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Comparative evaluation of the shear bond strength of a new nano- hybrid flowable ormocer with conventional composite

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Abstract

Background: The most important property of an orthodontic adhesive is durable bond strength which should withstand forces of orthodontic tooth movement and occlusal forces.Though conventionally used BisGMA basedcomposite resin has wide clinical acceptance for bonding of brackets,several drawbacks havebeen reported. The aim of the present study is to compare the shear bond strength and adhesive remnant index of a new nano hybrid composite (ORMOCER) admira-fusion to be used for orthodontic bonding.

Materials and methods: An in- vitro study was done on 40 maxillary premolars to evaluate and compare the SBS of orthodontic brackets bonded to enamel surface with Transbond XT, and Admira fusion flow using an Instron universal testing machine with a crosshead speed of 1 mm/min. The quantity of adhesive remaining on the tooth surface after debonding was also assessed using ARI. Mean and standard deviation is calculated for all parameters. Independent 't' test is performed for comparison of shear bond strength between both the groups.

Result: Greatest bond strength in Transbond group is 13.8Mpa whereas the lowest bond strength is 5.5MPa. Greatest bond strength in Ormocer group is 8.88 Mpa and lowest is 3.33Mpa. The mode of bond failure of both

Transbond and Admira fusion was at the enamel-adhesive interface.

Conclusion: The mean SBS of newer material was within the range required for most clinical orthodontic needs, and it showed the least ARI score signifying that failure mostly occurred at adhesive and enamel interface.

Keywords: shear bond strength, Adhesive remnant Index, Admira fusion, ormocer

Introduction

Bonding orthodontic brackets to etched enamel using chemical or light-cure adhesive systems has become a standard clinical practice and is the fundamental basis of contemporary orthodontics. Adequate bond strength, ease of handling the adhesive, biocompatibility and prevention of demineralization of surrounding enamelare critical for a direct bonding adhesives.[1]Though conventionally used BisGMA based composite resin has wide clinical acceptance for bonding of brackets,[2] several drawbacks have been reported. Incomplete polymerization, residual monomer is readily leached from cured resin are the major drawbacks of BISGMA resins.[3] BisGMA itself has been found to be cytotoxic in number ofcell culture studies.[4]Recently, Ormocer, an organically customized ceramic technology, was introduced for bonding orthodontic brackets to teeth.[5]It has properties such as excellent biocompatibility, considerable lower polymerization shrinkage, high abrasion resistance, and caries protective.[6]Ormocer overcame the concerns regarding estrogenicity and cytotoxicity associated with bisphenol A-glycidyl methacrylate-based composites.[7] Ormocer has inorganic silicon dioxide foundation to which polymerized organic units are added with methacrylate substituted ZrO2 and SiO2. Ajlouni et al compared the shear bond strength (SBS) of two adhesives,an organically modified matrix, Admira-ormocer (Voco, Cuxhaven, Germany), and the traditional Bis GMA matrix, Transbond XT (3M Unitek, Monrovia, Calif). Although their results shows that Admira can achieve SBS values that are similar to those obtained with Transbond XT but the thick adhesive paste of Admira need to be forcibly pushed into the bracket base during the bonding process for it to engage the retention pad.[8]

There are also studies which determine shear bond strength (SBS) of admira-flow (ORMOCER) to be used in bonding orthodontic brackets. The SBS of Admira flow is less when compared to the other flowable resin,however greater than admira-ormocer.[9,10] The chief advantage lies in the speed at which flowable resins set the brackets on teeth. Upon squeezing a flowable resin onto the base of a bracket, it spontaneously spreads over the bracket base and adapts readily to the bracket base and cavity wall. This spontaneity in spreading readily then presents the disadvantage in that the resin flows downward due to gravity finding it difficult to contain the flowable resin within the bracket base.

To overcome all these manufacturers have developed admira-ormocer fusion which may be suitable for orthodontic bonding. The aim of the present study is to compare the shear bond strength and adhesive remnant index of admira-fusion (ORMOCER) to be used for orthodontic bonding. Hence, the present study was planned to determine the clinical usefulness of Admira fusion flow based on the shear bond strength and debonding character in comparison with conventionally used Transbond XT

Materials and Methods

A total of 40 human lower premolars were collected and stored in a 0.2% thymol solution were included in the study. Criteria for selection of teeth for the study are anatomically and morphologically well-defined lower premolar teeth, intact buccal enamel and those indicated for orthodontic extraction. The exclusion criteria includes

teeth with caries heavy restorations, variations in crown with enamel structural defects, fractured crowns and fluorosed teeth. The selected teeth were mounted on self-cured acrylic blocks, up to cementoenamel junction with the buccal surface of crown perpendicular to base of the block.

The teeth were divided into group I (n = 20) teeth bonded using Transbond XT, group II (n = 20) teeth bonded using ormocer-Admira fusion flow. 40 preadjusted edgewise upper premolar stainless steel brackets (Victory series, 3M unitek) were used to bond the test specimen.

