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Original Article

Dentistry Section

Efficacy of New Adhesion Promoters on Compromised Hypocalcified Enamel

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ABSTRACT

Introduction: The amount of technological progress occurred in the last few years has brought an add up to the benefits of bonding in Orthodontics. Research-based findings have constantly led to the development of new materials that are aimed to simplify the clinical procedures like bonding of brackets to compromised enamel surfaces. Hence, the present study is aimed to assess the bond strength of orthodontic brackets on fluorosed enamel using adhesion promoters.

Aim: To evaluate the shear bond strength (SBS) of orthodontic brackets bonded on fluorosed enamel using conventional Transbond XT and new adhesion promoters such as Enhance LC and All Bond 3.

Materials and Methods: The study involved 90 non carious, extracted teeth with mild to moderate fluorosis randomly divided into 3 Groups. In Group - I (control group) the teeth were bonded with conventional Transbond XT and cured with LED light. In Group - II Enhance LC was applied to fluorosed enamel before bonding and in Group - III All Bond 3 was used. Shear bond strength was tested by using Universal testing Instron machine. ANOVA and Post-Hoc Tukey's tests were used to compare shear bond strength. Adhesive remnant on the tooth was assessed and scored using adhesive remnant index (ARI).

Results: Results showed a reduced SBS values (9.43MPa ±3.03) with conventional Transbond XT on fluorosed enamel. Among the adhesion boosters used Enhance LC illustrated lesser SBS values (12.03 MPa ± 4.42) compared with All Bond 3 (14.38MPa ±4.92). ARI showed bond failure at bracket resin interface in group I & group II and at enamel resin interface in group III although statistically insignificant.

Conclusion: It was concluded that using adhesion boosters on fluorosed enamel showed higher bond strength compared to the control group. Among the two adhesion promoters used All Bond 3 expressed highest bond strength compared to Enhance LC although statistically insignificant.

Keywords: All Bond 3, Adhesion boosters, Enhance LC, Fluorosed enamel, Shear bond strength

INTRODUCTION

Introduction of acid etching technique by Buonocore [1] opened new vistas in adhesive dentistry which includes direct bonding of orthodontic attachments. However, clinical bond failure is encountered frequently due to different reasons. Differences in the enamel structure may have a contributing effect in achieving optimal bond strength. One such clinical situation is bonding of brackets to fluorosed enamel which is exigent for the orthodontists practicing in endemic Fluorotic belts. Compromised bond strength in fluorosed enamel is because of its outer hyper mineralized layer which is resistant to acid etching [2].

With tremendous advances in technology alternative methods like sand blasting, silanating, and adhesion promoters have been introduced into the adhesion dentistry where bonding has become effortless to such compromised enamel surfaces. Several investigations have been carried out to evaluate the bond strength of brackets bonded to fluorosed enamel and there were inconsistent results regarding the usage of different materials to enhance the bond strength of fluorosed enamel.

Of all the methods described in the literature, one such method that has gained popularity during the last few decades is the use of adhesion promoters to amplify the bond strength on Fluorotic enamel. There are various adhesion enhancers that are currently available in the market. Adhesion promoters are multifunctional molecules that are adsorbed onto the enamel and alter its surface so that the interaction with the resin by a means of chemical or physical process is facilitated. Universally adhesion promoters either react with the cations of hydroxyapatite crystals or chelates with the calcium of etched tooth or react with surface water and inorganic portions of dentin, thus forming a combination of chemical and micromechanical adhesion to the enamel [3].

Enhance LC (Reliance, Itasca, Illinois, USA) is an adhesion booster that been employed with the purpose to augment the bond strength of fluorosed, hypo calcified, or primary enamel. It contains hydroxyethyl methacrylate (HEMA), tetrahydrofurfuryl cyclohexane dimethacrylate, and ethanol. The HEMA molecule has double functional groups, one hydrophobic and the other hydrophilic. Hydrophilic monomers in these adhesive systems facilitate resin to infiltrate etched enamel at the level of the enamel prisms. This property has the potential to reduce interfacial porosity and hence increases adhesion, achieving superior bond strength through polymerization [4-8].

