ORIGINAL ARTICLE

EVALUATION OF THE EFFECTS OF RESIDUAL RESIN REMOVAL AND POLISHING ON THE ENAMEL SURFACE AFTER BRACKETS DEBONDING

AVALIAÇÃO DOS EFEITOS DA REMOÇÃO DA RESINA RESIDUAL E DO POLIMENTO NA SUPERFÍCIE DO ESMALTE APÓS DESCOLAGEM DO BRAQUETE

Carlos Eduardo de Oliveira Lima[1], Luíz Sérgio Carreiro[1], Paulo Eduardo Bággio[1], Pedro Marcelo Tondelli[1], Ricardo Takahashi[1], Ane Caroline Godoi da Silva[2]

ABSTRACT

Considering the use of specific burs to remove residual resin after bracket debonding and the possibility of injuries to the dental enamel after using these burs, this study aimed to verify the variation in the enamel surface appearance in a qualitative way and evaluation with topographic images of the dental enamel. The use of Scanning Electron Microscopy (SEM) allowed to illustrate and evaluate the enamel surface after the final polishing phase using two methods: rubber cup or Robinson brush. Twenty-five human premolar teeth were obtained from extractions in patients who voluntarily sought the Oral Maxillofacial Surgery Residency at the Dental School from the State University of Londrina; the teeth were divided into four groups A, B, C and D containing 6 teeth each according to the burs used to remove the remaining adhesive and the chosen polishing, in addition to one tooth as a "control". Dental enamel surface roughness was evaluated after resin removal and enamel surface after polishing with the two methods presented. The results showed that by observation and inspection, the burs removed residual resin from all teeth, however, caused scratches and grooves as evidenced in the SEM images. Based on the results, there was no statistical difference between the polishing methods, and both were important for the reduction of abrasive marks and provided a smoother enamel surface.

Keywords: Dental enamel, Dental debonding, Orthodontic brackets, Scanning electron microscopy, Dental polishing.

RESUMO

Considerando o uso de brocas para remoção da resina residual após descolagem do braquete e a possibilidade de injúrias à superfície do esmalte após o uso dessas brocas, este trabalho teve como objetivo realizar um estudo experimental para avaliar a variação do aspecto superficial do esmalte de forma qualitativa, por meio da avaliação com imagens topográficas do esmalte dentário, utilizando-se a Microscopia Eletrônica de Varredura (MEV), a qual permitiu ilustrar e avaliar a superfície do esmalte após a fase de polimento final, realizada por dois métodos: taça de borracha ou escova Robinson. Foram utilizados 25 dentes pré-molares humanos, obtidos a partir de exodontias em pacientes que procuraram voluntariamente o curso de Residência em Cirurgia da Clínica Odontológica Universitária da Universidade Estadual de Londrina. Os dentes foram divididos em quatro grupos: A, B, C e D, contendo 6 dentes cada, de acordo com as brocas utilizadas para a remoção do remanescente adesivo e o polimento escolhido, além de um dente como "controle". Foi avaliada a rugosidade superficial do esmalte após a remoção da resina e a superfície do esmalte após o polimento com as duas opções apresentadas. Os resultados mostraram que, por observação e inspeção, as brocas removeram a resina residual de todos os dentes, porém, causaram riscos e ranhuras, como evidenciado nas imagens em MEV. Concluiu-se que não houve diferença estatística entre os métodos de polimento e que ambos foram importantes para a redução das marcas abrasivas, proporcionando uma superfície mais lisa do esmalte.

Palavras-chave: Esmalte dentário, Descolagem dentária, Braquetes ortodônticos, Microscopia eletrônica de varredura, Polimento dentário.

[1]PhD, professor, State University of Londrina, Paraná, Brazil.
[2]Undergraduate student of the Dental School of the State University of Londrina, Paraná, Brazil.

How to cite this article: Lima CEO, Carreiro LS, Bággio PE, Tondelli PM, Takahashi R, Silva ACG. Evaluation of the effects of residual resin removal and polishing on the enamel surface after bracket debonding. Nav Dent J. 2023;50(2): 5-14.

Received: 28/07/2023
Accepted: 04/09/2023

INTRODUCTION

The search for an efficient and safe method for removing residual resin after debonding orthodontic devices has resulted, over time, in a wide variety of procedures. Nevertheless, even when used correctly, they can cause grooves and irregularities on the enamel surface (1), making it difficult to obtain good results without iatrogenic damage (2). The rough surface makes proper cleaning difficult, invites the deposition and retention of biofilm, and the formation of stains (2).

In the orthodontic routine, aiming to minimize the grooves caused by the burs and obtain a smoother and more homogeneous surface closer to the surface of the initial enamel, after removing the remaining resin, materials are used for the final polishing. This is an essential step for orthodontic post-treatment, enabling the recovery of aggressions to the enamel surface, avoiding the accumulation of biofilm, minimizing the chances of stains and/or caries lesions. In addition, the careful removal of remaining resin provides a more favorable aesthetics, contributing to a good oral health and, consequently, an improvement in the patient's quality of life. Although final polishing is an essential step to reduce marks produced by instruments, there is still no consensus regarding the best method for carrying it out (3, 4).

In the present study, the importance of orthodontic bracket removal procedures after completion of treatment was considered, followed by the removal of residual resin that was used to bond these accessories and the final polishing of the enamel surface.

This research aimed to evaluate the enamel surface after removing the residual resin with burs, with the aid of the Scanning Electronic Microscope (SEM), as well as the use of two types of polishing, one using a Robinson brush and pumice paste, and another using a rubber cup with pumice paste.

