EVALUATION OF SHEAR BOND STRENGTH OF BRACKET BONDED USING LIGHT CURE COMPOSITE AND WITH AND WITHOUT PRIMER: A COMPARATIVE IN-VITRO STUDY.

Kavitha Ramsundar[a], Aravind Kumar Subramanian[b]*, Swapna Sreenivasagan[c]

Article History: **Received**: 26.07.2022 **Revised**: 24.08.2022 **Accepted**: 12.09.2022

Abstract: INTRODUCTION: Establishing adequate retention of orthodontic fixed appliances onto the tooth surface is a major challenge that most orthodontists face throughout the course of therapy. A primerless system possesses various superior characteristics such as decreased working time and short curing time. It offers adequate bond strength as well, which is one of the most important properties. **AIM:** The purpose of the study is to prove that without using the liquid primer, we can get sufficient bond strength. The elimination of this step will save time and exposure to unpolymerized compounds. **MATERIAL AND METHODS:** Twenty eight extracted human first premolars were mounted in plaster of Paris. The samples were categorized as follows GROUP I- Transbond XT Light Cure Adhesive with primer, Group II- Ormco Enlight Light Cure Adhesive with primer, Group III- Transbond XT Light Cure Adhesive without primer, Group IV- Ormco Enlight Light Cure Adhesive without primer. Each group consisted of seven samples. Brackets (0.022*0.028 in 3M UNITEK GEMINI) were bonded onto the premolars and shear bond strength testing was carried out using Instron testing machine. After testing, the samples were debonded and the tooth surface characteristics was studied under Scanning Electron Microscopy (SEM) to determine the adhesive remnant index(ARI). **RESULTS:** There was statistically significance in the shear strength between different groups, on comparison of Enlight with primer and other study groups, Enlight without primer and Enlight with primer, Transbond XT with primer and Enlight with primer, Transbond XT without primer and Enlight without primer. ($P < 0.05$). **CONCLUSION:** Our findings did not show any significant difference while using Transbond XT with primer and without primer.

Keywords: Shear bond strength; Primer; Without Primer; Light Cure Composite.

[a]. Post-graduate student, Department of Orthodontics, Saveetha Dental College,Saveetha Institute of Medical and Technical Sciences,Saveetha University, Chennai,India.
[b]. Professor & Head, Department of Orthodontics, Saveetha Dental College,Saveetha Institute of Medical and Technical Sciences,Saveetha University, Chennai,India.
[c]. Assistant Professor, Department of Orthodontics, Saveetha Dental College,Saveetha Institute of Medical and Technical Sciences,Saveetha University, Chennai,India.

***Corresponding Author**

Email ID: aravindkumar@saveetha.com.

DOI: 10.31838/ecb/2022.11.07.001

INTRODUCTION

Bonding is the mechanism by which the bracket attaches to the tooth surface. An ideal bracket bonding should be strong enough to withstand the stresses exerted on the tooth as a result of the orthodontic and masticatory forces, without causing any deterioration to the tooth surface (1). The desirable bracket to tooth tensile binding strength in orthodontic therapy is said to be in the range of 6 to 8 Mpa (2). Primer less composites are widely preferred over primer composites as they offer various advantages such as suitable working time and reduced bonding time. They also have the ability to release fluorides and confer resistance against caries.

In order to facilitate the bonding process, a substance termed as primer which is made up of unfilled resin particles is used along with light cure composites. The major function of a primer is to promote the penetration into the enamel surface thereby resulting in an efficient bonding (3). There are sufficient evidences in the literature, emphasizing the role of primers in orthodontic bonding in terms of improving the bond strength (4,5). However, elimination of use of a primer during the bonding procedure would be both economical and time saving (6). Reports of several in vitro investigations have revealed that tensile bond strength to be similar, in cases whether or not a primer is used (7-10). Literature evidences demonstrate that presence of an adequate amount of resin that is devoid of fillers present over the surface of composite resins can facilitate filling of the micropores in the etched enamel surface, so that the need of unfilled resins can be eliminated (3).The efficiency of the above mentioned filler-free resins were subsequently validated by various invitro scanning electron microscopic studies that had quantified the resin tags in terms of their penetration. (7,8,10-13) Our present study was undertaken with the objective of measuring and comparing the Shear bond strength (SBS) of the adhesive systems Transbond XT Light Cure Adhesive and Ormco enlight Light Cure Adhesive both with and without primer, so as to evaluate if the use of liquid primer can be eliminated without any compromise in the bond strength.

