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Original Research

Assessment of effect of fluoride-releasing orthodontic adhesives on the shear bond strength of orthodontic brackets

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ABSTRACT:

Background: Dental erosion is defined as the loss of tooth surface induced by acid without bacterial involvement. The present study was conducted to assess effect of fluoride-releasingorthodontic adhesives on the shearbond strength of orthodontic brackets. **Materials & Methods:** 40 extracted premolarswere randomly assigned to four groups in which group I (no treatment) was the control group. The eroded enamel surface within each group was treated as follows: group II received no treatment; in group III, the eroded enamel was treated with 35% phosphoric acid for 15 seconds, followed by a rinse for 10 seconds; and in group IV, the eroded enamel was treated with fluoride gel for 4 minutes. The brackets were bonded with either a resin composite adhesive or resin-modified glass ionomer cement. The specimens were tested for SBS, and the bond failure was assessed according to the adhesive remnant index (ARI). **Results:** The mean shear bond strength (MPa) with adhesive fuji ortho LC and Transbond XT in group I was 15.2 and 14.3, in group II was 18.5 and 16.2, in group III was 25.2 and 20.3 and in group IV was 15.4 and XT was 14.2 respectively. The difference was significant ($P< 0.05$). Failuremode distribution among the test groups indicated thatfailures at the adhesive–bracket interface were predominantin group I compared with the other groups. **Conclusion:** Fluoride pre-treatmentwas used to remineralize the eroded enamel surfaces before bonding resulted in a decrease in the SBS of the orthodontic brackets as comparedto other groups.

Key words: Enamel surfaces, Fluoride, shear bond strength

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INTRODUCTION

Dental erosion is defined as the loss of tooth surface induced by acid withoutbacterial involvement. In the initial stage of development, erosion is considered a superficial demineralization.[1] This corresponds to the softening of the enamel surface, resulting in the loss of strength,resistance, and structural components of the tooth. Erosive tooth wear develops in more advanced stages, either by prolonged demineralization of the tooth surface or mechanical stress. Erosive dental wear has become a more prevalent and growing clinical problem.[2]

Bond strength of orthodontic brackets is an important consideration in orthodontics. Shear bond strength (SBS) is the main factor, which has to be concerned in the evolution of bonding materials.[3]An interesting observation is the unit of bond strength being pounds per square inch compared with today's standard unit, Mega Pascal (MPa). The normal conversion would be 1 MPa =145.038 lbs force per square inch. The bond strength of the orthodontic bracket must be able to withstand the forces applied during the orthodontic treatment.[4]

Orthodontic brackets are subjected to a combination of shear, tensile, and torsion forces inside the mouth. The bond strength of orthodontic adhesives varies depending on several factors, such as the type of adhesive used, the bracket design, enamel morphology, and orthodontist technique.[5]Glass ionomer cements (GICs) and composite resins have been combined to provide increased fluoride release while maintaining bond strength. Resin infiltration is a different approach that has been developed to protect the enamel from dental erosion.[6]The present study was conducted to assess effect of fluoride-releasingorthodontic adhesives on the shearbond strength of orthodontic brackets.

We found that

MATERIALS & METHODS

The present study comprised of 40 extracted premolars. All teeth were randomly assigned to four groups in which group I (no treatment) was the control group. The remaining groups were exposed to an erosion challenge through short-term acidic exposure to HCl solution (0.01 M, pH 2.3) for 30 seconds, with an agitation speed of 50 rpm at an environmental temperature of 25°C (group I). The eroded enamel surface within each group was treated as follows: group II received no treatment; in group III, the eroded enamel was treated with 35% phosphoric acid for 15 seconds, followed by a rinse for 10 seconds; and in group IV, the eroded enamel was treated with fluoride gel for 4 minutes. The brackets were bonded with either a resin composite adhesive or resin-modified glass ionomer cement. The specimens were tested for SBS, and the bond failure was assessed according to the adhesive remnant index (ARI).Data thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.