METHODS

An experimental/laboratory study was carried out with the purpose of evaluating the use of two types of enamel polishing, after removing the orthodontic bracket and residual resin with two types of burs, one with high speed and the other with low speed. Human premolar teeth were used, extracted for orthodontic indications, from patients who voluntarily sought the Residency in Oral and Maxillofacial Surgery and Traumatology at the Dental School of the State University of Londrina (UEL), Brazil. The teeth were extracted without the need for tooth sectioning and kept in saline solution for a maximum period of 3 months.

As exclusion criteria, teeth with an origin other than the UEL, teeth with previous restorations, teeth extracted and stored outside the maximum period of 3 months or sectioned at the time of extraction, were discarded. The sample consisted of 25 healthy human premolars, 1 tooth being "Control" and the other 24 teeth divided into Group A, Group B, Group C and Group D, which had brackets glued and removed after 1 month and the residual resin removed with a bur. Except for the "Control" tooth, all specimens had metal brackets bonded with Transbond XT resin (3M Unitek ®, Monrovia, CA, USA) according to the manufacturer's instructions. The Groups were divided as follows: Group A: A1, A2: a high speed bur was used to remove residual resin; A3, A4, A5 and A6: high speed bur used to remove residual resin, followed by polishing with a Robinson brush and pumice stone; Group B: B1, B2: a high speed bur was used to remove residual resin; B3, B4, B5 and B6: bur at high speed used to remove residual resin, followed by polishing with a rubber cup and pumice stone; Group C: C1, C2: a low speed bur was used to remove residual resin; C3, C4, C5 and C6: bur at low speed used to remove residual resin, followed by polishing with a Robinson brush and pumice stone; Group D: D1, D2: a low speed bur was used to remove residual resin; D3, D4, D5 and D6: bur at low speed used to remove residual resin, followed by polishing with a rubber cup and pumice stone.

In preparation for bonding, all specimens underwent prophylaxis. The enamel was conditioned with 37% phosphoric acid (Magic Acid Vigodent®, Rio de Janeiro, RJ, Brazil) for 20 seconds, washed with a water/air spray, dried in oil-free air, until it reached a milky-white color. Then, the adhesive was applied with a brush and light-cured for 20 seconds. Transbond XT resin was dispensed onto the bracket base using spatula 1 (Duflex ®, Rio de Janeiro, RJ, Brazil). The bracket was positioned on the tooth surface using orthodontic forceps (Morelli ®, Sorocaba, SP, Brazil) and pressed firmly, allowing the resin to penetrate the mesh. The excess resin around the base of the bracket was removed with an exploration probe (Duflex ®, Rio de Janeiro, RJ, Brazil) and light-cured for 40 seconds, 10 seconds on each side using the Optilight Max LED curing light (Gnatus ®, Ribeirão Preto , SP, Brazil) in continuous light intensity mode and at a power of 1200 mW\cm^2. Subsequently, the samples were stored in a humid environment for a week, until the brackets were removed. Regarding the removal of the brackets, to transfer less amount of stress to the enamel and the adhesive layer, applied forces were used on the outer wings of the brackets using Straight How pliers (Starlet ®, São Paulo, SP, Brazil), through pressure on the fins, causing deformation of the base and consequent removal. The samples predominantly showed fractures at the bracket/adhesive interface, with the resin adhering to the tooth surface.

Samples with similar amounts of residual resin had this material removed with burs by a single professional, a specialist in Orthodontics, using a high speed handpiece and micromotor (low speed) according to the bur used, with the aid of a dental reflector. The high speed multi-blade with 18 blades bur, from the Angelus Prisma Dental (Reference Code 710359) and the low speed zirconia multi-blade bur, from the Morelli (Reference Code 75.03.001) were used. The bur was positioned parallel to the long axis of the teeth and horizontal, precise, one-way movements were performed on the resin. The pressure was carefully applied to the handpiece during cuts to maintain uniformity. The evaluation of the removal of residual resin was carried out by visual and macroscopic observation, until total removal of the remnants, with the aid of a dental reflector and a magnifying glass, in addition to the active tip of an exploration probe.

Regarding polishing, a Robinson brush was used, made with ultra-flexible nylon bristles (American Burrs, Palhoça, SC, Brazil) or a flexible and soft latex rubber cup (American Burrs, Palhoça, SC, Brazil); In both protocols, polishing was done with the aid of an extra-fine pumice stone (SS White, São Cristovão, RJ, Brazil) and water at low speed for 15 seconds and then washed with a jet of water for 20 seconds.

The research was mainly based on the evaluation of all phases using the Scanning Electron Microscope (SEM), 400x magnification, in search of the final parameters of each phase. The experimental part was developed at the Electronic Microscopy and Microanalysis Laboratory (LMEM) at UEL. In the preparation process, the samples were cleaned and dried, and the material was fixed on metal bases containing double-sided carbon adhesive tape. Then, they received a layer of gold approximately 20 nm thick, as the gold on the surface allows us to obtain high-resolution images. In this process we used a sputter coater, Bal-Tec brand, SCD 050. After that, the material was analyzed using a Philips Scanning Electron Microscope (SEM), Quanta 200; using a voltage of 20 kV and a working distance (WD) of 10 mm. The images were digitized and subsequently observed and compared to evaluate the appearance of the enamel surface, considering similar magnifications.

To evaluate roughness, the Enamel Roughness Index (ERI) was proposed, which evaluates the enamel surface in terms of smoothness conditions (Chart 1). To apply this index, the photographed area was subdivided into 100 equal parts, using a grid created on top of the photograph using the Power Point (Microsoft Corporation, Seattle, USA). After this, the number of damaged areas during the process of removing the orthodontic bracket and residual composite was evaluated. The evaluation was carried out directly on the computer screen, in a dark room to better visualize the enamel surface. Once the damaged areas were counted, the specimens had their appropriate score determined and were classified according to Table 1.

Therefore, the higher the group average, the greater the damage caused to the enamel after removal or removal plus polishing. The assessment was carried out in three different periods by the same individual, previously calibrated. The average found in the three assessments was noted and classified following the ERI. This index has greater reliability when compared to the surface roughness index (SRI), proposed by Howell and Weekes (5), since the ERI has a greater number of scores.

