# Effects evaluation of remaining resin removal (three modes) on enamel surface after bracket debonding

Karine Macieski*, Roberto Rocha**, Arno Locks***, Gerson Ulema Ribeiro****

## Abstract

**Introduction:** An appropriate selection of instruments is essential to perform a correct debonding technique, by properly removing orthodontic brackets and the remaining resin. **Objective:** The aim of this study was to evaluate three methods of remaining resin removal on enamel surface after bracket debonding, by means of Scanning Electron Microscopy (SEM). **Methods:** Eighteen bovine incisors were selected and divided into three groups (A, B and C) of six teeth each. Before bracket bonding, epoxy resin casts were obtained by impression of the teeth with addition silicon, in order to register baseline enamel characteristics and representing the control group. The methods for remaining resin removal were: Group A – gross and medium granulation Soflex discs; Group B – carbide bur in low-speed; Group C – carbide bur in high-speed. Soflex polishing system fine and ultrafine granulation discs were used for Group A, rubber tips for Groups B and C, and polishing paste for all groups. After polishing, impression of teeth were taken and casts were analyzed by means of SEM. The baseline enamel characteristics (Control Group) were compared to the final aspect of enamel to determine the method that generated less enamel abrasion. **Results and Conclusion:** The remaining resin removal by carbide bur in low-rotation, and enamel polished with rubber tips followed by polishing paste produced the smaller damage to the enamel.

**Keywords:** Dental enamel. Bracket. Debonding.

**How to cite this article:** Macieski K, Rocha R, Locks A, Ribeiro GU. Effects evaluation of remaining resin removal (three modes) on enamel surface after bracket debonding. Dental Press J Orthod. 2011 Sept-Oct;16(5):146-154.

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

* Specialist in Orthodontics, Federal University of Santa Catarina (UFSC).
** MSc and PhD in Orthodontics, Federal University of Rio de Janeiro. Head of Specialization Course in Orthodontics, UFSC.
*** MSc in Orthodontics, UFRJ. PhD in Orthodontics, State University of São Paulo (UNESP). Post-doctorate in Orthodontis, University of Aarhus, Denmark. Professor, Specialization Course in Orthodontics, UFSC.
**** MSc and PhD in Orthodontics, UFRJ. Professor, Specialization Course in Orthodontics, UFSC.

## INTRODUCTION

In the past, the fixation of orthodontic accessories was performed by banding all involved teeth. This procedure resulted in greater complexity and delay from the clinical aspect, compromised esthetics, patient discomfort, increased arch perimeter, among other disadvantages. Great changes occurred in clinical orthodontic with the establishment of the enamel acid etching technique by Buonocore[5] in 1955, allowing direct bonding of orthodontic brackets to dental surface.

Several studies were conducted for the development of adhesive materials that would fulfill the clinical requirements according to their physicochemical and mechanical properties. Recently, materials that present better bonding characteristics are composite resins, which present greater bond strength values to enamel, and the resin modified glass-ionomer cements, which chemically adhere to dental structures and also release fluoride to the oral environment.[24]

Although there are several advantages for direct bracket bonding, some disadvantages are also observed, including damage to enamel surface during bonding and mainly when removing brackets and the remaining resin. Enamel damage may be related to the use of abrasive prophylaxis,[21] acid etching,[12,13,15,21] excessive strength during bracket removal resulting in enamel fractures,[27] or to the mechanical removal of resin with rotary instruments.[9,12,21,25]

Thus, the ideal debonding method should remove the bracket and all remaining adhesive, resulting in minimal enamel surface alterations. Adequate instruments selection for brackets removal and for remaining resin removal, and also the type of adhesive are fundamental.[28]

Several studies[4,6,10,12,16,22,26] report different techniques for removing remaining resin and their effects on enamel surface. Reported procedures and instruments include: Pliers,[11,12,21,22,23] carbide burs in high or low speed,[6,9,12,13,21,22,23,25,26,28] polishing discs,[12,26,28] polishing paste or pumice,[23,26,28] as well as the ultrasound.[13,16] All techniques lead to different polishing degrees, abrasions and scratches incidence, and consequent damage to enamel surface.

The aim of the present study was to evaluate the enamel surface by means of Scanning Electron Microscopy (SEM), after using three different methods for remaining resin removal after bracket debonding. Baseline enamel characteristics (Control Group) were compared with possible enamel variations after resin removal, determining the method that generated less damage to enamel surface.

