Analysis of Primary and Permanent Molars Prepared with High Speed and Ultrasonic Abrasion Systems

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The aim of this study was to compare high speed and ultrasonic systems with regard to both topography and smear layer formation in the cavity preparations of sound primary and permanent molars. Class I occlusal cavities measuring 2.00 x 2.00 x 2.00 mm were performed in 14 molars, equally divided into two groups (GI = 7 primary teeth and GII = 7 permanent teeth). High speed rotary instruments produced regular layers of enamel and dentin, despite the marked presence of grooves and microfractures on enamel surfaces. On the other hand, ultrasonic abrasion yielded more irregular surfaces in enamel and dentin, with a granular and wavy aspect, but without microfractures in enamel. Both types of dental substrates were found to have an intense smear layer formation, partially or even completely obliterating the dentinal tubules ($p>0.05$), irrespective of the instrument used. No difference was observed in either primary or permanent teeth as regards the amount of smear layer produced by high speed or ultrasonic abrasion instruments ($p>0.05$). It was concluded that with regard to the topography of cavity preparations, there were differences between the instruments used, irrespective of the dental substrate. Both systems allowed dense smear layer formation, which completely or partially obliterated the dentinal tubules of primary and permanent teeth.

Key words: *Dental instruments, Cavity preparation, Ultrasound in dentistry, Primary teeth, Permanent teeth. Smear layer*

J Clin Pediatr Dent 32(1): 49–52, 2007

INTRODUCTION

Better understanding of the caries process and the physiological response of the tooth structure, as well as the advent of improved adhesive dental materials, made it possible to modernize dental treatment, resulting in emphasis on tooth preservation rather than radical removal of carious tissue.[15]

Within this context, more conservative techniques with the goal of removing only the softened, carious, and irreversibly demineralized tissue have emerged. Amongst these is the ultrasonic abrasion system[5] that consists of abrading enamel and dentin with diamond tips mounted on ultrasonic handpieces, resulting in reduced noise, vibration, and heat, in comparison with the high speed rotary systems.[17,18]

The technological innovation of *Chemical Vapor Deposition* (CVD) allowed the creation of dental diamond tips capable of being coupled to ultrasound appliances. These CVD tips are manufactured in a different way than conventional ones, and are processed in a reactor that allows the diamonds to adhere to the metal rod sufficiently to bear the vibratory effect of ultrasound. According to Borges *et al,*[4] the new diamond tip consists of a continuous diamond film without a metal binder between crystals, preventing tooth contamination by metal ions usually present in binder matrix of conventional tips. CVD tips are also highly resistant to cutting and demonstrate efficient cutting ability and longevity.

This technique provides an alternative way of removing the carious lesion, with the aim of obtaining more conservative preparation.[3,12] It consists of eroding enamel and dentin, not by means of the mechanical cutting action used in high-speed systems, but by means of vibration, through the high frequency 'oscillation' of the tips.[2] Though ultrasound has been sanctioned as a resource for use in dentistry for over 50 years, it is only recently that its physical properties and biological effects have been fully understood.[9]

These tips deliver a cutting power on dental structures, and may also used for removing restorations, performing gingival peeling and opening root canals.[12] However, few

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studies have been conducted concerning ultrasound cavity preparations in primary teeth.[1]

Therefore, the aim of this study was to compare *in vitro* cavity preparations performed in primary and permanent molars, using either high speed rotary (HR) or ultrasonic abrasion (UA) systems, considering the results in terms of topography (T) and presence of smear layer (SL).

MATERIALS & METHODS

This study was carried out after being approved by the local ethics committee. Fourteen healthy molars (7 primary and 7 permanent teeth) were obtained from a tooth bank and then stored in physiological solution, which was changed every 7 days until the beginning of the experiment. The teeth were evaluated by using an optical microscope with 40X magnification to exclude any failures on the occlusal enamel surface, such as cracks or marked erosion.

In order to facilitate both handling and instrumentation, the crowns of all teeth were separated from their roots and then attached to a device with epoxy resin. Two Class I cavities were randomly performed on the occlusal face of each tooth, one in the mesial pit and the other in the distal pit by using either high speed or ultrasonic abrasion techniques. Both cavities were 2.0 mm wide, 2.0 mm in diameter, and 2.0 mm deep. The length of the active tips of both instruments was fully used during cavity preparations in order to standardize the depth measurement, whereas width and diameter were measured with a digital caliper (Mitutoyo ®, Japan).

