

# Comparative Evaluation Of Shear Bond Strength Using “Fusion X-Tra” - A Newer Alternative Bonding Adhesive: An In-Vitro Study

<sup>1</sup>Avinash Jaiswal, <sup>2</sup>Shreya Pandey, <sup>3</sup>Abhay Jain, <sup>4</sup>Akram Ansari, <sup>5</sup>Tina Chugh, <sup>6</sup>Rajiv Ahluwalia

<sup>1</sup>Consultant Orthodontist, New Delhi, India.

<sup>2</sup>Senior lecturer, Department of Orthodontic and Dentofacial Orthopedics, Azamgarh Dental College, Azamgarh, Uttar Pradesh - 276138, India

<sup>3</sup>Professor and Head, Department of Orthodontic and Dentofacial Orthopaedics, HazaribagCollege of Dental Science, Hazaribag, Jharkhand - 825301, India.

<sup>4</sup>Professor, Department of Orthodontic and Dentofacial Orthopedics, Yamuna Institute of Dental Science, Yamuna Nagar, Haryana - 133103, India

<sup>5</sup>Reader, Department of Orthodontics and Dentofacial Orthopedics, Santosh Dental College, Santosh deemed to be University, Ghaziabad - 201009, India

<sup>6</sup>Professor and Head, Department of Orthodontics and Dentofacial Orthopedics, Santosh Dental College, Santosh deemed to be University, Ghaziabad - 201009, India

Corresponding author: Dr. Tina Chugh

Reader, Department of Orthodontics and Dentofacial Orthopedics, Santosh deemed to be University, Ghaziabad, Uttar Pradesh - 201009, India.

\*email: [tinachugh122@gmail.com](mailto:tinachugh122@gmail.com) (corresponding author mail ID)

DOI: 10.47750/pnr.2022.13.504.223

## Abstract

**Objective:** This in-vitro study aimed to evaluate and compare the Shear bond strength using Admira Fusion Xtra, an alternative bonding adhesive, and conventional bonding adhesive. **Materials and Method:** Two hundred seventy sound human maxillary premolars were randomly divided into three groups (n=90) Group 1 (Transbond XT), Group 2 (Fusion Flow), and Group 3 (Fusion Xtra) based on adhesives used for bonding the orthodontic metal brackets. All the samples were stored in artificial saliva and subjected to SBS evaluation using a universal testing machine at a cross speed of 0.5 mm<sup>2</sup>/min. The failure mode was analyzed using Adhesive Remnant Index (ARI). Statistical analysis was done using an unpaired student t-test and one-way and 3-way ANOVA for the shear bond strength and the Kruskal-Wallis test followed by Mann-Whitney was performed for ARI scores (p<0.01). **Result:** The mean values of shear bond strength of Admira Fusion Xtra showed statistically significant differences between other evaluated groups (p<0.001). The lowest and highest shear bond strength was attributed to each group respectively. Statistically significant differences were noted in the mean ARI scores between Fusion Xtra and another evaluated group (p<0.01). **Conclusion:** Admira Fusion Xtra enhances the shear bond strength of orthodontic brackets as compared to the Admira Fusion Flow and conventional orthodontic adhesive.

**Keywords:** Adhesive, ARI, Brackets, LED light-curing unit, Phosphoric acid, shear bond strength.

## INTRODUCTION

Composite resin is used by most orthodontists to bond brackets to the teeth. It is becoming increasingly popular due to its strong bond strength to the tooth surface.<sup>1,2</sup> Currently, many different adhesives are available for orthodontic bonding such as resin-based glass-ionomer adhesives, and diacrylate composite resin-based material, which is available in either chemical or dual-cured systems, and cyanoacrylate systems.<sup>3,4</sup>

Transbond X T (3M Unitek Corporation, Monrovia California) adhesive paste is one of the light-cured, hybrid composite resins. It contains an unfilled resin base that is Bis-GMA and TEGDMA in a 1:1 ratio, and the filler particles are a hybrid of silica with an average size of 3 micrometer<sup>5</sup>. However, in some recent studies, it has been reported that bisphenol A: which is a component structure of the monomer Bis GMA has some estrogenic and cytotoxic effects.

