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ORIGINAL ARTICLE

Topography and presence of a smear layer in deciduous molars prepared with high-speed cutting and ultrasonic abrasion: an *in-vitro* study

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Abstract

Objective. The aim of this *in-vitro* study was to compare the effect of high-speed cutting (HS) with ultrasonic abrasion (US) concerning the internal topography and the presence of a smear layer in a cavity preparation performed in healthy deciduous molars. ***Material and methods.*** Seven first deciduous molars were used. Two occlusal cavity preparation were done, one in the medial fossula and another in the distal fossula, which were chosen randomly. One preparation was carried out with a diamond point adapted to the HS system (GI), while a chemical vapor deposition (CVD) point adapted to a US device (GII) was used for the other preparation. Subsequently, all samples ($n = 14$) were cleaved to observe the inside and then prepared for evaluation using scanning electron photomicroscopy. The internal topography of the prepared cavities was descriptively analyzed. In order to assess the presence of a smear layer, scores were tabulated using the 2000 GMC program and analyzed using the Mann–Whitney test. ***Results.*** Concerning the internal topography, the presence of striae was verified in both groups. In the GI group they were finer, found in a greater number, and with narrower spaces between them. In the GII group, the striae were undulating, similar to the effect of wheels on sand, and with wider spaces between them. As regards the presence of a smear layer, there was no statistically significant difference between the groups ($P > 0.05$). ***Conclusions.*** In view of the methodology employed, it may be concluded that cavity preparation with a CVD point in a US abrasion system led to the formation of fewer striae and both devices promoted the marked presence of a smear layer, obstructing dentinal tubuli.

Key Words: *Deciduous tooth, dental cavity preparation, dental instruments, smear layer, ultrasound*

Introduction

With a better understanding of the carious process and the physiological dental response to caries, preservation of the dental structure in cavity preparations has become possible. This updated procedure puts less emphasis on the radical removal of decayed tissue [1]. In addition to the biological approach, which minimizes dental destruction, patient comfort has also become a major and constant concern in modern dentistry [2].

The ultrasonic abrasion (US) technique comprises one of these treatment approaches. This technique is an alternative to removing the carious lesion, aiming at a more conservative preparation [3]. It consists of eroding enamel and dentin not by means of the mechanical cutting action, as in high-speed systems [4], but by means of vibration, through the high-frequency 'oscillation' of the points [3]. Ultrasound has been a sanctioned resource in dentistry for >50 years [5], but only recently have its physical properties and biological effects been fully understood [6].

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According to Bowen et al. [7], the term *smear layer* is used to describe the debris found on the dental surface after cavity preparation in enamel, dentin, or cement. It can be present in lesser or greater amounts as a result of the cutting action of the instrument used. The thickness of a smear layer in cavities prepared with chemical vapor deposition (CVD) points adapted to an US device has been reported by Vieira and Vieira [8] to be smaller than that found in cavities prepared with a high-speed system. Nevertheless, these findings are restricted to permanent teeth, and few studies have been performed on deciduous teeth [9].

The goal of this study was to evaluate, *in vitro*, the internal topography and the presence of a smear layer in a cavity preparation using a diamond point adapted to a high-speed system in comparison with a new technology: the CVD point adapted to a US device.

Material and methods

Seven healthy deciduous first molars were selected and fixed to epoxy resin blocks to support them during the performance of the cavity preparation.

Two occlusal cavity preparation were done, one in the medial fossula and another in the distal fossula, which were chosen randomly. One preparation was carried out using a diamond point adapted to a high-speed system (GI), while the other used a CVD point adapted to a US device (GII). Both points had a width, diameter, and depth of 2.0 mm, with no cavosurface bevel. In order to achieve standardization in the preparations, a 2-mm deep internal spline was effected in the active end of each diamond and CVD point, and both the width and diameter of each cavity were measured by means of a digital pachymeter. Every cavity preparation was made by the same previously calibrated operator.

The order of the cavity preparation system used for each molar was also chosen randomly. During the second cavity preparation, the first preparation was protected with aluminum paper to avoid interference with its internal topography.

