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Influence of Primekote® polymer in orthodontic bonding

Influência do polímero Primekote® na colagem ortodôntica

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Resumo

Objetivo: Avaliar a resistência ao cisalhamento e o índice de remanescente adesivo (IRA) dos bráquetes que tiveram o polímero Primekote® incorporado a suas bases. **Material e método:** Foram confeccionados trinta corpos de prova com incisivos bovinos, divididos em dois grupos: o colado com bráquete TP® Nu-Edge(n=15) e grupo controle com bráquetes Morelli® (n=15) sem tratamento na base. O sistema adesivo Transbond™ XT foi utilizado nos dois grupos seguindo o mesmo protocolo de colagem e respeitando as instruções do fabricante. Os corpos de prova foram armazenados em água destilada por 24 horas, e posteriormente submetidos ao teste de cisalhamento na máquina de ensaios universais (EMIC-DL2000). O IRA foi avaliado por dois examinadores calibrados utilizando lupa estereoscópica com aumento de 20 vezes. **Resultado:** Na resistência ao cisalhamento o teste T-independente mostrou não haver diferença estatisticamente significante entre os grupos (p>0,05), ambos tiveram desempenho semelhante. O teste Wilcoxon foi utilizado nos valores obtidos no IRA revelando diferença estatística, sendo que os bráquetes TP® deixaram menos remanescente adesivo na superfície dental que os bráquetes Morelli®. **Conclusão:** Bráquetes TP® apresentaram maior adesão ao sistema adesivo pois foi encontrado menor IRA nos mesmos, porém esta característica não reflete em melhora no desempenho clínico.

Descritores: Resistência ao cisalhamento; braquetes ortodônticos; descolagem dentária; adesividade.

Abstract

Objective: The Primekote® (TP) polymer was incorporated to the of Orthodontic Bracket mesh base to improve bond strength and make it more efficient. The purpose of this study was to assess the shear bond strength and adhesive remnant index (ARI) of these brackets. **Material and method:** The test sample consisted of thirty bovine incisors divided into 2 groups: with a group with TP® brackets (n=15), and a control group with Morelli® brackets (n=15) without Primekote® technology. The TransbondTM XT was used as adhesive system in both groups, following the same protocol and manufacturer's instructions. Specimens were stored in distilled water for 24 hours and then submitted to shear bond strength test in a universal testing machine (EMIC DL2000). The assessment of ARI was performed under stereomicroscope by two calibrated examiners. **Result:** No significant differences (p>0.05) in shear bond strength were found between the two groups according to the independent t-test. The Wilcoxon test was used to assess ARI data and statistical difference was found between Morelli® and TP® Nu-Edge brackets; the last one left less remaining adhesive on tooth surface. **Conclusion:** TP® brackets had higher adherence to the adhesive system as shown by lower ARI scores, but this does not improve its clinical performance.

Descriptors: Shear strength; orthodontic brackets; dental debonding; adhesiveness.

INTRODUCTION

The acid-etching technique developed by Buonocore was a breakthrough that led to several changes in Dentistry, specifically in Orthodontics. This is because this technique makes it possible to directly bond brackets to the enamel in a simple, fast and safe manner[1,2]. This has contributed to the popularization of the technique, which has become the first choice for placement of orthodontic appliances[3]. However, the direct bonding technique is still under development[4] and has limitations. One of such limitations is the common unwanted detachment of accessories, a disadvantage that requires time-consuming clinical procedures for removing the remaining adhesive, and carrying out prophylaxis, surface preparation and rebonding[5].

Once bonded to teeth surface, and provided that orthodontic accessories are in the ideal position, such accessories should remain in their places throughout the orthodontic treatment in order to optimize the time and results. In an attempt to eliminate unwanted detachment of brackets, new materials have been tested in order to improve adhesion of the enamel/resin/bracket system and prevent unwanted debonding.