To overcome shortcomings that were associated with Transbond XT adhesive resin, a new light-cured restorative enamel/dentin bonding material has been recently introduced called Ormocer (VOCO Admira, Munchen Germany) developed in Fraunhofer University. It is a nanotechnology-based restorative material (nanofiller ceramic particles and organically modified ceramic) consisting of copolymers that are 3-dimensionally cross-linked in addition to silanated filler particles. Ormocer bonding agents have notably low polymerization shrinkage, lower wear rate, and increased mechanical properties when compared with other composites.<sup>6</sup> Admira Fusion flow and Admira Fusion X-tra, a light-cured filling material is based on Ormocer technology, its potential use as an alternate non-BisGMA based orthodontic adhesive with improved handling properties and good SBS is of great clinical importance.<sup>7,8</sup>

Hence, the present study was undertaken to evaluate and compare the shear bond strength and the clinical usefulness of Admira Fusion X-tra, Admira Fusion flow, and Transbond XT

## MATERIALS AND METHODS

In this study, 270 non-carious maxillary premolars (statistically appropriate sample size) were taken. Artificial saliva (Wet Mouth, ICPA Health products Ltd.) was used to store the extracted maxillary premolars. Before testing teeth were mounted in steel molds diameter of 2×4” inches filled with self-cure acrylic resin (DPI Mumbai, India), and the teeth were randomly distributed in three groups (n = 90). The group I (n = 90) Transbond XT, group II (n = 90) Admira Fusion Flow and group III (n = 90) Admira Fusion X-tra. Acid etching was done for 15 seconds on the tooth surface of premolars with 37% H<sub>3</sub>PO<sub>4</sub> (3M ESPE Scotchbond etching gel, St Paul, MN) followed by washing with distilled water and were further dried with air for 20 seconds and primer application was done. After executing the surface treatment of upper premolar stainless-steel brackets (Gemini series 3M/ Unitek, Monrovia, Calif), the mean surface area of the bracket base was 10.61 mm<sup>2</sup> which were further bonded with light cure adhesives.

Group I (n=90): The orthodontic brackets (3M Gemini, MBT 0.022 slot) were fixed using Transbond XT adhesive (Gemini series 3M/ Unitek, Monrovia, Calif) followed by photopolymerization (LED, Woodpecker) for 20 seconds.

Group II (n=90): In group II the orthodontic brackets (3M Gemini, MBT 0.022 slot) were fixed using Admira fusion flow adhesive (VOCO Admira, Munchen Germany) followed by photopolymerization (LED, Woodpecker) for 20 seconds.

Group III (n=90): In the group III the orthodontic brackets (3M Gemini, MBT 0.022 slot) were fixed using Admira Fusion X-tra (VOCO Admira, Munchen Germany) followed by photopolymerization (LED, Woodpecker) for 20seconds.

Artificial saliva (Wet mouth<sup>TM</sup>) was used to store a prepared sample for 24 hours at room temperature.

SBS testing was done using a knife-edged blade at the enamel/bracket interface in a Universal Testing Machine, in such a way that the force should be applied parallel to the enamel/bracket interface at a crosshead speed of 0.5 mm/min and shear load should be recorded at the point of failure. The force of debonding the bracket was recorded in Newton and later on converted into Megapascals (MPa).

After debonding procedure, the Stereomicroscope (Lyzer™) under 20 x magnifications was used to determine the amount of composite remaining on enamel surfaces after debonding and then classified according to the Adhesive Remnant Index (ARI)<sup>9</sup>. The ARI scores are given from 0 to 3.

The data collected for the SBS and ARI were first entered into Excel (Microsoft, Redmond, Wash). The data obtained were subjected to the following statistical analysis.

Adhesive Remnant Index (ARI) scores for the comparison of all the 3 groups, the Kruskal-Wallis test was used. Mann-Whitney U-test was done for inter-group comparison. SPSS 21.0 software was used for all the statistical analyses. All statistical tests' significance levels were pre-set at p 0.005. Other tests were also used like chi-square, posthoc test, and ANOVA test.

## RESULTS

Shear bond strength and descriptive statistics (Mean and SD) analysis of all the groups are shown in Table 1. In Transbond XT Group, when used with LED LCU at 20 seconds. The minimum value of 6.04 MPa was recorded and the maximum value of 15.15 MPa was recorded in Admira Fusion X-tra group. In Table 2 ANOVA was done to find out the significant difference in the mean shear bond strength among all the adhesive groups using LED LCU at 20 seconds. It is evident from table 2 that the mean shear bond strength recorded between the different groups is very highly significant (<0.001) and in Table 3 pair-wise inter-group comparison, a post-hoc test was done to evaluate in which group the difference exists. Results show a highly significant difference between Transbond XT and Admira Fusion Flow (<0.002), Transbond XT and Admira Fusion X-tra (<0.001), and no significant difference between Admira Fusion Flow and Admira Fusion X-tra (0.168).