High speed rotation was performed by using a cone-shaped diamond drill (#1061, KG Sorensen ®) mounted on a short-handled handpiece (Extra Torque 605, Kavo, Brazil) for fine granulation. For the ultrasonic abrasion system, the cavities were prepared by using CVD diamond tips (UTP 0525, 0.5 mm in diameter for 2.5 m diamond powder) mounted on a Laxys Easy ultrasonic device (DMC ®) by means of an adapter. The ultrasonic device was calibrated at level 3, corresponding to 70% of the maximum power.

After performing the cavities, both primary and permanent molars were prepared for descriptive evaluation of topography (T), that is, they were mesio-distally sectioned by using double-faced diamond discs and then cleaved into 2 fragments (by high speed and ultrasonic abrasion instruments), thus providing a internal view of both sides of the cavities (n = 28). Then, the samples were metalized and washed for analysis by scanning electronic microscopy (Model JSM – 5310, Japan) with 35X and 2000X magnifications.

Table 1. Scores for smear layer according to criteria by Rome et al.[13]

Score	Description
0	No smear layer, dentinal tubules open and free of debris
1	Moderate smear layer, outline if dentinal tubules observable or partially filled with debris
2	Heavy smear layer, cannot distinguish outlines of tubules

The presence of smear layer was evaluated according to criteria proposed by Rome *et al* [13] (Table I), and one investigator evaluated the microphotographs (intra-examiner kappa = 0.9).

The smear layer formation results were analyzed according to the instrument used and substrate prepared, and the GMC software (2000) was used to carry out the statistical tests for non-paired (Mann-Whitney, $P < 0.05$) and paired data (Wilcoxon, $P < 0.05$).

RESULTS

When evaluating the topography, one could observe that the substrates (enamel and dentin) were reached in 100% of the primary and 55% of the permanent teeth, irrespective of the instrument used (Figure 1). In addition, the cavities prepared with the high speed technique were shown to have grooves and microfractures in the enamel, whereas ultrasonic abrasion produced cavities with an irregular internal contour, and a wavy and granular aspect in enamel and dentine, but without microfractures in enamel.

Concerning the smear layer, the presence of a layer partially or completely obliterating the dentinal tubules (Figure 2) was observed. No statistically significant differences were observed in both types of substrates tested ($P > 0.05$, Mann-Whitney test) with either high speed rotary or ultrasonic abrasion.

Similarly, primary and permanent teeth showed no statistically significant differences in regards the amount of smear layer produced on the same substrate by both instruments used ($P > 0.05$, Wilcoxon test).

DISCUSSION

In the present study, the comparison between the conventional high-speed rotary instrument and the ultrasonic CVD system is justified, because nowadays there is an increasing tendency to use procedures that preserve healthy dental

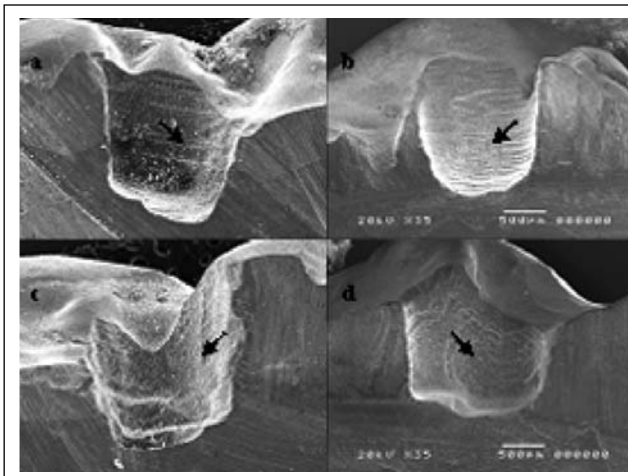

Figure 1. Topography of cavities prepared by high speed (1a, 1b) and ultrasonic abrasion (1c, 1d) instruments in deciduous (1a and 1c) and permanent (1b and 1d) teeth; arrows indicate grooves produced by high speed instrument (1a, 1b) and the apparently "fluffy" an organized in the form of clots aspect left by ultrasonic abrasion instrument (1c and 1d) (SEM-35X).

