IN VITRO COMPARISON OF SHEAR BOND STRENGTH OF TRANSBOND XT AND HELIOSIT ORTHODONTIC AS DIRECT BRACKET BONDING ADHESIVES

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ABSTRACT

Heliosit Orthodontic was developed to ease the bonding procedure of orthodontic attachments by eliminating the need for primer application both on the bracket base and the etched tooth surface. The aim of this study was to determine the shear bond strength of Heliosit Orthodontic and then compare it with the control group of Transbond XT. The study consisted of two groups A and B of 80 human premolar teeth each bonded with mesh based metal brackets. The bonding agent used in group A was Transbond XT and that of group B was Heliosit Orthodontic. Every effort was made to control the cofounding variables including light tip distance, force of application of bracket, storage of teeth before and after bonding and orientation of bracket in the acrylic block this was followed by debonding of the brackets by shearing in a universal testing machine. It was found that the mean shear bond strength of Transbond XT was 25.5 MPa and that of Heliosit orthodontic was 10.54 MPa. The t-test revealed that there was a significant difference between the shear bond strength of the two groups. In conclusion the bond strengths of both the composites tested were greater than the recommended values of Reynolds for the composites to be clinically useful. It is recommended that the bond strength and the viscosity of the Heliosit Orthodontic be increased for it to be clinically as effective as Transbond XT.

Key words: *Shear bond strength, Transbond XT, Heliosit Orthodontic*

INTRODUCTION

The evolution of bands to brackets in everyday orthodontic practice was due to the efforts of Buonocore[1]who proposed acid etching of the tooth 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 an orthodontic therapy.

Transbond XT (3M ESPE St. Paul, Minnesota, USA) bonding system has become a gold standard for bonding of brackets and buttons in orthodontic practice because of its ideal consistency, light curing ability, superior tooth/bracket adhesion and availability. Due to the difficulty in comparing the properties of materials and brackets between different studies, most researchers have used Transbond XT as the control group. This helps in the direct comparison of the material to be tested with that of the Transbond XT within the same environment and testing parameters.

The quest to overcome the shortcomings of conventional filled composites has led to the development of "Flowable Composites". Flow composites merit great attention due to their clinical handling characteristics.[5] These being non-stickiness, fluid injectability, adequate working time and short cure time. These properties make flow composites especially useful during indirect bonding of attachments.

Heliosit Orthodontic a flowable composite although initially intended for bonding of brackets, its application as a bonding agent for bonding lingual retainers[6,7]and even as a luting cement for prosthesis[8] has been tested. Heliosit orthodontic as a bonding agent of brackets has been scarcely studied. The aim of the present study was to evaluate and compare the shear bond strength of brackets bonded with Heliosit orthodontic and Transbond XT.

The objectives of this study were to compare the Shear bond strength of Transbond XT and Heliosit Orthodontic used for bonding of Orthodontic brackets to enamel. With the null hypothesis being that the shear bond strength of Heliosit orthodontic will be insignificantly different from that of the Transbond XT.

METHODOLOGY

Eighty extracted premolar teeth of either arch or side with intact and well supported enamel were col-

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lected. Any tooth with evidence of crack lines caries, hyposplasia or any other enamel aberration were excluded from the sample. The collected teeth were then washed thoroughly with plain water and stored in formaldehyde to disinfect them and to prevent them from drying up. Randomization software (Random Allocation Software, Version 1.0.0, Isfahan, Iran) was used to split the total population of teeth into two groups (A and B) of forty teeth each. Group A represented the teeth to be bonded with Transbond XT and group B the teeth to be bonded with Heliosit Orthodontic. The teeth of the two groups were then stored in different containers with normal saline in them.

Although every effort was made to control bias in the study, blinding during the bonding of the brackets was not possible. This was because the two composites being used in this study differ in appearance and consistency amongst each other, plus primer was not applied before the placement of bracket in case of group B. Since all the brackets were bonded by one person, only he knew the details of the distribution of teeth according to the composite to be used. The teeth after the bonding of brackets and clearing of the excess composite were indistinguishable.

