



## Efficacy of Two Methods for Restorative Materials' Removal in Primary Teeth

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### ABSTRACT

**Aim:** This *in vitro* study aimed to compare the time required for removal, the presence of residues of restorative material, tooth structure loss and dental surface morphology after removal of composite resin and amalgam restorations from occlusal cavities in primary molars using conventional high-speed bur and CVDentus® ultrasonic diamond tips.

**Materials and methods:** A total of 37 primary molars were allocated into four groups: Group 1 (n=9)—amalgam restorations removed using high-speed bur; Group 2 (n=10)—amalgam restorations removed using ultrasonic tip; Group 3 (n=8)—composite resin restorations removed using high-speed bur; Group 4 (n=10)—composite resin restorations removed using ultrasonic tip. After being restored, teeth were sectioned and analyzed through stereoscopic microscope images before and after restoration removal. The structural loss was analyzed by software of image analysis, and an examiner assessed for the presence of residues. Scanning electron microscopy was used to evaluate the morphology. Time and structural loss values were compared using ANOVA, and the percentages of samples with residues using Fisher test.

**Results:** There was no statistically significant difference in the tooth structure loss among different methods and restorative materials, as well as in the presence of residues of restorative material. However, diamond burs were faster than the ultrasonic method for both materials. Differences in dental morphology were observed between the methods of restoration removal, but not related to the restorative material.

**Conclusion:** Both conventional high-speed bur and ultrasonic diamond tip methods remove similar amounts of tooth structure, but the removal performed with diamond tips in ultrasonic devices is slower.

**Clinical significance:** This study shows that both ultrasonic and conventional high-speed bur methods for removing restorations generate similar loss of sound dental tissue, but the former is slower.

**Keywords:** Restoration removal, Composite, Amalgam, Ultrasonic, High-speed diamond tips.

**How to cite this article:** Bittar DG, Murakami C, Hesse D, Imparato JCP, Mendes FM. Efficacy of Two Methods for

Restorative Materials' Removal in Primary Teeth. J Contemp Dent Pract 2011;12(5):372-378.

**Source of support:** Nil

**Conflict of interest:** None declared

### INTRODUCTION

The longevity of restorative materials is of great importance to the preservation of primary teeth.<sup>1</sup> The replacement of failed restorations leads to larger cavity preparations, weakens the remaining tooth structure and establishes the onset of a repetitive restorative cycle.<sup>2</sup>

Nevertheless, there are situations where the replacement of restorations is inevitable. In such cases, the procedure should be conducted with care in order to maximize the preservation of sound tooth structure adjacent to the restoration that will be removed. Removal of failed restorations is usually done using high-speed burs under constant water cooling.

Alternative methods, such as the use of ultrasonic burs, air abrasion systems and high intensity laser, have been introduced in dentistry seeking to minimize undesired wear of sound tooth structure, as well as to offer greater comfort to the patient and facilitate procedures for dentists. Recently, diamond tips have been created using a technique known as chemical vapor deposition (CVD) to be used in ultrasonic devices.<sup>3</sup>

The use of these tips in ultrasonic devices has been tested for the procedures of cavity preparation and carious tissue removal.<sup>4-8</sup> This method could also be used for the removal of old restorations. However, to the best of our knowledge, there are no studies in literature comparing the use of ultrasonic diamond burs to conventional methods of restoration removal. Thus, the aim of the present study was to assess the amount of loss of sound tooth structure, the

time required for the procedure, the efficacy of removal and the dental surface's morphology after the removal of composite resin and amalgam restorations using ultrasonic diamond tips and high-speed diamond burs in primary teeth.

## MATERIALS AND METHODS

Prior to its execution, this study obtained proper approval by an ethics in research committee.

### Specimen Preparation

A total of 40 sound lower primary second molars were selected for this study, of which three were discarded during the experiment due to the presence of fractures.

