



COMPARISON OF SHEAR BOND STRENGTH OF FOUR DIFFERENT FLOWABLE COMPOSITES AND CONVENTIONAL ORTHODONTIC ADHESIVE WITH AND WITHOUT PRIOR ADHESIVE PRIMER APPLICATION.

Dental Science

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ABSTRACT

Background and Objectives: Flowable composites were marketed for bonding of brackets during early 21st century. Flowable composite merit special attention because of their clinical handling characters of non-stickiness, fluid injectability and shear bond strength comparable to that of traditional composite adhesives. The purpose of this invitro study was to evaluate and compare the shear bond strength of a conventional composite and four different flowable composites with and without prior adhesive primer application used for bracket bonding in orthodontic treatment.

Methods: The present invitro study was designed 100 pre adjusted edgewise stainless steel premolar brackets (Gemini, 3M Unitek) and 100 freshly extracted premolar teeth were divided into 5 groups and 2 Subgroups to be bonded with the above mentioned five adhesives. The brackets were bonded with Transbond XT, Transbond supreme LV, G-aenial Universal flow, Admira flow, Tetric Flow and cured using LED from the occlusal, gingival, mesial and distal aspects for 15 seconds each. The bonded teeth were then stored in distilled water for 24 hours before evaluation of bond strength. The shear debonding force was applied with Instron testing machine at cross head speed of 0.5mm/min. A custom made wire was used to apply the shear bond load with occluso-gingival direction. The exact force at which the bracket was debonded was noted from the electronic console attached to INSTRON Universal testing machine (33R 4467). Chi-square analysis was used to compare the mode of bond failure (ARI score).

However the result showed with prior adhesive primer application, Transbond XT showed the highest SBS and without prior adhesive primer application, Transbond supreme LV showed the highest SBS among all the flowable composites, whereas, SBS of conventional composite i.e. Transbond XT showed a significant reduction.

Interpretation and conclusion: Though Transbond XT is a clinically efficient material as again confirmed from this study, flowable composites, (mainly Transbond supreme LV) if their flow and viscosity are balanced to improve handling property can definitely be considered as a time saving and alternative bonding system due to its comparable bond strength without bonding agent.

KEYWORDS

(ARI, LED, ANOVA, SBS)

INTRODUCTION

Flowable composite merit special attention because of their clinical handling characters of non-stickiness, fluid injectability¹ and shear bond strength comparable to that of traditional composite adhesives.² Ostertag et al³ evaluated the influence of adhesive filler concentration on bond strength, keeping the filler particle size constant and indicated that there is an increase in shear and torsional bond strength with increasing concentrations of adhesive filler.

Considering the merits and demerits of BisGMA based composite resin, and flowable composite, the present in-vitro study was planned to evaluate Transbond supreme LV, G-aenial Universal flow, Admira flow, Tetric Flow flowable composites as an alternative orthodontic bonding agent by determining its shear bond strength with and without bonding agent and debonding characters and to compare it with that of conventionally used BisGMA based composite resin- Transbond XT composite.

OBJECTIVE

To evaluate and differentiate the shear bond strength of a conventional composite and four different flowable composites with and without prior adhesive primer application used for bracket bonding, and to determine and compare the amount of adhesive remnant on each tooth after debonding brackets for different composites.

METHODOLOGY

100 pre-adjusted edgewise upper premolar stainless steel brackets

(Gemini 3M Unitek) and 100 freshly extracted premolar teeth were used in the study.

After cleaning 100 freshly extracted teeth to remove debris and storing in 0.5% chloramine T solution to prevent bacterial contamination and dehydration, they were divided into 5 equal experimental groups (N=20). 4 experimental groups (N=20X4=80) of flowable composites and one experimental group (N=20) of conventional composite will be used to test shear bond strength.

The teeth were then mounted on self cured, stainless steel colour coded blocks of dimensions 25X10 mm such that the roots were completely embedded into the acrylic block up to cemento-enamel junction and the buccal surface of the crowns were perpendicular to base of the block.

