Passive ultrasonic irrigation provides less debris after post space preparation

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ABSTRACT

Objective: The present study evaluated the residues (debris) incidence in dentin fiber post space submitted to irrigation protocols using distilled water (DW), 2.5% sodium hypochlorite (HS), 2.5 % sodium hypochlorite and 17% EDTA (HSE), or 2.5% sodium hypochlorite energized by passive ultrasonic irrigation (HSUS). **Methods:** Forty bovine incisors root canals with standardized root length (17.0 mm) were obturated using single cone technique and epoxy resin sealer. After 7 days, the fiber post space was prepared using # 1 and # 2 Largo burs, and DC2 (White Post; FGM). The specimens were randomly divided into four groups (n = 10), according to the irrigation protocol: AD; HS, HSE or HSUS. After 48 hours, the roots were sectioned. Cervical and apical segment images were obtained using scanning electron microscopy (500X). Scores were assessed according to debris presence. **Results:** In cervical segment, HSE and HSUS presented debris incidence lower than DW and HS ($P < 0.05$). DW and HS or HSE and HSUS were similar to each other ($P > 0.05$). **Conclusions:** HSUS provided the lower debris incidence in dentin surface of the fiber post space ($P < 0.05$).

Keywords: Dentin. Endodontics. Sodium Hypochlorite. Dental Restoration, Permanent.

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Introduction

Two problems can be present after fiber space post preparation: 1) local contamination; and 2) persistence of residues (debris) on the dentin surface. The non-use of absolute isolation may cause a microbial contamination of the root canal, compromising the integrity of the endodontic treatment and interfering negatively on the periapical repair process.[1-4] On the other hand, the use of rotary instruments during space preparation, causes formation and deposition of debris on the dentin surface of the root canal, which could compromise the resin cements adhesion to root dentin.[5-9]

The use of an irrigation protocol that has antimicrobial activity and root canal debris removal before fiber pin cementation is an interesting alternative to solve these problems.[8,9] However, there are still many questions about which is the most appropriate irrigation protocol, because several substances have a negative effect on the physical properties of the resin cements.[10-14]

Sodium hypochlorite decomposes into sodium hydroxide and hypochlorous acid, is the universally recommended product to be used for root canal irrigation.[15-17] Although it has satisfactory antimicrobial activity, it does not adequately provide the removal of debris from the dentin surface after endodontic instrumentation[17,18] But, associated with 17% EDTA is observed a significant improvement of the radicular dentin cleaning.[16,18]

However, the debris formed —after the fiber space post preparation are different from those originated after the root canal chemical-mechanical instrumentation, because in its composition present endodontic obturation materials and other root canal residues.[5,6] So, the ultrasonic mechanical agitation associated with an irrigation solution can be a good alternative to solve this problem.[19]

For this purpose, the ultrasonic energization has been able to increase the bond strength of the cementation system in the root dentin, especially when a self-etching dentin adhesive system is used. [20] Despite those good results, there are still no studies that evaluate the dentin surface cleaning potential, provided by several irrigation protocols, after the space post preparation.

The aim of the present study was to evaluate the cleaning potential of the dentin surface submitted to irrigation protocols with distilled water, 2.5% sodium hypochlorite, 2.5% sodium hypochlorite followed by irrigation with 17% EDTA or 2.5% sodium hypochlorite energized by passive ultrasonic irrigation (HSUS), in the cervical and apical segments of fiber space post. The null hypothesis was that there was no difference between the irrigation protocols evaluated, in both cervical and apical segment.

Material and methods

Specimens Preparation

Forty bovine incisors with similar endodontic anatomy were used (ex vivo) and stored in a 1% thymol solution at 37°C until the moment of use. The roots were transversely sectioned using a double-sided diamond disk (KG Sorensen, Cotia, SP, Brazil), in length with 17mm.

In sequence, the patency length and the glide- path were obtained using a # 15K file. The root canals were instrumented with rotary instruments (ProTaper; Dentsply Maillefer, Ballaigues, Switzerland) to the F5 instrument, at 16 mm of length. In each change of instruments, the root canals were irrigated with 5mL of 2.5% NaOCl (Asfer, São Caetano do Sul, SP, Brazil). 17% EDTA, by 3 minutes intracanal, and 2.5% NaOCl were employed as final solutions irrigation.