The teeth were brushed under water and dental prophylaxis was done using low-speed rubber cups and prophylaxis paste containing pumice flour and they were thoroughly rinsed. The specimens were partially embedded in acrylic resin inside a rectangular matrix. Next, an occlusal cavity was prepared in the occlusal surfaces of each tooth, with dimensions of 2 mm in depth, 4 mm in length and 2 mm in width using a cylindrical diamond bur (#2096, KG Sorensen, Brazil) in a high-speed handpiece (KAVO, Joinville, Brazil) under constant irrigation. A millimeter probe was used for standardization.

### Restorative Procedure

The specimens were randomly divided into groups to be restored using composite resin of A4 color (n=18) (Z250, 3M/ESPE, St Paul, USA) or predosed amalgam capsules (n=19) (Permite, SDI, Bayswater, Australia) prepared in a mixing device (Ultram 2, SDI, Bayswater, Australia). The restorative procedures were done following the manufacturer's recommendation after acid etching and using an adhesive system (Adper Single Bond, 3M ESPE, St Paul, USA).

### Specimen Sectioning and Image Analysis

With the restorations in place, the teeth were transversely sectioned at the center of the restoration with the aid of a diamond saw mounted on a microtome (Labcut 1010™ Extec Corp, Enfield, USA) under constant water irrigation, thus dividing the restorations into two parts. The two parts were analyzed using 10× magnifying stereomicroscopic lens (SZPT Olympus™, Tokyo, Japan). The images were stored in a computer and the area of the teeth was determined by an image analysis software (Leica Qwin™, Leica Microsystems, Heidelberg, Germany) on each side of the sections (in mm<sup>2</sup>).<sup>8</sup>

### Restoration Removal

For the removal of the restorative materials, the two parts were joined using the previously made rectangular matrixes and adhesive tape. The samples were then randomly divided into various groups which are as follows:

- *Group 1 (n=9)*: Amalgam restoration removed using high-speed diamond bur
- *Group 2 (n=10)*: Amalgam restoration removed using ultrasonic diamond tips
- *Group 3 (n=8)*: Composite resin restoration removed using high-speed diamond bur
- *Group 4 (n=10)*: Composite resin restoration removed using ultrasonic diamond tips.

For groups 1 and 3, restoration removal was done using a high-speed handpiece (KAVO, Joinville, Brazil) and a cylindrical diamond bur (#2096, KG Sorensen, Brazil) for both amalgam and composite resin. Restorations were removed under constant irrigation, by one operator who was instructed to be as conservative as possible in order not to remove sound structures. The time required for completion of the removal was recorded in minutes using a digital stopwatch.

In specimens from groups 2 and 4, amalgam and composite resin restorations were removed using ultrasonic diamond CVDent 1000® tips (CVD-Vale, São José dos Campos, Brazil) of #C1 which were cylindrical. Cylindrical tips were used at a 70% power, according to the manufacturer's instructions. The same operator conducted this part of the experiment and the time required for completion of the removal was also recorded.

Image analysis was done in the same way as described above and the area of the teeth was measured after the restoration had been removed. For calculating tooth structure loss, the area of sound tissue remaining after removal of the restorations was subtracted from the initial area measurements. This methodology was previously described to investigate different approaches to replace amalgam restorations.<sup>8</sup>

An examiner, blinded regard to the experimental groups, assessed all specimens without visual aids in order to check for residues of the restorative materials.<sup>9</sup> The examiner classified the specimens with no residues or with residues of restorative material.