All Bond 3 (Bisco Schaumburg) is one of the novel adhesion enhancer which is extremely effective for dentin, enamel, amalgam, porcelain, composite and all metals. It facilitates excellent bonding in a wet/moist (referring to water and not blood or saliva) environment. It's primers contain hydrophilic monomers in an ethanol based solvent [5,6]. The effectiveness of these adhesion enhancers on bond strengths of brackets to enamel has been tested in several in vivo and in vitro studies [5-10]. However, very few studies have evaluated the shear bond strength of orthodontic brackets on fluorosed enamel using conventional method and usage of different adhesion promoters. Therefore, the present study is undertaken to compare and evaluate the shear bond strength using conventional and two different adhesion promoters. The null hypotheses tested in the study were that adhesion promoters do not increase the bond strength of fluorosed enamel and the recently introduced adhesion promoter i.e. All Bond 3 does not increase the bond strength of fluorosed enamel in comparison with Enhance LC.

MATERIALS AND METHODS

Ninety fluorosed, non carious, intact human upper first premolar teeth extracted for orthodontic reasons at SVS Institute of Dental

sciences, Mahbubnagar were used to assess the shear bond strength using adhesion promoters. The bond strength was selected as a critical variable for calculating the sample size. Ninety teeth (divided into 3 groups) were required to have an 80% chance (β error) of detecting a significant difference (two-sided 5% level) and a largest difference of 0.70 between groups with a standard deviation of 1. The fluorosed teeth were selected according to the Dean's Fluorosis Index (Grades 0 - 4) [11]. Based on the clinical changes of fluorosed teeth, only mild to moderate grades were considered in the study (Grades - 2&3). According to Dean's fluorosis Index, Grade – 2 represents teeth with extensive white opaque areas that does not involve 50% of the tooth surface and Grade -3 represents teeth with extensive white opaque areas involving entire enamel along with brown stains frequently [Table/Fig-1]. Each group had 15 Grade-2 fluorosed teeth and 15 Grade - 3 fluorosed teeth. The teeth were stored in normal saline prior to testing and were mounted vertically on colour coded acrylic (methyl methacrylate self cure resin) blocks, with only the crown portion exposed for the study. The entire sample was divided into 3 groups with 30 in each group. The sample in Group I was subjected to conventional Transbond XT that acted as control group, group II is treated with Enhance LC and group III is treated with All Bond 3. The buccal surfaces of all the mounted teeth were cleaned with soft rubber cup using pumice before bonding. Standard stainless steel maxillary first premolar brackets of MBT 0.022"x 0.028" slot (American Orthodontics) were used in the study. The surface area of the bracket base was 9.806mm^2 as per the information given by the manufacturers.

All the teeth were etched with 37 per cent phosphoric acid gel (3M Unitek, Monrovia, California, USA) for 30 seconds, rinsed and dried thoroughly until a characteristic frosty white appearance was observed. In group I, only a thin layer of Transbond XT primer (3M Unitek, Monrovia, California, USA) was applied on the etched enamel and cured for 20 seconds. Brackets were bonded with Transbond XT adhesive, (3M Unitek, Monrovia, California, USA) and excess flash removed. The teeth were cured using a Ledition (ivoclarvivadent) for 40 seconds on all surfaces. In group II, a thin layer of adhesion promoter (Enhance LC) was applied initially and cured for 10 seconds, followed by application of Transbond XT primer and bonded with Transbond XT adhesive accordingly.

In group 3 (All Bond 3) a thin layer of adhesion promoter (All Bond 3) was applied initially and cured for 10 seconds, followed by application of Transbond XT primer and bonded with Transbond XT adhesive accordingly.