The root canals were aspirated using a tip with 0.36 mm of diameter (Capillary Tips, Ultradent, South Jordan, UT, USA), dried with F5 absorbent paper (ProTaper; Dentsply Maillefer, Ballaigues, Switzerland). The root canals were obturated with gutta percha by single cone technique and an epoxy-based sealer (AH Plus; Dentsply De Trey, Konstanz, Germany). The roots were maintained at 99% of relative humidity and at 37°C, for 7 days.

After this period, the intraradicular space post was made using #1 and #2 Largo burs and finished with the DC2 bur (White Post DC; FGM, Joinville, SC) at low rotation (8,000 rpm), without refrigeration, in the length of 11 mm, from cervical to apical.

Table 1. Median, maximum and minimum values and of the first and third quartiles of scores attributed to incidence of debris, after the irrigation fiber space post protocols, on the dentin surface, in the apical root segment.

Group	Median	Maximum	Minimum	1st and 3rd Quartiles
AD[a]	2	2	2	2-2
HS[a]	2	2	2	2-2
HSE[a]	2	2	1	2-2
HSUS[b]	1	1	1	1-1

[ab] Different letters indicates statistical differences between the irrigation protocols evaluated (P <0.05). DW: distilled water; HS: 2.5% NaOCl; HSE: 2.5% NaOCl and 17% EDTA; HSUS: 2.5% NaOCl sodium hypochlorite 2.5% energized with passive ultrasonic irrigation.