A standard bonding procedure was employed for bonding of all brackets of Group A. First step was the polishing of the buccal surface of each tooth with a polishing rubber cup and non-fluoridated pumice powder in a slow handpiece with copious amount of water. The tooth was then thoroughly dried till desiccated. This was followed by etching with 37% phosphoric acid for 15 seconds. The acid was then rinsed for 30 seconds with plain water. After air drying, a thin coat of Transbond XT primer was painted with a brush which is provided by the manufacturer in the Transbond XT bonding kit. The primer was light cured for ten seconds, this was followed by the application of the Transbond XT composite to the base of the bracket. The bracket was then firmly placed 3.5 millimeters (mm) away from the occlusal surface with a tooth positioning gauge (Falcon Medical Instruments, Sialkot, Pakistan) on the buccal ridge of the premolar tooth. The force to press the bracket against the tooth was measured with a tension/compression measuring gauge (Dentaurum, Pforzheim, Germany). All of the excess material was then removed with a carver. This was followed by light curing for ten seconds each from the mesial and distal sides with a light curing gun (CU – 100A Rolence Enterprises Taiwan). The light intensity of the light curing unit was calibrated after every ten minutes at 800 milliwatt/centimeter^2 $\pm$ 25milliwatt/centimeter^2 by a digital light intensity measuring device (Apoza Enterprise Company Limited, Taipei Hsien, Taiwan).

For Group B, the same protocol was followed as that for Group A, except that no primer was used before the flowable composite application. Also the Heliosit Orthodontic was light cured for 20 second each on both the mesial and distal side of the bracket as specified by the manufacturer.

Shear bond strength of the orthodontic bracket was tested in a universal testing machine (Instron Corporation, Canton, Massachusetts, USA) with a crosshead speed of 0.5mm per minute and a load range of 0.04-20 Kg (Figure I). For the shear testing the teeth were embedded in acrylic block. The teeth were oriented such in the acrylic block so that when engaged in the Universal Testing Machine the base of the brackets were parallel to the direction of the force, thus producing pure shearing forces. A ligature wire of 0.09 inch was tied around the wings of the bracket and its free end was engaged in the other crosshead of the testing machine[9, 10]. The load applied at the catastrophic failure was recorded in Newton and converted to stress (force per unit area) i.e. Mega Pascal (MPa) by the software installed in the computer connected to the Instron Universal Testing Machine. The dimensions of the bracket base were measured with a digital vernier caliper accurate to the 1/100th of a millimeter. The area of the brackets base was determined to be 10.5 mm^2. The formula used by computer was 1 MPa = 1 N/mm^2.

SPSS 11.0 software was used for the statistical analysis. The variable in this study is shear force per unit area measured in MPa. Descriptive statistics included for the study included the mean, standard deviation (SD), range, variance, minimum and maximum of SBS (MPa). Student's t-test was performed to determine the statistical difference between the shear bond strength of the two groups. Significance for all statistical tests was predetermined at $P < 0.05$.

RESULTS

The mean, standard deviation minimum and maximum shear bond strength values of the two groups are summarized in Table 1. The results of the student t-test are summarized in Table 2. Means of the two groups are represented in Figure 2. The descriptive statistics revealed that the Mean SBS of Transbond XT was 25.5 MPa and that of Heliosit orthodontic was 10.54 MPa. The t-test revealed that there was a highly significant difference in between the SBS of the two groups as the P value was less than 0.001.

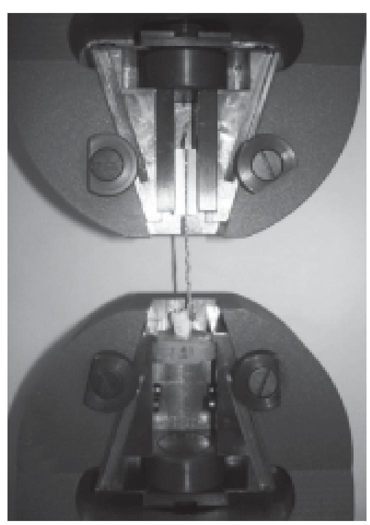

Fig 1: The tooth held in the crossheads of the universal testing machine before the debonding

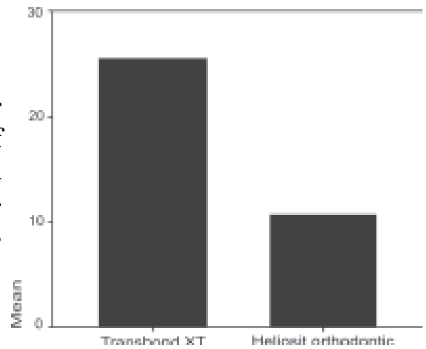

Fig 2: Mean shear Bond Strengths of Transbond XT and Heliosit Orthodontic in Mega Pascals