Distribution of Adhesive Remnant Index shown in Table 4,5,6 Descriptive statistics (Mean and SD) analysis and shear bond strength of all the groups shown in Table 4. Adhesive Remnant Index scores of Transbond XT when used with LED LCU at 20 seconds. ARI score varied from 0-to 3 with a minimum of 0 and a maximum number of scores was 3. Adhesive Remnant Index scores of Admira Fusion Flow when used LED LCU at 20 seconds. In Table 5 Kruskal-Wallis test was done to find out the significant difference in the mean ARI Score of LED at 20 seconds between Transbond XT, Admira Fusion Flow, and Admira Fusion X-tra groups. It is evident from Table 5 that the mean Adhesive Remnant Index Score recorded between the different groups is very highly significant (<0.002) and in Table 6 pairwise inter-group comparison (Mann-Whitney U test) was applied to find out in which group the difference exists. Results show a significant difference between Transbond XT and Fusion Flow (P<0.042), Transbond XT and Admira Fusion X-tra (P<0.002), and no significant difference between Admira Fusion Flow and Admira Fusion X-tra (0.566).

## DISCUSSION

Direct bonding of orthodontic metal brackets in fixed appliance therapy is a routine orthodontic procedure, which is used by the majority of orthodontists throughout the world since the emergence of orthodontic brackets bonding by Newman and the acid-etch technique by Buonocore.<sup>10</sup> This approach of bonding has various benefits over banding such as easy removal of plaque by the patients, minimizing decalcification of tooth surface, gingivitis and irritation of soft tissue with loose bands and give much more beautiful look of the patient.<sup>11</sup> Bonding of orthodontic brackets to the enamel surface with conventional method require an enamel conditioner, primer solution, and adhesive resin.<sup>12</sup>

Historically, there were various orthodontic adhesive material which was used for orthodontic bonding<sup>2</sup> Transbond XT (bisphenol A glycidyl dimethacrylate: BisGMA) resin-based adhesive material was introduced in 90's which show sufficient bond strength to withstand the orthodontic force<sup>4</sup>. Ormocer, a modified ceramic restorative material, is newly introduced for orthodontic bracket bonding. It has low polymerization shrinkage, low wear rate, and greater biocompatibility. Ajlouni et al (2005) in their study reported that after the initial half-hour of bonding shear bond strength achieved by Ormocer Admira is similar to Transbond XT. Recently, Admira Fusion Flow which is a flowable composite, and Admira Fusion Xtra were introduced. It features a nano-hybrid filler technology with an inorganic

filler content, which increases the bond strength. This newly introduced material Admira (Fusion Flow and Fusion X-tra) is an organically modified ceramic of 3-dimensionally cross-linked copolymer, which has a lower wear rate, greater biocompatibility, and less polymerization shrinkage compared to other adhesives used for orthodontic bonding.<sup>5</sup> Reynolds reported that 5.9 to 7.8 Mpa is the optimum SBS which is necessary to withstand normal orthodontic forces.<sup>13</sup>

The mean shear bond strength values obtained for Admira Fusion Flow and Admira Fusion X-tra in comparison to Transbond XT show a statistically significant increase ( $p$ -value $<0.001$ ). Admira Fusion X-tra shows the highest mean shear bond strength followed by Admira Fusion Flow and Transbond XT.

Fusion X-tra > Fusion Flow > Transbond XT

The findings of the study are supported by Ajlouni et al. They conclude a slight significant increase in shear bond strength of Ormocer Admira in comparison to Transbond XT. The findings of our study are also similar to the study done by Hamouda et al. Their result shows a significant difference in Ormocer Admira enamel bond strength compared with other different adhesive Prime & Bond NT and Excite. ( $P < 0.001$ ).<sup>13</sup> Rajeev et al also support this study as they showed a significant increase in Ormocer Admira flowable enamel bond strength among the other different adhesive Rely X U100 and Calibra. ( $P < 0.005$ ).<sup>14</sup>

## CONCLUSION

The conclusions drawn from the present study were

1. Admira Fusion X-tra and Admira Fusion Flow show higher SBS as compared to Transbond XT, with Admira Fusion X-tra having the higher mean SBS which will be important in situations requiring increased bond strength such as hypocalcified enamel and in posterior teeth where banding is not possible.
2. By incorporating Admira Fusion Xtra adhesive as a routine procedure in bonding, the loss of clinical time caused by debonded brackets can be averted.