Three specimens from each group were randomly selected (mesial and distal portions of the same specimen) for analysis under the scanning electron microscope (SEM). All samples were immersed in 2.5% glutaraldehyde for 12 hours at 4°C for fixation, washed with 20 ml buffer solution of sodium cacodylate 0.2 M with pH 7.4 for 1 hour, and washed in distilled water three times for

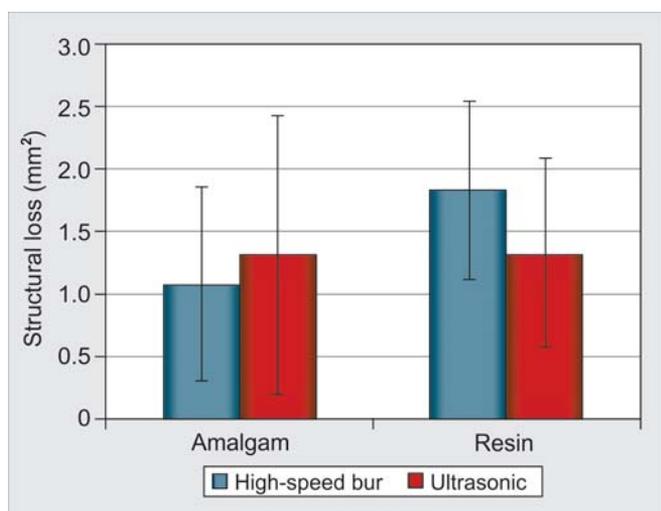
1 minute. For dehydration, the specimens were sequentially immersed in ethyl alcohol (25%, 50%, 75% and 95% for 20 minutes each), then transferred to a critical-point dryer (HMDS) for 30 minutes. The prepared specimens were mounted on aluminum stubs, gold-sputtered at 10 mA for 1 minute (Unit E500; Polaron Equipment Ltd., Watford, UK) and analyzed under SEM (1430 VP, LEO Electron Microscopy Ltd, Cambridge, UK) with magnification of 500× e 2000×.

### Statistical Analysis

The measurements of the time required to completely remove the restoration and the area of tooth structure loss underwent analysis using Kolmogorov Smirnov normality test. Since a normal distribution was observed, both variables underwent two-way ANOVA (restorative material and removal method as variables), followed by a Tukey complementary test. The percentage of cavities with residues of restorative materials in each group was compared among the groups using Fisher exact test. For all analyses, the significance level was set at 5%.

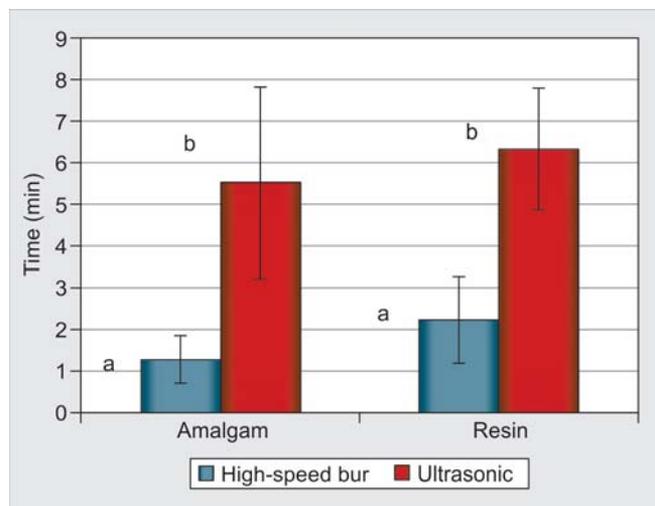
### RESULTS

Results regarding structure loss after the removal of restorations in the different groups are shown in Figure 1. No statistically significant differences in the average loss of dental structure were observed between the different methods of removal or between the different restorative materials.



