBS of the groups.

Group I		Group II		Group III		Group IV								
Light Bond		Light Bond+ Fluorosis		Transbond Plus		Transbond Plus+ Fluorosis		Post-hoc tests						
Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Sig.	I-II	I-III	I-VI	II-III	II-VI	III-VI
22.07	2.50	14.20	3.46	22.89	1.83	21.22	3.47	***	***	ns	ns	***	***	ns

ns: non-significant; ***:P<.001

Table 2. Frequency distribution of the ARI scores and the chi-square comparison of the test groups.

	ARI Scores						
Test Groups	**1**	**2**	**3**	**4**	**5**	**n**	**Test**
Group I (Control-Light Bond)	0	0	1	9	2	12	***
Group II (Light Bond+Fluorosis)	2	5	5	0	0	12	
Group III (Transbond Plus)	0	0	1	5	6	12	
Group IV (Transbond Plus+Fluorosis)	0	3	2	4	3	12	

surface.[17] Weerasinghe et al[16] removed this hypermineralized, acid resistant enamel surface before the shear test. Since this procedure is not suitable for orthodontic practice, we did not remove the enamel surface layer in our study.

Despite the statistical differences between the groups, all groups displayed clinically acceptable mean bond strengths (over 8 MPa).[18] Etch&rinse adhesive procedure has been used for years to bond orthodontic brackets to fluorosed or nonfluorosed enamel. Ng'ang'a et al[19] have reported that there were no differences between SBS of brackets to fluorosed or nonfluorosed enamel. On the other hand, Adanir et al[3] found that severity of fluorosis affected the SBS of a etch&rinse bonding system to fluorosed enamel. They recommended using an adhesion promoter to enhance bond strength of brackets when bonding composite resin to the fluorosed enamel.[20] The findings of the present study demonstrated that fluorosis significantly reduced the SBS of the brackets with standard etch&rinse protocol. The results are in agreement with previously published studies.[3,20,21] Therefore, first part of the null hypothesis was rejected.

To reduce chair time and increase cost effectiveness, alternative enamel conditioners such as SEP has been recommended for bonding of brackets. Transbond Plus SEP is a dental adhesive system developed for orthodontic bonding. When this SEP is used, the mean SBS of the fluorosed and non-fluorosed groups were 21.22±3.47 and 22.89±1.83 MPa, respectively. This result shows that satisfactory bond strengths can be obtained when SEP is used for bonding brackets to the fluorosed teeth. Therefore, the second part of the null hypothesis was accepted. This result is in contrast with Weerasinghe et al[16] who reported that severity of fluorosis affected the micro-SBS of a self-etching bonding system to fluorosed teeth. Their study also revealed that severe fluorosis decreased the SBS even with the traditional acid etching using 37% phosphoric acid.

A higher incidence of ARI scores 1,2 and 3 in group II (Light Bond+Fluorosis) revealed that bond failures in this group was mainly cohesive in nature. This result was also in accordance with the lowest SBS values obtained in this group.

It must be emphasized that this study was performed in vitro. Therefore, SBS obtained in this study may not correspond well with clinical success. Further in vivo studies are still needed to substantiate the results of this study.

CONCLUSIONS

• When standard etching protocol was used, enamel fluorosis significantly decreased the bond strength of orthodontic brackets.

• Satisfactory bond strengths were obtained when SEP was used for bonding brackets to the fluorosed teeth.

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