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Original article

Primer on the base of polycarbonate brackets: should we apply it or not?

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ABSTRACT

Objective: The purpose of this study was to evaluate shear bond strength of polycarbonate brackets bonded with or without the previous application of primer on their bases.

Materials and methods: Forty-six extracted bovine permanent mandibular incisors were obtained and randomly divided into two groups of 23 each: group 1 (control), 37% phosphoric acid and direct bonding with Orthoprimer (Morelli Orthodontic Products, São Paulo, Brazil) and Orthobond (Morelli Orthodontic Products); and group 2, Orthoprimer application on bracket base prior to conventional bonding. Polycarbonate maxillary central incisor brackets (Composite, Morelli Orthodontic Products) were used in this study. All products were used according to the manufacturer's instructions. An Universal Testing Machine was used to apply an occlusal shear force directly onto the enamel-bracket interface at a speed of 0.5 mm/min. The groups were compared using Student's t-test.

Results: Mean results and standard deviation (in MPa) for the groups were: group 1 - 5,81 (1,90); and group 2 - 6,09 (1,28). Significant difference was not observed in the bond strengths of the two groups evaluated ($p=0.5601$). The adhesive remnant index (ARI) did not indicate significant difference ($p=0.617$) between the two groups.

Conclusions: These results indicated that primer application on polycarbonate bracket base did not result in increased bond strength.

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1. Introduction

Plastic brackets were introduced in the 1960s and came into use at the beginning of the 1970s. Some of their advantages are: non-toxic, high abrasion and impact strength,

adequate coloring and translucency.¹ Nevertheless, clinical complications have been associated with their use including torque deformation² and a lower bond strength.^{3,4} Efforts have focussed on improving the characteristics of the attachment material by including stainless steel slots and ceramic fillers.^{4,5} However the chemically inert bracket bases fail to

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form good bonding with conventional orthodontic adhesives.⁶ According to the manufacturer's instructions of many commercial plastic brackets, these require the application of primer to increase bond strength.

The purpose of this study was to evaluate shear bond strength and adhesive remnant index (ARI) of polycarbonate brackets bonded with or without the previous application of primer on their bases. The null hypothesis to be tested is that there is no difference in the mean shear bond strength between the two groups.

2. Materials and methods

Forty-six freshly extracted bovine permanent mandibular incisors were collected and stored in a solution of 0.1% (wt/vol) thymol at room temperature. Teeth with cracks, fractures, hypoplastic enamel or any kind of enamel surface defect were excluded.

Each tooth was sectioned below the cement-enamel surface junction and the crowns were mounted in plastic rings with acrylic resin. The crowns were oriented so that the labial enamel surface was parallel to the force during the shear strength test. After complete polymerization, the specimens were polished at a polishing machine to remove overflowed acrylic and to standardize enamel rugosity.

The labial surfaces were cleaned and polished with a rubber cup and pumice for 5 seconds, followed by rinsing with water spray and drying with compressed air for 5 seconds. Polycarbonate maxillary central incisor brackets (Composite, Morelli Orthodontic Products, São Paulo, Brazil) were used in this study. The average brackets base surface area was determined to be 12,58 mm². The teeth were randomly assigned into two groups (n=23), and brackets were bonded according to the manufacturer's instructions, following one of two protocols:

Group 1 (control) – Teeth were etched with 37% phosphoric acid for 15 seconds. A layer of primer (Orthoprimer, Morelli Orthodontic Products) was applied only on the enamel surface.

Grupo 2 – Teeth were etched with 37% phosphoric acid for 15 seconds. A layer of primer (Orthoprimer) was applied on the brackets base and on the enamel surface.

All brackets were bonded with an orthodontic composite Orthobond (Morelli Orthodontic Products). The brackets were firmly seated on the tooth surface and excess resin was removed with a small dental probe. The curing light (Orthobond XT – Visible light curing unit, 3M Unitek, Monróvia, Califórnia, USA) was used for 10 seconds distally and then 10 seconds mesially. After bonding, the specimens were kept moist in distilled water at 37 °C for 24 hours. A Universal Testing Machine (EMIC DL500 MF, Paraná, Brazil) was used to apply an occlusogingival load to the bracket, which produced a shear force at the tooth-bracket interface with a crosshead speed of 0,5 mm/min. The force in newtons was recorded for each specimen and divided by the surface area of the bracket pad to obtain the shear stress value in megapascals (MPa).

