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Comparison of shear bond strength of brackets bonded with a conventional adhesive system and a resin based single component bonding material- An Invitro study

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Abstract

Introduction: Helios it Orthodontic (resin based, single component) was developed to ease the bonding procedure of orthodontic attachments by eliminating the need for primer application.

Aims & Objectives: This study was done to compare the shear bond strength of Trans bond-XT in comparison with Helios it Orthodontic and to compare the Adhesive Remnant Index.

Materials & Methods: The study consisted of Groups A and B total of eighty extracted premolar. Group A were bonded with Trans bond XT, Group B with Helios it Orthodontic. This was followed by debonding of brackets by universal testing machine. After debonding

each enamel surface was evaluated with a stereomicroscope & ARI were recorded.

Results: Group A had mean shear bond strength value of 11.40 Mpa when compared to Group B of 5.15. The ARI scores revealed no significant difference between the two groups (P>0.05).

Conclusion: The shear bond strength for Helios it orthodontic was comparatively less when compared to Trans bond XT. Helios it had clinically nonacceptable bond strength. Flowable composite can be advantageous as fewer steps in bonding process results in less errors. Further In- Vivo performance of flowable composite is yet to be analysed.

Keywords: Shear bond strength (SBS), Adhesive Remnant Index (ARI), Newton (N), Megapascal (Mg)

Introduction

In 1955, Buonocore introduced the acid etching bonding technique, and the concept of bonding resin to enamel has developed application in all fields of dentistry, including bonding of orthodontic brackets. By the 1970's, bonding of orthodontic brackets has become an accepted clinical technique.[1]

Since then, many new bonding agents have been developed such as composite resins, conventional glass ionomer cements, resin-modified glass-ionomer cements, polyacid modified composites (compomers), a two-step self-etch primer and adhesive and a one-step self-etch adhesive with different polymerization mechanism such as chemically, light or dual curing.[2]

Composite resins are one of the most frequently used adhesives in orthodontic bonding of brackets etc[2]. Traditional dental composite resins are densely loaded with reinforcing filler particles for strength and wear resistance. However, such a system has a number of shortcomings such as loss of enamel after acid etching, enamel damage caused by post debonding clean up procedures and enamel fracture which may take place during debonding[3].

The amount of residual bonding resin on the surface of the tooth or the bracket is an important factor for clinicians in selecting an orthodontic adhesive. Although difference in adhesive scores reflect the bonding strength, adhesive systems that show less residual resin are preferable because they are easier and safer to clean up after debonding procedure[39].

To overcome the shortcomings of conventional filled composites and to enhance the speed of orthodontic bonding procedure, no-primer adhesives have been introduced i.e., "Flowable Composites" (Helios it orthodontics- Ivoclar Vivadent)[24].

Helios it Orthodontic (Ivoclar Vivadent) although initially intended for bonding of brackets, its application as a bonding agent for bonding lingual retainers[20,21] and even as a luting cement for prosthesis[22] has been tested. Helios it orthodontic as a bonding agent of brackets has been scarcely studied.

Therefore, the aim of this paper was to evaluate and compare the shear bond strength and the adhesive remaining on the enamel of a brackets bonded with a conventional adhesive system Trans bond XT (3M Unitek) and in comparison, with a resin based, light cured, highly translucent, single-component bonding material Helios it orthodontic (Ivoclar Vivadent).

Materials and methods

This study was conducted on eighty extracted human premolar teeth in the Department of Orthodontics and Dentofacial orthopedics, HKE'S. S.N. Dental College, Gulbarga. These premolars were obtained from a group of patients who underwent therapeutic extractions. Only morphologically well-defined teeth with no caries, fractures, structural defects or any restoration were included.

The extracted premolar teeth were cleaned with distilled water to remove blood or any tissue debris. They were stored in 0.1% wt/ vol thymol solution to prevent bacterial contamination and dehydration. These eighty teeth were mounted with clear acrylic. The buccal surfaces of each tooth were polished with pumice slurry using rubber cup mounted on a low-speed hand piece.

The eighty extracted premolar teeth were divided into two groups (A and B) of forty teeth each. Group A represented the teeth to be bonded with Trans bond XT (3M Unitek) and Group B the teeth to be bonded with Helios it Orthodontic (Ivoclar Vivadent)

All brackets of group A are bonded with a standard procedure. The polished and dried buccal surface of each tooth was etched with 37% phosphoric acid for 30sec. The acid was then rinsed for 15sec with water and dried with oil –free and moisture-free air until the enamel had a faint white appearance.

A thin film of Trans bond XT primer was applied to the etched enamel surface with a brush. This was followed by the application of Trans bond XT composite to the base of bracket. The metal bracket (Gemini metal brackets, 0.022" slot, MBT, 3M Unitek, USA) with the help of bracket holder, were pressed gently at the Centre of the buccal surface of the teeth to ensure uniformity in the bracket seating. Subsequently, the excess adhesive was removed from the margins of the bracket with the help of an explorer. Then, the adhesive was light cured for 20 sec each on mesial and distal sides with a light curing gun.