Group I (GI)

Cavity preparations (n = 7) were performed with a (Kavo Extra Torque™ 605) high-speed pen under air/water refrigeration, with a KG Sorensen™ flat conical-trunk diamond point, number 1061, with a short handle (1.60 mm). The diamond point was replaced after every five preparations to maintain an ideal cut.

Group II (GII)

Cavity preparation (n = 7) was performed using a Laxys Easy (DMC™) ultrasound appliance with CVD (UTP0525) diamond points of the flat conical-trunk type, point diameter 0.5 mm and 2.5-μm powdered diamond, in the distal fossula of the occlusal surface of the deciduous molars. The ultrasound appliance was calibrated to 70% of its maximum power, and there was no replacement of the ultrasonic point. The preparation of the cavities was accomplished by moving the whole set in the direction of the vibration generated by the ultrasound, i.e. forwards and backwards, thus promoting a cutting action by oscillation. The water flow was adjusted in such a way that the vibratory movement of the point created a water-particle mist around itself.

Cavity preparation analysis

After the cavity preparation had been finished, the teeth were removed from the fixation blocks. Initially, the deciduous molars had been marked under refrigeration in the mesio-distal direction with the aid of a double-sided diamond disk. They were then cleaved, thus providing an internal view of both cavity preparations amounting to 14 dental hemisections.

For the metallization process, seven hemisections were kept for 24 h in a dissector which contained 0.25-mm blue silica gel for dehydration and humidity control. The hemisections were then attached to stubs by means of a carbonated double-sided adhesive tape and underwent a metallization process with gold, in order to allow evaluation by means of scanning electron microscopy (Model JSM 5310; JEOL, Tokyo, Japan) at magnifications of ×35 and ×2000.

To verify the presence of a smear layer, the photomicrographs taken were assessed by two examiners (K_p = 0.98) until they reached agreement. To this end, the criteria adopted were those described by Rome et al. [10], as follows: 0, dense smear layer, obliterated dentinal tubuli contour; 1, moderate smear layer, visible dentinal tubuli contour and tubuli partially filled with debris; and 2, no smear layer, open and free dentinal tubuli.

Statistical analysis

For analysis of the results concerning the presence of a smear layer, the data were tabulated in the GMC 2000 program and the Mann–Whitney test was employed, with a significance level of $P < 0.05$. The analysis of the topography of the cavities prepared was descriptive, and based on examination of the ×35 and ×2000 magnification photomicrographs taken.

Results

When the cavity prepared with the high-speed system was examined at a magnification of ×35, it was possible to observe the presence of circular striae,

which had the appearance of streaks caused by the cutting action of the instrument. These striae were finer, present in greater number and had fewer spaces between them in the same direction compared to those in the other group. In contrast, the preparation accomplished by US showed fewer circular striae with an undulating aspect (Figure 1). In addition to this, at a magnification of ×2000 it was possible to view undulated striae, with an appearance similar to the effect of wheels on sand, in the cavity preparations effected. These striae were more widely spaced and did not go in the same direction (Figure 2).

The presence of a dense smear layer obstructing the dentinal tubuli was noticed in all GI samples (100%) and in the majority of GII samples (71.44%). There was no difference in the presence of this smear layer between the groups ($P > 0.05$) (Table I). However, concerning the type of smear layer, differences could be observed between the GI and GII groups. While the GI group showed a smear layer which was compact, dense, and disorganized (Figure 3), the GII group presented a dense smear layer but it appeared to be fluffy and organized in the form of clots (Figure 4).

