Original Article

AN IN VITRO COMPARISION OF BOND STRENGTH OF PRECOATED AND UNCOATED BRACKETS USING SELF ETCHING PRIMER

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DOI: 10.47750/pnr.2022.13.S06.172

Abstract

Aim: To test the hypothesis that there is no significant difference in the shear bond strength and the adhesive remnant on the tooth after debonding between precoated and uncoated brackets using a self etching primer.

Materials and Methods: Adhesive Pre Coated Plus brackets, Uncoated brackets, Transbond XT adhesive and Transbond Plus self etching primer (TPSEP) were used in this study. The brackets were bonded to intact human premolar teeth. All the samples were divided into two groups --Group 1 (Uncoated brackets + Transbond Self Etching Primer + Transbond XT) & Group 2 (Adhesive Precoated Brackets + Transbond Self Etching Primer). Universal Testing Machine was used for calculating the shear bond strength of all samples. Image analysis equipment was used to measure the adhesive remnant on each tooth after debonding. Scanning Electron Microscope was used for this purpose.

Results: Group 1 (Uncoated brackets + Transbond Self Etching Primer + Transbond XT) & Group 2 (Adhesive Precoated Brackets + Transbond Self Etching Primer) had nearly equal mean shear bond strength which is 8.86 +2.14 Mpa for precoated while 9.08 + 2.76 Mpa for the uncoated group. Statistically both the groups have almost same shear bond strength and significant difference was absent. In percentage of adhesive remnant also statistical difference between group 1 & group 2 was absent.

Conclusion: There was no significant difference in the shear bond strength and the adhesive remnant on the tooth after debonding between precoated and uncoated brackets using a self etching primer.

Keywords: Adhesive Precoated Brackets, Uncoated Brackets, Shear Bond Strength.

INTRODUCTION

Orthodontic fixed appliance therapy is more successful when the attachments have sufficient bond strength and the bond failure rate is low. Till date there are three methods of bonding available namely chemical, mechanical and a combination of both. Also, the acid etching and the crystal growth are two processes by which enamel is conditioned. The acid-etch technique was introduced by Bounocore in 1955 and Newman in 19651,2. The crystal growth method results in the mechanical bonding between the crystal and the adhesive resin and a chemical bonding between crystal and the enamel. Alternatively, the advantage of self – etching primer (SEP) is that it is fast and simple to apply and also both etching and priming of enamel and dentin is done sufficiently in one step. Moreover, as the steps of the bonding process is reduced it will minimize the procedural errors, thus reducing technique sensitivity. In another endeavor, metal brackets have been precoated with composite resin to minimize chair- time and to make bonding procedures simple. Adhesive precoated bracket was introduced in September 1992. According to Cooper et al the advantage of adhesive precoated brackets (APC 3M Unitek) over conventional light – cured systems are (1) consistent quality and quantity of adhesive, (2) after bonding clean up become simple (3) increased asepsis (4) wasting is minimized during bonding and (5) improved inventory control3.The APCTM PLUS brackets (3M Unitek) was introduced in 2004 and its advantage is that it has improved tolerance to humidity than compared to its predecessors .Another advantage is that the adhesive also release fluoride. The new APCTM PLUS brackets which has the colour change properties is very efficient and provides accurate orthodontic bonding system. The adhesive is initially pink in colour and upon curing completely gets photo bleached to white colour4.

Materials and Methods:

The study was done in FAA Medical College & Hospital, Barpeta Assam between the periods 25-05-2021 to 20-04-2022.The study has got ethical clearance (No.FAAMCH/P.Est/I.E.C/26/2021/4949) from institutional ethics committee. Seventy human premolar teeth which were extracted for orthodontic treatment purpose were collected.

