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# Original Research

## Effect of different bracket base retention features on shear bond strength- An invitro study

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***ABSTRACT:***

**Introduction**: The frequency of bond failure during orthodontic treatment has prompted many manufacturers to improve bracket retention designs. Bracket retention mechanism, is one of the factors which determine the bond strength of the adhesive. The aim of this study was to evaluate the effect of different bracket base retention features on shear bond strength. **Materials and methods**: Brackets with four different base features were tested: polymer coated base {Nu Edge (TP Orthodontics)}, Foil mesh pad {Mini Diagonali (Leone)}, Photochemically etched base {Minimaster (American Orthodontics)}, Laser structured base {Discovery (Dentaurum)}. A scanning electron microscope was used to examine the base design. Brackets were bonded to human teeth and then debonded on the Universal testing machine. **Results**: The results show that the overall mean SBS associated with polymer coated base was significantly higher than the other brackets ($P < 0.05$) with a mean value of 20.73 ± 5.27 MPa. The mean SBS values of foil meshpad, photochemically etched base and laser structured base was 14.32 ± 4.51MPa, 17.75 ± 5.19MPa, and 20.44 ± 4.76 MPa respectively. **Conclusions**: The polymer coated base brackets showed the highest shear bond strength followed by laser-structured base and photochemically etched base brackets. The simple foil mesh pads showed the lowest shear bond strength.

**Key words**: shear bond strength, bracket base design, laser structured base, polymer coated base, bonding.

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### INTRODUCTION

Bonding orthodontic brackets to teeth has been a common procedure for last 40-50 years. The frequency of bond failure during orthodontic treatment has prompted many manufacturers to improve bracket retention designs.[1] Bracket retention mechanism,[2] is one of the factors which determine the bond strength of the adhesive. We can increase the bracket base retention by various mechanisms i.e. mechanical or chemical means or a combination of both .[3]

The Discovery (Dentaurum, Ispringen, Germany) brackets are a new type of laser structured base retention[4] which are produced by metal injection molding of stainless steel AISI 316 L and sintering to theoretical density.

The TP Orthodontics company (La Port, IN) incorporated the Primekote polymer[5] into the base of the Nu-Edge bracket, which promised increased bond strength of the bracket to the adhesive system, and which must remain constant even after 2 years of treatment

In Mini Master brackets, 80-gauge mesh is placed over a foil base which has been thoroughly etched via photochemical etching. The resultant porosities provide the necessary retention.[6] There are two main tests which we can use to measure and evaluate the strength of the orthodontic adhesives i.e. shear and tensile bond strengths. In shear bond strength test, the force is directed parallel to the long axis of the tooth and as closely as possible to the bracket-tooth interface.[6,7,8]

To be considered clinically successful for orthodontic purposes the orthodontic brackets should have an optimal bond strength of 5.9 to 7.8 mega-Pascals (MPa).[9]

This study was done to evaluate the effect of different types of bracket bases on shear bond strength and to determine which type of base presents the highest success rate.

## MATERIALS AND METHODS

This study was conducted on 120 extracted human premolar teeth which were non-carious and had intact buccal tooth surfaces. This study was cleared by the Ethical Committee of the institute. The extracted teeth that were collected were cleaned, washed, debrided and stored in a solution of 0.1% (wt/vol) thymol to prevent dehydration and bacterial growth.

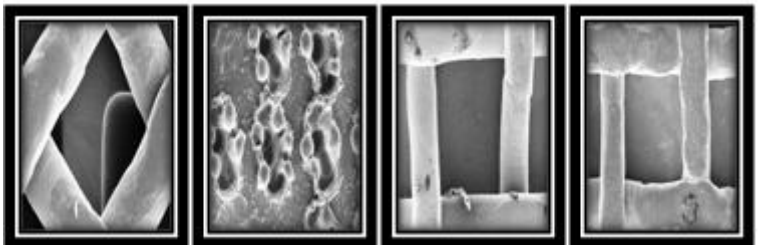
## BRACKETS UNDER STUDY

One hundred and twenty orthodontic brackets with different bracket retention mechanisms were chosen for evaluation (Table 1). The brackets taken into study are as under:

**Table 1: Different brackets, their base designs and number of samples**

| Bracket | Type of base | Number tested in each group |
|---|---|---|
| Nu Edge (TP Orthodontics) | Polymer coated base | 30 |
| Mini Diagonali (Leone) | Foil mesh pad | 30 |
| Minimaster (American Orthodontics) | Photochemically etched base | 30 |
| Discovery (Dentaurum) | Laser structured base | 30 |

Field emission scanning electron microscopy photographs at 500X magnification for the different bracket bases, in the ‘‘as received’’ condition, are presented in Fig 1.