One of the main goals of current orthodontic research is to obtain materials for bracket bonding that provides proper adhesion strength between resin, bracket and tooth in order to withstand masticatory loads and orthodontic forces and to resist the presence of fluids of the oral cavity and the interference of such fluids[6,7]. Fracture lines in bracket displacement in vivo and in vitro usually occur in the bracket/adhesive interface. For this reason, investment has been made in order to improve the adhesion means of orthodontic appliances to dental elements, thereby increasing the rate of success of orthodontic bonding[5].

Care to preserve the enamel surface is necessary during orthodontic treatment, to keep the initial surface roughness and smoothness, especially during removal of accessories, when the risk of fracture is higher[8]. Removal of brackets and subsequent cleaning of teeth enamel can be time-consuming for the dental surgeon. Furthermore, the operator must be careful to avoid iatrogenic accidents, destruction of enamel or fractures[5,9].

Authors such as Keizer et al.[7] have noted that fractures resulting in brackets falling-off most commonly take place in the resin-bracket interface. Because of this observation, new alternatives to increase adhesion between resin and bracket have been studied. To this end, the TP Orthodontics company (La Port, IN) released the Primekote® polymer incorporated into the base of the Nu-Edge bracket and which promises increased bond strength of the bracket to the adhesive system, which must remain constant even after 2 years of treatment. Another possible benefit is that increased adhesiveness could cause the adhesive system to be retained in the bracket base at the removal act. This would represent less adhesive remainings on the tooth surface, what facilitates the cleaning of the teeth at the end of treatment.

The aim of the present study is to evaluate the efficiency of this polymer through a shear test by comparing it to conventional bracket bonding. After shearing, the adhesive remnant index (ARI) was assessed to check the sites where adhesion fractures happened and to quantify the remainings in the teeth[8].

MATERIAL AND METHOD

The sample consisted of 30 permanent healthy bovine incisors obtained in a refrigerator. Bovine teeth are easy to obtain, have already been used in numerous studies and they are histologically similar to human teeth[10].

Intact teeth were selected from both, buccal and lingual surface, without cracks caused by pressure of the extractor and/or forceps. Specimens were initially cleaned and stored in thymol 0.1% under refrigeration, which besides conserving, promotes disinfection[10]. The 30 sample teeth were sectioned at cervical level using a carborundum disk and roots were discarded after the process. Teeth crowns were put on a glass plate so that the flattest surface of the vestibular face would stay parallel to the glass plate facilitating, this way, the determination of the bonding area. Then, standard PVC tubes were placed so as to involve the entire tooth crown and acrylic resin was poured into it to fill the spaces present between the tooth and the tube. After inclusion, specimens were sanded in polisher (Ecomet II/Buehler) with 4 types of sandpaper (wood sanders 180 and water 400, 600 and 1200), changed every 2 specimens in order to ensure complete polishing of specimens.

Specimens were prepared for bonding of brackets following the manufacturer's guidelines: prophylaxis with rubber cup at low speed and using pumice and water. Then, material was washed and dried with water and air from the triple syringe. In order to standardize bracket bonding areas, a mask was created with X-ray film, which could be submitted to acid-etching and be washed without damage.

After preparation, phosphoric acid gel 35% was applied for 15 seconds over all specimens. They were washed with a triple syringe for 15 seconds and dried with compressed air for 15 seconds. Subsequently, a thin and uniform layer of TransbondTM XT Adhesive-Primer (3M Unitek) was applied on the tooth surface that would receive the bracket for 3 seconds with disposable brush tips and this was dissolved with a slight air stream free from humidity. Then, a small amount of the TransbondTM XT (3M Unitek) adhesive agent was applied in the bracket base and this was positioned on the prepared tooth surface immediately after applying the adhesive. The bracket was adjusted in the end position by pressing it firmly for 2 seconds, carefully removing the excess with an exploratory probe (photopolymerization was performed for twenty seconds causing the beam focus for ten seconds on each side of the mesial and distal sides). The operator was previously calibrated and sought to apply the same pressure in all brackets during cementation. Visual verification was carried out aiming to check if thickness of resin layer between brackets and teeth surface was the same.