RESULTS

Table I Distribution of teeth

Groups	Surface treatment	Number	Fuji Ortho LC	Transbond XT
Group I	Control group	10	5	5
Group II	Eroded enamel without any etching	10	5	5
Group III	Eroded enamel treated with 35% phosphoric acid for 15 s, followed by a rinse for 10 s	10	5	5
Group IV	Eroded enamel treated with fluoride gel	10	5	5

Table I shows distribution of teeth depending upon surface treatment. Adhesive used was Fuji Ortho LC and Transbond XT in all groups.

Table II Comparison of shear bond strength

Groups	Adhesive	Mean	P value
Group I	Fuji Ortho LC	15.2	0.05
	Transbond XT	14.3	
Group II	Fuji Ortho LC	18.5	0.02
	Transbond XT	16.2	
Group III	Fuji Ortho LC	25.2	0.01
	Transbond XT	20.3	
Group IV	Fuji Ortho LC	15.4	0.05
	Transbond XT	14.2	

Table II, graph I shows thatmean shear bond strength (MPa) with adhesive fuji ortho LC and Transbond XT in group I was 15.2 and 14.3, in group II was 18.5 and 16.2, in group III was 25.2 and 20.3 and in group IV was 15.4 and XT was 14.2 respectively. The difference was significant (P< 0.05).

Graph I Comparison of shear bond strength

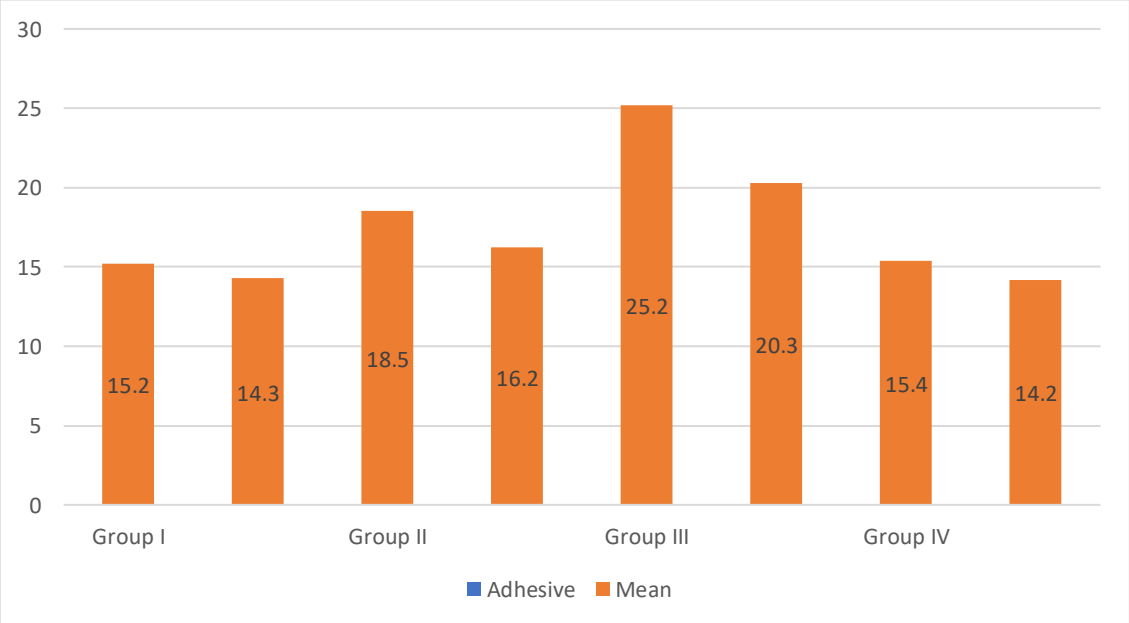

Table III Assessment of adhesive remnant index(ARI) scores

Groups	Adhesive	Score 0	Score 1	Score 2	Score 3
Group I	Fuji Ortho LC	10	25	30	35
	Transbond XT	20	10	25	45
Group II	Fuji Ortho LC	20	25	35	20
	Transbond XT	20	30	20	30
Group III	Fuji Ortho LC	0	40	50	10
	Transbond XT	10	40	40	10
Group IV	Fuji Ortho LC	10	40	20	30
	Transbond XT	20	30	25	25

Table III shows that the failuremode distribution among the test groups indicated thatfailures at the adhesive–bracket interface were predominantin group I compared with the other groups.