Criteria for teeth collection:

1. Intact tooth surface with no cracks.

2. No surface caries or restoration.

3. No sign of demineralization or hypoplasia

4. Intact enamel surface which is not treated with any chemical agent.

Teeth so collected were rinsed properly under running water so that debris and blood stains get removed. After rinsing the teeth were placed in 0.1% Thymol solution. Afterwards they were stored in distilled water at 40c for not more than 1 month according to International standards (ISO 11405/2003) for testing of adhesion to tooth surface. Self cure acrylic resin block of 2.5 x 3 cm2 dimension was used for fixing the teeth .The teeth were fixed up to the cemento-enamel junction, the root portion were fully embedded in the acrylic resin. For easy identification, the acrylic blocks were colour coded. Group 1 (Uncoated brackets + TPSEP + Transbond XT) acrylic blocks were pink in colour. Group 2 (APCTM Plus + TPSEP) acrylic blocks were white in colour. Wire loop made of 0.018 x 0.025 rectangular stainless mounted on an acrylic block of 2.5x3 cm2 dimension was used for debonding of brackets. Transbond XT (3 M Unitek) is the adhesive used for bonding uncoated brackets. Transbond Plus Self etching primer (3 M Unitek) is the primer used in our study. Attachment used in the study are precoated brackets (APCTM Plus) MBT 0.022 slot premolar Victory series (3 M Unitek) and uncoated brackets MBT 0.022 slot premolar Victory series (3M Unitek). Size of the sample was decided maintaining adequate power of (80%) and statistical significance at $P<0.05$. Samples were categorized into two equal groups. Group 1 consists of samples in which TPSEP, uncoated brackets and adhesive Transbond XT were used. The number of samples in group 1 was 35 (n=35). Group 2 consists of samples in which TPSEP and APCTM Plus brackets were used. The number of samples in group 2 was (n=35).Brackets were bonded on the buccal surface of teeth. Manufacturer's instruction were strictly followed while bonding the brackets.. In Group 1 the enamel surface was treated with Transbond Plus Self Etching Primer. After applying primer, Transbond XT adhesive was applied to the base area of each bracket and then firmly pressed onto the enamel surface. Time for light curing was 10 seconds. In Group 2 also after treating enamel surface with TPSEP, the precoated bracket was placed on to the tooth surface and pressed firmly. The adhesive which was excess was removed from around each bracket base in both the group. Time for light curing was 10 seconds as in group 1.Both Group 1 and Group 2 specimens were stored in distilled water at 370 c for 24 hours. Universal testing machine (Instron4444, Instron Corp, U.S.A.) was used to evaluate shear bond strength. The Instron machine has an upper grip (movable) and lower grip (fixed). Wire loop made of 0.108'' x 0.025" rectangular stainless steel wire was used for debonding of brackets. The specimen was fixed in lower grip and the wire embedded in acrylic block was placed in upper grip. The wire was passed beneath the gingival component of the brackets. A force which is parallel to the tooth surface was applied. Direction of force application was gingivo–occlusal direction. The cross head speed was 1mm/min. The Instron machine was connected with a computer for recording the breaking load. The debonding force amount of each bracket was registered in KN. The values were converted to Newton by multiplying with 103 which is converted to mega pascal by dividing the debonding Force (Newton) by surface area of brackets which is 9.8 mm2 which is obtained from information given by manufacturer. After debonding of brackets, the debonded specimens were studied under a stereo microscope (Leica MZ-6) having magnification power of 10x. Adhesive remnant index (ARI) given by Artun & Berglund5 was used for scoring.

Statistical Analysis: Descriptive statistics including the mean, standard deviation, minimum and maximum values of shear bond strength were evaluated for the two tested groups. The Leven's test for equality of variance was done to see that the samples were distributed normally or not. Independent samples student's test was performed on the shear bond strength data. The Mann – Whitney U Test, Kolmogorov- Smirmov normailty test, Wilcoxon W Test were used to evaluate significance in the ARI score of the tested groups.