**Fig. 1:** Tooth structural loss (mean and standard deviation) after utilization of two different methods for removal of two restorative materials. There were no significant differences among the groups ( $p > 0.05$ )

Concerning the time required for completely removing the restoration, the use of ultrasonic diamond tips in both amalgam and composite resin groups took three times longer than the use of high-speed burs and this difference was



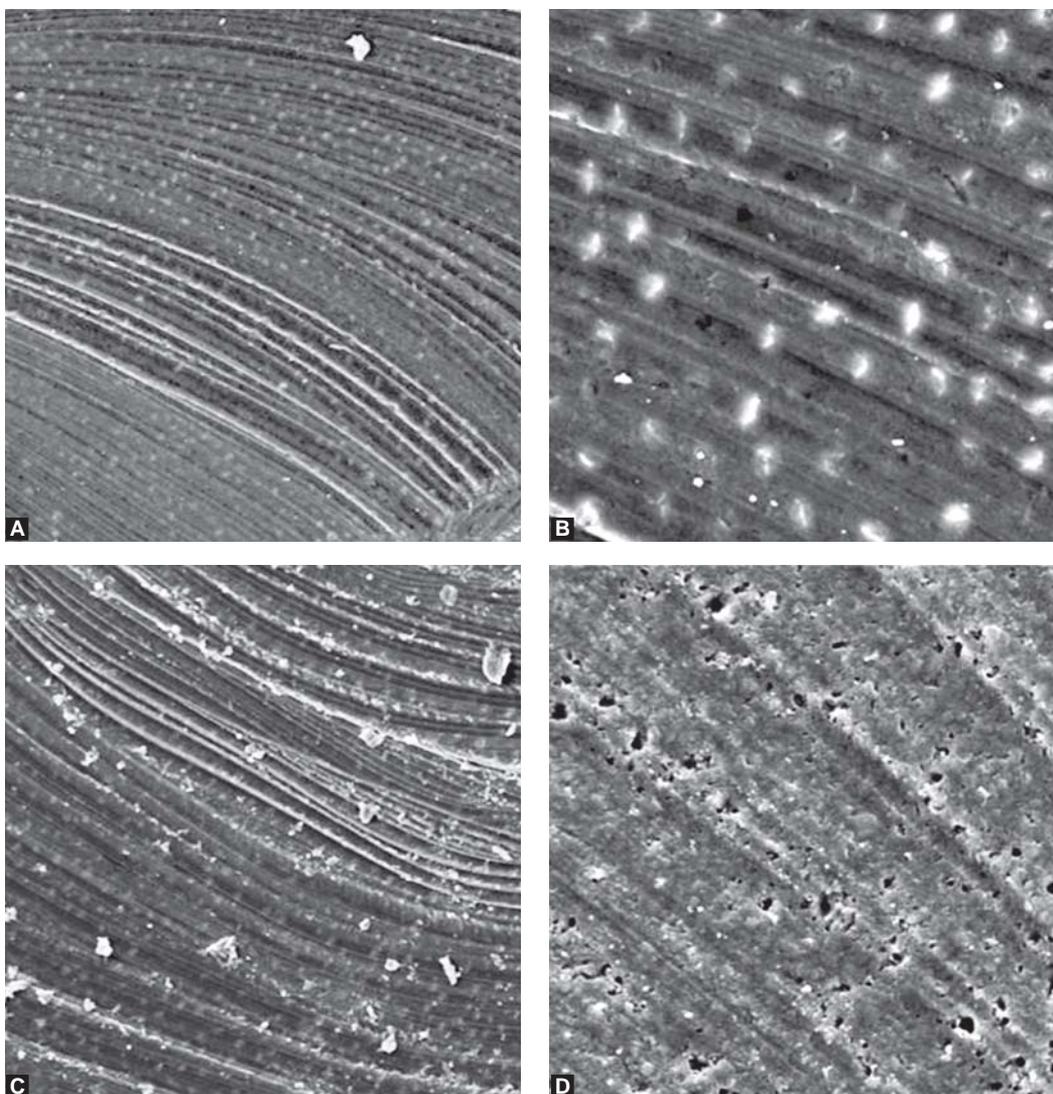
**Fig. 2:** Time for restoration removal (mean and standard deviation) using different methods. Different letters indicate statistically significant differences ( $p < 0.05$ )

statistically significant (Fig. 2). Yet, no significant differences were seen for the time required to remove the two different restorative materials (Fig. 2).

