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Friction Between Metallic Brackets Before and After Clinical Use: A Comparative Study

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Abstract

The friction is a factor that can result on changes in efficacy of sliding orthodontic mechanics. Different factors can impact on the friction force: the composition and properties of orthodontic wires and brackets, the cleaning of orthodontic braces, and even saliva. This study aimed to evaluate the friction in two brands before and after use in the oral environment. Ten patients from the orthopedic clinic of the Master's of Dentistry, with two premolars bonded of each patient. The patients were divided, according with total number of brackets (n= 40): 2 control groups - without exposure to the buccal medium - (G1 and G2) and 2 experimental groups - with exposure to the buccal medium - (G3 and G4). The brackets were testes on a friction machine and evaluated in a two-way ANOVA test. It was observed that the brand used in groups G2 and G4 presented greater friction with the orthodontic wire and the G2 group brackets presented similar frictional force to G3, which had already been exposed to clinical use. Brazilian brackets brands presented an increased friction after clinical use.

Keywords: Metallic Brackets; Orthodontics

Introduction

In orthodontic slide mechanics, the free movement between the wire and the bracket is desired for adequate treatment efficacy [1,2]. Among the forces that undermine this movement, the friction is highlighted as the resistance to movement when one object moves tangentially against another [3].

The most important factors that can influence friction are: the composition of the bracket and wire alloy slot, the cross-sectional area of the wire, the type of wire attachment to the bracket, and the roughness of the slot surface due to its method of fabrication [4].

According to House *et al.* [5], corrosion occurs in two simultaneous reactions: oxidation and reduction (redox). The corrosion process continues until it is fully consumed, unless the metal can form a protective surface (passivation), or until the reagent is fully consumed. The level of corrosion of any metal depends on the chemistry of the solvent in which it is immersed.

Several in vitro studies have shown the corrosion and release of nickel and chromium ions from orthodontic brackets in the oral cavity [6-8]. Lee *et al.* cited surface corrosion in the Nickel-Titanium (NiTi) arcs that can increase the friction between the wire and bracket interface, reducing the slip action during orthodontic treatment [9]. In addition, metal brackets with good corrosion resistance are clinically important [10].

Moreover, the investigation of friction on Brazilian orthodontic brackets may provide new evidence regarding orthodontic practice, due to the preferred use for metal brackets in Brazil and considering the piece of Market that Brazilian orthodontists represent [11].

Considering the scarcity of studies evaluating brazilian metal brackets, this research aimed to evaluate the friction in two brands before and after use in the oral environment.

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Materials and Methods

This study was approved by the Research Ethics Committee of UNICEUMA, according to opinion number 210,902. The volunteers were asked to sign a consent form and clarified before the start of their participation.

Individuals of both genders, aged between 18 and 30 years, were selected, presenting an adequate oral hygiene control standard, low caries index and normal salivary flow. Pregnant women, volunteers with high caries activity, gingivitis or periodontal disease, presenting local or systemic conditions or who did not agree with the terms of the survey were not included in this sample.

In all, 40 brackets were divided into 4 groups (n=10): 2 control groups - without exposure to the buccal medium - (G1 and G2) and 2 experimental groups - with exposure to the buccal medium - (G3 and G4) (Table 1). In this study, 10 patients from the orthopedic clinic of the Master's of Dentistry, UNICEUMA (São Luís, Maranhão, Brazil) who underwent corrective orthodontic treatment. The brackets were conventionally fixed to the buccal surfaces of the teeth 14 and 15 and after 60 days [12,13] were replaced with new brackets from the same prescription (Roth 0,22ll x 0,30ll) of both brands to be tested.

To preparation of the specimens, rectangular plates (40x55x0.5mm) were used in acrylic [14]. In each plate, two parallel and perpendicular straight lines (X axis and Y axis) were demarcated [15], in which the Y axis being equidistant from the lateral edges of the plate by 20mm and the X axis being 2mm apart from one of the Extremities. For each card, there is a corresponding bracket. Each bracket was fixed to the plate at the point of intersection of the traced axes, with the aid of the bracket. Transbond XT® composite resin (3M Unitek, United States of America) was used for bonding the brackets according to the manufacturer's recommendations.

The groups were submitted to mechanical friction tests in a Universal Testing Machine (EMIC, model DL2000, Tesc control software version 3.04). A device for positioning the bracket and orthodontic wires (CrNi, 0.021x0.025, Morelli, Brazil) was used in which it was coupled to a universal test machine and a 5 cm segment of each wire was placed in a forceps of the device. This device was placed parallel to the base of the bracket slot, with each wire drawn five times at a speed of 0.5mm/min with a 5N cell load. In these conditions, the dynamic friction was measured.

All specimens were prepared by the same operator. Due to the sensivity of this test, it was necessary to clean the brackets and orthodontic wires with 70% Ethyl Alcohol, in view of to prevent the interference of a possible previous contact with oily substances and dirt substances [12].

