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Research Article

Shear Bond Strength of Hybrid Orthodontic Brackets

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Abstract

Aim: The aim of this study was to evaluate the shear bond strength of hybrid orthodontic brackets, composed of a polymeric base and a metallic body, attached to human teeth.

Materials and Methods: Forty extracted human premolars were obtained and divided into two groups of 20 each: group 1 (control), metallic bracket NU-Edge (TP Orthodontics), and group 2, NV Hybrid (TP Orthodontics). After acid etching all brackets were direct bonded with application of Orthoprimer (Morelli Orthodontic Products) and Orthobond adhesive paste (Morelli Orthodontic Products) in both groups. All products were used according to the manufacturer's instructions. A universal testing machine was used to apply an occlusal shear force directly onto the enamel-bracket interface at a speed of 1.0 mm/min. groups were compared using Student's t test.

Results: Mean results and standard deviations for the groups were: group 1 = 4.85 Mpa (2.46), group 2 = 10.24 Mpa (4.66). A significant difference was observed in the bond strengths of the two groups evaluated ($P < .0001$).

Conclusion: The use of hybrid brackets with a polymeric base has resulted in higher adhesion strength values if compared to the conventional metallic brackets.

Keywords: *Acid Etching; Bonding; Brackets; Orthodontics; Shear-Bond Strength*

Introduction

In modern society the esthetic aspect of the orthodontic therapy is important because the number of adults that undergo orthodontic therapy is increasing [1]. The development of appliances that combine both acceptable esthetics and adequate technical performance is an important goal. Plastic brackets made of polycarbonate and plastic molding powder were first introduced by Newman [2,3]. The use of plastic brackets was limited because of their poor physical properties, resulting in problems such as fracture, stain, and distortion of the brackets. Lower bond strengths were also noted [4,5].

Recently, brackets composed of a polymeric base and a metallic body were presented. These hybrid brackets were developed to improve esthetics during orthodontic treatment, with a continuous effort to overcome several problems of some ceramic and/or plastic brackets: brittleness leading to bracket or tie-wing failure, iatrogenic enamel damage during debonding, enamel wear of opposing teeth, and high frictional resistance to sliding mechanics [6,7].

Purpose of the Study

The purpose of this study was to determine the shear bond strength of hybrid orthodontic brackets bonded to enamel. The null hypothesis was that there would be no difference in the shear bond strength between groups whether a metallic or a hybrid bracket was used.

Materials and Methods

Sample

A total of 40 human premolars free from caries, cracks, and fillings were used. These teeth had been extracted for orthodontic reasons and with the informed consent of the patients. The teeth were collected and stored in distilled water at room temperature. The teeth were cleansed of soft tissue and mounted in plastic rings with acrylic resin. The crowns were oriented so that the labial enamel surface would be parallel to the force during the shear strength test.

Bonding procedure

The teeth were divided into 2 groups, and brackets were bonded on the buccal surfaces according to the manufacture's instructions. Group I (Control): Metallic brackets NU–Edge (TP Orthodontics) and Group II: Hybrid brackets NV-Hybrid (TP Orthodontics). The average bracket base surface area was determined to be 11.87 mm^2 in the group I, and 12.24 mm^2 in the group II.

The buccal enamel surface of each tooth was dried and etched with 37% phosphoric acid during 15 seconds. The specimens were then rinsed with distilled water for 10 seconds and dried with oil-free air. In all cases, the frosty white appearance of etched enamel was noticed.

A layer of primer (Orthoprimer, Morelli Orthodontic Products, São Paulo, Brazil) was applied on the tooth. All brackets were bonded with Orthobond adhesive paste (Morelli Orthodontic Products). Firm pressure was used to completely seat the bracket on the tooth, and excess resin removed with a small dental probe. Each bracket was light-cured for 20 seconds with Radii LED Plus (Southern Dental Industries, Victoria, Australia). The light source was placed on the mesial side of the bracket/tooth interface for half the total cure time and on the distal side for the remaining time. The power densities were checked by a handheld radiometer (Demetron 100, Demetron Research, Dannbury, Connecticut, USA) to ensure that they were operating properly after each bracket was bonded and to certify the manufacturers' data.

Testing procedure

The bracket-tooth interface for each specimen was tested after 30 minutes in shear with a sharp, chisel-shaped rod attached to a universal testing machine (DL 500, EMIC, Paraná, Brazil) at a crosshead speed of 1.0 mm/minute until bracket failure. The edge of the chisel was carefully positioned at the interface of the tooth and bracket. The force in newtons (N) was recorded for each specimen and divided by the surface area of the bracket pad to obtain the shear stress value in megapascals (Mpa).