Nine teeth (100%) from group I showed no residues of amalgam after removal using high-speed burs. On the contrary, eight specimens (80%) from group II showed no residues of amalgam after removal using ultrasonic tips, while two specimens (20%) still had material residues. The difference between groups I and II were, nonetheless, not statistically significant ( $p = 0.474$ ).

For composite resin groups, seven specimens (87.5%) in group III (high-speed handpiece) had no residues and only 1 specimen (12.5%) had residues. In group IV (ultrasonic device), 8 specimens (80%) had no residues and 2 (20%) had residues. Once again, the differences between the two groups were not statistically significant ( $p = 1.000$ ).

Analysis of SEM images revealed that specimens in which the restorative material was removed using high-speed burs, regardless of whether amalgam or composite resin had been used, showed a greater amount of exposed dentinal tubules in the pulpar wall than in the axial wall of the cavity, a regular dentinal surface with scratches and a small quantity of smear layer (Figs 3A to D). In specimens where the restorative material was removed using the ultrasonic CVDentus<sup>®</sup> tips, the dentinal surface was irregular and had no scratches, with few exposed dentinal tubules and a greater quantity of smear layer (Figs 4A to D). Also, the characteristics were similar between groups where composite resin and amalgam had been used. Therefore, it can be observed that, regardless of the type of restorative material, the characteristics of the dentinal surface vary only according to the method of restoration removal used.



**Figs 3A to D:** (A) Image of dental surface morphology after removal of amalgam restoration using conventional high-speed bur (original magnification 500 $\times$ ) and (B) the same specimen in a higher magnitude (original magnification 2000 $\times$ ). (C) Image of dental surface morphology after removal of a resin restoration using conventional high-speed bur (original magnification 500 $\times$ ) and (D) the same specimen in a higher magnitude (original magnification 2000 $\times$ )