**A B C D**

**Fig 1: A) Photochemically etched base B) Laser structured base C) Sintered foil mesh pad base D) Polymer coated base**

## MOUNTING OF THE BONDED TEETH FOR TESTING THE SHEAR BOND STRENGTH

The acrylic blocks used to mount teeth were fabricated with self cure acrylic resin. These acrylic blocks were fabricated using a mold of stainless steel. Each tooth was placed in that mold filled with self cure acrylic and the roots of teeth were embedded in it up to 2-3mm apical to cemento-enamel junction. Crowns were kept exposed to facilitate easy bracket bonding on buccal surface.

Based on the type of bracket base, the whole sample was divided into four groups (A1, B1, C1 & D1) consisting of 30 samples each.

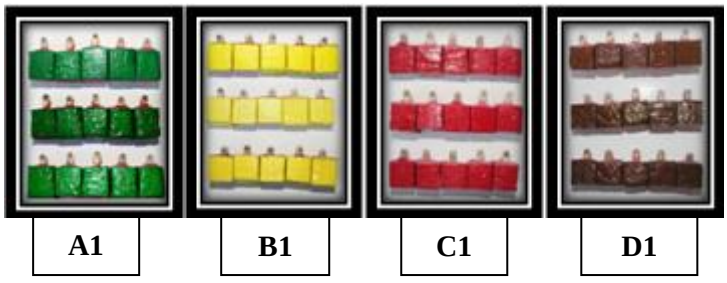
## COLOUR CODING OF THE ACRYLIC BLOCKS FOR IDENTIFICATION (FIG 2)

**Group A1** The acrylic blocks belonging to group A1 were color coded with green

**Group B1** The acrylic blocks belonging to group B1 were color coded with yellow.

**Group C1** The acrylic blocks belonging to group C1 with red.

**Group D1** The acrylic blocks belonging to group D1 with brown.



**A1 B1 C1 D1**

**Fig 2: Color coding: A1) Polymer coated base B1) Sintered foil mesh pads C1) Photochemically etched base D1) Laser structured base**

## TESTING OF SHEAR BOND STRENGTH

The bonding procedure followed was as per the Protocol recommended by the manufacturer**.** The test to ascertain the bond strength was conducted by using an Instron Universal Testing Machine. The prepared acrylic blocks were positioned in the Instron Universal Testing Machine with the long axis of the tooth parallel to the direction of the load application.

And the load was applied in a gingivo-occlusal direction, using a knife-edged rod (custom made). A load side density of 0-50 Kgs was set in the Instron Universal Testing Machine and the cross head speed was adjusted for 1mm per minute.

## RESULTS AND DISCUSSION

The mean SBS with respect to different bracket bases were listed in **Table 2 and Fig 3**.

**Table 2: Shear bond strength (MPA) in various groups**

| Group | Mean | SD | Minimum | Maximum | F-value | P-value |
|---|---|---|---|---|---|---|
| A1 | 20.73 | 5.27 | 12.08 | 32.08 | 5.443 | 0.002* |
| B1 | 14.32 | 4.51 | 2.68 | 21.18 | | |
| C1 | 17.75 | 5.19 | 5.54 | 28.51 | | |
| D1 | 20.44 | 4.76 | 11.11 | 28.08 | | |

***Statistically Significant Difference (P-value<0.05)**

Evaluating the effect of groups on SBS, ANOVA revealed significant effect of groups on SBS (F=5.443, p 0.002*)