After debonding, the teeth and brackets were examined under 10x magnification (Olympus Optical, Hamburg, Germany) to evaluate the amount of resin remaining on the tooth. The adhesive remnant index (ARI) was used to describe the quantity of resin remaining on the tooth surfaces. The ARI score has a range between 0 and 3 as follows: 0, indicates that no composite remained on the enamel; 1, less than 50% of composite remained on the tooth surface; 2, more than 50% of the composite remained on the tooth; 2, 100% of the composite remained; and 3, all of the composite, as well as the impression of the bracket base, remained on the tooth [8].

Statistical analysis

Descriptive statistics, including the mean, standard deviation, and minimum and maximum values, were calculated for each group tested. The data of bond strength of each group were verified for homogeneity with the Shapiro-Wilk method. The Student T test was used to determine whether significant differences were present in the bond strengths between the 2 groups. The Mann-Whitney U test was used to evaluate differences in the ARI scores among groups. All statistical analyses were performed with the software Prism 5.0 (Graph-Pad Software, San Diego, California, USA) at a 5% level of significance.

Results

Both groups had normal distributions according with the Shapiro-Wilk test [Group I (P = .7915) and Group II (P = .2539)]. The descriptive statistics comparing the shear strength of the two groups are shown in table 1. The Student's t-test showed significant differences (P < .0001) between the groups evaluated. The NV Hybrid group had a mean shear bond strength of 10.24 + 4.66 MPa, whereas the group with conventional bracket had a mean of 4.85 + 2.46 MPa.

	N	Mean	SD	Range	t-Test*
Control	20	4.85	2.46	0.71 - 10.11	A
NV Hybrid	20	10.24	4.66	0.19 - 18.69	B

Table 1: *Results of student's t-test comparing shear bond strengths (MPa) of groups.*
**P < .0001. Different letters indicate statistically significance difference.*

The ARI scores for the two groups tested are listed in table 2. The results of Mann-Whitney U comparisons for the ARI indicated that there was a significant difference (P = .00032) between the group test as compared with the control group. With the use of the bracket NV Hybrid, there was a higher frequency of ARI scores of 1, which indicated that less composite remained on the teeth.

	N	0	1	2	3
Control	20	1	1	3	15
NV Hybrid	20	0	8	7	5

Table 2: *Frequency Distribution and Results of Mann-Whitney U test* of the ARI[#] of Experimental Groups.*
**P=.0032*
[#]ARI indicates adhesive remnant index; 0- No adhesive remaining on tooth; 1- Less than half of enamel bonding site covered with adhesive; 2- More than half of enamel bonding site covered with adhesive; 3- Enamel bonding site covered entirely with adhesive.

Discussion

The null hypothesis tested was rejected. The results of the present study indicated that the shear bond strength of NV hybrid brackets was significantly higher when compared with metallic brackets. The use of Orthobond associated with metallic brackets had not produced high bonding values, and these results are consistent with a previous study [9]. However, the mean bond strength obtained with the use of hybrid brackets are higher if compared with polycarbonate brackets [10-12] and compatible with ceramic brackets [13,14].

There is not universally accepted minimum clinical bond strength. However, the bond strength required to withstand normal orthodontic forces is believed to be between 8 and 9 MPa [14]. In most studies, the bond strengths of esthetic brackets were significantly lower than those of metal brackets [11,15-20]. In our study, bracket failure occurred between 4.85 and 10.24 MPa. The results suggest that adequate bond strengths can be achieved with NV Hybrid brackets when bonding is carried out to a dry enamel surface.

The evaluation of the ARI scores indicated significant difference in bond-failure site between the two experimental groups. These results showed that NV Hybrid left less adhesive on the enamel than when metallic brackets were used. This fact can be advantageous for clinicians because bond failure at the bracket-adhesive interface or within the adhesive is more desirable than at adhesive-enamel interface, in order to avoid enamel fracture at time of debonding [21,22].

Laboratory studies have the advantage of being able to control and limit the many variables that affect shear bond strength in the mouth, but bond strength tests have shown wide variation. When comparing debonding forces measured *in vivo* and *in vitro*, Pickett found that the bond strengths *in vivo* were significantly lower than those measured *in vitro*. Possible reasons suggested could be the length of time the appliance was in the oral environment, exposing the bonded brackets to acid, saliva, and variable patient abuse and masticatory forces, all of which may have contributed to the decreased bond strength [23].

Because of its new properties, NV Hybrid brackets can be considered as an interesting and promising material. However, this was a laboratory study and care should be taken in interpreting the results. To recommend the use of this product in a large scale, more studies are required, particularly *in vivo* studies and clinical trials [24,25].