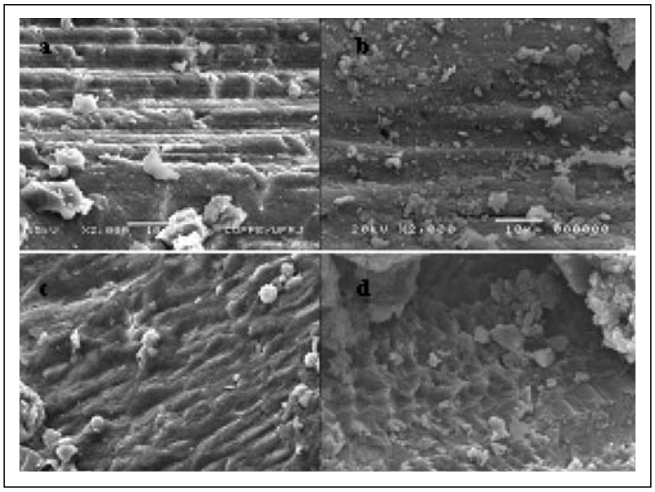

Figure 2. Internal aspect of the cavities showing presence of smear layer produced by high speed (2a and 2b) and ultrasonic abrasion systems (2c and 2d) in deciduous (2a and 2c) and permanent (2b and 2d) teeth (SEM – 2000X).

structure and also allow improvement in the tooth / restorative material interaction.[6] This is so particularly in primary teeth, because this substrate has scarcely been studied to verify these conditions. In addition to being a conservative method, the ultrasonic system with the use of CVD diamond tips, minimizes noise and vibration, characteristics common in the high-speed rotary cutting instrument, as described by Predebon *et al.*[12] These aspects are generally associated with fear of dentists and of dental treatment,[1, 5, 9] an undesirable situation particularly in the case of children.

Minimal invasiveness during cavity preparations is possible, by mounting diamond tips on ultrasound handpieces. This happens due to the high precision cuts provided by the diamond tip and the vibration provided by the conventional ultrasonic devices,[11] which are very useful clinical characteristics, since there is an increasing trend towards seeking to preserve healthy dental structure.[7, 15] Additionally, one of the advantages of such a system is less discomfort caused to patients, because noise, vibration, "pressure sensation", and heat are markedly reduced during this treatment.[8, 18]

It is known that the surfaces created for cavity preparation will play a significant role in considering the adhesive materials to be used for dental restoration, since their efficacy can, to a large extent, prevent microleakage from occurring.[10,14,19] However, there is a lack of studies in the literature comparing the influence of high speed and ultrasonic abrasion systems on primary and permanent teeth, with respect to the inner topography produced during cavity preparations.

In an attempt to answer this question, the results obtained in the present study demonstrate that no significant differences were found as regards the inner topography produced by both instruments, despite the morphological and structural differences between primary and permanent teeth.[16]

By using the scanning electronic microscopy (SEM), it could be observed that 45% of the cavity preparations in permanent teeth involved the enamel only, which could be explained because these teeth have a distinctive morphology and a thicker enamel layer in comparison with primary teeth.[16]

Cavity preparations performed with high speed rotary instruments were found to be regular, despite the presence of grooves and lines. Whereas, cavities prepared by using the ultrasonic abrasion system presented an irregular contour with a wavy and granular aspect in enamel and dentine what was corroborated by another author. [15]

In 2003, one study[11] reported that the ultrasonic cut provided by vibration resulted in fewer enamel fractures, in comparison with diamond tips used at high speed rotation, as no pressure is applied. The SEM analysis carried out in the present study also corroborated this, and the finding could be very useful for considerably reducing microleakage in primary and permanent tooth restorations.

Regarding the smear layer formation, both high speed and ultrasonic abrasion systems had a similar behavior, irrespective of the substrate evaluated. However, the high speed abrasion produced a thicker and more disorganized smear layer than the ultrasonic system. Further studies are needed to assess whether the "soft" smear layer produced by ultrasonic abrasion would be easier to remove, and whether the inner topography would result in better bonding of restorative materials to both primary and permanent teeth.

CONCLUSION

It could be concluded that there were differences between the inner topographies of cavities produced by the two systems, irrespective of the dental substrate. Both systems produced a thick smear layer that partially or completely obliterated the dentinal tubules in primary and permanent teeth.

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