The teeth to be bonded with stainless steel metal brackets using five adhesives under study were grouped as given below

Color coding of blocks	Adhesive used for bonding	No of metal brackets (sample size)
Red-Group I	Tetric flow, Ivoclar	20
Yellow-Group II	GC- aenial universal flow	20
White-Group III	Admira flow, Voco	20
Green-Group IV	Transbond supreme LV	20
Blue-Group V	Transbond XT	20

BONDING PROCEDURE

Conditioning of the enamel surface

After polishing the buccal surface of the teeth (all the 100 test specimens) with pumice slurry using rubber cup, the teeth were washed with distilled water and dried using oil free air from a three-way syringe. 37% ortho phosphoric acid was applied to the labial surface and left for a period of 15 seconds. The acid was then washed away with a spray of water for 10 seconds. The tooth surface was then air-dried using oil and moisture free three 3-way syringe until a dull frosty appearance was seen on the surface.

Bonding procedure used for GROUP I - GROUP V –

The primer was applied to the etched surface with the help of an applicator brush and cured with LED for 30 seconds, rinsed for 15 seconds and dried with oil-free and moisture-free air for 20 seconds until the enamel will become faintly white.

After acid etching, for each experimental group, half of the specimens (N=10) a thin layer of primer was applied and light cured according to manufacturer’s instructions. Primer was not applied for another half of the specimen (N=10) of each experimental group.

The adhesive was then applied to the base of the metal bracket directly from the syringe. Using a bracket holder, the bracket was then positioned on the tooth surface along the midline at a distance of 4 mm from the occlusal surface with the help of a bracket positioner.

The adhesive was cured using a LED curing unit from the occlusal, gingival, mesial and distal aspects for 10 seconds each. A radiometer was used to determine the intensity of the LED. The bonded teeth were then kept in distilled water at room temperature for 24 hours before debonding.

EVALUATION OF BOND STRENGTH:

Shear bond strength was tested with a INSTRON Universal testing machine (33R 4467) and was evaluated according to the following procedure for all the five samples. The machine has two vertically placed jaws.

- The custom made aluminium sleeves with the tooth embedded was placed in the lower jaw with custom made jig (Fixed head)
- A custom made chiesel was fitted to the upper jaw of the machine (Movable head)

EVALUATION OF THE DEBONDING CHARACTERISTICS

The debonded tooth surface was examined under an optical microscope at 16X magnification to determine the bond failure interface.

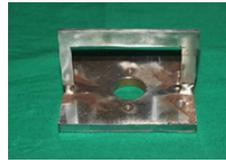
The adhesive remaining on the bracket base after debonding was scored according to the modified Adhesive Remnant Index (ARI) based on the following guidelines

- Score 0 = no adhesive left on bracket
- Score 1 = less than 25% of adhesive left on bracket
- Score 2 = 25% of adhesive left on bracket
- Score 3 = 50% of adhesive left on bracket
- Score 4 = 75% of adhesive left on bracket
- Score 5 = 100% of adhesive left on bracket.

The values obtained from the Shear Bond Strength testing (SBS) and the modified ARI scores of the three adhesives were tabulated and the subjected to statistical analysis.



Fig 15: Colour coded of custom made aluminium sleeves.



Custom made metal jig.



Aluminum block with Tooth embedded attached to lower jaw of testing machine with custom made jig and chiesel mounted to upper jaw.

RESULTS

Statistical Methods Applied:

The values obtained from the Shear Bond Strength testing and modified ARI scores of the five adhesives were tabulated and analysed using *Mean and Standard deviation, ANOVA and Chi square test*

Table 1: Mean Shear bond strength & standard deviation

Group	Subgroup	N	Mean	Std. Deviation
1	1	10	10.80	1.25
	2	10	12.55	1.42
2	1	10	10.66	1.54
	2	10	12.41	0.45
3	1	10	12.79	0.84
	2	10	8.38	1.19
4	1	10	11.06	1.74
	2	10	12.76	1.34
5	1	10	14.42	1.62
	2	10	6.31	1.46

Table 2:- Comparison between the 5 materials directly without taking into consideration the application of bonding agent

Subgroup	N	Mean	SD	F(df1,df2)	P-value
1	1	10.80	1.25		
	2	10.66	1.54		
	3	12.79	0.84	12.76(4,45)	<0.001*
	4	11.06	1.74		
	5	14.42	1.62		
2	1	12.55	1.42		
	2	12.41	0.45		
	3	8.38	1.19	57.49(4,45)	<0.001*
	4	12.76	1.34		
	5	6.31	1.46		

2 way ANOVA *P<0.05 Statistically Significant
p>0.05 Non Significant, NS

Table 3:- comparison of shear bond strength with and without bonding agent application