CHART 1 – ENAMEL ROUGHNESS INDEX (ERI).

1	up to 10% of the scratched surface
2	up to 20% of the scratched surface
3	up to 30% of the scratched surface
4	up to 40% of the scratched surface
5	up to 50% of the scratched surface
6	up to 60% of the scratched surface
7	up to 70% of the scratched surface
8	up to 80% of the scratched surface
9	up to 90% of the scratched surface
10	More than 90% of the scratched surface

The research was approved by the Research Ethics Committee of the State University of Londrina – UEL, through protocol number CAAE 17075519.5.0000.5231.

The data obtained were analyzed using the R package version 1.2.2 software and considered the weights presented by the study's sampling design. Considering the procedures, the Shapiro-Wilk analysis of variance, Barlett analysis for homogeneity of variances and the Tukey test for multiple comparisons were used.

RESULTS

Scanning Electron Microscopy (SEM) images, with 400x magnification, after using burs to remove residual resin, showed enamel surfaces with different levels of irregularities and images showing scratches or grooves. There were no significant differences between the 2 different methods of final enamel polishing tested. Despite the important and efficient result of the polishing, observed in the SEM images, we can state that no enamel surface was restored to its original appearance.

All protocols tested efficiently removed the remaining resin, considering both by visual assessment, with the aid of the dental reflector and the active part of the exploration probe, and by SEM. However, they led to considerable changes in the topography of the enamel with the appearance of grooves and small erosions (scratches) on the surface (Figure 2: A1 and A2; Figure 3: B1 and B2; Figure 4: C1 and C2; Figure 5: D1 and D2). The debonding procedures, followed by removal of the remaining resin with the two types of burs (Tungsten burs with 18 blades at high speed, brand Angelus prism dental and Tungsten zirconia burs at low speed, Morelli), resulted in a slightly rough surface , with irregularities on the enamel surface at different levels, as shown by the averages of the ERI, with 7.5 for Group A (Tungsten carbide burs with 18 blades at high speed), 4.5 for Group B (Tungsten carbide burs with 18 blades at high speed), 8.5 for Group C (zirconia Tungsten burs at low speed) and 5.0 for Group D (zirconia Tungsten burs at low speed) (Table 1).

For Group A, in which resin removal was carried out with a Tungsten carbide burs with 18 blades at high speed, and polishing with a Robinson brush and pumice stone, the photomicrographs revealed a great number of erosions and scratches (Figure 2: A1 and A2) compared to the Control tooth (Figure 1). After polishing with pumice, well-polished enamel surfaces were observed, although some marks or depressions were still present. (Figure 2: A3, A4, A5 and A6).

For Group B, with the resin removal performed using a Tungsten carbide burs with 18 blades at high speed, followed by polishing with a rubber cup and pumice stone, moderate striations on the enamel surface were observed after removal of the residual resin (Figure 3: B1 and B2). The use of pumice stone was efficient in polishing the enamel, softening the abrasive marks, though it was not able to remove more obvious grooves (Figure 3: B3, B4, B5 and B6).

In the protocol used in Group C, zirconia Tungsten burr was used at low speed, which efficiently removed the remaining resin, generating light grooves and striations on the tooth surface (Figure 4: C1 and C2). Subsequently, the use of a Robinson brush and pumice stone resulted in more efficient enamel polishing (Figure 4: C3, C4, C5 and C6), approaching the topography of the enamel of the control tooth.

For Group D, erosions and scratches caused by the zirconia Tungsten carbide burs at low speed (Figure 5: D1 and D2) were smoothed after polishing with a rubber cup and pumice stone, resulting in a smoother enamel surface, but with some depressions (Figure 5: D3, D4, D5 and D6), observed microscopically.

In general, the zirconia Tungsten burs at low speed were slightly more aggressive than those at high speed, and the polishing phase with pumice paste showed a positive influence on surface recovery of the enamel. This is confirmed by observing the photomicrographs that, in the images of phases "1 and 2", can be seen a blunt action of an object (bur), which caused grooves and small erosions on the treated surface. In the photos of phases "3, 4, 5 and 6", there is a recovery through polishing, which left the surface smoother, but below the image of the control tooth, as shown by the ERI averages, with 1.75 for Group A (multi-blade burs with 18 blades at high speed to remove resin, followed by polishing with a Robinson brush and pumice stone), 1.5 for Group B (multi-blade burs with 18 blades at high speed to remove the resin, followed by polishing with a rubber cup and pumice stone), 1.0 for Group C (zirconia Tungsten burs at low speed to remove the resin, followed by polishing with a Robinson brush and pumice stone), and 2.25 for Group D (zirconia Tungsten burs at low speed to remove the resin, followed by polishing with a rubber cup and pumice stone) (Table 1).

After carrying out the simple analysis of variance and considering the procedures, the assumptions of normality of residues (Shapiro-Wilk, p-value 0.0647) and homogeneity of variances (Barlett, p-value 0.6932) were satisfied for the data transformed by the logarithmic function. As the analysis of variance was significant (p-value 0.000203), Tukey's multiple comparison test was performed considering a significance level of 5% and found that the groups with polishing did not differ from each other but differed significantly of all groups of teeth that were not polished. Besides, the groups polished with the rubber cup do not differ from the groups polished with the Robinson brush.

TABLE 1 – SCORE VALUES ASSIGNED TO EACH TOOTH FOR THE ENAMEL ROUGHNESS INDEX (ERI).