Half of the specimens were bonded with Morelli brackets (control group) and the other half with Nu-Edge brackets with base treated with Prime-Kote® polymer (TP Orthodontics). All the 30 orthodontic brackets were made to incisors and, thus, had flat base without curvature, selected with the aim to obtain maximum contact with the tooth surface.

After bonding of brackets, specimens were stored in distilled water to simulate the presence of saliva for 24 hours.

The shear test was performed on the universal testing machine (EMIC - DL 2000 - São José dos Pinhais - Paraná) with constant speed of 5 mm/min and using load cell of 50 kgf (Figure 1). Due to the reduced dimensions of brackets, a perpendicular chisel-shaped tip was used in the upper edge of the base of the bracket (Figure 2). After shearing, groups were examined at random under stereomicroscope (x20) by two calibrated examiners. Examiners were unaware of which group the specimens belonged to. For this, samples were coded. Depending on the percentage of resin adhered to the enamel, the specimens were classified according to scores of the Adhesive Remnant Index (ARI) described by Bishara, Trulove[11]: score 1 - all adhesive left on the tooth, score 2 - more than 90% of adhesive left on the tooth, score 3 - more than 10% and less than 90% of adhesive left on the tooth, score 4 - less than 10% of adhesive left on the tooth, score 5 - no adhesive left on the tooth. All values are recorded in tables and statistically analyzed using the SPSS 20.0 program.

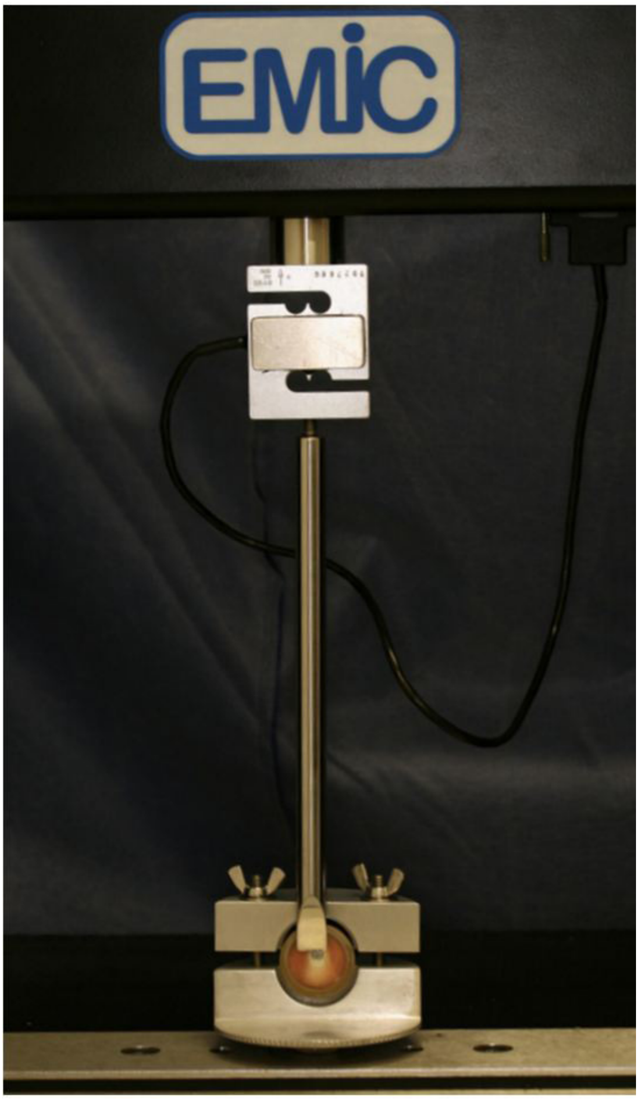

Figure 1. Universal testing machine (EMIC - DL 2000).