MATERIALS AND METHODS

The present in-vitro study was undertaken in a university hospital facility. The sample size required for the study was calculated based on a previous study (14), by setting the level of significance as 0.05 and power of 95%. A sample size of six maxillary premolar teeth per group was estimated. Extracted premolar teeth that were healthy with no facial developmental abnormalities, non-carious and non-restored were only included in the study.

These selected teeth were kept in hydrogen peroxide for a period of 24 hours and subsequently cleaned with distilled water and further stored in saline. Then the teeth were mounted in plaster of paris in such a way exposing only their coronal portion. The selected samples were randomly allocated into four different study groups i.e Group 1 - Transbond XT Light cure primer with adhesive, Group 2-Transbond XT Light cure adhesive without primer, Group 3 - Ormco enlight light primer with adhesive and Group 4 - Ormco enlight light cure adhesive without primer. The specimens underwent a phase of polishing that was done using a rubber cup and polishing paste, after which they were washed thoroughly and air dried. Then (0.022*0.028 in 3M UNITEK GEMINI) premolar brackets were bonded onto the specimens. The specimens were etched for 15 seconds using 'AXOETCH' etchant containing 37% phosphoric acid thixotropic etching gel.

Group wise bonding sequence followed in our study protocol is given below.

Group I (n=6): Application of Transbond XT Light cure prime, bonding of the bracket followed by 40 seconds of light curing.

Group II (n=6): Application of Transbond XT composite without primer, bonding of the bracket followed by 40 seconds of light curing.

Group III (n=6): Application of Ormco enlight light primer with adhesive, bonding of the bracket followed by 40 seconds of light curing.

Group IV (n=6): Application of Ormco enlight light without primer and bonding of the bracket followed by 40 seconds of light curing.

All the brackets were attached to the tooth surface with a stable pressure uniform in all the specimens and the extra adhesive that spread around the brackets were removed cautiously. The study procedures were carried out by a single operator so as to avoid inter operator variability.

Figure 1. Steps for bonding

Shear bond strength evaluation (SBS):

Evaluation of SBS of the samples bonded with brackets was carried out using Instron Universal testing equipment fitted with a flattened steel rod for application of occlusal-gingival pressure to the bonded bracket resulting in a shear force along the interface of the tooth and the bracket. The strength of the samples was measured and recorded in terms of Megapascals (MPa) (Fig.1)

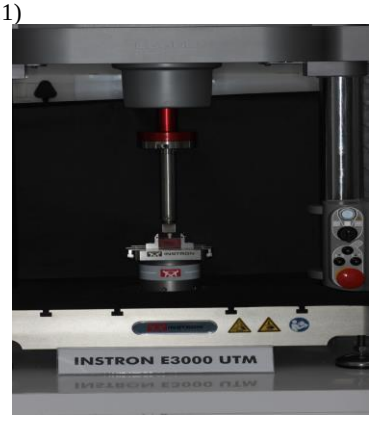

Figure 2. Procedure of testing the sample in Instron E3000 UTM

Evaluation of Adhesive remnant index:

Brackets were removed from the samples by debonding and the tooth samples were studied under magnification to inspect the changes in the enamel surface of each individual tooth to measure the quantity of leftover adhesive over the tooth surface. Adhesive Remnant Index (ARI)(15) scores were calculated based on the amount of leftover adhesive: Score 0 was assigned when that the tooth surface was completely free of adhesive, Score 1 was assigned to samples that had remnant adhesive which is less than half of the tooth surface, Score 2 was assigned when the remnant adhesive was seen on more than half of the tooth surface, Score 3 was assigned when the tooth surface exhibited leftover adhesive showing distinct impression of bracket mesh and Score 4 was assigned to samples that had enamel fracture. Thus, overall ARI of each sample was estimated.

