ORIGINAL RESEARCH

Evaluation of the Effects of Topical Fluoride Varnish and Fluoride Releasing Adhesive on Shear Bond Strength of Orthodontic Brackets: An *In Vitro* Study

Charu Chauhan[1], Rajat Mangla[2], Geetanjali Gandhi[3], Deepankar Bhatnagar[4], Kanika Singh[5], Rheia Baijal[6]

Abstract

Aim: The aim of this study was to evaluate the *in vitro* effects of topical fluoride varnish and fluoride-releasing adhesive on the shear bond strength (SBS) of orthodontic brackets.

Materials and methods: A total of 60 extracted premolars were bonded to 0.022, stainless steel brackets and equally divided into three groups ($n = 20$) based on the adhesive used—Group I- Transbond XT Plus color change (3M Unitek), Group II- Transbond XT followed by application of fluoride varnish, and Group III- Transbond XT (3M Unitek) adhesive and their bond strengths were compared. Brackets were debonded with a universal testing machine. The modified adhesive remnant index (ARI) was also recorded. Data were analyzed by using an analysis of variance, and a *post hoc* test was performed for multiple comparisons among the groups.

Results: There were no significant differences between the SBSs ($p = 0.91$) between the groups. Also, no significant difference was found in the modified ARI ($p = 0.093$).

Conclusion: The orthodontic adhesives used in our study, with or without the application of topical fluoride varnish, did not have a significant effect on the bond strengths of brackets.

Clinical significance: Adhesives evaluated in this study can be successfully used for bonding brackets.

Keywords: Fluoride releasing adhesive, Fluoride varnish, Shear bond strength.

International Journal of Clinical Pediatric Dentistry (2023): 10.5005/jp-journals-10005-2501

Introduction

Adhesive dentistry is a constantly developing field. For the past many decades, the dental profession has endeavored to attain a good adhesion of the composite resin to the tooth structure.[1]

In 1955, acid etching was introduced by Buonocore when banding was done on all teeth so as to prepare them for orthodontic treatment.[1–3] The potential to bond orthodontic brackets improved esthetics and oral hygiene as well as considerably decreased the patients' chairside time.[2] Orthodontics continues to progress gradually with the advancement of novel bonding materials.[2]

Patients with malocclusion have a huge number of plaque retention sites making demineralization around orthodontic brackets a major concern in them.

Hence reducing the carious lesions and white spot formation around the brackets becomes mandatory in orthodontics. Any carious lesions around the brackets can be reduced or eliminated with the use of fluoride compounds such as gel, toothpaste, mouth rinses, and varnishes.[4–6] Therefore, preventive measures independent of patient compliance have been developed; these include bonding materials having fluoride-releasing properties that discharge additional fluoride near the brackets.[7,8] These materials follow a typical pattern of fluoride release, with the largest amount of fluoride being released within the first few days of application, followed by a quick decline to lower levels due to the small amount of incorporated fluoride—a phenomenon called "burst effect."[9]

One of the most popularly used fluoride-releasing materials includes fluoride varnishes. Many years ago, they were developed to prolong the fluoride contact time with enamel. They were introduced in the 1960s as Duraphat—5% sodium fluoride in a colophony base (by Colgate pharmaceuticals Inc., Canton Massachusetts, United States of America) and in the 1970s as fluorprotector™, which is a transparent, clear polyurethane lacquer containing 0.1% weight fluoride ion as difluorosilane.[10,11] These have become popular because of their ease to use and the lack of dependence on patient cooperation.[9] It has been observed that fluoride varnishes decrease enamel demineralization around brackets, but the requirement of their reapplication during the treatment results in high cost and increased clinical chair time.[12–15]

With the advent of new materials in orthodontics, fluoride-releasing glass ionomer cement (GIC), resin-modified

[1–6]Department of Orthodontics & Dentofacial Orthopaedics, Maharishi Markandeshwar College of Dental Sciences and Research (MMCDSR), Mullana, Ambala, Haryana, India

Corresponding Author: Geetanjali Gandhi, Department of Orthodontics & Dentofacial Orthopedics, Maharishi Markandeshwar College of Dental Sciences and Research (MMCDSR), Mullana, Ambala, Haryana, India, Phone: +91 9416732239, e-mail: geetanjali.gandhi223@gmail.com

How to cite this article: Chauhan C, Mangla R, Gandhi G, *et al.* Evaluation of the Effects of Topical Fluoride Varnish and Fluoride Releasing Adhesive on Shear Bond Strength of Orthodontic Brackets: An *In Vitro* Study. Int J Clin Pediatr Dent 2023;16(1):37–41.