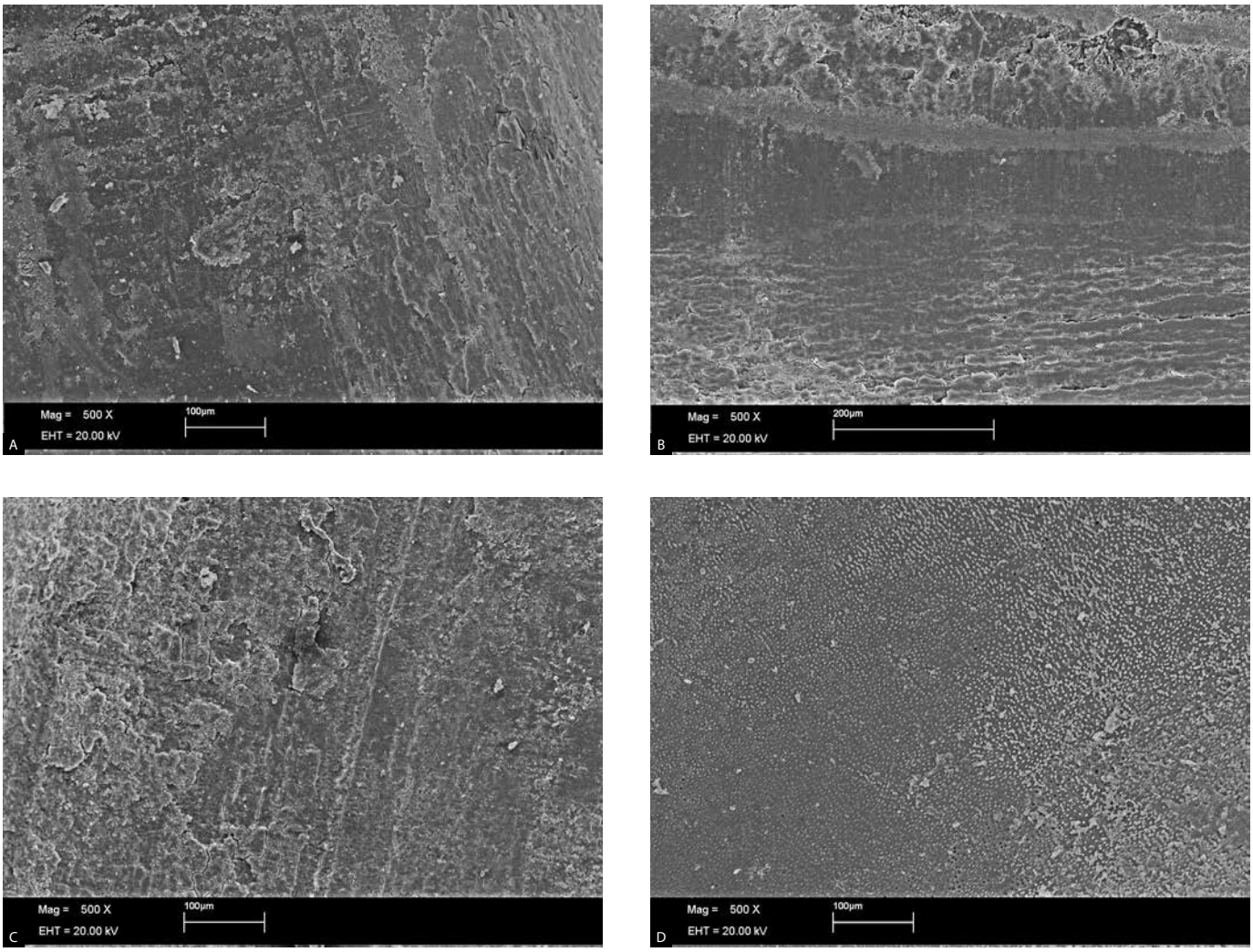

Figure 1. Representative images of the incidence of residues on the dentin fiber space post, after the irrigation with several irrigation protocols, in apical segment:. **A)** (DW), distilled water; **B)** (HS), 2.5% NaOCl; **C)** (HSE) 2.5% NaOCl and 17% EDTA at 17% and **D** (HSUS), 2.5% NaOCl energized with passive ultrasonic irrigation (HSUS) (scale: 100µm).

Table 2. Median, maximum and minimum values and of the first and third quartiles of scores attributed to incidence of debris, after the irrigation fiber space post protocols, on the dentin surface, in the cervical root segment.

Group	Median	Maximum	Minimum	1st and 3rd Quartiles
AD[a]	2	2	2	2-2
HS[a]	2	2	2	2-2
HSE[b]	1	1	1	1-1
HSUS[b]	1	1	0	1-1

[ab] Different letters indicates statistical differences between the irrigation protocols evaluated (P <0.05). DW: distilled water; HS: 2.5% NaOCl; HSE: 2.5% NaOCl and 17% EDTA; HSUS: 2.5% NaOCl sodium hypochlorite 2.5% energized with passive ultrasonic irrigation.