STATISTICAL ANALYSIS:

The study data was tabulated and statistical analysis was performed using SPSS software (Version 17.0 SPSS.Inc.,Chicago,IL,US). One way ANOVA test and Post Hoc Tukey test were employed to test the difference in the shear bond strength among the study groups.

RESULTS

The results showed that there was significance when
1) Enlight with primer was compared with enlight without primer and Trandbond XT without primer.
2) Enlight without primer was compared with enlight with primer.
3) Transbond XT without primer was compared with Englight with primer.
The ARI scores of the study groups:
1) Transbond XT without primer showed a score of 3 and 1.
2) Transbond XT with primer showed a score of 0,1 and 3.
3) Enlight without primer showed a score of 0,2 and 3.
4) Enlight with primer showed a score of 1,2 and 3.

Table 1. Mean and std. difference while comparing with the groups.

GROUPS		MEAN	STD. DIFFERENCE	SIG
ENLIGHT WITH PRIMER	ENLIGHT WITHOUT PRIMER	20.24833	7.19470	.048
	TRANSBOND XT WITH PRIMER	23.27333*	7.19470	.020
	TRANSBOND XT WITHOUT PRIMER	26.09000*	7.19470	.008
ENLIGHT WITHOUT PRIMER	ENLIGHT WITH PRIMER	-20.24833*	7.19470	.048
	TRANSBOND XT WITH PRIMER	3.02500	7.19470	.974
	TRANSBOND XT WITHOUT PRIMER	5.84167	7.19470	.848
TRANSBOND XT WITH PRIMER	ENLIGHT WITH PRIMER	-23.27333*	7.19470	.020
	ENLIGHT WITHOUT PRIMER	-3.02500	7.19470	.974
	TRANSBOND XT WITHOUT PRIMER	2.81667	7.19470	.979
TRANSBOND XT WITHOUT PRIMER	ENLIGHT WITH PRIMER	-26.09000*	7.19470	.008
	ENLIGHT WITHOUT PRIMER	-5.8416	7.19470	.848
	TRANSBOND XT WITH PRIMER	-2.81667	7.19470	.979

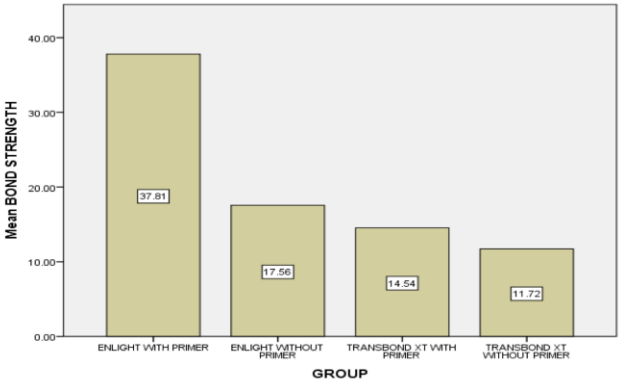

Figure 3. Graphical representation of mean for shear bond strength

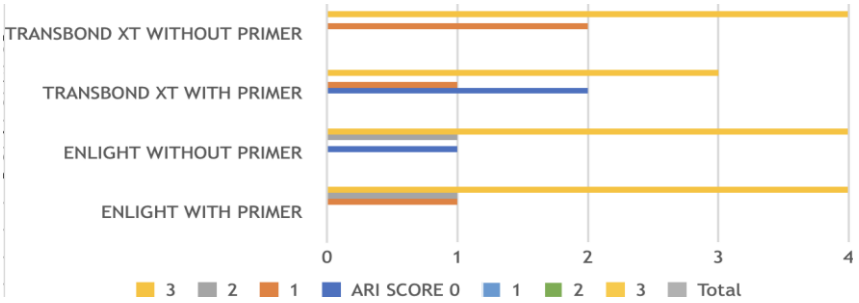

Figure 4. Graphical representation of ARI scores for the four groups.