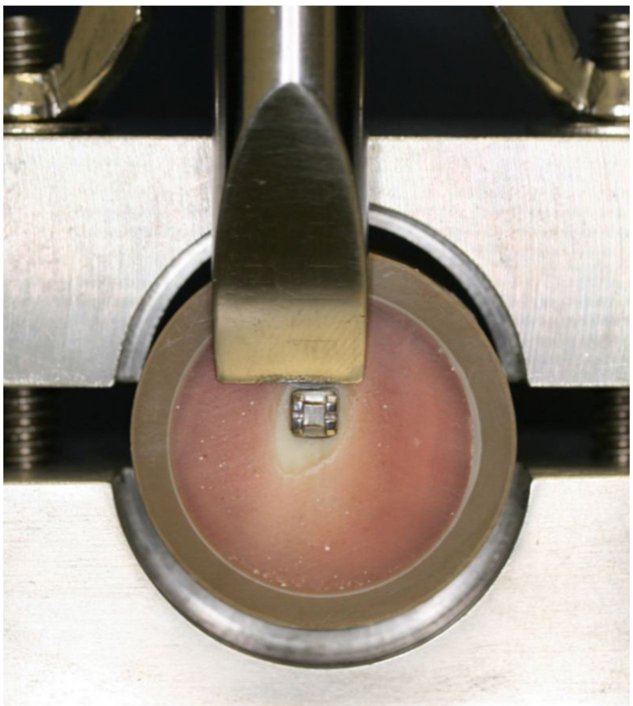

Figure 2. Chisel-shaped tip.

RESULT

For statistical analysis, the values found in the shear test were initially submitted to Kolgomorov-Smirnov test to verify normality, and then to t-test for independent samples, which showed statistically significant difference in strength between groups ($p<0.05$) (Figure 3). The areas of the brackets were different, but after adaptation, this difference disappeared and the groups showed similar shear strength.

The ARI was analyzed using the nonparametric Wilcoxon test, which showed statistical difference between variables. TP® brackets left less adhesive on teeth after shearing (Figure 4).

DISCUSSION

Bracket debonding is a common occurrence in orthodontic treatment, whether to change bracket position for better tooth movement, at the completion of treatment, or due to technical failures. The Primekote® polymer was tested under the promise of increasing the shear strength and consequently reducing unintentional fall of brackets during orthodontic treatment.

It is known that the base of brackets interferes with the shear strengh needed for debonding. Therefore, the two bracket groups were studied for incisors, aiming to standardize samples and control bias. Furthermore, the flat base minimizes the thickness of resin layer between the orthodontic appliance base and the tooth surface, which could result in changes in the pattern of polymerization obtained[12]. Furthermore, in order to minimize bias, the operator

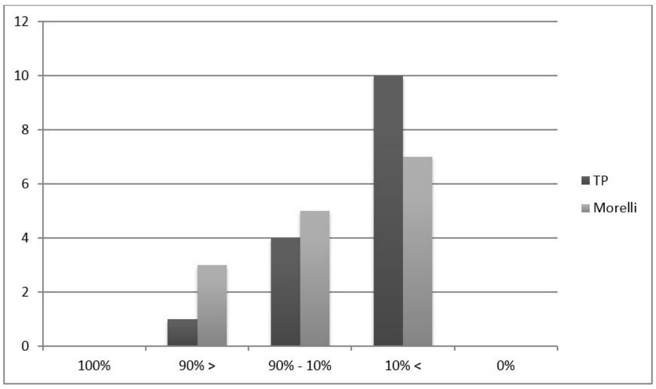

Figure 3. Comparison of ARI values between TP and Morelli groups.

