Research Paper

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Efficacy of Primerless Light Cured Orthodontic Composite over two conventional Bonding Systems; an inVitro Study

Medical Sciences

KEYWORDS : Adhesives, SEM, SBS, ARIndex

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ABSTRACT

Objective: To study bonding and debonding characteristics of primerless orthodontic composite in comparison with two conventional bonding systems.

Materials and Methods: Thirty extracted human premolar teeth mounted on similar sized aluminum blocks were divided into three groups of ten teeth each. All teeth were bonded with three different bonding systems with metallic premolar brackets (0.022" Ortho Organizers) and were evaluated for shear bond strength using an Instron testing machine. Surface characteristics were studied under scanning electron microscopy (SEM) and evaluated using the adhesive remnant index (ARIndex). Results were evaluated and compared.

Results: Shear bond strength (SBS) of primerless light cure Heliosit® (Ivoclar Vivadent, Schaan,Liechtenstein,) composite is clinically significant and lies intermediate to Transbond XT® light-cure composite (3M Unitek, CA, USA) and Rely-a-Bond® self-cure composite(Reliance Orthodontic Product, Inc., Illinois, USA).

Conclusion: Heliosit® light cured primerless composite may be recommended for routine clinical use due to its ideal characteristics of sufficient bond strength and reduced chances of enamel damage at debonding.

INTRODUCTION

The evolution from bands to brackets in everyday orthodontic practice was due primarily, to the efforts of Buonocore[1] who proposed acid etching of teeth to bond metal brackets and Newman[2-4]who recommended BIS-GMA as a bonding agent. There has been vast progress in adhesion technology since those times, but there is still a long way to go. The most common problem faced by orthodontists worldwide is the retention of fixed appliances on the surface of enamel during the course of orthodontic therapy.

The quest to overcome the shortcomings of conventional filled composites has led to the development of flowable composites. They merit great attention due to good clinical characteristics. Heliosit® light cure composite, a primerless orthodontic bonding agent, has been scarcely studied[5]. Unique properties[6-8]of this composite are: 1) Superior clinical handling characteristics, 2) Non sticky, 3) Fluid injectability,4) Adequate working time, 5) Short curing time, 6) Especially useful during indirect bonding of attachments. 7) For bonding lingual retainers, 8) As a luting cement for prosthesis. There were no studies comparing the efficacy of Heliosit with both conventional self cure and light cure bonding systems. The aim of this study was to evaluate shear bond strength and debonding characteristics of three commonly used orthodontic bonding systems namely: 1) Heliosit® light cure adhesive, Ivoclar Vivadent,Schaan, Liechtenstein. 2) Rely-a-Bond® self cure adhesive, Reliance Orthodontic Products Inc, Illinois, USA). 3) Transbond XT® light cure adhesive, 3M Unitek, CA, USA.

MATERIALS & METHODS

Thirty extracted human premolar teeth with intact and well supported enamel were collected. Any teeth with evidence of crack lines, caries, hypoplasia or any other enamel aberration were excluded from the sample. The collected teeth were washed thoroughly with plain water and stored in distilled water to prevent drying[9]. The teeth were mounted on similar sized aluminum blocks and were divided into three groups of ten teeth each. Group A (Fig.1) represented the teeth bonded with primerless light cured orthodontic composite Heliosit® . Group B (fig.2) comprised of teeth bonded with Rely-a-bond® self-cure adhesive. Group C (fig.3) were bonded with Transbond XT® light cure adhesive. All teeth (fig.4) were bonded with metallic maxillary premolar brackets (0.022" Ortho Organizers) and were evaluated for shear bond strength using an Instron testing machine (fig.5) (CHYD/PTC/UTM/3, Shimadzu, Japan) with the range of 0-50KN,accuracy of 0.01N and crosshead speed of 1mm per minute. Surface characteristics were studied under scanning electron microscope, S-3700N, Hitachi (figs.6, 7) and evaluated using the ARIndex. Results were evaluated and compared. The difference in shear bond strength between groups was analyzed by a one-way analysis of variance (ANOVA) statistical analysis at a 0.05 level of significance. Post Hoc test was used for multiple comparisons between the groups. The mean difference is significant at the level of 0.05(Table.2) and for ARI score (Table.3). Further ANOVA (Table.4) and Post Hoc tests (Table.5) were performed to determine whether there were any statistically significant differences between groups. The statistical analyses were performed using SPSS 12.0.1 for Windows (SPSS Inc, Chicago, III).