## REFERENCES

1. Artun J, Bergland S. Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment. *Am J Orthod* 1984; 85:333-40.
2. Drake CW, Maryniuk GA, Bentley C. Reasons for restoration replacement: differences in practice patterns. *Quintess Int* 1990; 1: 125-30.
3. Powers M J, Hwa-Bong K, Turner DS. Orthodontic adhesives and bond strength testing. *Sem Orthod* 1997; 3:147-156.
4. Örtendahl TW, Örtengren U. A new orthodontic bonding adhesive. *J Clin Orthod*, 2000; 34: 50-54
5. Bradburn G, Pender N. An in vivo study of the bond strength of two Light-cured composites used in the direct bonding of orthodontic brackets to molars. *Am J Orthod Dentofac Orthop* 1992; 10 1:418-426.
6. Ajlouni R, Bishara SE, Solimann MM, Oonsombat C, Lafoon. The use of Ormocer as an alternative material for bonding orthodontic bracket. *Angle Orthod* 2005; 75:106-108.
7. Uysal T, Sari Z, Demir A. Are the flowable composites suitable for orthodontic bracket bonding? *Angle Orthod* 2004; 7:697.
8. Tecco S. A new one step flowable composite for orthodontic use—an in vitro bond strength study. *Angle Orthod* 2005; 75(4):672-7.
9. Jacobson A. Comparison of three curing light systems for polymerization of orthodontic adhesives: an in vivo study. *Am J Orthod Dentofac Orthop* 2001; 120(3):331-332.
10. Gittner R, Hartwich RM, Jost-Brinkmann PG. Influence of various storage media on Shear bond strength and enamel fracture when debonding ceramic brackets: An in Vitro study. *Semin Orthod* 2010; 16(1):49-54.
11. Graber WL, Vanarsdall LR, Robert L. *Orthodontics: current principles and techniques*. 3rd ed. St. Louis: Mosby publication; 579.

12. Turk T, Elekdag-Turk, Isci D. Effect of Self-etching primer on shear bond strength of orthodontic brackets at different debond times. Angle Orthod 2007; 77(1): 108-112.

13. Reynolds I: A review of direct orthodontic bonding. Br.J Orthod1975; 2:171-178.

14. Vinagre A R, Messias A L, Gomes M A, Costa A L, Ramos J C.Effect of time on shear bond strength of four orthodontic adhesive systems: Rev Port Estomatol Med Dent Cir Maxilofac:2014;55(3): 142-151.

Tables:

“Table 1: Descriptive Statistics of the Shear Bond Strength (MPa) values of all the Groups”

Adhesive	Timing (Seconds)	N	LED			
			Min.	Max.	Mean	SD
Transbond XT	20	15	6.04	11.01	9.40	1.16
Fusion Flow	20	15	7.74	12.70	11.82	1.72
Fusion Xtra	20	15	8.95	15.15	13.12	2.36

“Table 2: Comparative Mean Shear Bond Strength of all three Groups”

Shear bond strength (Mpa) at 20 seconds				
LED	Mean	Std. Deviation	F-value	p-value
Transbond XT	9.40	1.16	16.110	< 0.001*
Fusion Flow	11.82	1.73		
Fusion Xtra	13.12	2.36		
* Significant difference				

“Table 3: Inter-group comparison of Mean Shear Bond Strength”

Shear bond strength (Mpa) at 20 seconds			
Groups	Groups	Mean Difference	p-value
Transbond XT	Fusion Flow	-2.41	0.002*
Transbond XT	Fusion Xtra	-3.72	< 0.001*
Fusion Flow	Fusion Xtra	-1.31	0.168
Post-hoc Bonferroni test * Significant difference			

“Table 4: Descriptive Statistics of the ARI values of all the Groups”

Adhesive	Timing	n	LED				Halogen			
			Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
Transbond XT	20	15	0	3	1.73	0.80	1	2	1.53	0.52
Fusion Flow	20	15	1	3	2.33	0.72	1	3	1.93	0.70
Fusion Xtra	20	15	2	3	2.67	0.49	1	3	2.27	0.59

“Table 5: Comparison of Adhesive Remnant Index at 20 seconds between Transbond XT, Fusion Flow, and Fusion Xtra”

Adhesive Remnant Index Score at 20 seconds				
LED	Mean	Std. Deviation	Critical value	p-value
Transbond XT	1.73	0.80	7.19	0.002*
Fusion Flow	2.33	0.72		
Fusion Xtra	2.67	0.49		
Kruskal-Wallis test * Significant difference				

“Table 6: Inter-group Comparison of Adhesive Remnant Index at 20 seconds between Transbond XT, Fusion Flow, and Fusion Xtra”

Adhesive Remnant Index Score At 20 Sec			
Groups	Groups	Mean Difference	p-value
Transbond XT	Fusion Flow	-0.60	0.042*
Transbond XT	Fusion Xtra	-0.93	0.002*
Fusion Flow	Fusion Xtra	-0.33	0.566
Mann-Whitney U test * Significant difference			