The same protocol was followed as that of Group A, except that of no primer was used before the flowable composite application. Also, the Helos it Orthodontic was light cured for 20sec each on both mesial and distal side of the bracket as specified by the manufacturer. Both the specimens were stored in distilled water separately.

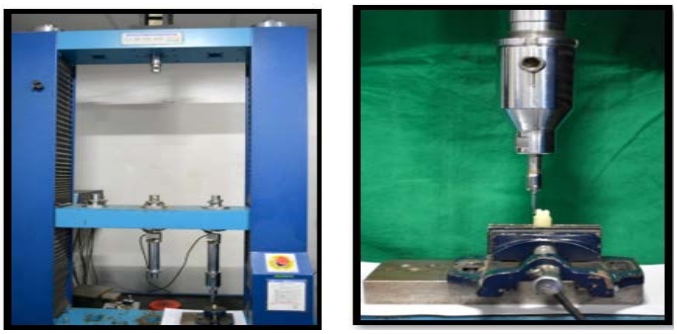

Fig 1: (a) Universal Testing Machine (b) Close-up view with tooth mounted on it.

A. Shear Bond Strength Testing

Bond strength testing was carried out on a universal testing machine (Star testing systems, made in India, Model STS 248) The cross head of the universal testing machine moved at a uniform speed of 3mm/min. The load was progressively increased till the bracket debonded from the tooth surface. The debonding force was measured in terms of Newton's. This was repeated for all the sample. The bond strength value obtained in terms of Newton's were converted into megapascals (MPa) by dividing the values in terms of Newton's by the surface area of bracket base. (MPa= $N/mm)^{2.}$

B. Evaluation Of the Residual Adhesive

After debonding each enamel surface was evaluated on a stereomicroscope (Wuzhou New found instrument co. Ltd, China. Model: XTL 3400E) under 15X magnification and rated according to the ARI scores proposed by Artun&Bergland[10], as follows.

0 = No composite remaining on the enamel.

1 = Less than half the composite remaining on the enamel.

2 = More than half the composite remaining on the enamel.

3 = All composite remaining on the enamel.

C. Statistical Method

The values obtained from the shear bond strength testing and the Adhesive Remnant Index was tabulated and analyzed using Z- Test to determine the statistical significance of the data.

Result

The shear bond strength of the two groups was recorded using universal testing machine and subjected to statistical analysis. Table 1 shows the shear bond strength values of both groups. The descriptive statistics for shear bond strength of the two groups included the mean, standard deviation, Z values (P value) were calculated and presented in Table 2. The Z -test revealed that there was a highly significant difference in between the two groups as the P value was less than 0.0001. The mean shear bond strength of Trans bond XT was 11.40Mpa and the mean SBS of Helios it orthodontic was 5.16Mpa

Table 1: Comparison of mean shear bond strength of two groups using Z – test

	Group A Trans bond XT	Group B Helios it
Mean	11.40	5.16
Sd	7.15	1.82
Z value (p value)	5.36>1.96(<0.00001) is significant	

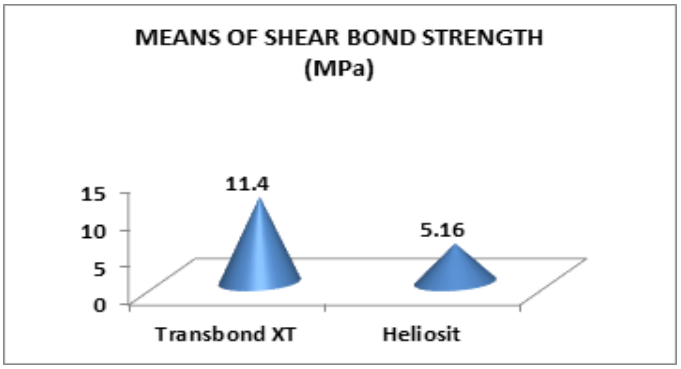

Fig 2: The mean shear bond strength of Trans bond XT and Helios it

A. Stereomicroscopic Examination Results

The ARI scores of the two groups examined are presented in Table 4. The descriptive statistics of the ARI included the mean, SD and P value which are tabulated in Table 5.

The Z-Test revealed that there was no statistically significant difference between the two groups (P > 0.05)

Table 2: Mean and Standard Deviation (SD) Of ARI Score. Comparison By Z Test.

	Group A **Trans bond XT**	**Group B** **Helios it**
Mean	1.95	1.80
Sd	0.77	0.75
Z value (p value)	0.88<1.96(0.1894>0.05**)** is not significant	

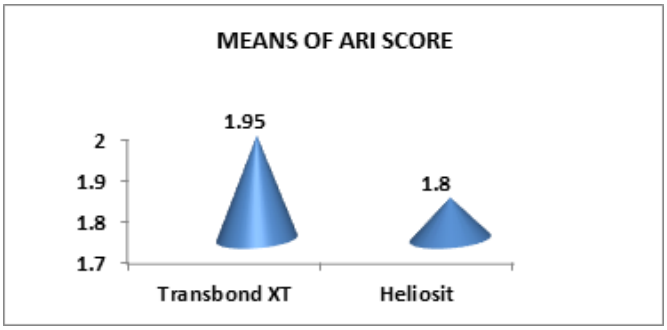

Fig 3: ARI scores of both groups

Discussion

The direct bonding of orthodontic brackets has revolutionized and advanced the clinical practice of orthodontics. However, there is a need to improve the bonding procedure by saving time and also minimizing enamel loss, without jeopardizing the ability to maintain clinically useful bond strength[16].