## MATERIAL AND METHODS

Eighteen bovine incisors, presenting no visible fractures or cracks to naked eye were selected. They were stored in a 0.5% thymol solution at room temperature. Teeth were randomly divided into three groups (A, B and C) of six teeth each.

Roots were separated from the crowns at the cement-enamel junction. Crowns were positioned in polyvinyl chloride (PVC) cylinders, fixed by their lingual surface with self-cured acrylic resin.

A marking with two perpendicular line segments (Fig 1) was made with double sided diamond discs (KG-Sorensen), guiding brackets placement (Fig 2) and allowing further SEM analysis at the same enamel area.

The specimens received prophylaxis with rubber cups (Microdont) and pumice (SS White – Extra-fine). Impressions with addition silicon were performed (Express, 3M ESPE) and epoxy resin casts obtained (Fig 3). The epoxy resin casts replicated enamel surface prior to bracket placement (Fig 4) with no damage and thus, represented the Control Group. New impressions of specimens were made after each procedure of remaining resin removal. New epoxy resin casts were obtained to determine the effects of each procedure on enamel surface in comparison to the baseline data.

FIGURE 1 - Fabrication of a guide for bracket bonding.

FIGURE 2 - Guide marking for bracket bonding.

FIGURE 3 - Impression with addition silicon and epoxy resin.

FIGURE 4 - Dental cast in epoxy resin prior to bracket placement – Control group.

Edgewise brackets 0.022 x 0.028-in slot (Morelli) for maxillary lateral incisors and direct bonding were employed. Enamel was etched with 37% phosphoric acid for 15 seconds. Transbond XT Light Cure Adhesive (3M Unitek) was used for the adhesive procedure.[2,3] Composite resin was placed at the brackets base and pushed toward dental surface. The brackets edges followed the marking guides and excess composite resin was removed.

Composite resin was light activated following the manufacturers' instructions. The specimens were store in distilled water at room temperature for 7 days, up to complete composite resin setting and prior to brackets removal.[7]

Brackets were removed with the aid of an Ortho-pli band plier, with pressure at the bracket wing, perpendicularly to the slot orientation.

### Tested methods of remaining resin removal

» Group A: Soflex (3M ESPE), gross and medium granulation discs, used with low pressure for remaining adhesive removal; and fine and ultra fine granulations for 20 seconds for each polishing procedure (Fig 5) were employed. Final polishing was performed with the polishing paste Enamelize – Cosmedent (Fig 6), applied with felt discs for 20 seconds.

» Group B: TP Orthodontics #100-122 carbide debonding bur in low-speed (Fig 7), used in

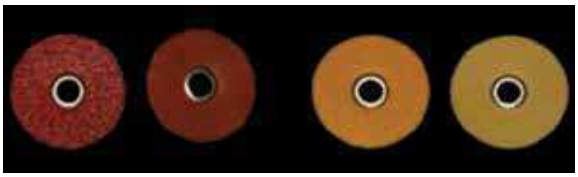

FIGURE 5 - Soflex discs – gross, medium, fine and ultra fine granulation (3M ESPE).


FIGURE 6 - Polishing paste for enamel - Enamelize (Cosmedent) and felt discs.

FIGURE 7 - TP Orthodontics #100-122 carbide debonding bur.

FIGURE 8 - Rubber point sequence 557626 Astropol (Ivoclar-Vivadent).

unidirectional movements; followed by polishing with abrasive impregnated silicon burs 557626 Astropol (Ivoclar-Vivadent) in low-speed for 20 seconds (Fig 8) were used. Final polishing was performed with the polishing paste Enamelize (Cosmedent) applied with felt discs for 20 seconds.

» Group C: TP Orthodontics #100-121 carbide debonding bur in high speed (Fig 9) was used in unidirectional movements; followed by impregnated silicon burs – 557626 Astropol (Ivoclar-Vivadent) – in low speed for 20 seconds for each point. Final polishing was performed with the polishing paste Enamelize (Cosmedent), applied with felt discs for similar time.

The visual assessment of remaining adhesive removal was performed under direct visual assessment with the aid of dental chair light and explorer, to simulate the clinical conditions.

The epoxy resin casts were covered with 3 µm layer of palladium and gold (Fig 10). They were evaluated by scanning electron microscopy (Philips XL 30) (Fig 11), with 40X magnification and 20 kv acceleration voltage. The photomicrographs were evaluated by a single evaluator, through visual comparison of the enamel characteristics prior (Control Group) and after the finishing procedures for remaining resin removal. This allowed assessing changes forced on enamel surface on each tested group in comparison to the images obtained at baseline (Control Group).