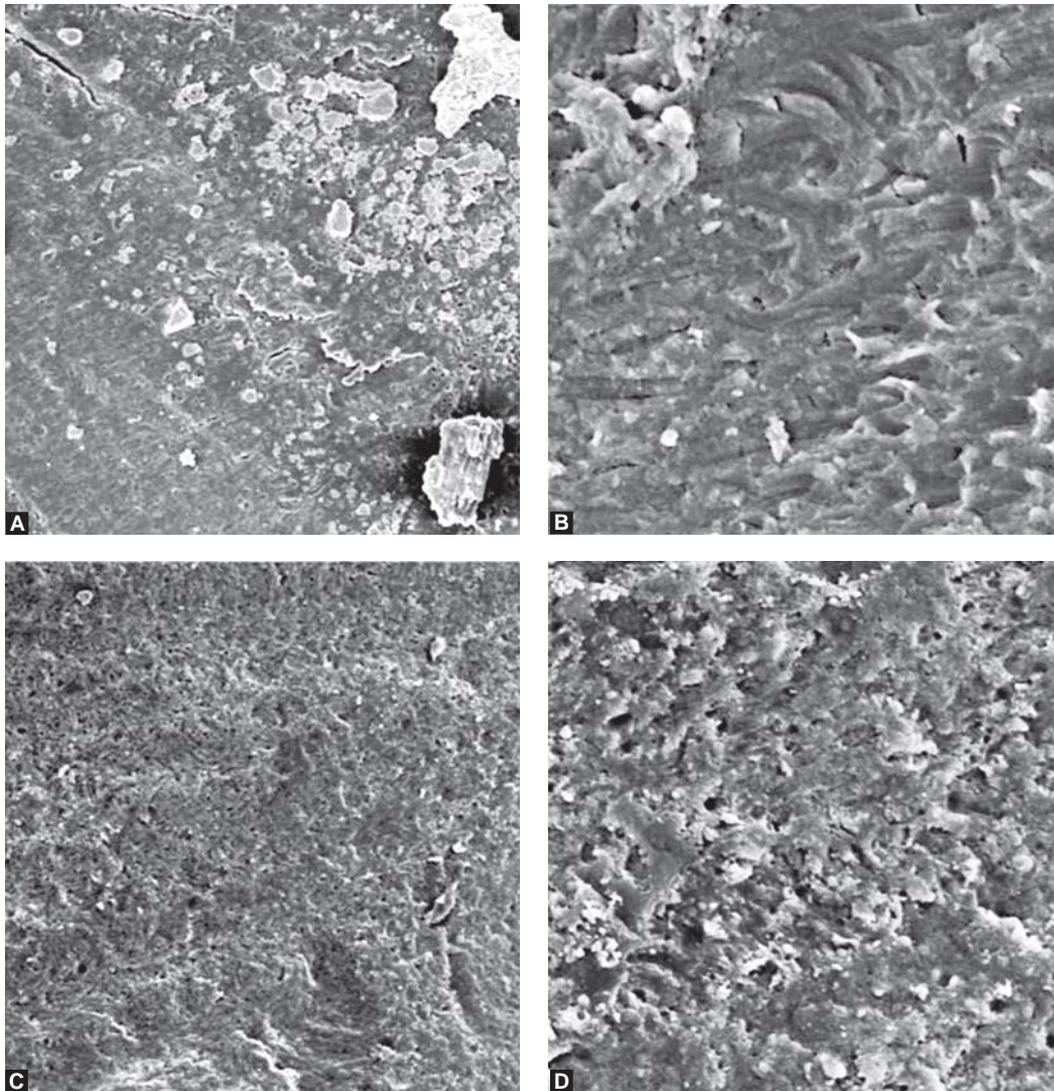
## DISCUSSION

In spite of philosophical changes that have been ongoing recently in an attempt to drastically decrease the number of restorations that are replaced, in some situations, it is impossible to avoid such replacement. For such cases, conventional high-speed burs are the most commonly used methods. However, dental professionals must be very careful in order to avoid removing sound tooth structure. The investigation of more conservative methods of restoration removal is, therefore, desirable. Thus, the present study aimed to assess the use of ultrasonic diamond tips as an alternative method to the use of conventional high-speed burs in regards to the preservation of dental structure, the efficacy of removal, and the time required to completely removing the restoration. This is the first study in literature to compare methods of restoration removal. Moreover, the

methodology used is innovative and was created by our research group for this purpose.<sup>8</sup>

The creation of diamond tips to be used in ultrasonic devices enables the preparation of cavities without the use of high-speed handpieces.<sup>5,7</sup> The concept of using ultrasonic devices was initially brought up with the purpose of diminishing patient discomfort while making more conservative cavity preparations.<sup>4</sup> Furthermore, it was hypothesized that such ultrasonic diamond tips would be beneficial in the removal of old restorations.

In the present study, the use of ultrasonic tips caused similar amounts of sound structure loss as high-speed burs, regardless of the type of material that was removed. This finding is probably due to the fact that the operator was instructed to be conservative while using both methods of removal. Also, the technique involved in the use of



**Figs 4A to D:** (A) Image of dental surface morphology after removal of amalgam restoration using ultrasonic tip (original magnification 500×) and (B) the same specimen in a higher magnitude (original magnification 2000×). (C) Image of dental surface morphology after removal of a resin restoration using ultrasonic tip (original magnification 500×) and (D) the same specimen in a higher magnitude (original magnification 2000×)

ultrasonic tips demands previous training in order to optimize its performance.<sup>7, 10</sup>

It was expected that the removal of composite resin restorations would cause a greater loss of sound tooth structure than the removal of amalgam due to the similarity in color of the material to the tooth. However, there was no significant difference between the amounts of sound structure removed regarding the type of material. This result can be explained by the fact that the color of composite resin chosen (A4) for restoration contrasted with the tooth's color on purpose. In fact, since there is usually not a great concern regarding the color of posterior dental restorations, the use of contrasting colors in such cases allows for less removal of sound structures when replacing or polishing the restoration. Future studies to evaluate the replacement of restorations are needed to investigate this issue. Also,

there were no significant differences in relation to the presence of residues of restorative materials after removal neither in regards to the type of material used nor to the method used for removal. This implies that both methods were similarly efficient in performing conservative replacement of restorations.