Source of support: Nil

Conflict of interest: None

GIC, and composite resins containing fluoride were eventually developed.[16–19]

Also, there is a formulation of orthodontic adhesives having high physical properties and low polymerization shrinkage, hence making the procedure of bonding much easier. One of these most popular adhesives used is Transbond XT (3M Unitek). It can bond both metal and ceramic brackets to the tooth surface.

The recent products being developed in this field are color-changing adhesives which, above their physical properties, have the crucial advantage of facilitating flash clean up as any remnant of adhesive is visible at bracket seating,[20] examples being Transbond™ Plus, which is manufactured by 3M Unitek (Monrovia, California, United States of America).

Presently preventing enamel demineralization during treatment is one of the major concerns in orthodontics. So, the need of the hour is developing an adhesive system with sufficient bond strength in addition to the prevention of enamel demineralization.

Therefore, the aim of our study was the comparison of the SBS of orthodontic brackets bonded using fluoride-releasing adhesive Transbond™ Plus; with conventional light cure adhesive followed by the use of fluoride-releasing varnish (Cleanpro XT varnish by 3M Unitek) and with that of conventional light cure adhesive used alone.

Aim and Objectives

The purpose of the present study was the evaluation the effects of topical fluoride varnish and fluoride-releasing adhesives on the SBS of orthodontic brackets in comparison with the conventional method (Transbond XT adhesive).

Materials and Methods

The sample comprised 60 freshly extracted human premolars, which were obtained from patients undergoing extractions for the purpose of orthodontic treatment in the Department of Orthodontics and Dentofacial Orthopedics, MM College of Dental Sciences and Research, Ambala, Haryana, India. The samples were then stored at room temperature in distilled water containing 0.1% thymol.

Teeth were selected on the basis of visual observation of the solidity of the buccal surfaces.

The inclusion criteria were as follows:

- Intact buccal enamel.
- No pretreatment with peroxide, acid, or alcohol.
- No caries.
- No visible cracks.
- No sign of hypoplasia.

The extracted premolars were then rinsed using water and polished with a fluoride-free powder using a rubber cup on a slow-speed handpiece. Then the teeth were taken, and a point was marked below the Cemento-enamel junction. The roots of teeth were removed below this point by sectioning using abrasive discs with a straight handpiece.

Crowns were fixed in self-cure acrylic resin, with their buccal surfaces oriented in the horizontal direction. The exposed tooth surface was washed with distilled water and air-dried.

Marking for attachment of the premolar bracket was done on the buccal aspect of the tooth by measuring half of the distance mesiodistally as well as occlusogingivally. Etching of the buccal aspect of teeth was done for 20 seconds using 37% orthophosphoric acid gel by placing it over the area of intended bracket placement. The etchant was rinsed off with water for 10 seconds, and the surface was dried with compressed air.

Premolar metal orthodontic brackets with 0.022 inch slots (3M Unitek Gemini series) were used. Transbond XT primer was brushed on the mesh of the bracket base and cured with a curing light. The application of primer was also done on the tooth surface that was etched previously. The brackets were bonded using orthodontic adhesives according to the following protocol:

- Group I: The teeth were bonded by using fluoride-releasing adhesive, that is, Transbond XT plus (3M, Unitek).
- Group II: The teeth were bonded with Transbond XT (3M ESPE) before the application of fluoride-releasing varnish.
- Group III: Control group in which teeth were bonded by using the conventional method, that is, by using Transbond XT (3M Unitek).

Determination of SBS

After bonding, the samples were mounted in the universal testing machine with the buccal surfaces kept parallel to the debonding force. The applied load at fracture was recorded in newtons (N) and converted into MPa by dividing the load by the mean area of bracket bases.

The 10× magnification was used to examine the enamel surface of each premolar. Scoring of the residual adhesive left was done with the modified ARI, which is as follows:

- All composite remained on the surface of the tooth
- Greater than 90% of the composite residue on the tooth
- Between 10 and 90% of the composite residue is left.
- A total of <10% of the composite residue left.
- No residue remained on the tooth.

The data obtained were subjected to statistical analysis.