Conclusion

- The use of hybrid brackets with a polymeric base has resulted in higher bond strength values if compared to the conventional metallic brackets.
- The amount of adhesive remaining on enamel after debonding was significantly higher when using hybrid brackets if compared to metallic brackets.

Bibliography

1. Buttke TM and Proffit WR. "Referring adult patients for orthodontic treatment". *Journal of the American Dental Association* 130 (1999): 73-79.
2. Newman GV. "Adhesion and orthodontic plastic attachments". *American Journal of Orthodontics* 56 (1969): 573-588.
3. Newman GV. "First direct bonding in orthodontia". *American Journal of Orthodontics Dentofacial Orthopedics* 101 (1992): 190-191.
4. Aird JC and Durning P. "Fracture of polycarbonate edgewise brackets: a clinical and SEM study". *British Journal of Orthodontics* 14 (1987): 191-195.
5. Dobrin RJ., *et al*. "Load-deformation characteristics of polycarbonate orthodontic brackets". *American Journal of Orthodontics* 67 (1975): 24-33.
6. Kusy RP and Whitley JQ. "Friction between different wire-bracket configurations and materials". *Seminars in Orthodontics* 3 (1997): 166-177.
7. Kusy RP and Whitley JQ. "Frictional resistances of metal-lined ceramic brackets versus conventional stainless steel brackets and development of 3-D friction map". *The Angle Orthodontist* 71 (2001): 364-374
8. Artun J and Bergland S. "Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment". *American Journal of Orthodontics Dentofacial Orthopedics* 85.4 (1984): 333-340.
9. Vilar RV., *et al*. "Shear Bond Strength of Brackets Bonded with Two Light-curing Orthodontic Adhesives". *The Journal of Adhesive Dentistry* 11 (2009): 259-262.

10. Crow V. "Ex-vivo shear bond strength of fiberglass reinforced aesthetic brackets". *British Journal of Orthodontics* 22.4 (1995): 325-330.

11. Guan G., *et al*. "Shear bond strengths of orthodontic plastic brackets". *American Journal of Orthodontics Dentofacial Orthopedics* 117 (2000): 438-443.

12. Souza NF., *et al*. "Primer on the base of polycarbonate brackets: should we apply it or not?". *Progress in Orthodontics* 11 (2010): 37-40.

13. Özcan M., *et al*. "A brief history and current status of metal/ceramic surface conditioning concepts for resin bonding in dentistry". *Quintessence International* 29 (1998): 713-724.

14. Özcan M., *et al*. "Evaluation of failure characteristics and bond strength after ceramic and polycarbonate bracket debonding: effect of bracket base silanization". *European Journal of Orthodontics* 30 (2008): 176-182.

15. Akin-Nergiz N., *et al*. "Shear bond strength of a new polycarbonate bracket-an in vitro study with adhesives". *European Journal of Orthodontics* 18 (1996): 295-301.

16. Blalock KA and Powers JM. "Retention capacity of the bracket bases of new esthetic orthodontic brackets". *American Journal of Orthodontics and Dentofacial Orthopedics* 107 (1995): 596-603.

17. Fernandez L and Canut JA. "In vitro comparison of the retention capacity of new aesthetic brackets". *European Journal of Orthodontics* 21 (1999): 71-7.

18. Harria AM., *et al*. "Shear peel bond strengths of esthetic orthodontic brackets". *American Journal of Orthodontics and Dentofacial Orthopedics* 102 (1992): 215-219.

19. Sunna S and Rock WP. "Clinical performance of orthodontic brackets and adhesive systems". *British Journal of Orthodontics* 25 (1998): 283-287.

20. Willems G., *et al*. "In vitro peel/shear bond strength evaluation of orthodontic bracket base design". *Journal of Dentistry* 25 (1997): 271-278.

21. Bishara SE., *et al*. "Effect of an acidic primer on the shear bond strength of orthodontic brackets". *American Journal of Orthodontics and Dentofacial Orthopedics* 114 (1998): 243-247.

22. Britton JC., *et al*. "Shear bond strength of ceramic orthodontic brackets to enamel". *American Journal of Orthodontics and Dentofacial Orthopedics* 98 (1990): 348-353.

23. Pickett KL., *et al*. "Orthodontic in vivo bond strength: comparison with in vitro results". *The Angle Orthodontist* 71 (2001): 141-148.

24. Cal-Neto JP., *et al*. "Bond failure rates with a self-etching primer: a randomized controlled trial". *American Journal of Orthodontics and Dentofacial Orthopedics* 135 (2009): 782-786.

25. Rosenbach G., *et al*. "Effect of Enamel Etching on Tensile Bond Strength of Brackets Bonded In Vivo with a Resin-reinforced Glass Ionomer Cement". *The Angle Orthodontist* 77.1 (2007): 113-116.

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