

# Influence of Irrigants in Association with Ultrasound for Cleaning Root Dentin Surface after Post Space Preparation: EDS Analysis

Influencia de Irrigantes en Asociación con Ultrasonido para la Limpieza de la Superficie de la Dentina Radicular Después de la Preparación del Espacio para Postes: Análisis de Espectroscopia de Energía Dispersiva

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**ABSTRACT:** This study evaluated the cleanliness of post space after different irrigation protocols, associated or not to the use of ultrasound. Thirty-six single-rooted bovine roots were instrumented with rotary system, irrigated with 1 % hypochlorite and filled with Ah Plus sealer and gutta-percha cones. After seven days in stove at 37 °C, two-thirds of canal filling was removed by drilling and the post space preparation was irrigated with 2.5 % NaOCl (group NaOCl); 0.2 % chlorhexidine (group CLX); distilled water (group Water); 2.5 % NaOCl + ultrasound (group NaOCl-US); 0.2 % chlorhexidine + US (Group CLX-US); or water + US (Group Water-US). Roots were cleaved in mesiodistal direction, prepared for scanning electron microscope (SEM) to evaluate the smear layer and debris presence and for energy dispersive spectroscopy (EDS) analyses, to evaluate chemical components of dentin after treatment. The data were subjected to statistical analysis (two-way Anova and Tukey's test 5 %). EDS analysis showed the presence of chemical components of filling material in the samples from all groups. SEM images showed large amount of obliterated dentinal tubules. The use of ultrasound influenced the removal of some components of filling material ( $p < 0.05$ ), but not allowed for total cleaning. It was concluded that none of the irrigating solutions, associated or not to the use of ultrasound were able to completely clean the post space.

**KEY WORDS:** endodontics, energy dispersive spectroscopy, irrigation, post space preparation.

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## INTRODUCTION

The use of prefabricated glass fiber post has been widely accepted in dentistry, particularly in anterior tooth. Their modulus of elasticity, similar to dentin, allows better dissipation of masticatory loads to tooth structure (Marchi *et al.*, 2008; Zhou & Wang, 2013), fact not observed in cast metallic posts. Moreover, they have also advantages such as esthetics, biocompatibility, and corrosion resistance (Fernandes *et al.*, 2003).

Clinical studies have demonstrated favorable results regarding the use of those posts in medium-term (Cagidiaco *et al.*, 2008). However, bonding to root

canal dentine remains a challenge because of limited access and visibility. Adhesion to root canal might be compromised by the presence of sealer and gutta-percha remnants and consequently deficient dentine hybridization (Perdigão *et al.*, 2007).

The difficulty to completely remove root canal filling will result in material remnants on root dentin walls, and the presence of such residues impairs the adhesion of glass fiber post. Thus, several methods have been tested aiming to completely remove filling material, for adequate luting of intraradicular post (Coniglio *et al.*, 2008a, 2008b; Zhang *et al.*, 2008; Bitter *et al.*, 2012).

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Passive ultrasonic irrigation (PUI) has been used in endodontics in assisting the removal of smear layer after chemo-mechanical preparation of root canals (Capar & Aydinbelge, 2013; Mozo *et al.*, 2014). The tip of the device operates not touching dentinal walls, shaking irrigating substances. Bubbler resulted from that agitation forms burst and increase temperature and pressure, which results in a wave impact against root canal walls, removing debris (van der Sluis *et al.*, 2007).

Some previous studies evaluated the cleaning of post space using different irrigants and materials, by optical and scanning electronic microscope (SEM) analyses (Coniglio *et al.*, 2008a, 2008b; Bitter *et al.*; Serafino *et al.*, 2004, 2006). However, those methods are qualitative, while energy dispersive spectroscopy (EDS) analysis of root dentin walls allows quantifying and identifying the chemical remaining components, and differentiating constituents of filling material and tooth.