The debonded buccal surface of each specimen was evaluated with a stereoscopic magnifying glass (Carl Zeiss, Goettingen, Germany) at 10X magnification and the adhesive remnant index⁷ (ARI) was quantified according to the follow-

Table 1 – Results of Student's t-test Comparing Shear Bond Strengths (in MPa) of Groups.

Groups	N	Mean*	SD	Range
1. Control	23	5.81	1.90	1.04-11.14
2. Primer on Base	23	6.09	1.28	3.51-8.41

* P=0.5601.

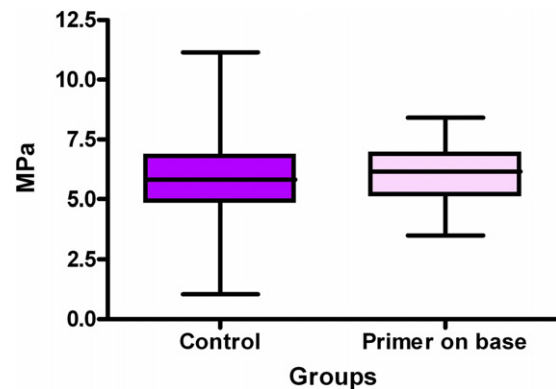


Fig. 1 – Box Plots for shear bond strength (MPa) of experimental groups.

ing criteria: 0 = no adhesive left on tooth, 1 = less than half of the adhesive left on tooth, 2 = more than half of the adhesive left on tooth, and 3 = all the adhesive left on tooth.

Descriptive statistics, including the mean, standard deviation, and minimum and maximum values, were calculated for each group tested. The data of bond strength were tested for normality with the Shapiro-Wilk method. Student's t-test was used to determine whether significant differences were present in the bond strength between groups. The chi-square test was used to evaluate differences in the ARI scores between groups. All statistical analyses were performed with the software Prism 4.0 (GraphPad Software, San Diego, California, USA) at a 5% level of significance.

The author(s) declare that the work has been realized in agreement with the Helsinki Declaration principles and that the Informed Consent has been achieved from all the participants involved in the study.

3. Results

The descriptive statistics comparing the shear bond of the two groups are shown in Table 1. Student's t-test did not show significant differences (p=0.5601) between groups evaluated. Group 1 had a mean shear bond strength of 5,81 (1,90) MPa, whereas Group 2 had a mean of 6,09 (1,28) MPa (Fig. 1). The ARI scores for the two groups tested are listed in Table 2. The results of chi-square comparisons for the ARI did not indicate significant difference (p=0.617) between the two groups.

4. Discussion

The null hypothesis tested was accepted. The results of the present study indicated that there was no statistical difference

Table 2 – Frequency Distribution and Results of Chi-square Analysis of the ARI of Experimental Groups.

Group	N	ARI Scores* #			
		0	1	2	3
1. Control	23	0	4	5	15
2. Primer on base	23	1	2	4	16

* 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; and 3, enamel bonding site covered entirely with adhesive.

P=0.617.

in the shear bond strength and ARI between plastic brackets bonded with or without previous application of primer in their base. These results are consistent with others studies^{4,8} and are sufficient for clinical purposes according to Reynolds⁹ and Newman.¹⁰

Evaluation of the ARI scores did not indicate significant difference in bond-failure site among the 2 experimental groups. Besides, more than 50% of composite remained on the tooth. The evaluation of ARI scores can be advantageous for clinicians, who can choose materials that demonstrate a higher amount of remnant adhesive on tooth after debonding, avoiding enamel fractures.^{11,12}

From a clinical standpoint, the application of primer on the base of plastic brackets need to be carefully evaluated, due to the divergence between the manufacturer's instruction and scientific findings. Nevertheless, this was a laboratorial study and care should be taken in interpreting the results. Another option suggests that combined sandblasting and silane-coupling treatment can increase the bond strength of plastic brackets.¹³ In order to recommend clinicians to apply or not a layer of primer on the base of plastic brackets, more studies are necessary, particularly in vivo studies and clinical trials.

5. Conclusions

The application of primer did not result in increased bond strength, and the clinical performance of the groups evaluated was not significantly different.

The amount of adhesive on enamel after debonding was similar in both groups.

Care should be taken to recommend or not the application of primer on bracket's base due to the divergence between scientific findings and manufacturer's instructions.

Conflict of interest

The authors have reported no conflicts of interest.

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Riassunto

Obiettivo: L'obiettivo di questo studio è quello di valutare la resistenza al taglio di attacchi in policarbonato incollati con e senza applicazione di primer sulla loro base.