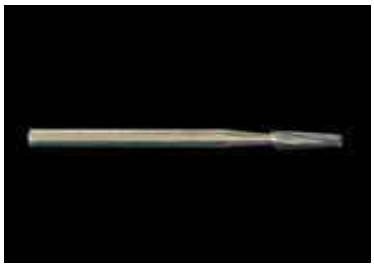

FIGURE 9 - TP Orthodontics #100-121 carbide debonding bur.

FIGURE 10 - Epoxy resin cast covered with palladium and gold.

FIGURE 11 - Scanning Electron Microscope.

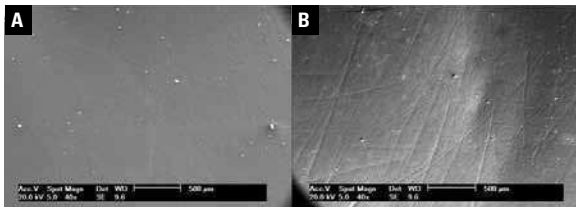


FIGURE 12 - Enamel characteristics variation prior to bracket bonding – Control group.

## RESULTS

Large variation on the original enamel characteristics of each evaluated tooth was detected (Control Group) (Fig 12). For this reason, the replication of teeth with epoxy resin prior to orthodontic bracket bonding was essential, and the comparison between original enamel characteristics and characteristics after bonding, debonding and final polishing was possible.

All tested protocols efficiently removed the remaining resin, evaluated by visual assessment and by SEM, but led to irreversible changes on enamel surface.

For Group A, Soflex gross and medium granulation discs were able to remove resin, but with higher difficulty in comparison to the other tested methods. The photomicrographs revealed great number of scratches (Fig 13B) in comparison to the Control Group (Fig 13A). Scratches were softened by polishing with the sequence of fine and ultra fine discs (Fig 13C) and the polishing paste (Fig 13D). Well polished enamel surfaces were microscopically observed after using the sequence of discs. However, great changes on enamel topography with surface flattening were also present. The remaining resin removal and polishing consequently relied on enamel removal.

Carbide bur in low speed, in Group B, efficiently removed remaining resin, generating light and fine striae on dental surface (Fig 14B), and preserving the baseline enamel characteristics (Fig 14A). Striae were softened by employing the silicon points' sequence, resulting in efficient enamel polishing (Fig 14C). The polishing paste removed light abrasions, propitiating a microscopically good enamel surface (Fig 14D). This procedure resulted in lower detectable enamel loss compared to the other tested procedures, and enamel topography remained closer to the baseline observation.

For Group C, carbide bur in high speed easily removed remaining resin. However, even when used with proper care, it produced a large number of moderate striae on enamel surface under microscopic evaluation (Fig 15B), resulting in a difficult control of enamel loss. The silicon points sequence employment was efficient for enamel polishing, softening the abrasive marks promoted by carbide debonding burs (Fig 15C), although not being able to completely remove them. The polishing paste was able to further reduce striae formed during carbide bur stage (Fig 15D).

All tested polishing agents were efficient in reducing the abrasions that inevitably occur during remaining resin removal. Soflex fine and ultrafine granulation discs considerably removed scratches promoted by coarser discs. The employment of

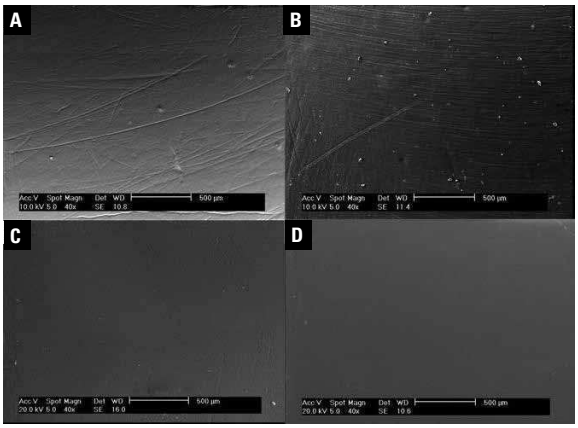


FIGURE 13 - **A**) Group A photomicrography prior to bracket bonding (control). **B**) After remaining resin removal with Soflex gross and medium granulation discs. Many abrasive marks on dental surface can be observed. **C**) Soflex fine and ultra fine granulation discs polishing. Decreased number of scratches, with the most intense ones still present. **D**) Use of polishing paste. The surface characteristics were improved.