An 'Instron' universal testing machine AGS-10k NG (SHIMADZU) from Indian Institute of Chemical Technology, Hyderabad A.P, was used to measure the shear bond strength. The acrylic blocks were secured in the lower cross head of Instron machine and a loop made of 0.8 mm stainless steel wire encircling the bracket attached to the upper cross head of Instron machine was used to apply a shear force while debonding. The cross head of Instron machine moved at the uniform speed of 1 mm per minute [Table/Fig-2].

After debonding the enamel surfaces of all teeth were clinically evaluated for residual adhesive remaining on the tooth surface by contrasting the adhesive with an articulating paper [Table/Fig-3]. The amount of residual adhesive was classified using ARI developed by Artun and Bergland [12]. The adhesive remnant index is considered as Score – 0 when no adhesive is seen on the tooth, Score -1 when less than ½ of adhesive is seen on the tooth, Score-2 when more than ½ of adhesive is seen on the tooth and Score- 3 when entire adhesive is seen on the tooth surface.

STATISTICAL ANALYSIS

Statistical analysis was done using SPSS 16 version. A p-value of <0.05 was considered statistically significant. Comparison of shear bond strength was done among the 3 study groups using ANOVA. Pair wise comparison of three groups was done using post-hoc tukey's test. Comparison of ARI index among the 3 groups was done using Kruskal Wallis test.

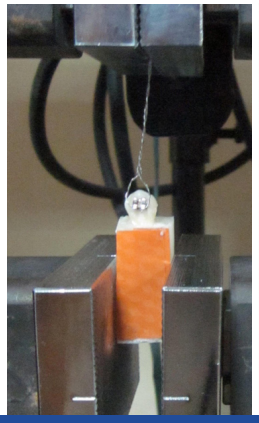
RESULTS

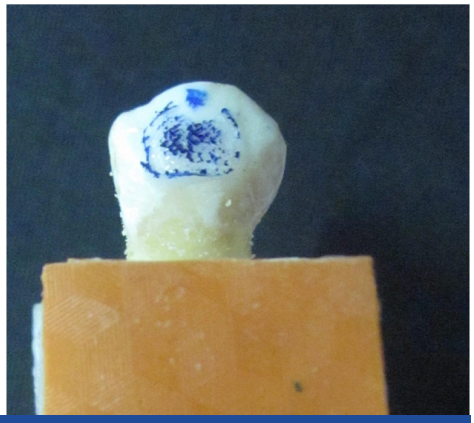
The results of the present study illustrated clinically acceptable bond strength (6-8 MPa) [13] in all the groups as shown in [Table/Fig-4]. There is no statistically significant difference in the shear bond strength of sample with grade -2 and grade-3 (Dean's fluorosis Index) fluorosed teeth in each group. One-way ANOVA test reveals that there was statistically significant difference in the shear bond strength among the three groups. Shear bond strength (SBS) was found to be least in Group I (9.43 MPa) and highest in Group III (14.38 MPa) as shown in [Table/Fig-5]. Pair wise comparison of three groups using Tukey's post-hoc test confirms a statistical significance among Group I and Group II (p=0.048), a high statistical significance among Group I and Group III(p<0.001) and insignificant difference among Group II and Group III (p=0.082) respectively.

ARI comparison between groups was done using Kruskal Wallis test that showed p-values greater than 0.05 depicting insignificant difference between the groups. Group I (Transbond XT) showed highest ARI score followed by Group II (Enhance LC) and least in Group III (All bond 3) as shown in [Table/Fig-6].

DISCUSSION

In the present study, shear bond strength ranged from 9.41 to 14.38 MPa for all the groups which indicates excellent bond strength above the clinically accepted range 6-8 MPa [13]. The lowest values (mean = 9.41 MPa) were obtained from samples of Group I. These results are in consistent with the values obtained from Adanir N et al., [8] who have concluded that fluoride affected enamel significantly reduced the bond strength. In contrast to the present study the results obtained by Ng'ang'a et al., [14] revealed that there is no significant difference in the bond strength of brackets bonded to Fluorotic enamel and non Fluorotic enamel. The present study demonstrates that use of adhesion promoters on Fluorotic enamel increased the shear bond strength significantly.