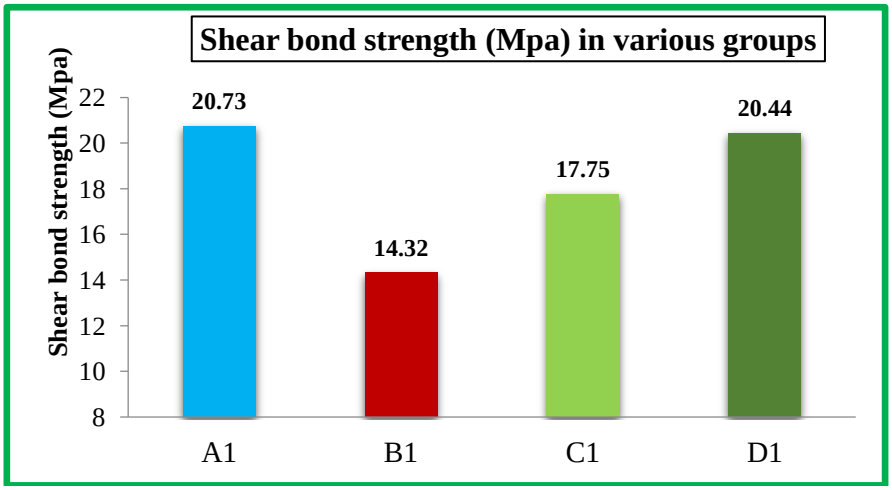



**Fig. 3: Shear bond strength (Mpa) in various groups**

Intergroup comparison based on shear bond strength was made and the results are shown in **Table 3.**

Comparison of the mean SBS among different groups using Tukey's test showed the following results:

**Table 3: Intergroup comparison based on shear bond strength in various groups**

| Group comparison | Mean difference | P-value | Significance |
|---|---|---|---|
| A1 vs B1 | 6.41 | 0.001 | S |
| A1 vs C1 | 2.98 | 0.024 | S |
| A1 vs D1 | 0.29 | 0.872 | NS |
| B1 vs C1 | -3.43 | 0.013 | S |
| B1 vs D1 | -6.11 | 0.001 | S |
| C1 vs D1 | -2.69 | 0.042 | S |

**NS: Not significant; S: Significant**

In the present research, all the groups showed optimal mean values of the SBS. The brackets with polymer coated base achieved the highest mean shear bond strength which was closely followed by brackets with laser structured base while brackets with photochemically etched base and foil mesh pads had comparatively lower mean shear bond strengths. The lowest individual SBS of a bracket was 2.68MPa which belonged to group B1 and the highest individual SBS of a bracket was 32.08MPa which belonged to group A1. This huge variation between minimum and maximum values could be the result of variations in adhesive layer thickness. Every adhesive has its own critical thickness at which the SBS is highest.[10]

The SBS of photochemically etched base was greater than foil meshed brackets and this was in accordance with the study of MacColl et al. [11] which considered that the retention of foil-meshed brackets is significantly enhanced if they are either microetched/photoetched or sandblasted before bonding to the teeth. The results of the study conducted by Chaudhary GH et al. [12] also showed the similar results. The laser structured bracket base retention mechanism provided high SBS (20.44 ± 4.76MPa) when compared with the photochemically etched base and simple foil mesh base bracket

retention mechanism. This was in consensus with the study done by Sorel et al.[1] and the other previously published data which concluded that the shear bond strength results were more favorable for the laser structured base than simple foil mesh base bracket retention mechanism. The adhesive bond strength of the brackets with a laser structured retention base appears to be significantly larger (twice as much) than single-mesh bond strength.[1] Fleishmann et al.[13], found that the metallic bracket with laser retentions was the one with the highest mean adhesion force although there were no significant differences between the evaluated brackets. Devanathan [14] who studied Nu Edge brackets thoroughly also came to the same conclusion that polymer coated base resulted in enhanced bond strength. Dalaie et al. [6] study also had the same findings and concluded with that the brackets with laser structured base had the highest mean SBS followed by the bracket with mechanical lock base and bracket with photochemically etched base. The undercuts created by the laser irradiation provide retention. These structures are possibly responsible for the high SBS of this bracket. The brackets with the polymer coated base exhibited the highest SBS. This result was in accordance with the study done by Vargas et al.[5] which concluded that the polymer coated bracket showed better adhesion than the Morelli without polymer coated base since its shear strength was approximately 12.33% higher. Mini Diagonali brackets are fabricated as a single mass. The undercuts present probably provide less mechanical retention and this may be the reason of the lowest SBS in this group. Goyal et al [15] found Mini Diagonali brackets achieved the lowest mean shear bond strength in their research. However, in all four groups the mean SBS values were higher than the minimum required bond strength value of 6-8MPa and thus they may be safely used in clinical setting.