Group I (Transbond XT)

The primer was applied to the etched surface. The Transbond XT adhesive was then applied to the base of the metal bracket directly and then positioned at a distance of 4mm from the occlusal surface along the long axis of the tooth. The adhesive was cured using a LED (light emitting diode) curing unit from the occlusal, gingival, mesial and distal aspects for 10 seconds each.

Group II (Admira fusion flow)

The Admira fusion flow adhesive was then applied to the base of the metal bracket directly. The procedure for bonding Admira fusion flow is same as that of Transbond XT with reference to application of primer, positioning of bracket and curing.

The bonded specimens were stored in distilled water for 24 hours at room temperature before evaluation of bond **strength.**

Evaluation of Shear Bond Strength

Debonding was carried out with an Instron universal testing machine with a crosshead speed of 1 mm/min. The following formula was used to evaluate the SBS in MPa, shear bond strength (MPa) = Force in Newton/ Base area of the bracket (sq. mm).

Evaluation of the Residual Adhesive

The debonded tooth surface was examined using magnification glass(10 X). Modified ARI scores were used to determine adhesive remaining on the enamel.

Statistical Analysis

Mean and standard deviation is calculated for all parameters. Independent 't' test were performed for comparison of shear bond strength and the adhesive remnant index between both the groups.

Result

Mean, standard deviation, standard error mean of shear bond strength among the two groups(Transbond XT and Admira Fusion Flow) is determined(Table 1)(Fig. 1).

Group	N	Mean	Std. Deviation	Std. Error Mean
1	20	8.9880	2.54931	.57004
2	20	5.3555	1.58424	.35425

Table 1: Mean, standard deviation, standard error mean of shear bond strength among the two groups(Transbond XT and Admira Fusion Flow)

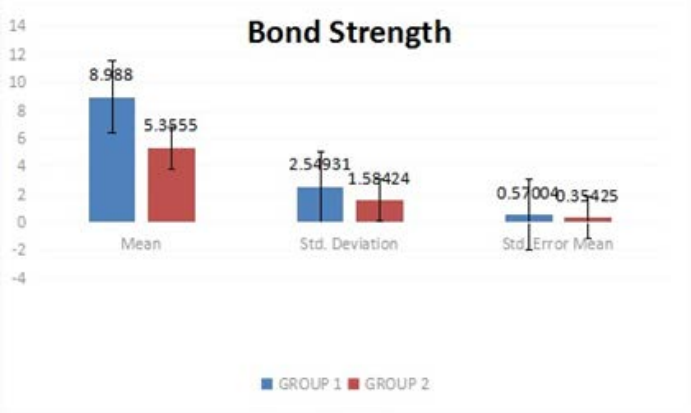

Fig. 1: Mean, standard deviation, standard error mean of shear bond strength among the two groups(Transbond XT and Admira Fusion Flow)

Greatest bond strength in Transbond group is 13.8 Mpa whereas the lowest bond strength is 5.5MPa. Greatest

bond strength in Ormocer group is 8.88 Mpa and lowest is 3.33 Mpa. The mean shear bond strength of Transbond (8.98 MPa) is higher than the Ormocer group (5.35 Mpa) which is statistically significant. Independent 't' test is used for comparison of shear bond strength between both the groups(Table 2). The Adhesive Remnant Index (ARI) scores is determined using modified ARI scores for both the resins(Fig. 2)(Table 3).

ARI score of score 1 (If there is less than half of adhesive remaining) is seen in both the groups indicating that bond failure was seen more commonly at adhesive and enamel interface. Independent 't' test is used for comparison of Adhesive Remnant Index between the groups(Table 4).

		INDEX				Total
		0	1	2	3	
Group	1	5	13	1	1	20
	2	5	12	3	0	20
Total		10	25	4	1	40

Table 2: Independent 't' test for comparison of shear bond strength between both the groups

Study Groups	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	1.462	.234	5.41	38	.000	3.63250	.67115	2.2738	4.991
Equal variances not assumed			5.41	31.77	.000	3.63250	.67115	2.2650	4.999

Table 3: The Adhesive Remnant Index (ARI) scores for the resins

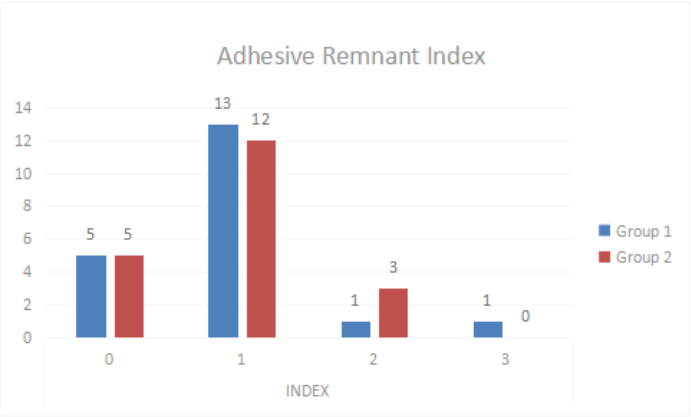

Fig. 2 :The Adhesive Remnant Index (ARI) scores for the resins

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	.000	1.000	.000	38	1.000	.000	.215	-.436	.436
Equal variances not assumed			.000	37.516	1.000	.000	.215	-.436	.436