Group	Subgroup	N	Mean	SD	Mean Difference	t	df	p-value
					(95% CI)			
1	1	10	10.80	1.25	-1.75(-3.01, -0.49)	-2.92	18	0.009*
	2	10	12.55	1.42				
2	1	10	10.66	1.54	-1.74(-2.86, -0.62)	-3.43	10	0.006*
	2	10	12.41	0.45			57	
3	1	10	12.79	0.84	4.40 (3.43, 5.38)	9.48	18	<0.001*
	2	10	8.38	1.19				
4	1	10	11.06	1.74	-1.69(-3.15, -0.22)	-2.43	18	0.02*
	2	10	12.76	1.34				
5	1	10	14.42	1.62	8.11(6.66, 9.55)	11.75	18	<0.001*
	2	10	6.31	1.46				

*P<0.05 Statistically significant p>0.05 Non Significant, NS

DISCUSSION

When using an adhesive system, the four flowable composites performed similarly to the conventional orthodontic composite resin, similar to previous studies.^{15,16} Without adhesive, the SBS increased in three out of four flowable composites i.e. in Tetric flow, G-aenial universal flow and Transbond Supreme LV similar to other studies^{15,17} Albaladejo A et al, also found similar results with Transbond supreme LV.¹⁴ Flowable composites like Transbond supreme LV contains a dimethacrylate polymer that modifies the rheology of the material and provides a flow-on demand handling characteristic, allowing the material to flow under pressure yet hold its shape after placement until light cured. On the other hand, Transbond XT showed 6.31 MPa. This orthodontic composite resin had a higher filler concentration (77% quartz-silica filler) than the other flowable composites used and hence higher SBS values as reported in earlier studies.⁹

Simona.T¹² and Michele.D.Attilio¹¹ have reported very high values of 23.23 MPa and 23.47 MPa for Transbond XT and 34.80 MPa and 24.98 MPa for Flowable composites compared to the values expressed in the present study. They suggested that Flowable composites can be used for orthodontic bonding.

Dong-Bum-Ryou¹³ reported a lower SBS value for Flowable composites compared to that of Admira Flow in the present study and he concluded that Flowable composites with no intermediate bonding resin could be conveniently applied for orthodontic bracket.

However, Tancan Uysal¹⁰ reported a very low value for Flowable composites ranging from 6-8 Mpa compared to 17.10 MPa showed for Transbond XT and concluded that Flowable composites were not suitable for orthodontic bonding.

The frequency distribution of the modified ARI scores reveals that 60-70% of the samples in all the five study groups showed score 1-2 suggestive of a cohesive fracture i.e. debonding occurred mainly within the adhesive. Further, it requires minimal clean up and less damage during debonding.

The above discussion on the present study reveals that Transbond XT used with prior adhesive primer application had the highest bond strength i.e. 14.42 MPa whereas, all the four flowable adhesives showed more SBS than Transbond XT when used without primer. However, the SBS values of all the five adhesives were within the clinically acceptable levels and they exhibit cohesive type of bond failure.

The flowable composites have decreased filler particle i.e. it flows while being applied and contoured but remains firm when stationary. However, when they were used for bonding in the present study drifting of the brackets was noticed due to its increased flowability which required extra care to position the brackets.

It is evident from the present study that flow property and viscosity of adhesive plays an important role. Thinner and flowable adhesive paste will facilitate better penetration of the adhesive into mesh of the bracket base and the micro porosities of the etched enamel surface and improve handling properties and bond strength. Therefore, a balance is required between the flow and viscosity to obtain optimal consistency to achieve optimal bond strength and improve handling property.

Though Transbond XT is a clinically efficient material as again confirmed from this study, flowable composites, (mainly Transbond supreme LV) can definitely be considered as an alternative bonding system due to its comparable bond strength with and without bonding agent and debonding characters. Considering the in vivo nature of the present study the findings should be interpreted with caution while applying it for clinical application. The efficacy of the flowable composites as a bonding agent needs in vivo and clinical assesment through a survival analysis. Preliminary evaluation done in this study however will be a valuable guide for future in clinical use.

CONCLUSION

Based on our findings we can draw the following conclusions:

1. Among the five composite Transbond XT had the highest SBS when used with prior adhesive primer application for bracket bonding.
2. Among the five composite Transbond supreme LV had the highest SBS when used for bracket bonding without prior adhesive primer

application.

3. All the five composites have ARI score of 1-2 and the debonding mainly occurs within the adhesive.
4. Flowable composites mainly Transbond supreme LV can be considered as an alternative orthodontic bonding agent for bracket bonding without adhesive primer.

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