ERI	1	2	Mean (1 / 2)	3	4	5	6	Mean (3 / 4 / 5 / 6)
A	8	7	**7,5**	2	1	1	3	**1,75**
B	6	3	**4,5**	2	1	2	1	**1,50**
C	8	9	**8,5**	1	1	1	1	**1,00**
D	6	4	**5,0**	3	1	2	3	**2,25**
Control Tooth			**Score**		**Mean (C)**			
"C"			**1**		**1**			

A1, A2: *High Speed to remove residual resin;* **A3, A4, A5 and A6**: *High Speed to remove residual resin + Robinson brush with pumice stone;*
B1, B2: *High Speed to remove residual resin;* **B3, B4, B5 and B6**: *High Speed to remove residual resin + rubber cup with pumice stone;*
C1, C2: *Low Speed to remove residual resin;* **C3, C4, C5 and C6**: *Low Speed to remove residual resin + Robinson brush with pumice stone;*
D1, D2: *Low Speed to remove residual resin;* **D3, D4, D5 and D6:** *Low Speed to remove residual resin + rubber cup with pumice stone.*

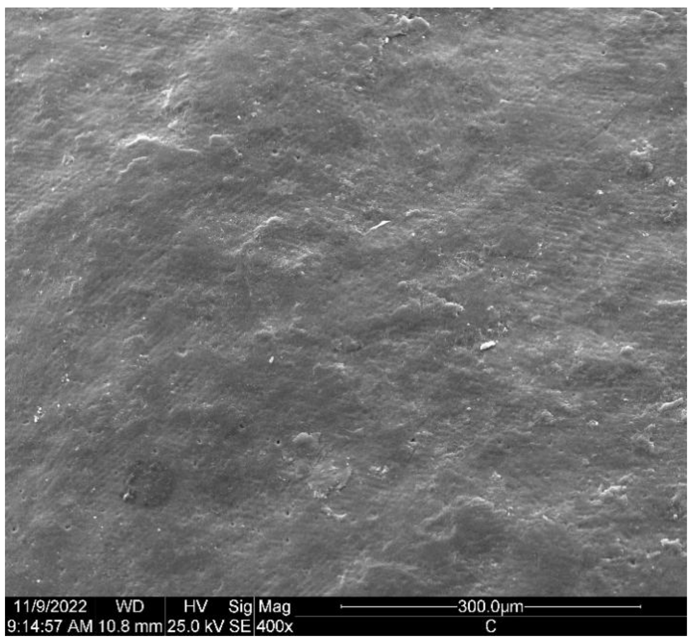

Figure 1: *Control tooth (C). SEM 400x.*

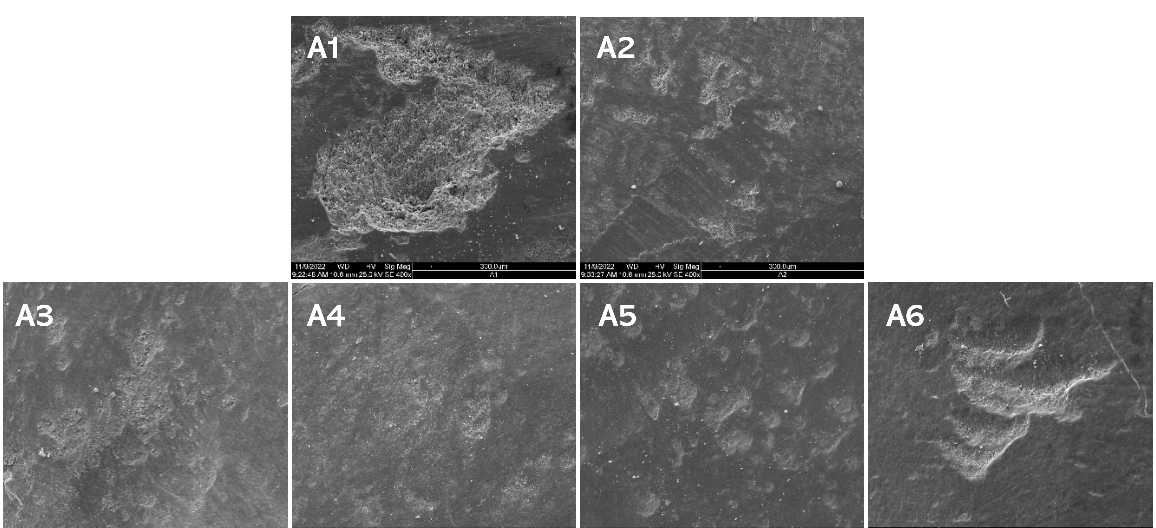

Figure 2 – Group A. A1, A2: *High Speed to remove residual resin;* **A3, A4, A5 and A6**: *High Speed to remove residual resin + Robinson brush with pumice stone. SEM 400x.*