Fig. 1 Group A samples with Heliosit® Primerless Composite



Fig. 2 Group B samples with Rely-A Bond® self cure composite



Fig.3 Group C samples with Transbond XT® light cure composite



Fig 4 Sample groups after bracket bonding

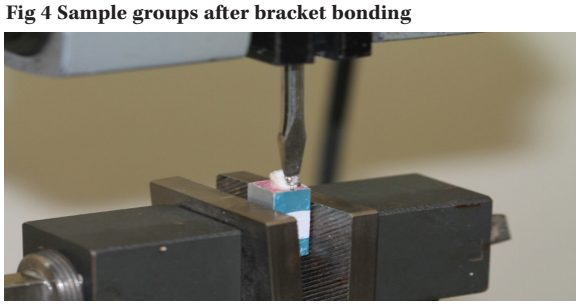

Fig.5 Bracket debonding on an Instron Machine



Fig.6 Scanning Electron Microscope

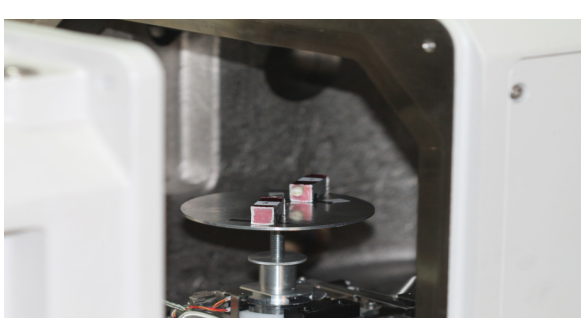

Fig.7 Sample testing with SEM

RESULTS

Shear bond strengths were measured for ten samples in each experimental group. The mean shear bond strength in Megapascals (MPa), standard deviation, and minimum/maximum values for each group is shown in Table 1.

Table.1

GROUPS	No's:	Mean (in MPA)	SD	Minimum (in MPA)	Maximum (in MPA)
Heliosit® Primerless light cure composite	10	7.9305	.51522	7.12	8.62
Rely-a-Bond® self cure composite	10	7.2134	.36153	6.36	7.65
Transbond XT® light cure composite	10	9.9944	.87770	7.95	10.83
Total	30	8.3794	1.34153	6.36	10.83

Table 2
Post Hoc Tests
(Multiple Comparisons)

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A Heliosit	B Rely-a-Bond	.71710*	.27887	.016	.1449	1.2893
	C Transbond XT	-2.06390*	.27887	.000	-2.6361	-1.4917
B Rely-a-bond	A Heliosit	-.71710*	.27887	.016	-1.2893	-.1449
	C Transbond XT	-2.78100*	.27887	.000	-3.3532	-2.2088
C Transbond XT	A Heliosit	2.06390*	.27887	.000	1.4917	2.6361
	B Rely-a-Bond	2.78100*	.27887	.000	2.2088	3.3532

*. The mean difference is significant at the 0.05 level.

Table 3 (ARI scores)

Descriptives

ARI SCORE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
A. Heliosit	10	2.8000	.63246	.20000	2.3476	3.2524	2.00	4.00
B. Rely-a-Bond	10	3.3000	.82327	.26034	2.7111	3.8889	2.00	4.00
C. Transbond XT	10	4.0000	.66667	.21082	3.5231	4.4769	3.00	5.00
Total	30	3.3667	.85029	.15524	3.0492	3.6842	2.00	5.00

Table 4

ANOVA

ARI SCORE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.267	2	3.633	7.161	.003
Within Groups	13.700	27	.507		
Total	20.967	29			

Table 5
Post Hoc Tests

Multiple Comparisons

ARI SCORE

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A. Heliosit	B Rely-a-Bond	-.50000	.31856	.128	-1.1536	.1536
	C Transbond XT	-1.20000*	.31856	.001	-1.8536	-.5464
B. Rely-a-Bond	A Heliosit	.50000	.31856	.128	-.1536	1.1536
	C Transbond XT	-.70000*	.31856	.037	-1.3536	-.0464
C. Transbond XT	A Heliosit	1.20000*	.31856	.001	.5464	1.8536
	B Rely-a-Bond	.70000*	.31856	.037	.0464	1.3536

*. The mean difference is significant at the 0.05 level.