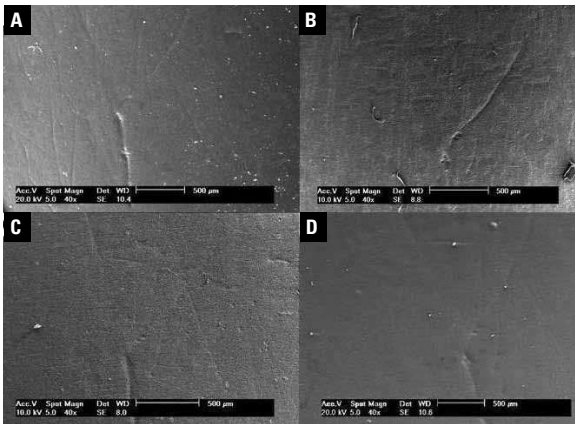


FIGURE 14 - **A**) Group B photomicrography prior to bracket bonding (control). **B**) After remaining resin removal with debonding burs. Light striae can be observed, with enamel surface characteristics close to baseline observation. **C**) Polishing with the sequence of silicon points. The majority of striae were removed. **D**) Final polishing with polishing paste. Improved surface smoothness was detected.

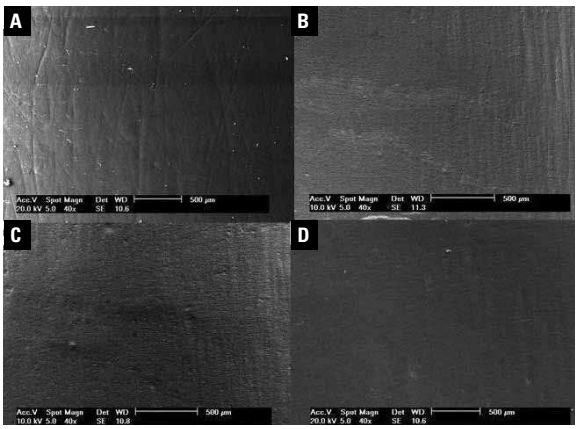


FIGURE 15 - **A**) Group C photomicrography prior to bracket bonding (control). **B**) After remaining resin removal with carbide bur in high speed. Moderate striae in higher number is detected. **C**) Polishing with the silicon points sequence. This step was efficient for enamel polishing and softening striae, although not being able to completely remove them. **D**) Final polishing with polishing paste. Further reduction of striae produced by carbide burs is observed.

silicon points sequence softened striae promoted by debonding burs. Excellent final polishing results were obtained with the polishing paste, which considerably reduced enamel variations caused by previously used instruments, and therefore important to obtain a smoother enamel surface.

## DISCUSSION

All tested methods clearly removed the remaining resin, but irreversible enamel surface alterations were generated. For Group A, the discs sequence produced well polished surfaces, assessed by either a microscope or by naked eye, but on expense of great change on enamel topography and consequently on enamel removal. For Group B, during naked eye assessment, enamel presented glossy appearance after remaining resin removal. This glossy aspect was improved with the whole polishing procedure leading to optimum enamel surfaces. For Group C, enamel presented no glossy appearance, in other words, lower enamel smoothness after the employment of carbide bur in high speed. The glossy appearance was reestablished after the employment of silicon points and polishing paste, leading to a clinically acceptable enamel surface.

Enamel loss during remaining resin removal has been reported in the literature, varying from 27.5 to 48 µm,[4] 55.6 µm,[10] and from 26.1 to 41.2 µm.[21] This variation is dependent on the quantity of bonding material fillers, being non significant in comparison to enamel mean

thickness of 1,500 to 2,000 µm.[4] The quantity of enamel loss during debonding procedures becomes clinically significant considering that higher fluoride concentration is present at enamel outer surfaces and decreases considerably after the first 20 µm.[4] The employment of conservative instruments and techniques is thus important, once multiple bonding procedures reaching this depth should be considered.