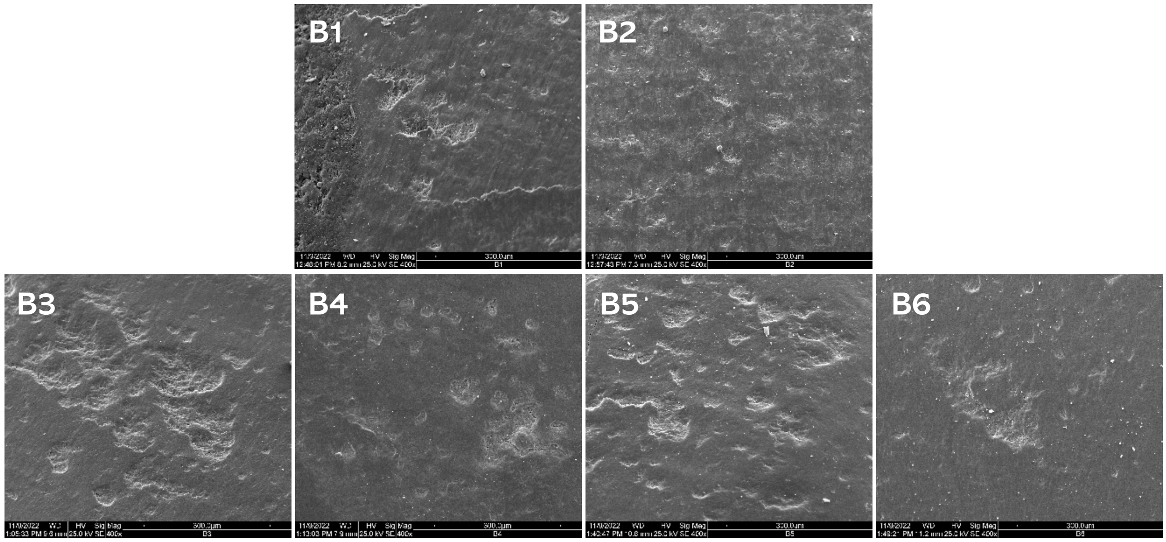

Figure 3 – Group B. B1, B2: *High Speed to remove residual resin;* **B3, B4, B5 and B6**: *High Speed to remove residual resin + rubber cup with pumice stone. SEM 400x*

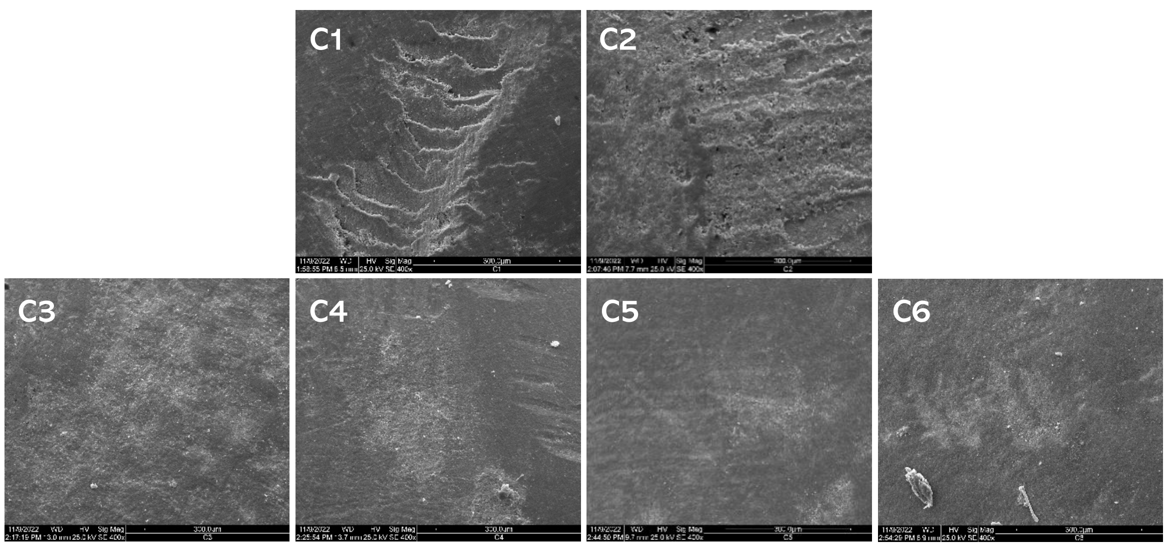

Figure 4 – Group C. C1, C2: *Low Speed to remove residual resin;* **C3, C4, C5 and C6**: *Low Speed to remove residual resin + Robinson brush with pumice stone. SEM 400x.*

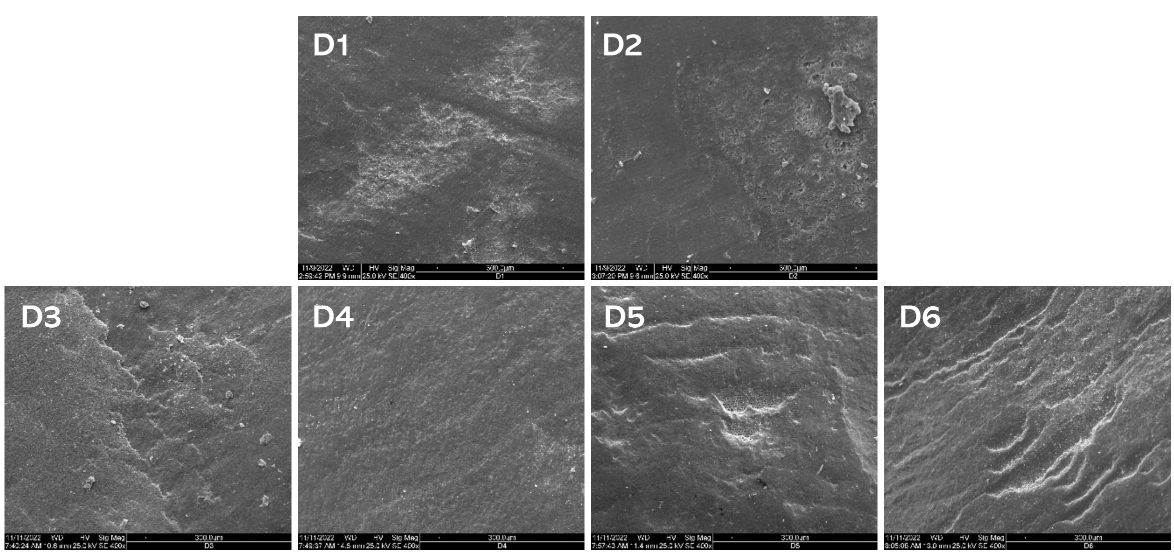

Figure 5 – Group D. D1, D2: *Low Speed to remove residual resin;* **D3, D4, D5 and D6**: *Low Speed to remove residual resin + rubber cup with pumice stone. SEM 400x.*

DISCUSSION

One of the biggest challenges after orthodontic treatment is the precise removal of the adhesive residue, aiming to avoid not only irreversible iatrogenic injuries, such as rough surfaces, vertical cracks, pulp necrosis, loss of the external surface rich in fluoride, but also the presence of residues of adhesive in the adhesion area (6).