Scanning electron microscopy (SEM) view of enamel surface after debonding Group-A (Heliosit®) (fig.8 A,B) and SEM view of bracket base surface after debonding Group- A Heliosit® (fig.8 C,D).

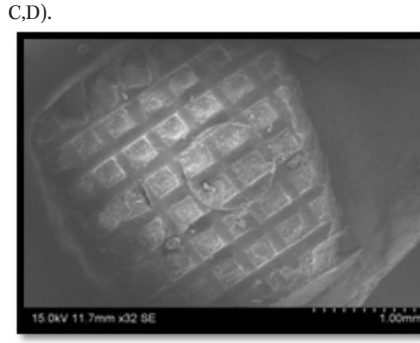

Fig.8 a, Magnification 32X

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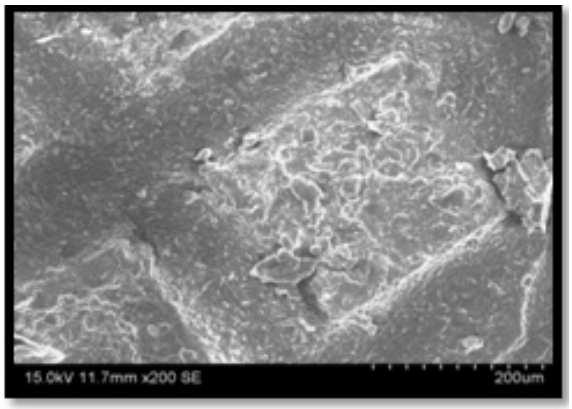

Fig. 8 b Magnification 200X

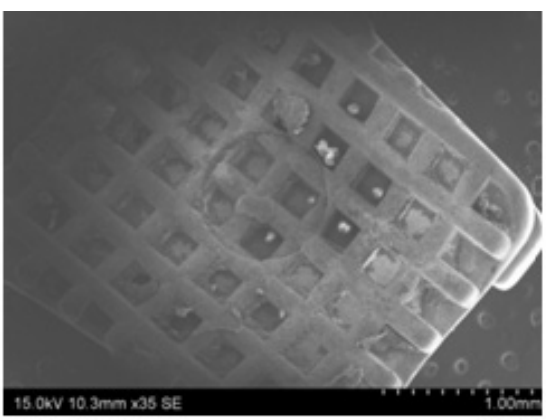

Fig. 8 c, Magnification 35X

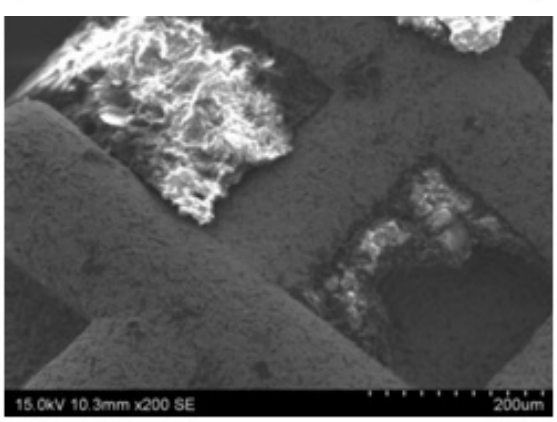

Fig. 8 d, Magnification 200X

Scanning electron microscopy (SEM) view of enamel surface after debonding in Group B Rely-A-Bond® (fig.9 A, B) and SEM view of bracket base surface after debonding Group B Rely-A-Bond® (fig.9 C, D).