Table 4: Independent 't' test for comparison of Adhesive Remnant Index betweenthe groups

Discussion

The most important property of an orthodontic adhesive is durable bond strength which should withstand forces of orthodontic tooth movement as well as forces of occlusion.[11] BISGMA was the most commonly used orthodontic adhesive. The major disadvantages with bisGMA are decalcification around the bracket during treatment, loss of enamel during debonding, loss of bond strength in the presence of saliva and incomplete polymerization with residual monomer. Studies have reported the cytotoxic effect of leached monomer on living cells mainly due to bisphenol component of residual monomer. Hence an alternative to BISGMA to overcome these side effect is required. Recently Ormocer, a three-

dimensionally cross-linked copolymers was introduced. It has inorganic-organic copolymers along with inorganic silanated filler particles. It showed coefficient of thermal expansion comparable to normal tooth structure, hence reduced polymerization shrinkage than conventional composites. The wear rate is also less when compared to composites. [6,12]

The primary objective of the present study is to determine the shear bond strength and debonding character of Admira fusion flow in comparison with conventionally used Transbond XT. The result of the present study shows that the new adhesive Admira fusion flow can achieve SBS values comparable to those attained with Transbond XT.The mean bond strength of Admira Fusion Flow is well near the range of 5.88 - 7.85 MPa suggested by Reynolds.[13]

The result of our study is in accordance with the study by Ajlouni et al.[8] They compared SBS of two adhesive materials; modified ceramic matrix Admira and conventional Bis GMA Transbond XT. They found that Admira had lower wear rate and more biocompatible than traditional composites.

Our findings are also in accordance with that of Park et a1.[9] They measured the SBS of orthodontic brackets bonded to the teeth using flowable resin. Brackets were bonded using Transbond XT and six other dissimilar flowable resins.one among the flowable resin were admira flow. They found that Transbond XT adhesive (12.1 MPa) had higher SBS values than Admira flow (7.0 MPa)

Studies have shown that the perfect site of bond failure should be at the enamel-adhesive interface, as this might make bonding and succeeding debonding a lot easier.[14] This is essential as enamel damage is not only due to acid etch but also during bracket debonding. Hence, orthodontist should not only concentrate on bonding adhesive and its bond strength but also on debonding method along with the amount of adhesive remaining after procedure.

Our second objective was to measure the amount of adhesive left over on the tooth surface after debonding using ARI.[15] We found that Transbond XT and admira fusion flow showed similar ARI score and mode of bond failure was at the enamel-adhesive interface. This shows that bond strength at the enamel-adhesive interface was relatively stronger. The mode of bond failure of Admira fusion flow was located at the enamel-adhesive interface, indicating easy clean up after debonding causing lesser enamel damage.

Kumar et al.[10] compared Ormocer based flowable adhesive (Admira flow) with BisGMA-based adhesive (Transbond XT) and found that the latter had high SBS value. They suggested that flowable Ormocer may be used as a substitute to generally used BisGMA-based adhesive; however, its effectiveness should be determined clinically by in vivo studies. Both the groups showed a modified ARI score of three, suggesting a cohesive type of failure.

Pradeep et al.[16] compared SBS and debonding characters of the Transbond XT (BisGMA-based composite) and flowable composites and found an insignificant difference in SBS among the groups.their findings is similar to our study. Modified ARI revealed that the common bond failures were seen at enamel-adhesive interface or cohesive type failure in both the groups. Hence, flowable composites may be successfully used for orthodontic bracket bonding.

To summarize, we found that the brackets bonded with new adhesive Admira fusion flow can achieve SBS values comparable to those attained with Transbond XT, however Transbond XT has the highest bond strength.Both Transbond XT and Admira fusion flow showed the similar ARI score and mode of bond failure was at the enamel-adhesive interface.The bond strength newer material

Admira fusion flow was within the range required for most clinical orthodontic needs.

Conclusion

An in vitro study was done on 40 maxillary premolars to evaluate and compare the SBS of orthodontic brackets bonded to enamel surface with Transbond XT, and a new adhesive material Admira fusion flow. The quantity of adhesive remaining on the tooth surface after debonding was also assessed using ARI. The mean SBS of newer material was within the range required for most clinical orthodontic needs, and it showed the least ARI score signifying that failure mostly occurred at adhesive and enamel interface.

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