The protocols used to remove the brackets and residual adhesive caused irregularities and grooves in the enamel and severe damage to the enamel surface, and polishing was unable to reduce the damage (1-4, 6-15).

The removal of remnants resins from the tooth surface with the use of rotary instruments after orthodontic treatment can eventually cause damage to the enamel (2, 6, 9, 11, 13, 15) and loss of surface structure with exposure of the endings of the enamel prism to the oral environment, accumulation of biofilm and pigments in microcracks, which can cause a decrease in surface resistance to organic acids. Eventually, these changes make the enamel more susceptible to demineralization and results in stains at the resin/enamel interface (1, 2, 6, 9, 12, 14, 16-18), which may cause irreversible damage to the enamel (3, 8, 10, 19). Thus, it is necessary to consider the importance of trying, after removing the residual resin from the enamel, to restore the surface as close as possible to the pre-treatment conditions (9), even though no enamel surface has been restored to its original appearance (19). The hypothesis that the use of burs to remove residual resin damages and alters the enamel surface was confirmed by this study.

There are several techniques for removing residual resin, such as diamond burs, polishing tips, and tungsten carbide multi-blade burs at low and high speed (16). They can still be removed with pliers, scrapers, abrasive discs, stones, or ultrasonic instruments; irregularities caused by these rotating instruments result in greater roughness of the enamel surface (1).

Although there was no consensus in the literature, the most common way to remove adhesive residues after orthodontic removal is using tungsten carbide burs (1), and this option has been suggested by several authors (7, 16, 19-25).

According to Ferreira *et al.* (19), the debonding procedure, followed by removal of the remaining resin with a tungsten carbide multi-blade burs resulted in a slightly rough surface, with different levels of irregularities on the enamel surface. Conical tungsten carbide burs with 12 and 30 blades at high speed proved to be fast and efficient in removing residual resin (26). In the present study, a Tungsten carbide burr with 18 blades was used at high speed and a zirconia Tungsten burr at low speed; In general, burs at low speed were slightly more aggressive than those at high speed, without statistical significance though. On the other hand, some studies have shown that burs used at low speed obtained better results, causing less damage (1, 3, 27).

Instead of the tungsten carbide burr, there are reports in the literature that it is preferred to other materials, such as Arkansas stone, which produces thin, shallow scars with a more homogeneous morphological appearance (13), aluminum oxide discs (12), residual adhesive remover, which caused less damage to the enamel surface (28), fiberglass burs, which scratch the surface less, being a good option for finishing and post-removal polishing of orthodontic brackets (29, 30), discs Sof-Lex, which are presented as a more economical option (31), and the carbide finishing burs, which removes residual adhesive resin gently and effectively after detaching the bracket (32). There are still indications for the diamond bur, which removed the resin in approximately half the time compared to the eight-blade burr (8), and the Stainbuster burr, which created a smoother enamel surface, close to natural enamel (14).

The difference in cutting efficiency and residual resin removal can be determined by the rotation speed of the burr (29). Some authors (33, 34) preferred burs used at low speed, which would be safer.

Polishing after removing the orthodontic bracket is necessary and essential to obtain a surface with less surface roughness (31) and recover the enamel surface, leaving it smoother and brighter (3, 7, 9, 16, 22, 34, 35). According to some authors (10, 19, 20), polishing methods were unable to restore the original enamel surface after bonding and detaching the brackets and removing the residual resin. However, after removing the adhesive residue, all teeth had acceptable and satisfactory enamel surfaces (1).

The literature has little information about the effect of different systems for polishing enamel after removing orthodontic brackets, therefore, more studies are needed to test these finishing techniques (26), as well as finding increasingly more effective methods with less damage to the enamel surface (21).

In a comparative study, the enamel polishing was compared with aluminum oxide paste and water slurry of fine pumice (22). Although no statistically significant differences were found in polishing between the groups, SEM analysis showed a smoother enamel surface when polishing is carried out with aluminum oxide paste compared to pumice stone, in addition to visually presenting a brighter surface. According to Macieski *et al.* (3), final polishing with polishing paste or pumice stone is considered an essential step to reduce the abrasive marks produced by the instruments during the removal of the remaining adhesive and is essential to obtain smoother enamel surfaces.

In the current study, the specimens were polished with pumice, using a Robinson brush or rubber cup for 15 seconds. After polishing, there was an improvement or recovery in the enamel surface, previously damaged with grooves and scratches caused by burs, as can be seen in Table 1, which shows the individual scores per specimen and phase respectively, both after use of burs, such as recovery after polishing; corroborating the literature, stating that polishing with pumice promotes a smoother and more homogeneous surface and reduces roughness after using burs, becoming an essential step after orthodontic treatment (2, 3, 6, 7, 9, 11, 15, 20, 23, 36).

However, one study showed that final polishing with pumice was not sufficient to restore the enamel surface to the pre-treatment level (33). Furthermore, it was also shown that polishing with aluminum oxide paste, when compared to pumice stone, presents better results (22).

Vieira *et al.* (20) performed polishing with a rubber cup, pumice stone and water for 10 and 30 seconds, and the results provided by SEM analysis showed that the pumice stone is necessary after removing the brackets and the procedures did not provide a surface equal to healthy enamel. On the other hand, Pignata *et al.* (11) used pumice stone, water, and a rubber cup for 30 seconds to polish the enamel and showed better results with increasing enamel polishing time, since the damage was minimized, reducing scratches and grooves, leaving only the deepest ones. Contrastingly, Cardoso *et al.* (6) polished with a pumice stone (SS White) and a rubber cup (Microdont) for 10 seconds and restored the initial conditions of the enamel. For Tavares (9) and Gregório *et al.* (36), polishing with a rubber cup, pumice stone and water was efficient, as this process reduced the roughness values of all groups evaluated, as well as Fonseca, Pinheiro and Medeiros (16), who recommended polishing the enamel surface with rubber cups to increase smoothness and shine similar to natural enamel.