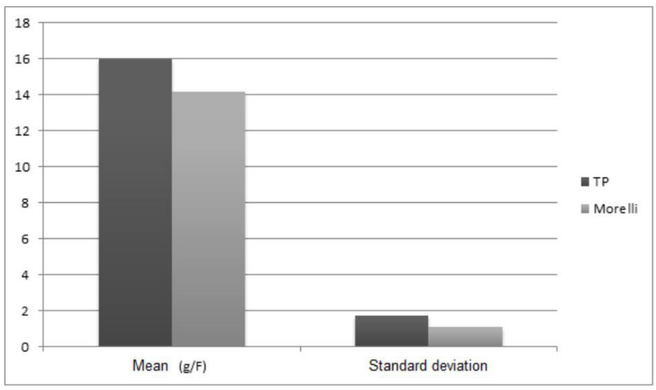

Figure 4. Mean and standard deviation of TP and Morelli groups.

was previously calibrated before the bonding process so as to standardize all stages and the pressure during cementation.

Initially, the results indicated that the difference in shear strength between the two groups was statistically significant. The TP® bracket showed better adhesion than the Morelli® since its shear strength was approximately 12.33% higher. However, areas of bracket base were different. It is known that the greater the contact area of the bracket/adhesive/enamel interface, the greater the resistance of this set to shear tests. Thus, results were corrected, adjusting the intensity of force according to the respective areas. TP® brackets feature 19 mm^2, while Morelli brackets had 16.8 mm^2. After this correction, no significant statistical difference between the shear strength of the two groups was observed.

Regarding the ARI, different values were found to the two groups. While most of the remaining adhesive of the Morelli® group was found adhered to the tooth, indicating that shearing fissure happens in the resin/bracket interface[7], remainings were more adhered to the bracket in the TP® group, indicating that fracture happens along the enamel/resin interface. These findings are in line with what was expected for the Primekote® polymer, since this polymers is intended to improve the adhesion of the resin to the bracket base[13].

The evaluation of specimens after the shear bond strength test showed that TP® brackets, because they have greater adherence to the bonding material, remove this material at the moment of debonding for removal. Because of this, part of the enamel is possibly removed by trauma, increasing the chance of creating cracks or fractures[14]. In contrast, when the control group was removed, an adhesive layer was left adhered to the enamel, which must be removed in subsequent steps. In this case, the tooth enamel is preserved[3,5]. Taking into account that, in any case, teeth have to be polished after orthodontic treatment and removal of accessories, the teeth that had TP® bonded brackets would present greater loss of tooth substance, despite the use fo the safest techniques.

Finally, the difference in shear values found between groups was not large enough to justify the choice for TP® brackets. These brackets are still subject to unwanted debondings and consequently rebonding during orthodontic treatment. In addition, its characteristic of fissuring at the resin/enamel interface represents more damage to the enamel because retention happens through micromechanics and the total removal of the hybrid layer incurs greater structural loss[15].

CONCLUSION

There was no statistically significant difference between the shear strength of the two brackets studied. This fact was observed after the adjustment carried out to correct the difference in bracket base areas. The treatment of bracket base with Prime-Kote® polymer did not result in greater shear strength than the control group.

The group with treatment at the base had higher fracture index at the resin/enamel interface (score 4), while the control group showed higher fracture index at the bracket/resin interface (score 3). This indicates that brackets bonded with Prime-Kote® polymer leave less remaining adhesive on teeth, increasing the chance of damage to the enamel.