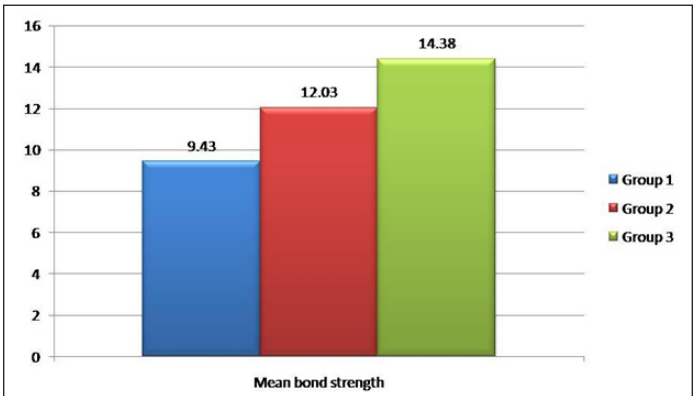




[Table/Fig-1]: Dean's fluorosis index of grade II and grade III **[Table/Fig-2]:** Universal Instron testing machine **[Table/Fig-3]:** Adhesive contrast using articulating paper

Parameter	Group-I	Group-II	Group-III	p-values		
Bond strength (Megapascals)	Mean ± SD	Mean ± SD	Mean ± SD			
(MPa)	9.43 ± 3.03	12.03 ± 4.42	14.38 ± 4.92	Group I Vs Group II	(p=0.048)	Significant
				Group I Vs Group III	(p=0.001)	Significant
				Group II Vs Group III	(p=0.082)	Not Significant

[Table/Fig-4]: ANOVA with Post-hoc Tukey's test for shear bond strength of the groups



[Table/Fig-5]: Bar graph showing shear bond strength(MPa) of the groups

Test Groups	ARI Scores				p-values
0	I	II	III	n	
Group –I0	7	4	19	30	p-value=0.092 Not Significant
Group – II0	5	17	8	30	
Group – III0	6	16	8	30	

[Table/Fig-6]: Kruskal Wallis Test for ARI

Therefore, the first null hypothesis was proved discarded. These findings are consistent with the results obtained from Adanir N et al., [8] who concluded that the use of adhesion promoters on the fluorotic enamel amplified the bond strength. Their study was done on 45 (30 fluorosed and 15 non fluorosed) in which the Fluorotic group bonded with Enhance LC showed highest bond strength. Newmann GV et al., [15] compared adhesion potential of Bowen's adhesion promoters (Megabond), with sandblasting, silanating and coatings upon 80 mesh metal brackets and summarized that Adhesion promoters (Megabond-Bowen surface active agents) result in favourable increased shear bond strengths.

The present adhesive industry has evolved with a variety of adhesion boosters promoted as Orthosolo, Enhance LC, All Bond 2, Megabond and All Bond 3, each, marketing itself as the best. The clinician is however, confused as to choose which one, to achieve the optimal shear bond strength. With regard to SBS on non fluorosed teeth, or recycled brackets using different adhesion promoters it was found that Enhance LC and Orthosolo were found to be superior [6,16-18]. The Adhesive remnant index (ARI) data showed a pattern of resin/bracket interface following debonding with almost the entire residue on the enamel in all the groups. This is in support with results obtained from the studies of Hoogan P et al., which showed similar distribution of ARI scores [17].

LIMITATIONS OF THE STUDY

1. The brackets were bonded manually. Inspite of all the care taken, the thickness of adhesive could vary from tooth to tooth.
2. Bond strength testing within half an hour of bracket placement was not done because of technical difficulties.
3. The test conditions of present study cannot be directly compared to the complex intra-oral environment. This applies to all invitro studies

CONCLUSION

Bond strength of all three groups on fluorosed enamel showed a clinically acceptable range. All Bond 3 significantly increased the bond strength of brackets bonded to Fluorotic enamel when compared with Enhance LC. ARI score confirmed that All Bond 3 showed the bond failure site at enamel resin interface although not statistically significant.

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