Discussion

In this study, the comparison between the conventional diamond points adapted to the high-speed system and the new-technology CVD point adapted to the US device is justified inasmuch as there is nowadays a tendency to use procedures that increasingly preserve healthy dental structure and also allow improvement of the tooth/restorative material interaction [11,12]. This is so particularly in deciduous teeth, because these substrates are only rarely studied to verify these conditions. In addition to this, the ultrasonic system—making use of CVD diamond points—minimizes pain, noise and vibration,

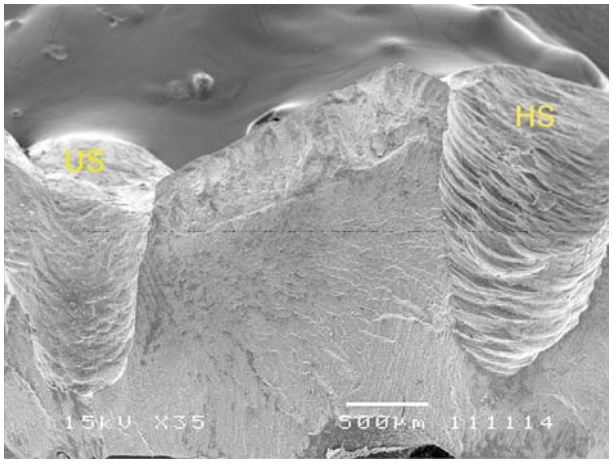

Figure 1. Scanning electron photomicrographs of the dentin of deciduous first molars prepared with a high-speed system (HS) and with ultrasonic abrasion (US). Original magnification ×35.

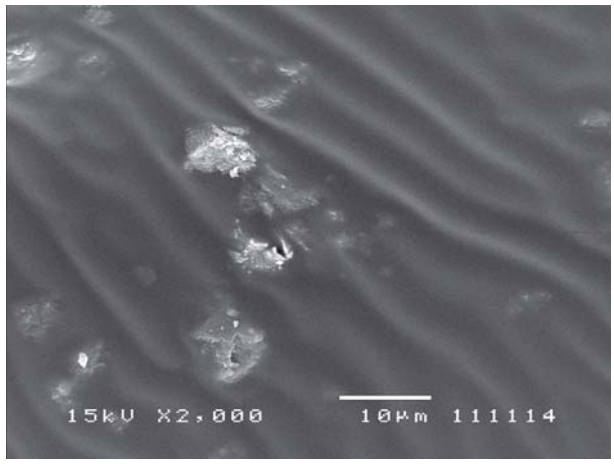

Figure 2. Scanning electron photomicrograph of the dentin of deciduous first molars prepared with ultrasonic abrasion showing striae with an appearance similar to that produced by wheels on sand. Original magnification ×2000.

characteristics common to the high-speed rotatory cutting instrument. These aspects are generally associated with fear of dentists and dental treatment [6,13] which is an undesirable situation, particularly in the case of pediatric patients.

Considering the morphological aspect of dental topography in preparations performed with a high-speed system, the presence of a great number of striae was verified. They were fine and closely spaced, as already described in the literature [14,15]. This creasy topographical aspect, according to Watson and Cook [16], is a consequence of the eccentricity of the cut, which is caused by the alternate compression and relaxation of the high-speed diamond points against the tooth. Another cause of this is the nature of the manufacturing process of the conventional diamond points, in which granules are 'glued' to the metallic shank [17]. Such an occurrence does not happen with the US system, owing to the vibratory nature of its action and the characteristics of the CVD point, which has a single diamond layer deposited on its active end [18]. Thus, the dental topography resulting from the action of this system was similar to the 'clot aspect' or 'raspberry aspect', as already described by Lima [19]. A small amount of striae were also observed in the GI group, corroborating studies made by Vieira and Vieira [8]. Furthermore, these

Table I. Presence of a smear layer in cavities prepared with diamond points in a high-speed system and with CVD points in an ultrasonic abrasion device.

	Score[a]; *n* (%)		
System	0	1	2
High speed	7 (100.00)	0 (0.00)	0 (0.00)
Ultrasonic abrasion	5 (71.44)	1 (14.28)	1 (14.28)

[a]Mann–Whitney test ($P > 0.05$).