Table 1: Descriptive statistics including the mean, standard deviation, minimum and maximum values and standard deviation, co-efficient of variation, range &standard error of shear bond strength were evaluated for each of two tested group.

Para-Meter	Group	Mean	Std. Error	95% Confidence Interval for Mean		Median	Variance	Std. Deviation	Minimum	Maximum	Range
				Lower Bound	Upper Bound						
SBS	Precoated	8.86	0.36	8.13	9.60	8.21	4.56	2.14	5.94	12.96	7.02
	Uncoated	9.08	0.47	8.13	10.03	8.63	7.64	2.76	5.72	16.00	10.28

Table 2: Levene's Test for Equality of Variances & t- test for Equality of Means (Parametric)

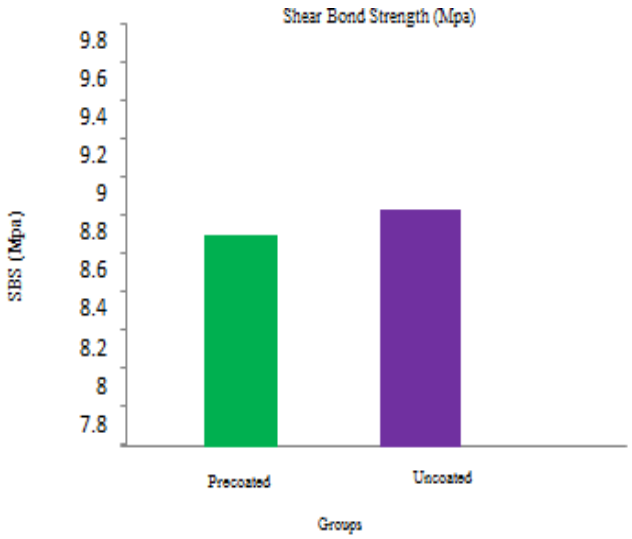
		Levene's Test		t-test						
		F	Sig	T	df	P	Mean Difference	Std. Error Difference	95%Confidence Interval of the Difference	
									Lower	Upper
SBS	Equal Variances Assumed	1.831	0.181	0.361	68. 000	0.7	-0.213	0.590	-1.391	0.965
	Equal Variances not assumed			0.361	63. 925	0.7	-0.213	0.590	-1.392	0.967

Table 3: Levene's test for equality of variance for adhesive remnant index of the two groups

	Group	N	Mean Rank	Sum of Ranks
ARI	Precoated	35	38.50	1347.50
	Uncoated	35	32,50	1137.50
	Total	70		

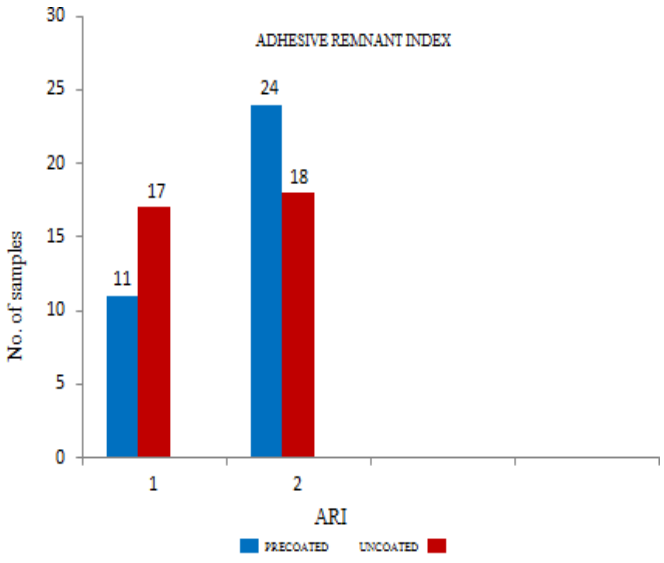
Table 4: Mann-Whitney U Test, Kolmogorov –Smirmov Normality test, Wilcoxon W Test to evaluate significant difference in ARI score between the two groups