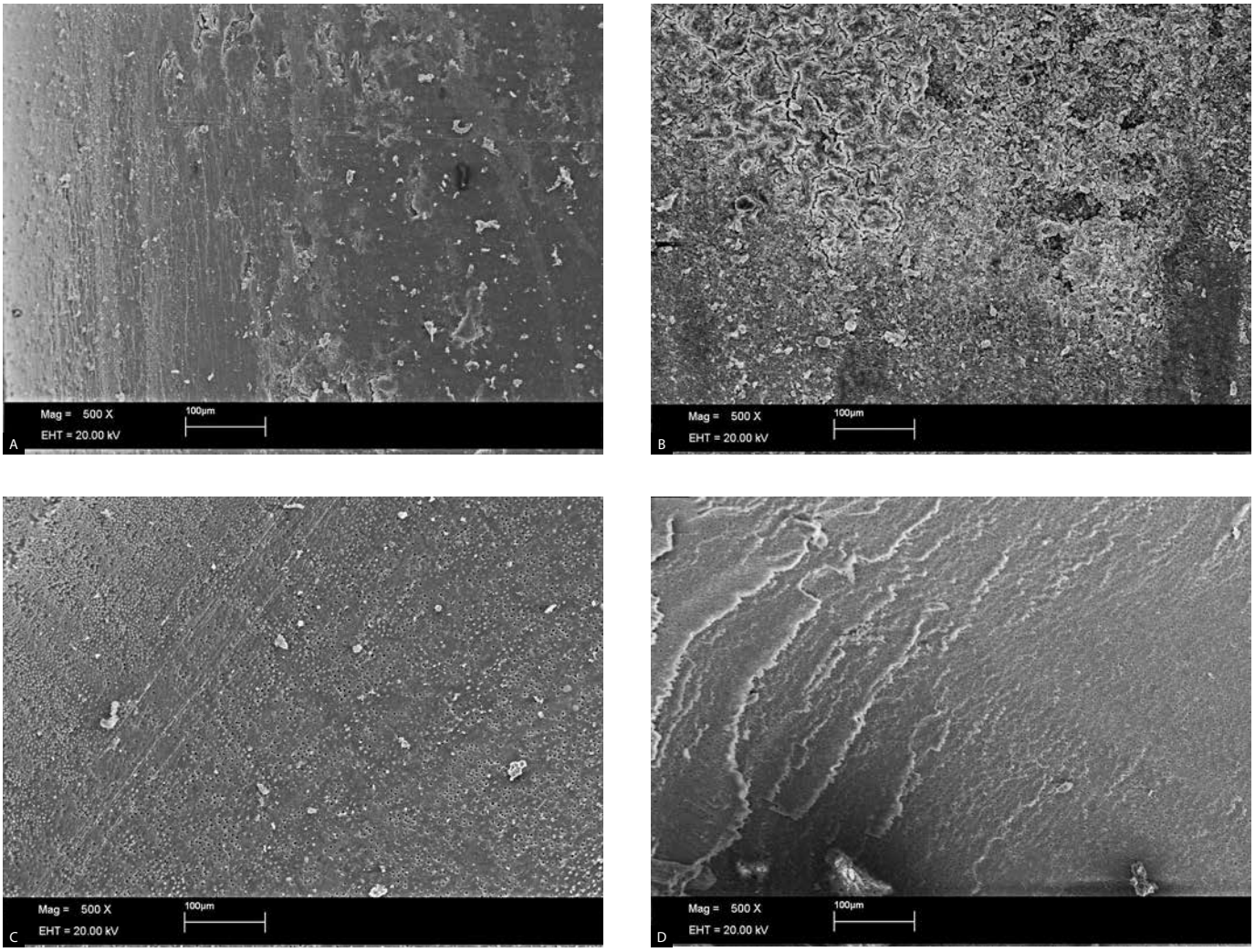

Figure 2. Representative images of the incidence of residues on the dentin fiber space post, after the irrigation with several irrigation protocols, in cervical segment:. **A)** (DW), distilled water; **B)** (HS), sodium hypochlorite at 2.5% ; **C)** (HSE) 2.5% NaOCl and 17% EDTA at 17% and **D)** (HSUS), 2.5% NaOCl energized with passive ultrasonic irrigation (HSUS) (scale: 100µm).

Evaluated Groups

The roots were then divided into 4 groups (n = 10, each group), according to the irrigation protocol:

» DW - Space post was irrigated with 5 mL of distilled water, using a 30 G irrigation cannula (Navitip; Ultradent, South Jordan, UT, EUA);

» HS - Similar to previous irrigation protocol, but using 2.5% NaOCl (Asfer, São Caetano do Sul, SP, BRA);

» HSE - After irrigation with 5 mL of 2.5% NaOCl, irrigation was performed with 5 mL of 17% EDTA (Biodinâmica, Ibiporã, PR, BRA), kept intracanal for 3 min, and submitted to final irrigation with 5 mL of 2.5% NaOCl;

» HSUS – In this irrigation protocol, the space post was filled with 2.5% NaOCl and activated by ultrasonic agitation, with an E4 tip (NSK-Nakanishi, Joinville, SC, BRA) adapted in a power generator unit (Various II; NSK-Nakanishi, Joinville, SC, BRA), at power level 2, in 4 cycles of 15s each.

Once the irrigation was finished, the prepared space post were immediately aspirated with a 0.48 mm diameter suction tip (Capillary Tips, Ultradent, South Jordan, UT, USA) and dried with F5 absorbent paper tips (ProTaper; Dentsply Maillefer, Ballaigues, Switzerland).

SEM analysis

The roots were cut longitudinally, in the vestibulolingual direction, using a chisel. To analyze the presence of debris on the dentin surface, the specimens were initially dehydrated for 5 days, at 37 °C, kept in a closed chamber containing silica gel for 2 days and mounted with double face carbon tape in metallic stubs.

After the metallization process, the specimens were submitted to scanning electron microscopy (LEO 435VP, Carl Zeiss Microscopy Ltd, Cambridge, United Kingdom) at 20.0 kV. To obtain the images, the extension of the intraradicular preparation was divided into two segments, cervical and apical segments, with similar length.