Instruments used for resin removal must keep the majority of dental enamel topographic characteristics, due to dental tissues health and esthetics. Inadequate procedures may remove enamel and alter the original tooth morphology, creating depressions, facets and fractures,[4,11,14,25] which may lead to areas of decalcification and thus, possible cavitated carious lesions.[1,8,9,16,19] Incomplete resin removal facilitates dental plaque accumulation and compromise esthetics due to color variations of remaining resin, which might occur by bacterial activity or food dye impregnation.[8,9,16,19]

Although there is a 21 to 44% bond strength reduction in permanent or primary bovine enamel, the employment of bovine teeth represents a viable solution for adhesion studies. This reduction is related to faster bovine teeth development, the presence of greater surface irregularities and larger enamel crystals.[17] On the other hand, the advantages of being similar to human enamel and easy acquisition surpass their disadvantages.

Several studies[6,8,10,11,16,18,22,23,25,26,28] revealed SEM and epoxy resin casts as presenting good characteristics for evaluating enamel morphology changes after different procedures for bracket debonding and surface polishing. Great variation on enamel characteristics was detected for each presently evaluated tooth, similarly as reported by Zarrinia, Eid and Kehoe.[28] For this reason, resin epoxy casts were necessary prior to bracket bonding to allow higher accuracy of the comparative analyses among the effects of performed procedures on dental enamel.

The remaining adhesive removal with gross and medium granulation Soflex discs was efficient, but occurred more difficultly and caused enamel surface flattening with consequent enamel loss. The same observations were detected by Campbell[6] and Zarrinia, Eid e Kehoe.[28] Zachrisson and Artun,[26] and Gwinnet and Gorelick,[11] in contradiction to the present results, considered this method inefficient, with remaining resin left on enamel surface.

Tungsten carbide burs in both low[1,6,12,15,17] or high speed[6,9,22,23,28] have been the most indicated instrument for remaining resin removal. However, during the comparison of this bur in both speeds during remaining resin removal, Rouleau, Marshall and Cooley[23] observed better results when using high speed, while other studies[12,13,21] detected better results for low speed. Better results were also detected in the present study for the use of carbide bur in low speed, being more conservative for enamel.

All tested polishing agents were efficient for decreasing striae and scratches, which inevitably occur during remaining resin removal, propitiating enamel surface smoothness. Soflex fine and ultrafine granulation discs considerably reduced scratches resulted by coarser discs, as detected in other reports.[11,22,28] In agreement with other studies,[6,22] the silicon points sequence softened striae resulting from carbide burs in low and high speed, leading to a glossier and smoother surface.

Similarly to the present study, the final polishing with polishing paste or pumice is considered an essential step to reduce abrasive marks produced by instruments during debonding and remaining adhesive removal.[4,6,11,16,22,26,28] The use of polishing paste in all tested groups clinically improved the gloss aspect, and microscopically provided a smoother enamel surface.

The aspect of enamel surface after debonding should be compared to adjacent surfaces. It is important for this assessment to evaluate enamel in dry and wet conditions, once reflection and refraction phenomena associated with wet surfaces may hide irregularities.[11]

Further studies might enhance the knowledge about the quantity of enamel loss and the depth of abrasive marks.

## CONCLUSIONS

» All tested methods for remaining resin removal generated changes in the enamel surface.

» The tested procedures efficiently removed the remaining resin. Soflex discs presented the highest removal difficulty, while carbide bur the easiest. But this last led to more abrasive marks production.

» Carbide bur in low speed generates light striae on dental surface. However, it maintains the enamel surface characteristics similar to the characteristics prior to the bracket bonding, leading to fewer variations in comparison to the other tested methods.

» All tested polishing agents were efficient to reduce abrasive marks, being indispensable to achieve smoother enamel surfaces.

» The remaining adhesive removal performed with carbide debonding bur in low speed, silicon points polishing and final polishing with polishing paste is the procedure that results in less damages to enamel surface, being the choice sequence of procedures for remaining resin removal.