	ARI	P value
Mann-Whitney U	507.5	0.1461
Wilcoxon W	1137.5	
Z	-1.4533	
Kolomogorov-Smirnov Z	0.7171	0.6825



Bar diagram showing the diagrammatic representation of mean shear bond strength of the two groups- Group 1:TPSEP/Transbond XT (Uncoated) and Group 2: TPSEP/APC Plus (Precoated)

Graph 1



Bar diagram showing the diagrammatic representation of ARI score

Graph 2

Results:

Descriptive Statistics for shear bond strength which include mean, minimum value, maximum value and standard deviation, co-efficient of variation, range & standard error of the two groups is shown in Table 1. The Precoated group shows a mean of 8.86 Mpa having standard deviation of 2.14 while the uncoated group shows mean of 9.08 Mpa having standard deviation of 2.76. The Levene's test for equality of variance was done for evaluating whether the samples were normally distributed or not and also the Independent Samples Students t Test was performed on the shear bond strength data to evaluate whether any significant difference of the two groups present or not. The results are given in Table 2.The results show that the shear bond strength data were normally disturbed (P=0.181). Independent Samples Student's Test results on the shear bond strength data (t= -0.0361, df=68, P=0.720), reveal that the groups were not significantly different.

Adhesive remnant index: The Levene's Test for Equality of Variance was done for evaluating whether the adhesive remnant index data of the two groups – precoated and uncoated were normally distributed or not. The Levene's Test for Equality of Variance is shown in Table3. The results confirmed that the scores were not normally distributed (p= 0.024).Mann-Whitney U test, Kolmogorov-Smirmov Normality test, Wilcoxon W test were done to evaluate whether there was any significant difference in adhesive remaining over the tooth surface between the two groups which is shown in Table 4. The results of the above tests (Mann-Whitney U, Wilcoxon W ,Z statistics) reveal that both the groups were not significantly different (P=0.1461), Kolmogorov-Smirnov was also not significant (P=0.6825).

Discussion:

Research has been carried out into the possible use of adhesive precoated brackets as way to save valuable chair-side time since the introduction of APC Brackets. Studies had also been done in past to evaluate the effect of non-use of primers in orthodontic bonding but the existing literature have some contradiction6. Previously a study was done on non rinse conditioner and it was found that the bond strength obtained while using non-rinse conditioner was comparable with the bond strength obtained when using phosphoric acid as an etchant7. So, the self-etching primer has gained popular since it can provide etching and priming simultaneously and hence save the chair side time.

In our study it was found that the uncoated & precoated brackets had nearly equal mean shear bond strength which is 8.86 ± 2.14 Mpa for precoated while 9.08 ± 2.76 Mpa for the uncoated group. Statistically significant difference was absent and both the groups have similar shear bond strength.

In case of Adhesive Remnant Index (ARI), out of 35(n=35) uncoated brackets samples ,17 samples showed ARI score of 1 and 18 samples showed ARI score of 2.While in case of precoated brackets out of 35 (n=35) precoated bracket samples, 11 samples showed ARI score of 1 and 24 samples showed ARI score of 2. This implies that in case of precoated brackets, adhesive left on the tooth surface is slightly more compared to uncoated brackets. But statistical difference in percentage of adhesive remaining on the tooth surface after debonding between the two groups was insignificant.