Traditionally, the use of a primer was an essential part of bonding procedure of composite adhesives to allow good wetting and penetration of the adhesive into the enamel surface[3].

More recently a new resin based, flowable composite orthodontic (Helios it orthodontic – Ivoclar Vivadent)

has been introduced that does not require the use of a primer during bonding. The present in vitro study was undertaken to compare the shear bond strength and the adhesive remaining on the enamel of a bracket bonded with a conventional adhesive system (Trans bond XT) and in comparison, with a resin based, light cured, highly translucent, and single- component bonding material Helios it Orthodontic (Ivoclar Vivadent).

In our study extracted human premolar were taken which were stored in thymol solution for a maximum of 5-6 months, which was in accordance to Salman, who concluded that water, isotonic saline solution and thymol solution can be used as storage medium which do not affect the bond strength. The teeth were mounted in self-cured acrylic block. The brackets were bonded to the extracted premolar teeth with one of the two composite according to the recommended procedure and debonded. Assessment of shear bond strength was then done using the universal testing machine.

After debonding procedure, the enamel surface of each premolar tooth was examined on stereomicroscope for adhesive remnant index score. The bond strength achieved in our study for Helios it orthodontic is 5.16Mpa with a standard deviation of 1.82Mpa. This bond strength was less than the once achieved in the previous studies by Aasrum et al (6.4 Mpa)[13], Bradburn & Pedder (7.22 Mpa)[12], Joseph and Rossouw (17.80 Mpa +_ 3.54 Mpa)[11].

We are not able to determine the cause of this vast difference in the SBS of Helios it orthodontic between different studies. The mean shear bond strength of Trans bond XT achieved in our study is 11.40 Mpa +_ 7.15 Mpa. This was higher than one achieved in some previous study of Sunna et al (11.22 Mpa)[15], Rock and Abdullah (8.23 Mpa)[14] but less when compared to the studies of Tecco et al (23.23 MPa + 5.23 MPa)[3].

The SBS value required for clinical use in orthodontics is not well determined. Certainly, the bond between the bracket base and the enamel surface should be strong enough to resist stress and occlusal forces during the treatment, while the bracket could be detached easily and without damaging the enamel surface at the time of appliance removal.

Reynold suggested that the bond strength values of between (5.9Mpa – 7.8Mpa)[9] are sufficient for a clinically effective orthodontic bond, although clinically valid bond strengths have been registered as resisting in – vitro force of 4.9Mpa.

After the analysis of the result, we will refute our hypothesis that, there is a marked difference between the SBS of two bonding agents i.e., Trans bond XT (11.40 MPa) and Helios it orthodontic (5.16 Mpa). Helios it orthodontic, flowable composite has lesser SBS when compared to conventional composite (Trans bond XT).

It is the opinion of some authors that the SBS of Helios it orthodontic should be improved to make it up to par with the time-tested Trans bond XT.

The ARI score system has proved to be of value in studies of orthodontic adhesive system. It is quick and simple method that needs no special equipment. However, its reliability requires investigation, with special attention on effects of magnification on evaluation of adhesive remnant.

The results of present study for ARI scores showed that there was no significant difference with P> 0.05 between the group that was bonded with flowable composite (Helios it orthodontic) as compared with conventional composite (Trans bond XT).

The present investigation revealed that the flowable composite can be used for bonding orthodontic brackets without the intermediate low- viscosity resin, while

concomitantly increasing bond strength and reducing the working time.

Considering the in vitro nature of the present study, the finding should be interpreted with caution while applying it for clinical application. It was found that shear bond strength is significantly higher in vitro than they are after comprehensive orthodontic treatment in vivo. Optimum conditions for placement of brackets and moisture isolation exists only in the in vitro environment. On the other hand, in vivo studies of shear bond strength testing often have the problem that, in the oral environment, saliva penetrates between the surfaces of brackets and further the blood contamination at any stage of the bonding procedure results in a significant and drastic drop in the shear bond strength of orthodontic brackets.

Further research should focus on the in- vivo performance of Helios it orthodontic for its effective bond strength.

Conclusion

The following conclusion can be drawn from the study of this paper

1. The shear bond strength for Helios it orthodontic was comparatively lesser with that of SBS of Trans bond XT.
2. The ARI scores tested showed no statistical significance between the two groups.

In general, though the flowable composite (Helios it orthodontic) reduces the working time by reducing the number of steps in bonding procedure, but there is need to still improve its bond strength comparative to the traditional composite (Trans bond XT).

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