Janiszewska-Olszowska *et al.* (23) recommended the use of pumice paste for polishing and contraindicated Arkansas stones, green stones, diamond burs and lasers for removing residual adhesive. Other options for polishing the enamel surface were also mentioned, after removing the residual resin, such as finishing with graduated polishing discs or ceramic burs, which cause less damage to the enamel surface (7); the use of Enhance with polishing pastes (21); rubber cup and polishing paste (1); silicate paste and rubber cup (32); PoGo micro polisher (37); Sox-Flex discs (31) and the Enhance finishing and polishing kit followed by the use of a Prisma Gloss polishing cup and paste (38).

When comparing polishing at high and low speed, it was observed that polishing at high speed generated a rougher surface with irregularities; the best result was obtained with the use of a rubber cup at low rotation and with refrigeration, which resulted in an enamel surface with fewer scratches and grooves, exhibiting a shiny and smooth surface (19). In this research, it was observed that the polishing phase proved to be important and efficient for the recovery of the enamel surface, and that this efficiency occurred both with the use of a Robinson brush plus pumice stone and with the use of a rubber cup with pumice stone, even though, it does not restore the initial condition of the enamel.

Removing resin residue from the tooth surface after detaching orthodontic accessories, without iatrogenic damage, is difficult to achieve, but it is an essential step to eliminate biofilm retention and restore the aesthetic surface of the tooth (2, 12, 14, 15, 18). Some authors have suggested new studies to find increasingly effective methods that cause less damage to the enamel surface, as restoring enamel to its original morphology is still a challenge (14, 19, 21).

CONCLUSION

Based on the studies and results found, the types of burs used in this evaluation were effective and removed the residual resin after debonding the bracket but caused micro abrasions and changes to the enamel surface. There was no statistically significant difference between polishing with a Robinson brush and pumice stone, when compared to polishing with a rubber cup and pumice stone, and observation of the images showed that, in most cases, polishing was effective in reduction of the surface roughness of the enamel, providing a smoother and more polished enamel surface, below the image of the control tooth though.

The authors declare that there is no conflict of interest.

Corresponding author:
Carlos Eduardo de Oliveira Lima
Address: State University of Londrina/University Dental Clinic – COU
Celso Garcia Cid Highway, PR 445, Km 380 – University Campus / UEL
Londrina – Paraná – Brazil CEP 86044-766
eduardolima@uel.br

REFERENCES

1. Pont HB, Özcan M, Bagis B, Rend Y. Loss of surface enamel after bracket debonding: An in-vivo and ex-vivo evaluation. Am J Orthod Dentofacial Orthop 2010; 138(4): 387.
2. Ryf S, Flury S, Palaniappan S, Lussi A, Meerbeek B, Zimmerli B. Enamel loss and adhesive remnants following bracket removal and various clean-up procedures in vitro. Eur J Orthod 2012; 34(1): 25-32.
3. Macieski K, Rocha R, Locks A, Ribeiro GU. Effects evaluation of remainning resin removal (three modes) on enamel surface after bracket debonding. Dental Press J Orthod 2011: 16(5): 146-154.
4. Pyakurel G, Hassan GS, Sajedeen M. Evaluation of Enamel Surface after Removal of Adhesive Resin: An in Vitro Study. Orthod J Nepal 2018; 8(2): 12-16.
5. Howell S, Weekes W T. An electron microscope evaluation of the enamel surface subsequent to various debonding procedures. Aust. Dent. J. 1990: 35(3): 245-252.
6. Cardoso L A M, Valdrighi HC, Vedovello Filho M, Correr AB. Effect of adhesive remnant removal on enamel topography after bracket debonding. Dental Press J Orthod 2014; 19(6):105-12.
7. Retief DH, Denys FR. Finishing of Enamel Surfaces after Debonding of Orthodontic Attachments. Angle Orthod. 1979; 49(1):1-10.
8. Eliades T, Gioka C, Eliades G, Makou M. Enamel surface roughness following debonding using two resin grinding methods. Eur J Orthod 2004; 26(3): 333-338.
9. Tavares SW Análise *in vitro* de diferentes métodos da remoção da resina residual no esmalte dentário. Tese (Doutorado) – Universidade Estadual de Campinas, Faculdade de Odontologia de Piracicaba. 2006: Piracicaba, SP, 69.
10. Özer T, Basaran G, Kama JD. Surface roughness of the restored enamel after orthodontic treatment. Am J Orthod Dentofacial Orthop 2010: 137(3): 368-74.
11. Pignatta LMB, Duarte JS, Santos ECA. Evaluation of enamel surface after bracket debonding and polishing. Dental Press J Orthod 2012; 17(4): 77-84.
12. Faria-Júnior EM, Guiraldo R, Berger SB, Lopes MB. In-vivo evaluation of the surface roughness and morphology of enamel after bracket removal and polishing by different techniques. Am J Orthod Dentofacial Orthop 2015: 147(3): 324-9.
13. Pinho MM, Pinto GFV, Mesquita P, Silva FS, Souza JCM, Ferreira AP, *et al.* Damage on tooth enamel after removal of orthodontic adhesive by Arkansas' stone and tungsten carbide burs. Rev Port Estomatol Med Dent Cir Maxilofac 2017; 58(1):32-38.
14. Shah P, Sharma P, Goje SK, Kanzaryia N, Parikh M. Comparative evaluation of enamel surface roughness after debonding using four finishing and polishing systems for residual resin removal - an in vitro study. Prog Orthod 2019; 20(18): 1-10.
15. Cesur E, Arslan C, Orhan AI, Bilecenoglu B, Orhan K. Effect of different resin removal methods on enamel after metal and ceramic bracket debonding: An in vitro micro-computed tomography study. J Orofac Orthop. 2022: 83(3): 157-171.
16. Fonseca DM, Pinheiro FHSL, Medeiros SF. Sugestão de um protocolo simples e eficiente para a remoção de braquetes ortodônticos. R Dental Press Estética 2004: 1(1): 112-119.
17. Sundfeld RH, Franco LM, Machado LS, Pini NIP, Salomão FM, Anchieta RB, *et al.* Treatment of enamel surfaces after bracket debonding: case reports and long-term follow-ups. Oper Dent 2016; 41(1): 8-14.
18. Rezende M, Grande RS, Higashi C, Kossatz S, Loguercio AD. Técnica para remoção do remanescente adesivo após descolagem de braquetes ortodônticos. Rev Clin Ortod Dental Press 2014; 13(3):91-9.
19. Ferreira EF, Vilani GNL, Jansen WC, Brito HHA, Ferreira RAN, Manzi FR, *et al.* Enamel loss and superficial aspect during bonding and debonding of metallic brackets. Biosci. J. 2016; 32(2): 550-559.
20. Vieira AC, Pinto RA, Chevitarese O, Almeida MA. Polishing after debracketing: its influence upon enamel surface. J Clin Pediatr Dent 1993; 18(1): 7-11.
21. Osorio R, Toledano M, García-Godoy F. Enamel surface morphology after bracket debonding. J Dent Child 1998; 65(5): 313-17.
22. Vidor MM, Felix RP, Marchioro EM, Haha L. Enamel surface evaluation after bracket debonding and different resin removal methods. Dental Press J Orthod 2015; 20(2): 61-7.
23. Janiszewska-Olszowska J, Tomkowski R, Tandecka K, Stepien P, Szatkiewicz T, Sporniack-Tutak K, *et al.* Effect of Orthodontic Debonding and Adhesive Removal on the Enamel – Current Knowledge and Future Perspectives – a Systematic Review. Med Sci Monit 2014; 20: 1991-2001.
24. Sugsompian K, Tansalarak R, Piyapattamin T. Comparison of the Enamel Surface Roughness from Different Polishing Methods: Scanning Electron Microscopy and Atomic Force Microscopy Investigation. Eur J Dent 2020; 14(2): 299-305.
25. Nazir S, Cheema JS, Ahmed F, Khan UQ, Alam MA, Rehman ST. Comparison of enamel surface roughness parameters for resin removal following debonding using tungsten carbide bur and soflex discs with high speed and low speed hand pieces. Pakistan Oral & Dental Journal 2020; 40(1): January-March.
26. Ulusoy C. Comparison of finishing and polishing systems for residual resin removal after debonding. J Appl Oral Sci 2009; 17(3): 209-15.
27. Leão Filho JCB, Braz AKS, Araujo RE, Tanaka OM, Pithon MM. Enamel Quality after Debonding: Evaluation