Concerning the time required for preparing cavities, some authors affirmed that the use of high-speed burs is quicker when compared to ultrasonic CVDentus<sup>®</sup> tips.<sup>10-11</sup> The findings of the present study indicate that the use of ultrasonic diamond tips takes approximately three times longer than the use of high-speed burs in the procedure of restoration removal, which is in accordance with previous studies.<sup>10-11</sup> Yet, the time required to completely remove a restoration also depends on other factors, such as the power of the method used, the type of restorative material the depth

of the cavity, the patient's cooperation and the dental professional's ability. Based on the two studies cited above, the present research used cylindrical CVDentus® ultrasonic tips to obtain good cutting efficacy and the power of the ultrasonic device was correctly set.

Considering the results obtained, the two methods of restoration removal tested were similar, except regarding the time required for the procedure. The cost of such ultrasonic tips and device is also a disadvantage of this alternative method.<sup>7</sup> Nonetheless, the findings of this study should be interpreted within the limitations of its *in vitro* methodology. Thus, there would be no advantage in using ultrasonic tips for the removal of restorations. Yet, some studies report advantages of this method. Cavity preparations using ultrasonic devices appear not to cause scratches or fractures on the walls of the cavity, having no undesired effect on the margins of the preparations.<sup>6,12-13</sup> This pattern was also observed in the morphology of specimens of the present study.

Other findings concerning the morphology of dental cavity were that samples with restorations removed by ultrasonic tips showed more smear layer and smaller number of exposed dentinal tubules. Some authors have asserted that the greater the quantity of smear layer and the smaller the number of exposed dentinal tubules, the worst is the adhesion of restorative materials when a self-etching adhesive is used.<sup>13</sup> However, total-etching adhesive systems would not be influenced by the method of restoration removal.

Concerning other points which need to be assessed, there are reports of better acceptance by patients during the preparation of cavities and removal of carious tissue using CVDentus® tips.<sup>4,7</sup> This would be a great advantage in the clinical practice of pediatric dentistry. It is believed that this is due to the fact that ultrasonic tips promote easy cutting with low impact, little noise, causing less or no pain and it does not elevate pulpar temperature.<sup>4,7,10</sup> On the contrary, longer appointments would be necessary to remove a restoration with ultrasonic tips, provoking higher discomfort for the child. This issue, however, should be addressed in further clinical investigations.

Other advantages that have been cited are associated to the biosafety, durability of the ultrasonic tips, greater safety during procedures because the tips do not cut soft tissues and also the better visibility of the operative field.<sup>4,7,10</sup> However, it was not possible to assess such reported advantages in this *in vitro* study. Therefore, additional studies are needed in order to evaluate whether the use of ultrasonic diamond tips can be a good alternative to conventional methods.

## CONCLUSION

In conclusion, the efficacy and the amount of structure loss using ultrasonic diamond tips for the removal of composite resin and amalgam restorations does not present differences when compared to the conventional high-speed bur method. However, the method requires longer period of working time.

## CLINICAL SIGNIFICANCE

Both ultrasonic and conventional high-speed bur methods for removing restorations generate similar loss of sound dental tissue. However, the removal with ultrasonic tips is slower.

## ACKNOWLEDGMENT

The authors wish to thank the participants of the Postgraduation in Pediatric Dentistry Seminar of FOUSP for the critical comments put forth.

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