REFERENCES

1. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res. 1955 Dec;34(6):849-53. PMid:13271655. http://dx.doi.org/10.1177/00220345550340060801.
2. Yadav J, Mehrotra P, Kapoor S, Mehrotra R. Basis of orthodontics-bonding: a review. Int J Dent Sci Res. 2013 Apr;1(1):28-33. http://dx.doi.org/10.1016/j.ijdsr.2013.04.005.
3. Bishara SE, Olsen ME, VonWald L, Jakobsen JR. Comparison of the debonding characteristics of two innovative ceramic bracket designs. Am J Orthod Dentofacial Orthop. 1999 Jul;116(1):86-92. PMid:10393585. http://dx.doi.org/10.1016/S0889-5406(99)70307-0.
4. Goyal A, Chandna AK, Sehgal V, Kannan S, Gupta A, Rajain A, et al. Retentive shear strengths of various bonding attachment bases: an in vitro study. J Indian Orthod Soc. 2013 Jul;47(3):121-7. http://dx.doi.org/10.5005/jp-journals-10021-1143.
5. Knosel M, Mattysek S, Jung K, Sadat-Khonsari R, Kubein-Meesenburg D, Bauss O, et al. Impulse debracketing compared to conventional debonding. Angle Orthod. 2010 Nov;80(6):1036-44. PMid:20677952. http://dx.doi.org/10.2319/033110-48.1.
6. Pithon MM, Oliveira MV, Ruellas AC, Bolognese AM, Romano FL. Shear bond strength of orthodontic brackets to enamel under different surface treatment conditions. J Appl Oral Sci. 2007 Apr;15(2):127-30. PMid:19089115. http://dx.doi.org/10.1590/S1678-77572007000200010.
7. Keizer S, ten Cate J, Arends J. Direct bonding of orthodontic brackets. Am J Orthod. 1976 Mar;69(3):318-27. PMid:766645. http://dx.doi.org/10.1016/0002-9416(76)90079-8.
8. Hosein I, Sherriff M, Ireland AJ. Enamel loss during bonding, debonding, and cleanup with use of a self-etching primer. Am J Orthod Dentofacial Orthop. 2004 Dec;126(6):717-24. PMid:15592221. http://dx.doi.org/10.1016/j.ajodo.2003.10.032.
9. Devanna R, Keluskar KM. Crystal growth vs. conventional acid etching: a comparative evaluation of etch patterns, penetration depths, and bond strengths. Indian J Dent Res. 2008 Oct-Dec;19(4):309-14. PMid:19075433. http://dx.doi.org/10.4103/0970-9290.44533.
10. Sabatoski MA, Maruo IT, Camargo ES, Guariza O Fo, Tanaka OM, Maruo H. Influence of natural bovine enamel roughness on bond strength after etching. Angle Orthod. 2010 May;80(3):562-9. PMid:20050753. http://dx.doi.org/10.2319/031309-148.1.
11. Bishara SE, Trulove TS. Comparisons of different debonding techniques for ceramic brackets: an in vitro study. Part II. Findings and clinical implications. Am J Orthod Dentofacial Orthop. 1990 Sep;98(3):263-73. PMid:2206042. http://dx.doi.org/10.1016/S0889-5406(05)81604-X.
12. Samruajbenjakul B, Kukiattrakoon B. Shear bond strength of ceramic brackets with different base designs to feldspathic porcelains. Angle Orthod. 2009 May;79(3):571-6. PMid:19413398. http://dx.doi.org/10.2319/060308-290.1.

13. Guzman UA, Jerrold L, Vig PS, Abdelkarim A. Comparison of shear bond strength and adhesive remnant index between precoated and conventionally bonded orthodontic brackets. Prog Orthod. 2013 Oct;14(1):39. PMid:24325904. http://dx.doi.org/10.1186/2196-1042-14-39.
14. Bishara SE, Ostby AW, Laffoon J, Warren JJ. Enamel cracks and ceramic bracket failure during debonding in vitro. Angle Orthod. 2008 Nov;78(6):1078-83. PMid:18947289. http://dx.doi.org/10.2319/112007-540.1.
15. Algera TJ, Kleverlaan CJ, Prahl-Andersen B, Feilzer AJ. The influence of different bracket base surfaces on tensile and shear bond strength. Eur J Orthod. 2008 Oct;30(5):490-4. PMid:18684707. http://dx.doi.org/10.1093/ejo/cjn029.

CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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