by Optical Coherence Tomography. Brazilian Dental Journal 2015; 26(4): 384-389.
28. Janiszewska-Olszowka J, Tandecka K, Szatkiewicz T, Stepién P, Sporniak-Tutak K, Grocholewicz K. Three-dimensional analysis of enamel surface alteration resulting from orthodontic clean-up –comparison of three different tools. BMC Oral Health 2015; 15(1): 146.
29. Garg R, Dixit P, Khosla T, Gupta P, Kalra H, Kumar P. Enamel Surface Roughness after Debonding: A Comparative Study using Three Different Burs. JCDP 2018; 19(5): 521-526.
30. Teles G S, Ferreira L C L, Anauate Netto C. Estudo da ação de pontas de acabamento sobre o esmalte dental e restaurações com resina composta. IV Jornada de Iniciação Científica e Tecnológica UNIBAN BRASIL, 2012. Disponível em: https://repositorio.ufsc.br/handle/123456789/213332 Acesso em 10 de janeiro de 2023.
31. Qabel F, Talaei R, Saeedi S, Ghorbani R, Ameli N. Comparative effect of three polishing systems on porcelain surface roughness after orthodontic bracket debonding and composite resin removal: Anatomic force microscopy. APOS Trends in Orthodontics 2019; 9(4): 223-229.
32. Radlanski RJ. A new carbide finishing bur for bracket debonding. J Orofac. Orthop 2001; 62(4): 296-304.
33. Ahrari F, Akbari M, Akbari J, Dabiri G. Enamel surface roughness after debonding of orthodontic brackets and various clean-up techniques. J Dent 2013; 10(1): 82-93.
34. Sigileão LCF, Marquezan M, Elias CN, Ruellas AC, Sant'anna EF. Efficiency of different protocols for enamel clean-up after bracket debonding: an *in vitro* study. Dental Press J Orthod 2015; 20(5): 78-85.
35. Bilal MF, Ali LA, Hamid DH, Amin RAM. Evaluation of enamel surface roughness using different types of polishing system after orthodontic bracket debonding. Erbil Dental Journal 2021; 4(1): 54-60.
36. Gregório MCL, Barros Júnior TV, Toposki F, Moro A, Correr GM. Efeito de diferentes métodos de remoção de remanescente adesivo na rugosidade superficial do esmalte após descolagem de braquetes. Orthod Sci Pract 2017; 10(40): 42-46.
37. Challa P, Chakravarti S, Yudihistar PV, Rayapudi N. Evaluation of one-step micro polishers for residual resin removal after debonding on fluorosed teeth. APOS Trends in Orthodontics 2014; 4(5): 121-125.
38. Alnajar HA, Kadhim HA. Enamel Polishing after Orthodontic Bracket Debonding using two Different Protocols and two Different Adhesives. J. Int. Dent. Medical Res 2020; 13(1): 86-90.