Materiali e metodi: Quarantasei incisivi inferiori permanenti bovini estratti sono stati divisi in maniera random in due gruppi di 23 denti ciascuno: gruppo 1 (controllo), acido orto fosforico al 37% e incollaggio diretto con Orthoprimer (Morelli Orthodontic Products, São Paulo, Brazil) e Orthobond (Morelli Orthodontic Products); gruppo 2, applicazione di Orthoprimer sulla base degli attacchi prima dell'incollaggio convenzionale. In questo studio sono stati utilizzati attacchi in policarbonato da incisivi centrali superiori (Composite, Morelli Orthodontic Products). Tutti i prodotti sono stati utilizzati seguendo le istruzioni del produttore. È stata utilizzata una macchina per Test Universale per applicare una forza di taglio occlusale direttamente a livello dell'interfaccia smalto-attacco ad una velocità di 0,5 mm/min. I gruppi sono stati confrontati utilizzando il t-test di Student.

Risultati: Le medie e deviazioni standard (in MPa) per i gruppi erano i seguenti: gruppo 1 - 5,81 (1,90) e gruppo 2 - 6,09 (1,28). Le forze di adesione nei due gruppi non presentavano differenze significative ($p = 0.5601$). L'indice di adesivo residuo (ARI) non mostrava differenze significative nei due gruppi ($p = 0.617$).

Conclusioni: Questi risultati indicano che l'applicazione di primer sulla base di attacchi in policarbonato non determina un aumento della forza di adesione.

Résumé

Objectif: Le but de cette étude était d'évaluer la force en adhesion des brackets de polycarbonate métalliques avec ou sans l'application précédente de primer sur leurs bases.

Matériaux et méthodes: Quarante-six incisives mandibulaires permanentes bovines extraites ont été obtenues et aléatoirement divisées en deux groupes de 23 pièces: groupez 1 avec l'acide phosphorique, de 37% et bondage direct Orthoprimer (produits orthodontiques de Morelli, São Paulo, Brésil) et Orthobond (produits orthodontiques de Morelli); et groupe 2, avec application d'Orthoprimer sur la base des brackets avant le bondage conventionnel. Des brackets centraux maxillaires incisives de polycarbonate (Morelli) ont été utilisés dans cette étude. Tous les produits ont été employés selon les instructions du fabricant. Une Universal Testing Machine a été utilisée pour appliquer une force de usure occlusale directement sur l'interface d'émail-brackets à une vitesse de 0.5 mm/min. Les groupes ont été comparés utilisant le t-essai le test de Student.

Résultats: Les résultats moyens et l'écart type (dans le MPA) pour les groupes étaient: groupe 1 - 5.81 (1.90); et groupez 2 - 6.09 (1.28). On n'a pas observé la différence significative dans les forces en adhesion des deux groupes évalués ($p = 0.5601$). L'index adhésif de reste (ARI) n'a pas indiqué la différence significative ($p = 0.617$) entre les deux groupes.

Conclusions: Ces résultats ont indiqué que l'application de primer sur la base des brackets de polycarbonate n'a pas eu comme conséquence la force en adhesion accrue.

Resumen

Objetivo: El propósito de este estudio fue evaluar la resistencia al remoción de brackets de policarbonato, con o sin la previa aplicación de primer en la base.

Material y método: En cuarenta y seis dientes de bovinos extraídos (incisivos inferiores permanentes) divididos aleatoriamente en dos grupos de 23 cada uno: grupo 1 (control), con composito Orthoprimer y Orthobond (Productos de Ortodoncia Morelli) y ácido fosfórico 37%. El grupo 2, con aplicación Orthoprimer sobre la base del bracket antes de la aplicación convencional. Se utilizaron en este estudio Brackets de incisivos centrales superiores en policarbonato (Composite, Morelli Ortodoncia Productos). Todos los productos se utiliza según las instrucciones del fabricante. se utilizó una máquina de ensayos universales para aplicar una fuerza de corte oclusal directamente en la interfase del Bracket/esmalte a una velocidad de 0,5 mm/min. Los grupos se compararon mediante la t de Student.

Resultados: La media de los resultados y la desviación estándar (en MPa) de los grupos fueron: Grupo 1 - 5,81 (1,90), y grupo 2 - 6,09 (1,28). La diferencia no fue significativa en la fuerza de adherencia de los dos grupos evaluados ($p=0,5601$). El índice de adhesivo remanente (ARI) no indican diferencia significativa ($p=0.617$) entre los dos grupos.

Conclusiones: Estos resultados indican que la aplicación de primer en la base de los brackets de policarbonato no aumenta a una fuerza de adhesión entre el Bracket y el esmalte.

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