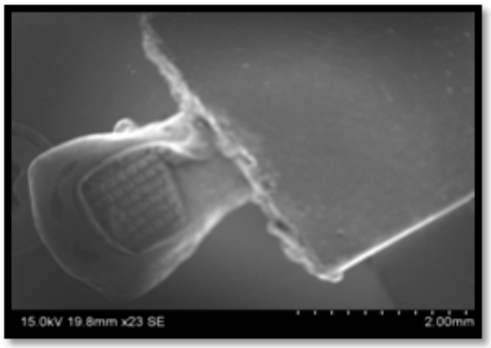

Fig.9 A. Magnification 23X

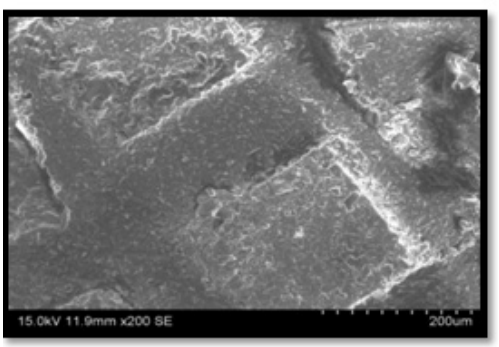

Fig. 9 B. Magnification 200X

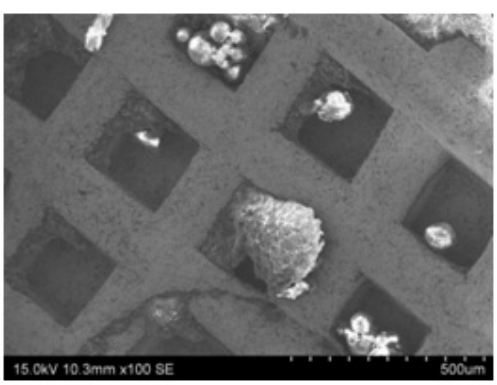

Fig. 9 C Magnification 100X

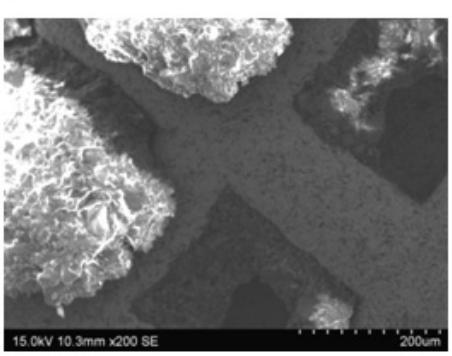

Fig.9 D Magnification 200X

Scanning electron microscopy (SEM) view of enamel surface after debonding Group C Transbond XT® (fig.10 A, B) and SEM view of bracket base surface after debonding Group C Transbond XT® (fig.10 C).

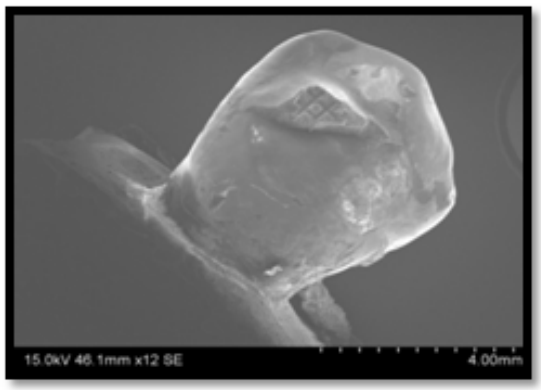

Fig.10 A. Magnification 12X

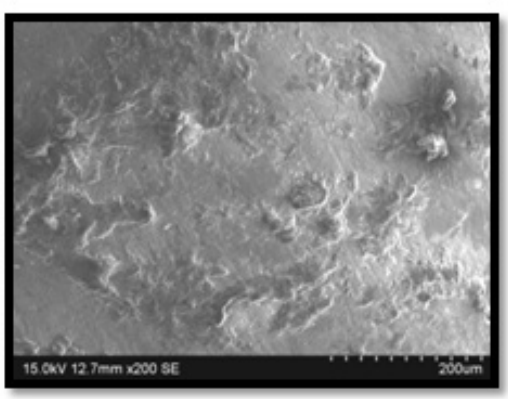

Fig.10 B. Magnification 200X

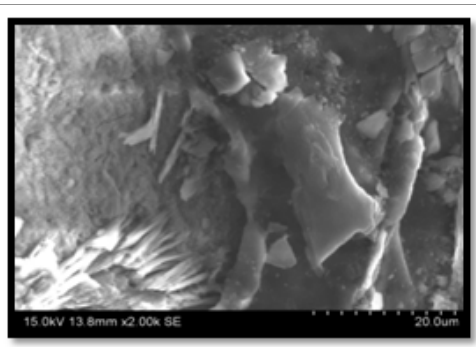

Fig.10 C. Magnification 2000X showing enamel tear out

DISCUSSION

The aim of this study was to investigate the characteristics of primerless light cure composite in orthodontic bonding and evaluate whether the bond strength and clinical handling properties were adequate for routine clinical use.