## CONCLUSION

1. In this study, shear bond strength of all four types of brackets tested was well above the average clinically acceptable values thus they may be safely used in clinical settings.
2. The polymer coated base brackets showed the highest shear bond strength followed by laser-structured base and photochemically etched base brackets
3. The simple foil mesh pads showed the lowest shear bond strength.
4. Bond strength of the bracket does not solely depend on the bracket base area but also on the different retention mechanisms incorporated in the bracket bases.

## REFERENCES


1. Sorel O, Alam RE, Chagneau F and Cathelineau G. Comparison of bond strength between simple foil mesh and laser-structured base retention brackets. Am J Orthod Dentofac Orthop. 2002;122:260-6
2. Giudice GL, Giudice AL, Isola G, Fabiano F. Evaluation of bond strength and detachment interface distribution of different bracket base design. Acta Medica Mediterranea,2015,31;585
3. Bishara SE, Fehr DE, Jakobsen JR. A comparative study of the debonding strengths of different ceramic brackets, enamel conditioners and adhesives. Am J Orthod Dentofac Orthop. 1993;104:170-9
4. Sernetz F, Binder F. Improvement of bond strength of orthodontic titanium brackets and tubes by laser structuring. Proceedings of the 5th International Conference on Joining Ceramics, Glass and Metal; 1997 May 12-14; Jena, Germany. DVS Berichte Band 184, 1997, 82-85.
5. Vargas EO, Nuernberg CC, Maciel JV, Bolognese AM. Influence of Primekote polymer in orthodontic bonding. Rev Odontol UNESP. 2017 Mar-Apr; 46(2): 61-65
6. Dalaie K, Mirfasihi A, Eskandarion S, Kabiri S. Effect of bracket base design on shear bond strength to feldspathic porcelain. Eur Journal of Dentistry 2016;10:3:351-355
7. Knox , Hubsch P, Jones ML. Influence of bracket base design on the strength of the bracket-cement interface. Journal of Orthodontics/vol27/2000/249-54
8. Sharma-Sayal SK, Rossouw PE, Kulkarni GV, and Titley KC. The influence of orthodontic bracket base design on shear bond strength. Am J Orthod Dentofac Orthop. 2003;124:74-82
9. Bishara SE; Soliman MM; Oonsombat C ,Laffoon JF. The Effect of Variation in Mesh-Base Design on the Shear Bond Strength of Orthodontic Brackets. Angle Orthod 2004;74:400–404.
10. Bishara SE, Gordan VV, VonWald L, Olson ME. Effect of an acidic primer on shear bond strength of orthodontic brackets. Am J Orthod Dentofacial Orthop 1998; 114:243-7
11. MacColl GA, Rossouw PE, Titley KC and Yamin C. The relationship between bond strength and orthodontic bracket base surface area with conventional and microetched foil-mesh bases. Am J Orthod Dentofac Orthop.1998;113:276-81
12. Chaudhary GH, Mattevi GS, Gakunga PT. Comparison of Shear Bond Strength of Four Types of Orthodontic Brackets with Different Base Technologies. APOS Trends Orthod 2017;7:273-8
13. Fleishmann LA, Sobral MC, Santos GC Junior, Habib F. Estudo comparativo de seis tipos de braquetes ortodônticos quanto à força de adesão. Rev Dent Press Ortodon Ortop Facial 2008; 13: 107-16.
14. Devanathan D. Method to improve bracket bond durability, 2013. http://www.tportho.com.
15. Goyal A et al. Retentive shear strengths of various bonding attachment bases: An in vitro study. The Journal of Indian Orthodontic Society,2013;47(3):121-127