DISCUSSION

Our study was undertaken to examine if sufficient bond strength can be attained without using the liquid primer. In orthodontic practice, it could be noted that some patients tend to report with frequent bracket failure than others, the cause of bracket failure could be attributed to a variety of factors such as nutrition, tooth morphology and so on. As a result, the common assumption of bracket failure independence will be invalid (16).

A study by Yashpal et al. analyzed various self and light cured adhesives, they demonstrated that the bond strength Heliosit light Cured Primerless Composite to be clinically significant with sufficient shear bond strength (SBS), but the strength was intermediate when compared to that of Transbond XT light-cured composite. They concluded, light cured primerless composite (Heliosit) to beneficial in clinical application despite being a primerless system. Although Transbond XT had a stronger bond, it produced more enamel damage during debonding (14).Nandhra et al reported that over a 12-month timeframe, bonding APCTMII Victory SeriesTM brackets without TransbondTM XT Primer is similar to the bonding of APCTMII Victory SeriesTM brackets with TransbondTM XT Primer. When bonding with or without primer, there was no discernible change reported in the bonding time taken per bracket (3). There are other literature evidences evaluating the shear bond strength of adhesives and metal brackets. Wang et al. (17) reported that brackets with large bases provide higher bond strength. In their research, Reynolds et al. (2) determined that a bond strength between 6 to 8 MPa is clinically adequate for orthodontic bonding. Bond strengths exceeding 10 MPa have been associated with an increased risk of enamel fracture during debonding. (18).

Our study results showed that there was significance when Enlight with primer was compared with Enlight without primer and Transbond XT without primer ,Enlight without primer was compared with enlight with primer and Transbond XT without primer was compared with enlight with primer. The ARI scores indicate that Transbond XT without primer showed a score of 3 and 1,Transbond XT with primer showed a score of 0,1 and 3,Enlight without primer showed a score of 0,2 and 3 and Enlight with primer showed a score of 1,2 and 3.

CONCLUSION

From our study, the following conclusion can be drawn,

1) Bond strength while using enlight with primer was significantly increased when compared to enlight used without primer.

2) No significant difference was noted between the bond strength of Transbond XT with primer and without primer.

3) Bond strength was more while using enlight with primer where as low while using Transbond XT without primer.

4) The ARI score showed no difference among four groups.

ACKNOWLEDGEMENT & DECLARATIONS:

Funding: The authors declare that the study was undertaken with no specific grant.

Ethics approval: The study protocol was approved by the Ethical Committee, Saveetha Institute of Medical and Technical Sciences.

REFERENCES

i. Akova T, Yoldas O, Serdar Toroglu M, Uysal H. Porcelain surface treatment by laser for bracket-porcelain bonding [Internet]. Vol. 128, American Journal of Orthodontics and Dentofacial Orthopedics. 2005. p. 630–7. Available from: http://dx.doi.org/10.1016/j.ajodo.2004.02.021

ii. Reynolds IR. A Review of Direct Orthodontic Bonding [Internet]. Vol. 2, British Journal of Orthodontics. 1975. p. 171–8. Available from: http://dx.doi.org/10.1080/0301228x.1975.11743666

iii. Nandhra SS, Littlewood SJ, Houghton N, Luther F, Prabhu J, Munyombwe T, et al. Do we need primer for orthodontic bonding? A randomized controlled trial [Internet]. Vol. 37, The European Journal of Orthodontics. 2015. p. 147–55. Available from: http://dx.doi.org/10.1093/ejo/cju024

iv. Coreil MN, McInnes-Ledoux P, Ledoux WR, Weinberg R. Shear bond strength of four orthodontic bonding systems [Internet]. Vol. 97, American Journal of Orthodontics and Dentofacial Orthopedics. 1990. p. 126–9. Available from: http://dx.doi.org/10.1016/0889-5406(90)70085-q