TABLE 1: MEAN, STANDARD DEVIATION, MINIMUM AND MAXIMUM SHEAR BOND STRENGTH OF THE TWO GROUPS IN MEGA PASCALS

Groups	N	Mean	Std. deviation	Minimum	Maximum
Transbond XT	40	25.4962	1.6942	22.00	28.92
Heliosit Orthodontic	40	10.5445	1.8676	6.55	14.48

TABLE 2: STUDENTS T-TEST TO EVALUATE THE SIGNIFICANCE OF SHEAR BOND STRENGTH BETWEEN TWO GROUPS

(I) Groups	(J) Groups	Mean difference (I-J)	Std. error	Significance
Transbond XT	Heliosit orthodontic	14.9517*	.4662	.000

*Significant Value $P < 0.05$

The mean difference is of very high significance at $P < 0.001$

DISCUSSION

The aim of this study was to improve the bonding and debonding procedure by reducing the time needed to bond the brackets by eliminating the need to apply primer/unfilled resin on the tooth prior to bracket placement. It was also anticipated that the time spent for the cleanup of tooth after the debonding of the brackets will be shortened because the composite residue after the brackets has been removed during debonding procedure without jeopardizing the ability to maintain clinically useful bond strength and without causing any deleterious effects on the tooth structure.

After the analysis of the results we will refute our hypothesis that the bond strength of Heliosit Orthodontic is similar to the Transbond XT, rather there is a marked difference between the SBS of the two bonding agents. Reynolds[11, 12] proposed a minimum bond strength of 6-8 MPa for orthodontic brackets to adequately sustain the orthodontic and occlusal forces during the orthodontic therapy. Although both the composites tested have a higher value than the recommended values of Reynolds it is the opinion of the authors that the SBS of Heliosit Orthodontic should be improved to make it upto par with the time tested Transbond XT.

The bond strength achieved in our study for Heliosit Orthodontic was 10.54 MPa with a standard deviation of 1.86 MPa. This bond strength 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) and Schmidlin et al[16] (16.6 MPa ± 6.4 MPa). We were not able to determine the cause of this vast difference in the mean SBS of Heliosit Orthodontic between different studies. This difference might suggest that inconsistent study designs make researchers unable to compare the results of the various studies.

The mean shear bond strength of Transbond XT achieved in our study was 25.5 MPa ± 1.69 MPa. This was higher than achieved in some previous studies[9, 17-27] but was comparable to the studies of Tecco et al[28] (23.23 MPa ± 5.23 MPa), D'Atillio et al[29] (23.47 MPa, ± 4.86 MPa), Rock and Abdullah[30] (8-23 MPa), Sinha et al[31] (18.9 MPa), Tang et al[32], Sunna et al[33] (11-22 MPa) and Rix et al[34] (20.19 MPa). When comparing our study to those of Tecco et al and D'Atillio et al it can be appreciated that the standard deviation (S.D.) in our study was considerably less. The higher S.D. in the studies of Tecco et al and D'Atillio et al might be due the fact that they did not keep the distance of the light source tip from the brackets constant. The variability of bond strengths due to the difference in light tip distance is also suggested by various other authors,[35-37] as well as that of the time of curing[36, 38-43] and thus it is recommended that this protocol be fol-lowed in future studies to make the results more accurate.

There were a few limitations in our invitro 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, this is because the bio-degradation in the oral cavity is the result of a combination of; disintegration and dissolution in saliva, chemical and physical degradation, wear caused by chewing food, erosion by the food itself, and bacterial activity,[44,45] and thus it is such a complex interaction of processes that it cannot be reproduced in vitro.[44]

CONCLUSIONS

There was a significant difference in the shear bond strength of the Transbond XT and Heliosit Orthodontic in our study. Although the bond strengths of both the composites tested were greater than the recommended values of Reynolds, it is the recommendation of the authors that the Transbond XT be preferably used for bonding of the orthodontic attachments, because of its higher bond strength. We would also recommend that these composites be tested invivo in a randomized clinical control trial.

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