Four different sites were analyzed in each segment and a representative image of the debris profile present in the area was obtained, with magnification of 500X. To evaluate the presence of debris on the dentin surface, there was assigned scores from 0 to 2 according to the degree of dirt observed, according to the parameters described by Serafino et al.[5]:

0 - Absence of debris and / or residues of endodontic cement and / or gutta percha, with all openings of dentinal tubules visible on the dentin surface;

1 - Small presence of debris and / or residues of endodontic cement and / or gutta percha, with some openings of dentinal tubules visible on the dentin surface;

2 - High presence of debris and / or residues of endodontic cement and / or gutta percha, with all dentinal tubule openings obstructed.

The date were submitted to Kruskal Wallis and Dunn (P = 0.05).

Results

At cervical segment, the irrigation protocols HSE and HSUS showed similar presence of debris (P > 0.05), but in lower incidence than the observed in the AD and HS protocols (P < 0.05). AD and HS were similar to each other (P > 0, 05). In the apical segment, HSUS showed the lowest incidence of debris when compared to the other irrigation protocols (P < 0.05), which were the same among each other (P> 0.05).

Tables 1 and 2 shows the median, maximum and minimum values, first and third quartiles of the incidence of debris on the dentinal surface, respectively, for the apical and cervical segments of the space post.

Figures 1 and 2 show representative images of the incidence of debris pattern on the dentin surface after the use of the different irrigation protocols, respectively, of the apical and cervical segments of the prepared space for fiber pin.

Discussion

The irrigation protocols used showed different results to cleaning the dentin surface of the fiber space post. Therefore, the null hypothesis was rejected. In the cervical segment, HSUS and HSE were similar, but showed lower incidence of debris than the other irrigation protocols. On the other hand, at the apical segment, the HSUS provided the lowest incidence of debris in dentin surface.

Sodium hypochlorite is the most used solution for root canal irrigation due to its satisfactory antimicrobial properties, ability to dissolve decomposing organic matter, and reasonable diffusion in the

root dentin.[16] However, it has low potential for debris removal and / or smear layer of the dentinal surface.[17] The problem is that the constitution of the debris formed after the space post is different from those originated after the chemical and mechanical preparation of the root canals, because there is also the presence of residues of endodontic obturation materials.[5,6]

Resin materials, such as gutta percha and epoxy resin (AH Plus), are routinely used for root canals obturation, and the preparation of the fiber space post is performed without local refrigeration, it causes the plastification of these materials, which can impregnate the dentin surface.[14,21] Despite this considerations, as showed in figures 1 and 2, the passive ultrasonic agitation promoted a lower incidence of debris on the dentin surface, such as results obtained in the root canal irrigation.[19]

However, two observations are interesting to describe regarding to what was observed in the cervical segment: 1) The cleaning provided by the HSUS irrigation protocol was similar to the HSE and; 2) The profile of the dentin surface after ultrasonification was different from the one provided by the HSE.

The bur used (DC2; Whistepost) to obtain the final conformation of the fiber space post may have provided greater attrition in the cervical segment than in the apical, due to its own morphological characteristic. This possibly caused the best removal endodontic obturation of the dentin surface. The amount of dentine debris in the cervical segment of the fiber space post matches the average penetration of root canal obturation materials in the root dentin, which justifies the good performance of the HSE.[22]

Thereafter, the incidence of root canal obturation material residues on the dentin surface seemed to be lower in the cervical segment than in the apical. The results indicates that the debris on this segment consisted mainly of dentin particles, which can be removed by NaOCl and 17% EDTA irrigation protocol.[15,17,22] On the other hand, the removal of residuals from the obturator material in the apical segment is more difficult, only being favorable by means of the ultrasonic agitation, as observed in our results.

Another important observation in the present study was the final characteristic of the dentin surface submitted to ultrasonic solution agitation. In the cervical segment, the presence of irregularities in the dentinal surface was frequently observed, but usually with a low incidence of debris (Fig 2D). This could have occurred due to the conical shape of the E4 insert, which, because of it has a larger cervical diameter, may have accidentally hit the dentin surface. This image is described in other studies that used ultrasound in root canal irrigation.[19]

Thus, the present study warns about the importance of previous cleaning the dentin surface of the fiber space post, being recommended to use protocols with ultrasonic solution agitation. Other analyzes, such as the evaluation of these protocols on the bond strength of fiber post cementation system in the root dentin, still need to be carried out to determine the influence and repercussion of the results on the adhesive interface and its clinical significance.

Conclusion

The 2.5% NaOCl passive ultrasonic irrigation provide a lower dentin residues incidence on the dentin fiber space post.

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