Our study results were same as the study done by Ascension Vicente et al (2007) in terms of shear bond strength that statistically significant difference is absent in the shear bond strength between APC and uncoated brackets 7. However in our study the adhesive remnant index score of the precoated and uncoated groups is same and the difference is not statistically significant which was not in conformity with the observation by Ascension Vicente et al. The findings of this study were also same with the study done by Bishara et al (2002)8.The study showed that the shear bond strengths of the precoated metal brackets and uncoated brackets using conventional adhesive are same. This findings of Bishara et al was similar to the results of our present study. However the present study was not in co-ordinance with another study done by Bishara et al (1998) which showed less bond strength for APC brackets compared to uncoated bracket9. However both the studies showed no statistically significant difference in terms of comparison of adhesive remnant index between precoated and uncoated brackets .Reynolds (1975) observed that for most clinical orthodontic needs minimum and sufficient bond strength is 5.9 to 7.8 Mpa 10. Reynold et al also observed that to get a successful Orthodontic bond approximately an in vitro bond strength of 4.9 Mpa is required. In our study both the groups have bond strength (mean shear bond strength is 8.86 ± 2.14 Mpa for precoated while 9.08 ± 2.76 Mpa for the uncoated group) which is much more than the minimum values suggested by Reynolds. According to Retief (1974) bond strength of 13.5 Mpa can cause fractures of enamel surface 11. Few other studies also showed that as the bond strength increases, risk of enamel damage also increases12,13. Therefore it is safe to avoid bond strength greater than13.5 Mpa to prevent fracture of enamel .Our study findings also reveal that mean shear bond strength values of both the groups (mean shear

bond strength is 8.86 Mpa for precoated while 9.08 Mpa for the uncoated group) were below the value suggested by Retief and appear to be relatively safe. According to this study, the use of Transbond Self etching Primer and APC brackets reduces clinical operational time at the same time maintaining optimum shear bond strength. Moreover, APC brackets have some advantages which make it favorable for clinical use. Also decalcification of the enamel adjacent to the brackets is prevented or minimized due to release of fluoride which is beneficial .6 In one study, APC bracket system was compared with conventional adhesive system14. The results found in that study was that compare to no-mix system ,the time taken for positioning and curing adhesive precoated system was longer , statistically this difference was not significant. However, the rate of bracket bonding failure and score for peri-bracket flash were minimized in the APC group than the control group and which was significant statistically. The new APCTM PLUS Bracket System with colour change properties paved way for a advantageous and time efficient orthodontic bonding system. The adhesive is initially pink in colour and upon curing, pink colour is completely photo bleached to white colour. The colour change property provide visual aid to the clinicians and has the benefits that it helps in easy and more efficient cleaning of adhesive flash, meaning excess adhesive which is left on tooth surface is very less and hence chance of plaque formation is low. The pink colour also may help in easy bracket placement by providing better bracket reference 4.In a recent systematic review, which investigated whether there is any differences between the adhesive precoated bracket and uncoated bracket system regarding bracket failure rate, it was found that none of these two bracket system is superior to each other regarding failure rate15. In contrary to our present study that have favored the APC system, this study concludes that operator coated bracket systems are superior over APC with respect to bonding time which is statistically significant although this is most likely not clinically significant.

The above discussion reveals that although the shear bond strength of APC brackets varied in various studies, all of the them were within clinically acceptable range .It also showed that adhesive remnant index of the precoated brackets is more or less equal to the uncoated brackets, hence paving the way for entry of APC brackets with self-etching primer as a simple and accurate bonding system.

Conclusion:

The hypothesis that states that there is no significant differences in the shear bond strength and adhesive remnant between precoated brackets and uncoated brackets using self etching is therefore accepted. In conclusion it can be said that the combination of Transbond self etching primer with APCTM plus brackets minimizes operating time at the same time does not compromise shear bond strength .Also, other added advantages of APC brackets like colour indicator and release of fluoride are very useful. Therefore APCTM plus brackets with self etching primer can provide new horizon in orthodontic bonding system. In vitro studies are very useful in initial evaluation, however in vitro result should be supported by in vivo results.

Key Message: The colour changing APCTM plus brackets with self etching primer can provide new horizon in orthodontic bonding system. It can provide an advantageous and efficient Bonding System.

Ethical Clearance: The present study has got ethical clearance from institutional ethics committee.

Financial Support: Nil

Conflict of Interest: Nil

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