Results

Descriptive statistics were computed for all the groups in Table 1. The study had three main groups. Table 2 shows a general linear analysis of variance (ANOVA) performed to test the differences among the 3 groups. Because the data were not normally distributed, therefore, a Scheffe test was performed, depicted in Table 3. The ANOVA and

Table 1: Revealed the individual and mean SBS of all groups

					Shear bond strength values of Group I, Group II, and Group III (Descriptives)			
	N	*Mean*	*SD*	*Standard error*	*Lower bound*	*Upper bound*	*Minimum*	*Maximum*
Group I	20	9.4815	4.46740	0.99894	7.3907	11.5723	3.90	20.45
Group II	20	12.3045	4.54148	1.01550	10.1790	14.4300	7.18	19.90
Group III	20	11.1030	2.76848	0.61905	9.8073	12.3987	7.95	15.90
Total	60	10.9630	4.11071	0.53069	9.9011	12.0249	3.90	20.45

Scheffe test was used to ascertain any significant difference in the ARI scores among all the groups in Tables 4 and 5. Table 5 depicts modified ARI scores in multiple comparisons within the groups which showed a statistically insignificant difference confirmed by the Scheffe test.

Discussion

Direct bonding of brackets to enamel was made a reality by Buonocore, Bowen, Tavas, and Watts. From their efforts, acid etching, self-cure composite resins, GIC, fluoride-releasing adhesives, and visible light-cured adhesives were developed.

Many researchers have scrutinized prolonged fluoride-releasing materials having an adequate SBS as an alternative to conventional resins.[1,22,23] Fluoride-releasing resins are a newer generation of preventive materials that comprise apt enamel bonding physical properties and fluoride-releasing agents. These resins also provide clinically desirable SBS and easily removable residues during debonding procedures.[23]

Our study evaluated the SBS of orthodontic brackets bonded using fluoride-releasing adhesive Transbond™ Plus; with conventional light cure adhesive followed by the use of fluoride-releasing varnish (Cleanpro XT varnish by 3M Unitek) and with that conventional light cure adhesive used alone.

Shear Bond Strength (SBS)

As per the literature, 6–8 MPa is the minimum bond strength required to withstand normal orthodontic forces (Reynolds, 1975).[20] In this study, all materials exhibited satisfactory SBS. Available literature reports 2.86–7.59 MPa as an ideal bond strength

Table 2: The results of ANOVA showed a statistically insignificant difference between the SBS groups I, II, and III ($p < 0.05$)

	ANOVA test				
	Sum of squares	*Degrees of freedom (Df)*	*Mean square*	*F*	*Significance*
Between groups	80.281	2	40.141	2.496	0.091
Within groups	916.696	57	16.082		
Total	996.977	59			

Table 3: Revealed the comparison of groups I, II, and III. The multiple comparisons within the groups showed a statistically insignificant difference ($p \leq 0.05$), confirmed by the Scheffe test

	SCHEFFE test					
					95% confidence interval	
	(J) S.no	*Mean difference (I–J)*	*Standard error*	*Significant*	*Lower bound*	*Upper bound*
Group I	Group II	–2.82300	1.26816	0.093	–6.0105	0.3645
	Group III	–1.62150	1.26816	0.447	–4.8090	1.5660
Group II	Group I	2.82300	1.26816	0.093	–0.3645	6.0105
	Group III	1.20150	1.26816	0.641	–1.9860	4.3890
Group III	Group I	1.62150	1.26816	0.447	–1.5660	4.8090
	Group II	–1.20150	1.26816	0.641	–4.3890	1.9860

Table 4: Mean value of the modified ARI was 3.5 ± 1.14

	Modified Adhesive Remnant Index Results (Descriptives)							
					95% confidence interval mean			
	N	*Mean*	*SD*	*Standard error*	*Lower bound*	*Upper bound*	*Minimum*	*Maximum*
Group I	20	3.5500	1.14493	0.25624	3.0137	4.0863	1.00	5.00
Group II	20	3.4500	0.75915	0.16975	3.0947	3.8053	2.00	4.00
Group III	20	3.5000	1.43270	0.32036	2.8295	4.1705	1.00	5.00
Total	20	3.5000	1.12747	0.14556	3.2087	3.7915	1.00	5.00

Mean value of modified adhesive remnant index was 3.5 ± 1.14

Table 5: Depicts that comparison between groups was statistically insignificant (ANOVA)

	ANOVA test				
	Sum of squares	*Df*	*Mean square*	*F*	*Significance*
Between groups	0.100	2	0.050	0.038	0.963
Within groups	74.900	57	1.314		
Total	75.000	59			

It depicts that comparison between groups was statistically insignificant.