DISCUSSION

Numerous factors influence the bond strength of orthodontic brackets. These include the size and design of the bracket base. The attachment must be able to deliver orthodontic forces, withstand masticatory loads, be esthetic, and be easy to remove at the end of treatment.[7] Bracket bases do not bond chemically to enamel or resin; therefore, efforts have been made to improve mechanical retention.[8] The increasing demand for a more esthetic metal-bonded appliance has led to, among other things, a reduction in the size of the brackets and their bases. However, the smaller retentive area of the bracket base influences bond strength.[9]

Erosive dental wear has become a more prevalent and growing clinical problem. Excessive intake of acidic food and drinks has led to an increase in the incidence of erosive tooth wear. Gastroesophageal reflux and eating disorders often result in erosive lesions.[10]The key to avoiding the progression of erosive lesions is to lower the direct interaction of exogenous or endogenic acids with the tooth surface.[11] However, this is not always achievable, and strategies have been suggested to restore enamel loss at the initial stages of dental erosion.[12] The prevention of enamel erosion and remineralization of enamel through orthodontic treatment is a crucial issue.[13]The present study was conducted to assess effect of fluoride-releasingorthodontic adhesives on the shearbond strength of orthodontic brackets.

We found that mean shear bond strength (MPa) with adhesive fuji ortho LC and Transbond XT in group I was 15.2 and 14.3, in group II was 18.5 and 16.2, in group III was 25.2 and 20.3 and in group IV was 15.4 and XT was 14.2 respectively.Althagafi et al[14]in their study eighty extracted premolars were randomly assigned to four main groups in which group C (no treatment) was the control group. The remaining groups were exposed to an erosion challenge through short-term acidic exposure to HCl solution (0.01 M, pH 2.3) for 30 s, with an agitation speed of 50 rpm at an environmental temperature of 25°C. The eroded enamel surface within each group was treated as follows: group N received no treatment; in group P, the eroded enamel was treated with 35% phosphoric acid (Ultradent Products, South Jordan, UT, USA) for 15 s, followed by a rinse for 10 s; and in group F, the eroded enamel was treated with fluoride gel (Bifluorid 12; Voco-GmbH, Cuxhaven, Germany) for 4 min. The brackets were bonded with either a resin composite adhesive (Transbond XT; light-cure adhesive, 3M Unitek, CA, USA) or resin-modified glass ionomer cement (Fuji Ortho LC-GC Corporation, Japan). The specimens were tested for SBS, and the bond failure was assessed according to the adhesive remnant index (ARI). Statistically significant differences were found among the tested variables ($P < 0.05$). Group P showed the highest mean SBS values regardless of the type of adhesive used, and the difference was statistically significant ($P < 0.05$). The application of the fluoride gel showed no statistically significant improvement in SBS values. The failure mode distribution among the test groups indicated that failures at the adhesive–bracket interface were predominant in group C compared with the other study groups.

We found that the failuremode distribution among the test groups indicated thatfailures at the adhesive–bracket interface were predominantin group I compared with the other groups.Uysal et al[15] reported that the reduced SBS of the brackets was due to the atypical enamel surfaces and the lack of resin tag formation, which are responsible for the micromechanical interlocking achieved at the enamel. Reynolds[16] affirmed that a minimum SBS of 5.9–7.8 MPa is adequate for the orthodontic brackets to withstand masticatory and orthodontic forces without detachment. Lenzi et al[17] reported an increase in the bond strength of eroded enamel when an etch-and-rinse adhesive system was used.

CONCLUSION

Authors found that

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