## REFERENCES


1. Arcuri MR, Strung RA, Clancy JM. Scanning electron microscope analysis of tooth enamel treated with rotary instruments and abrasives. J Prosthet Dent. 1993;69(5):483-90.
2. Bishara SE, Ajlouni R, Laffoon JF. Effect of thermocycling on shear bond strength of acyanoacrylate orthodontic adhesive. Am J Orthod Dentofacial Orthop. 2003;123(1):21-4.
3. Bishara SE, Ajlouni R, Laffoon J, Warren J. Effects of modifying the adhesive composition on the bond strength of orthodontic brackets. Angle Orthod. 2002;72(5):464-67.
4. Brown CRL, David CW. Enamel loss during orthodontic bonding and subsequent loss during removal of filled and unfilled adhesives. Am J Orthod. 1978;74(6):663-71.
5. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res. 1955;34(6):849-53.
6. Campbell PM. Enamel surfaces after orthodontic bracket debonding. Angle Orthod. 1995;65(2):103-10.
7. Chanda RA, Stein E. Time-related bond strength of light-cured and chemically cured bonding systems: an in vitro study. Am Orthod Dentofacial Orthop. 1996;110(4):378-82.
8. Diedrich P. Enamel alterations from bracket bonding and debonding: a study with the scanning electron microscope. Am J Orthod. 1981;79(5):500-22.
9. Eliades T, Gioka C, Eliades G, Makou M. Enamel surface roughness following debonding using two resin grinding methods. Eur J Orthod. 2004;26(3):333-8.
10. Fitizpatrick DA, David CW. The effects of wear, acid etching, and bond removal on human enamel. Am J Orthod. 1977;72(6):671-81.
11. Gwinnett AJ, Gorelick L. Microscopic evaluation of enamel after debonding: clinical application. Am J Orthod. 1977;71(6):651-65.
12. 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;126(6):717-24.
13. Ireland AJ, Hosein I, Sherriff M. Enamel loss at bond-up, debond and clean-up following the use of a conventional light-cured composite and a resin-modified glass polyalkenoate cement. Eur J Orthod. 2005;27(4):413-9.
14. Katona TR. Stresses developed during clinical debonding of stainless steel orthodontic brackets. Angle Orthod. 1997;67(1):39-46.
15. Kinch AP, Taylor H, Waritier R, Oliver RG, Newcombre RG. A clinical study of amount of adhesive remaining on enamel after debonding, comparing etch times of 15 and 60 seconds. Am J Orthod. 1989;95(5):415-21.
16. Krell KV, Courey MJ, Bishara SE. Orthodontic bracket removal using conventional and ultrasonic debonding techniques, enamel loss, and time requirements. Am J Orthod Dentofacial Orthop. 1993;103(3):258-66.
17. Oesterle LJ, Shellhart WC, Belanger GK. The use of bovine enamel in bonding studies. Am J Orthod Dentofacial Orthop. 1998;114(5):514-9.
18. Oliver RG. The effect of different methods of bracket removal on the amount of residual adhesive. Am J Orthod Dentofacial Orthop. 1988;93(3):196-200.
19. Osorio R, Toledano M, Garcia GF. Bracket bonding with 15- or 60-second etching and adhesive remaining on enamel after debonding. Angle Orthod. 1999;69(1):45-8.
20. Owens SE Jr, Miller BH. A comparison of shear bond strengths of three visible light-cured orthodontic adhesives. Angle Orthod. 2000;70(5):352-6.
21. Pus MD, Way DC. Enamel loss due to orthodontic bonding with filled and unfilled resins using various clean-up techniques. Am J Orthod. 1980;77(3):269-83.
22. Ritief DH, Denys FR. Finishing of enamel surfaces after debonding of orthodontic attachments. Angle Orthod. 1979;49(1):1-10.
23. Rouleau BD, Marshall GW, Cooley RO. Enamel surface evaluations after clinical treatment and removal of orthodontic brackets. Am J Orthod. 1982;81(5):423-6.
24. Sória ML, Menezes LM. Resistência de união ao esmalte bovino: avaliação de três cimentos de ionômero de vidro. Rev Dental Press Ortod Ortop Facial. 2003;9(6):89-97.
25. Waes H, Matter T, Krejci I. Three-dimensional measurement of enamel loss caused by bonding and debonding of orthodontic brackets. Am J Orthod Dentofacial Orthop. 1997;112(6):666-9.
26. Zachrisson BU, Arthur J. Enamel surface appearance after various debonding techniques. Am J Orthod. 1979;75(2):121-37.
27. Zachrisson BU, Skogan O, Höymyhr S. Enamel cracks in debonded, debanded, and orthodontically untreated teeth. Am J Orthod. 1980;77(3):307-19.
28. Zarrinnia K, Eid NM, Kehoe MJ. The effect of different debonding techniques on the enamel surface: an in vitro qualitative study. Am J Orthod Dentofacial Orthop. 1995;108(3):284-93.


Submitted: November 3, 2008
Revised and accepted: May 24, 2009

**Contact address**
Karine Macieski
Rua Governador Jorge Lacerda, 1817 – Centro
CEP: 88.750-000 – Braço do Norte/SC, Brazil
E-mail: kamacieski@gmail.com