Table 6: SCHEFFE Test

	(I) VAR00001	(J) VAR00001	Mean Difference (I–J)	Std. Error	Sig.	95% confidence interval	
						Lower Bound	Upper Bound
Scheffe	Group 1	Group 2	0.10000	0.36250	0.963	–0.8111	1.0111
		Group 3	0.05000	0.36250	0.991	–0.8611	0.9611
	Group 2	Group 1	–0.10000	0.36250	0.963	–1.011	0.8111
		Group 3	–0.05000	0.36250	0.991	–0.9611	0.8611
	Group 3	Group 2	–0.05000	0.36250	0.991	–0.9611	0.8611
		Group 3	0.05000	0.36250	0.991	–0.8611	0.9611

Multiple comparisons within the groups showed a statistically insignificant difference ($p > 0.05$) as confirmed by SCHEFFE Test

necessary to resist orthodontic force.[9] All bonding materials, when evaluated in our study, presented SBS values ranging from 9.48 to 12.3 MPa. The results of ANOVA showed a statistically insignificant difference between groups I, II, and III ($p = 0.091$). Table 3 revealed the SBS between groups and within groups to be statistically insignificant ($p = 0.091$).

The results of our study imply that fluoride varnish has no significant effect on the bond strength of orthodontic brackets bonded to enamel using either a conventional or fluoride-releasing adhesive.

Nhan[10] suggested that the tested fluoride varnish did not negatively affect the bond strength of orthodontic brackets, and this study corroborates with the results of our study.

From the mean bond strengths of composite given by studies, it seems that they will be able to withstand the masticatory and orthodontic forces during treatment.[21,22]

Yetkin and Sayar, in their study, found high SBS values for Transbond XT. The bond strength was above the desired SBS value of 6–8 MPa.[24]

Modified ARI

The ARI is a method to determine the amount of remaining adhesive on the tooth surface after the debonding is done. A low score would indicate an adhesive remnant at the bracket/composite resin interface, which is desirable during orthodontic bonding because it leaves the composite resin on the tooth and avoids enamel damage. On the other hand, a high score would indicate an adhesive failure at the enamel/composite resin interface. The Scheffe test showed insignificant differences among the three groups in the present study. Besides, some researchers consider less adhesive on enamel to be advantageous as less time is required for the removal of the residue (Tables 4, 5 and 6).[20]

The prime difference between adhesives is the color-changing property of Transbond XT Plus. Color change adhesive facilitates excess adhesive removal during bonding.

According to the results of the present study, the mean SBS and ARI score values showed a statistically insignificant difference between all three groups.

Summary and Conclusion

The results of our study suggest that brackets bonded with Transbond XT before the application of fluoride-releasing varnish exhibited the highest SBS, although the difference with the other two groups was not statistically significant. Under the conditions of the present *in vitro* study, it can be deduced that the fluoride varnish application had no effect on the strength of brackets bonded to enamel, so the use of varnishes can be recommended along with the orthodontic adhesives without compromising the bond strengths.

Clinical Significance

With the introduction of new materials in orthodontics, it becomes imperative to evaluate their properties and establish utility based on them. The Transbond XT Plus adhesive used in our study has been shown to provide good bond strength, along with a better prescription for bracket positioning and flash clean-up due to its color-changing property. Also, the use of fluoride varnish after the bonding of brackets did not affect the SBS verifying the fact that they can be safely applied for bonding to prevent carious lesions without compromising the bond strength. Hence, our research corroboratively adds to the available literature.

Orcid

Geetanjali Gandhi https://orcid.org/0000-0002-9095-5227

References

1. Hegde NM, Bhandary S. An evaluation and comparison of shear bond strength of composite resin to dentin, using newer dentin bonding agents. J Conserv Dent 2008;11(2):71–75. DOI: 10.4103/0972-0707.44054
2. Sharma S, Tandon P, Chugh VK. A comparison of shear bond strength of orthodontic brackets bonded with four different adhesives. J Orthod Sci 2014;3(2):29–33. DOI: 10.4103/2278-0203.132892
3. Newmann GV. Epoxy adhesives for orthodontic attachments: progress report. Am J Orthod 1965;51(12):901–912. DOI: 10.1016/0002-9416(65)90203-4
4. Mirzahi E. Enamel demineralization following orthodontic treatment. Am J Orthod 1982:82(1):62–67. DOI: 10.1016/0002-9416(82)90548-6
5. Endo T, Ozoe R, Shinkai K, et al. Shear bond strength of brackets rebonded with a fluoride-releasing and–recharging adhesive system. Angle Orthod 2009;79(3):564–570. DOI: 10.2319/061008-300.1
6. Tufekci E, Pennella DR, Mitchell JC, et al. Efficacy of a fluoride-releasing orthodontic primer in reducing demineralization around brackets: an in-vivo study. Am J Orthod Dentofac Orthop 2014;146(2):207–214. DOI: 10.1016/j.ajodo.2014.05.016
7. Paschos E, Kurochkina N, Huth KC, et al. Failure rate of brackets rebounded with antimicrobial and fluoride releasing, self-etching primer and the effect on prevention of enamel demineralization. Am J Orthod Dentofac Orthop 2009;135(5):613–620. DOI: 10.1016/j.ajodo.2008.01.016
8. Cohen WJ, Wiltshare WA, Dawes C, et al. Long-term in vitro fluoride release and rerelease from orthodontic bonding materials containing fluoride. Am J Orthod Dentofac Orthop 2003;124(5):571–576. DOI: 10.1016/s0889-5406(03)00573-0
9. Devi VRS, Anand MK, Venkateswaran S, et al. Comparison of shear bond strength of self-etching fluoride releasing adhesives with and