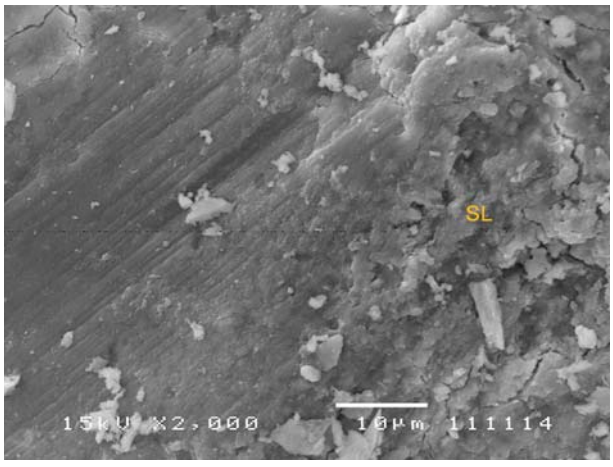

Figure 3. Scanning electron photomicrograph of the dentin of deciduous first molars prepared with a high-speed system. A dense smear layer is present and the contour of dentinal tubuli is obliterated. The smear layer is compact and disorganized. Original magnification ×2000. SL = smear layer.

striae were undulating and more widely spaced when compared to those produced by the high-speed preparation [14,15]. Considering all the points above, the authors suggest that the kind of cutting point and the action method of the instruments used to perform the cavity preparation did influence the internal topography of the teeth prepared.

As regards the presence of a smear layer, Eick et al. [20] stated that every cavitary instrumentation produces such a layer. Nevertheless, Yazici et al. [11] affirmed that instrumentation causing US increases superficial roughness without, however, producing a smear layer. This has not been observed or confirmed by some authors [16,21] or in the present research. In this study, a smear layer was produced in every single cavity preparation carried out with a high-speed system, but this layer was noted to be dense, totally obliterating the entrance of the dentinal tubuli, as already described [8,21], and completely disorganized, corroborating the findings of Brännström et al. [22]. Although in the teeth prepared with the US system there was dense production of the smear layer, obliterating the dentinal tubuli, this layer had a fluffy aspect and was in the form of clots. These findings do not corroborate the results obtained by Vieira and Vieira [8], who reported that 80% of cavities prepared with the US system presented a fine smear layer and unobstructed dentinal tubuli. It is important to emphasize, however, that the dental substrate utilized by the authors cited above was different from that used in the present study.

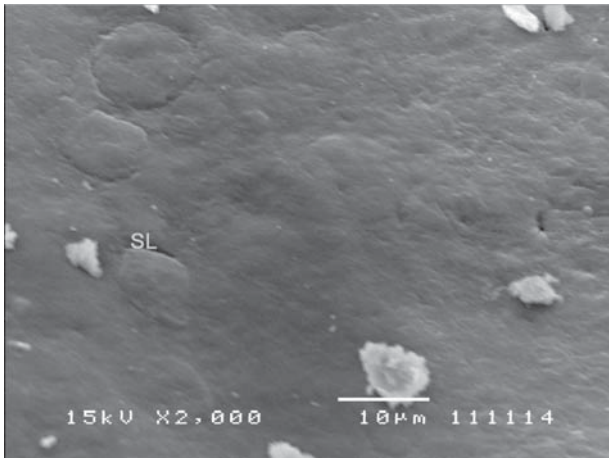

Figure 4. Scanning electron photomicrograph of the dentin of deciduous first molars prepared with ultrasonic abrasion. A dense smear layer is present and the contour of dentinal tubuli is obliterated. The smear layer appears to be fluffy and organized in the form of clots. Original magnification ×2000. SL = smear layer.

The CVD point used in US not only seemed to produce cavity preparations with a small amount of smear layer, but this layer also appeared to be 'fluffy and loosely adhered'. Thus, further studies are suggested, using different techniques of acid-etching, so that the influence of these points on the adhesion potential of restorative materials could be better understood, particularly in the case of deciduous teeth, which present an insufficiently researched substrate.

Conclusions

Cavities prepared with CVD points adapted to the US system resulted in smaller amounts of striae and both devices promoted the marked presence of a smear layer, obstructing dentinal tubuli.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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