Heliosit® orthodontic composite lies intermediate (fig.11) between Transbond XT® and Rely-a-Bond® orthodontic composite with respect to shear bond strength. Heliosit® orthodontic composite achieves clinically significant bond strength values greater than 7 Mpa as suggested by Reynolds (6-9 MPa)[10-12].The bond strength achieved in our study for Heliosit® Primerless orthodontic adhesive is higher than the ones achieved by Aasrum et al[13](6.4 MPa) and Bradburn and Pender[14](7.22 MPa±2.11 MPa), but considerably less than those achieved by Joseph and Rossouw[15](17.80 MPa±3.54 MPa), Schmidlin et al[16](16.6 MPa±6.4 MPa) and Owais Khalid et al[9](10.54 MPa ±1.86 MPa) This could be on account of lower SBS value bonding be on account of lower SBS values can this be explained.

There were a few limitations in the study design. Every effort was made to replicate the oral environment but whatever the measures taken, the oral environment cannot be simulated outside the mouth because bio-degradation in the oral cavity is the result of a combination of distentegration and dissolution in saliva, chemical and physical degradation, wear caused by chewing food, erosion by the food itself and bacterial activity[17-18].Thus, such complex interactions of multiple processes cannot be reproduced in vitro[19].

Debonding characteristics of Heliosit® primerless light cured composite show a clean enamel surface (fig.12) without any enamel cracks during debonding due to its flowable nature and good clinical handling characteristics as compared to Transbond XT® (light cure adhesive and Rely-a-Bond self-cure adhesive.

Table 6 Comparison of Shear Bond Strength of three Groups in Megapascals (MPa)

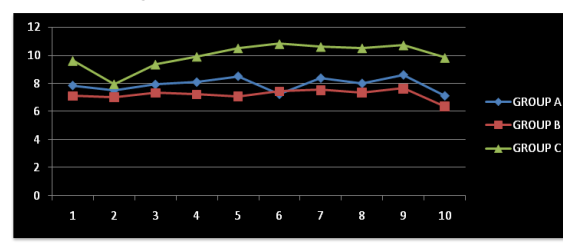

Fig.11 Group A- Heliosit® primerless composite (LC), Group B- Rely-a-Bond® self cure composite ,Group C -Transbond XT® light cure composite.

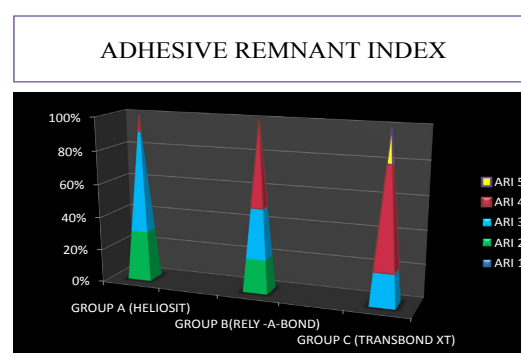

Fig.12 Showing Group A(Heliosit) with least ARI score

Modified ARI score [10]

1= All composite remained on the tooth with the imprints of the bracket base

2= More than 90% of the composite remained on the tooth

3= 10-90% of the composite remained on the tooth

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4= Less than 10% of the composite remained on the tooth

5= No composite remained on the tooth

Table.6 showing overall comparison between three orthodontic bonding adhesives

	Heliosit®	Rely-a-bond®	Transbond XT®
Mean bond strength	7.9 MPa	7.2MPa	9.99MPa
Enamel cracks during debonding	Less	Moderate	High
Clinical handling characteristics	Very good	Poor	Moderate
Working time	More	Very less	Moderate
Chair side time	Decreased	Moderate	Increased
Other use	As luting flowable composite for bonding retainer	No	No

CONCLUSIONS

Heliosit® primerless light cured orthodontic composite (Ivoclar Vivadent,Schaan, Liechtenstein,) has the following properties which make it suitable for routine use during orthodontic bonding procedures.

Clinically significant shear bond strength

Safe debonding characteristics without risk of enamel damage to teeth

Improved clinical handling characteristics

Decreased chair time since it is a primerless system

Faster curing because the material is translucent allowing better light penetration.

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