without pumice prophylaxis. Indian J Dent Res 2015;26(4):390–395. DOI: 10.4103/0970-9290.167639
10. Nhan RT, Xu X, Yu Q, et al. The effect of topical fluoride varnish on the shear bond strength of orthodontic brackets. Aust Orthod J 2015;31(1):14–19. DOI: 10.21307/aoj-2020-135
11. Staley RN. Effect of fluoride varnish on demineralization around orthodontic brackets. Semin Orthod 2008;14(3):194–199. DOI: 10.1053/j.sodo.2008.03.004
12. Clark DC. A review on fluoride varnishes: an alternative topical fluoride treatment. Community Dent Oral Epidemiol 1982;10(3):117–123. DOI: 10.1111/j.1600-0528.1982.tb01334.x
13. Mehta A, Paramshivam G, Chugh VK, et al. Effect of light-curable fluoride varnish on enamel demineralization adjacent to orthodontic brackets: an in-vivo study. Am J Orthod Dentofac Orthop 2015;148(5):814–820. DOI: 10.1016/j.ajodo.2015.05.022
14. Kaminsky LS, Mahoney MC, Leach J, et al. Fluoride: benefits and risks of exposure. Crit Rev Oral Biol Med 1990;1(4):261–281. DOI: 10.1177/10454411900010040501
15. Kimura T, Dunn W, Taloumis LJ. Effect of fluoride varnish on the in vitro bond strength of orthodontic brackets using a self-etching primer system. Am J Orthod Dentofac Orthop 2004;125(3):351–356. DOI: 10.1016/j.ajodo.2003.04.007
16. Ekhlassi S, English JD, Elis RK. Bond strength comparison of color-change adhesives for orthodontic bonding using a self-etching primer. Clin Cosmet Investig Dent 2011;3:39–44. DOI: 10.2147/CCIDEN.S13646
17. Ward DH. Using resin-modified glass-ionomer bases to effectively reduce post-op direct composite restorations. Inside Dent 2006;2(3):1–9.
18. Newman AR, Newman VG, Sengupta A. In vitro bond strengths of resin modified glass ionomer cements and composite resin self-cure adhesives: introduction of an adhesive system with increased bond strength and inhibition of decalcification. Angle Orthod 2001;71(4):312–317. DOI: 10.1043/0003-3219(2001)071<0312:IVBSOR>2.0.CO;2
19. Schmit JL, Staley RN, Wefel JS, et al. Effects of fluoride varnish on demineralization adjacent to brackets bonded with RMGI cement. Am J Orthod Dentofac Orthop 2002;122(2):125–134. DOI: 10.1067/mod.2002.126595
20. Vilchis RJ, Yamamoto S, Kitai N, et al. Shear bond strength of a new fluoride-releasing orthodontic adhesive. Dent Mater J 2006;26(1):45–51. DOI: 10.4012/dmj.26.45
21. Pseiner BC, Freudenthaler J, Jonke E, et al. Shear bond strength of fluoride-releasing orthodontic bonding and composite materials. Eur J Orthod 2010;32:268–273.
22. Turkkahraman H, Adanir N, Gungor Y, et al. In vitro evaluation of shear bond strength of colour change adhesives. Eur J Orthod 2010;32(5):571–574. DOI: 10.1093/ejo/cjp149
23. Rastelli MC, Coelho U, Jimenez EE. Evaluation of shear bond strength of brackets bonded with orthodontic fluoride-releasing composite resins. Dental Press J Orthod 2010;15(3):106–113. DOI: 10.1590/S2176-94512010000300013
24. Yetkin D, Sayar G. Effect of fluoride releasing bonding materials on shear bond strength of orthodontic brackets. Turk J Orthod 2020;33(1):52–58. DOI: 10.5152/TurkJOrthod.2020.19052