Groups	Comercial brand	n	Exposure
G1	Morelli Ortodontia®	10	Control
G2	Eurodonto®	10	Control
G3	Morelli Ortodontia®	10	60 days of clinical exposure
G4	Eurodonto®	10	60 days of clinical exposure

Table 1: Description of Groups Involved in the study.

The data from the friction test were evaluated to test the null hypothesis using the program Bioestat 5.0 (Instituto Mamirauá, Brazil). The comparison between groups was performed through two-way ANOVA, with tukey test, considering a $p < 0.05$.

Results

The brackets of the G1 group (not exposed to the oral environment) have lower friction when compared to the brackets of the group G3 and G4, exposed to the oral environment. The brackets of group G2, from control group, present less friction when compared to the same brackets exposed to the buccal environment.

It was observed that the brand used in groups G2 and G4 presented greater friction with the orthodontic wire. In addition, there was no difference between the control groups (G1 and G2). The G2 group brackets presented similar frictional force to G3, which had already been exposed to clinical use (Figure 1).

Discussion

The metallic brackets studied presented a low coefficient of friction, even after a clinical use period probably due to the good resistance to corrosion. Most of the manufactured orthodontic brackets are composed of stainless steel, because it has excellent mechanical properties, low cost and good resistance to corrosion [16].

Keith et al. was primarily studied static friction in two types of ceramic brackets and one type of steel bracket using rectangular wires and the study found lower friction resistance and minimal changes with the use of steel brackets when compared to ceramic brackets. These data related to metal brackets do not match the data found in this study, since there was a significant difference between the metallic brackets that were exposed to the buccal medium.

Some studies indicate that the coefficient of friction is lower in the combination wire and stainless steel bracket providing a sliding mechanics more favorable [17-19]. These data are consistent with the results found in this research, since both brass and wire are made of stainless steel, and between G1/G3 and G2/G4, in which the first one presents a lower coefficient of friction.

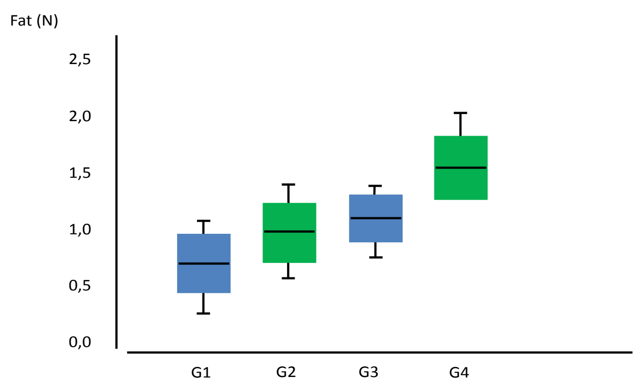

Figure 1: Friction force of metallic brackets according to groups of exposure.

The degradation of the clinical support material of the contact surfaces of the arches after in vivo orthodontic use has already been associated with changes in friction, suggesting that clinical use may result in biodegradation of materials, especially in cases of poor hygiene [20,21]. In this study, a limited number of signs of degradation induced during the test from the evaluation of friction were observed, even with differences in friction after clinical use.

Most of the studies focus on the evaluation of commercial brands of orthodontic brackets to an in vitro biodegradation process, based on simulations and absence of clinical use [16]. In these studies, it is argued that a period of 60 days of submission to a process of chemical-mechanical aging may result in changes in the surface and composition of the metal alloys of brackets. These data justify assuming that there were changes in the surfaces of the brackets tested in this research, since they underwent an aging process for the same period in the oral cavity, resulting in a significant difference between the control and test groups after the friction test.

Parmagnani *et al.* [22] evaluated the resistance to friction of metallic brackets using rectangular orthodontic stainless steel wires before and after the use of airborne abrasive sodium bicarbonate and evaluated the surface micromorphology of these supports by means of electron microscopy. Two trademarks of metal brackets were evaluated. A device adapted to a universal test machine was used to simulate the retraction movement in the sliding mechanics by measuring the tensile force required to slide the yarn 10 mm along the test sample carriers. There was greater resistance to friction after blasting, regardless of the brass mark. Micromorphological analysis showed that blasting caused changes in the metal bearing surfaces. They concluded that blasting is not recommended in the grooves of ceramic or metal substrates. This corroborates with data from this research, since a universal test machine was used to measure the dynamic friction and it was verified that there was a greater resistance to the friction in the two marks after the use in the buccal environment.

Among the limitations of this study, it was verified that other variables can be evaluated based on the same methodology with the following possibilities of work: evaluation of bracket micromorphology through the SEM, evaluate if the type of section of the wire changes the results, the (Whether conventional, ceramic or self-ligating), insertion of the elastomer, brass material and use of lubricants may alter the final results [1,23].

Conclusion

The brands of brackets tested showed a higher coefficient of friction after clinical use, indicating possible signs of biodegradation that need more sensitive methods for investigation.

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