v. Lowder PD, Foley T, Banting DW. Bond strength of 4 orthodontic adhesives used with a caries-protective resin sealant [Internet]. Vol. 134, American Journal of Orthodontics and Dentofacial Orthopedics. 2008. p. 291–5. Available from: http://dx.doi.org/10.1016/j.ajodo.2008.03.002

vi. Paschos E, Okuka S, Ilie N, Huth KC, Hickel R, Rudzki-Janson I. Investigation of Shear-Peel Bond Strength of Orthodontic Brackets on Enamel after Using Pro Seal™ [Internet]. Vol. 67, Journal of Orofacial Orthopedics / Fortschritte der Kieferorthopädie. 2006. p. 196–206. Available from: http://dx.doi.org/10.1007/s00056-006-0541-9

vii. Barnes IE. The adaptation of composite resins to tooth structure. Part 4. Study 4: the influence of cavity wall instrumentation upon the adaptation of composite resins, and discussion [Internet]. Vol. 142, British Dental Journal. 1977. p. 319–26. Available from: http://dx.doi.org/10.1038/sj.bdj.4803914

viii. Pre´vost AP, Fuller JL, Peterson LC. Composite and intermediate resin tag formation in acid-etched enamel: A scanning electron microscopy evaluation [Internet]. Vol. 52, The Journal of Prosthetic Dentistry. 1984. p. 204–7. Available from: http://dx.doi.org/10.1016/0022-3913(84)90096-9

ix. Low T, Von F. The direct use of composite materials in adhesive dentistry [Internet]. Vol. 141, British Dental Journal. 1976. p. 207–13. Available from: http://dx.doi.org/10.1038/sj.bdj.4803819

x. Jörgensen KD, Shimokobe H. Adaptation of resinous restorative materials to acid etched enamel surfaces [Internet]. Vol. 83, European Journal of Oral Sciences. 1975. p. 31–6. Available from: http://dx.doi.org/10.1111/j.1600-0722.1975.tb00416.x

xi. Retief DH, Woods E. Is a low viscosity bonding resin necessary? [Internet]. Vol. 8, Journal of Oral Rehabilitation. 1981. p. 255–66. Available from: http://dx.doi.org/10.1111/j.1365-2842.1981.tb00500.x

xii. Low T, LEEand KW, Fraunhofer JA. The adaptation of composite materials to etched enamel surfaces [Internet]. Vol. 5, Journal of Oral Rehabilitation. 1978. p. 349–55. Available from: http://dx.doi.org/10.1111/j.1365-2842.1978.tb01253.x

xiii. Miletic V. Dental Composite Materials for Direct Restorations. Springer; 2017. 319 p.

xiv. Chitra P, Yashpal. A Comparison of the Efficacy of a Primerless Orthodontic Bonding Adhesive as Compared to Conventional Materials: an Invitro Study [Internet]. Vol. 04, Dental Journal of Advance Studies. 2016. p. 049–55. Available from: http://dx.doi.org/10.1055/s-0038-1672045

xv. Artun J, Bergland S. Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment. Am J Orthod. 1984 Apr;85(4):333–40.

xvi. Petracci E, Farella M, Galeone C, Albano A, Ferraroni M, Decarli A. Survival analysis with clustered observations of orthodontic brackets [Internet]. Vol. 28, Statistics in Medicine. 2009. p. 3483–91. Available from: http://dx.doi.org/10.1002/sim.3641

xvii. Wang WN, Li CH, Chou TH, Wang DDH, Lin LH, Lin CT. Bond strength of various bracket base designs [Internet]. Vol. 125, American Journal of Orthodontics and Dentofacial Orthopedics. 2004. p. 65–70. Available from: http://dx.doi.org/10.1016/j.ajodo.2003.01.003

xviii. Oz AA, Oz AZ, Arici S. In-vitro bond strengths and clinical failure rates of metal brackets bonded with different light-emitting diode units and curing times [Internet]. Vol. 149, American Journal of Orthodontics and Dentofacial Orthopedics. 2016. p. 212–6. Available from: http://dx.doi.org/10.1016/j.ajodo.2015.07.036