The aim in this study was to evaluate the cleaning of post space after different irrigation protocols, associated or not to ultrasound. The Null hypotheses of this study are: (i) cleaning and dentin composition are not affected by the irrigation solution used; (ii) ultrasound has no effect during post space cleaning and (iii) the association of ultrasound and irrigating solutions do not influence the post space cleaning.

## MATERIAL AND METHOD

**Selection and sample preparation.** Thirty-six unradicular bovine teeth were selected and the crowns were removed at the cemento-enamel junction, using a diamond disk (Labcut 1010 Low Speed Diamond Saw-EXTEC, Chicago, IL, USA) under water-cooling. Roots with 18 mm in length were obtained. They were treated by one endodontist using rotary files (Mtwo System - VDW, Munich, Germany); were irrigated with 1% hypochlorite solution and were filled with gutta-percha cones (Dentsply/Maillefer, Petrópolis, Brazil) and AH Plus sealer (AH Plus – Dentsply/Maillefer, Petrópolis, Brazil).

**Preparation and cleaning of post space.** Two-thirds of the root filling extent (12 mm) was cleared by specific drill (#2 Reforpost Drill – Angelus Dental Products, Paraná, Brazil). The cleaning of post space was conducted using different protocols, divided into six groups (Table I).

In groups NaOCl, CLX and W, 5 mL of correspondent substance was dispensed, using a 5 mL syringe (Injex – Surgical Products, São Paulo, Brazil) and the irrigation time was standardized (30 s). For ultrasound groups the ultrasound's water reservoir (CVDent 1000 - CVDentus Dental Products – São Paulo, Brazil) was filled with 5ml of substance, according to group distribution, and solution was dispensed for 30 s. The tip of ultrasound (E1- Irrisonic – Helse Dental Technology, São Paulo, Brazil) did not touch the root walls, acting passively.

**EDS analysis.** The EDS analysis was conducted to assess remnants of chemical components on dentin surface after different cleaning protocols used. The origin of each chemical element quantified is shown in Table II. Statistical analysis was performed (two-way Anova and Tukey's test:  $p < 0.05$ ).

One root of each group was sectioned in mesiodistal direction, dehydrated in alcohol and metallized for scanning electronic microscope (SEM) observation.

Table I. Description of groups according to irrigants used and association to ultrasound application.

Groups (n= 6)	Cleaning
NaClO	2.5 % Sodium Hypochlorite
CLX	0.2 % Chlorhexidine
Water	Distilled water
NaClO-US	2.5 % Sodium Hypochlorite + ultrasound
CLX-US	0.2 % Chlorhexidine + ultrasound
Water-US	Distilled water + ultrasound

Table II. Origin of chemical elements quantified on EDS analysis

Tooth	C, O, Ca, P, Mg
Sealer	W, Ca, Zr, Si, Fe, O
Gutta-percha	O, Zn, C, Ca

## RESULTS

The comparison between cleaning protocols tested is shown in Tables III and IV. Among the elements of the filling material, there was a statistically significant difference in the weight percent of tungsten. According the components of tooth, there was significant difference in carbon, calcium, oxygen and phosphorus concentrations.

Upon comparing the use of the substance with and without ultrasound, there was a significant reduction in weight percent for zinc and silicon, regardless of the substance used. For the other elements, there was no influence of the use of ultrasound (Table V).

Comparing only the three substances tested, there was no significant difference in the weight percent of any of the remaining elements after cleaning both the filling material or tooth substrate ( $p < 0.05$ ).

Figure 1 is a representative image of dentin surface of post space for all groups of the present study.

Table III. Weight percentage of the elements of remaining filling material after cleaning in all groups (Mean  $\pm$  SD).

Groups	Element				
	Zn	Si	W	Zr	Fe
NaClO	8.67 (1.05)	0.37 (0.08)	7.24 (0.88)	9.45 (0.62)	0.21 (0.14)
Cix	4.16 (0.98)	0.35 (0.09)	4.02 (0.80)	9.62 (0.52)	0.14 (0.06)
Water	4.09 (0.44)	0.30 (0.05)	3.93 (0.53)	8.34 (0.45)	0.13 (0.04)
NaClO + US	1.37 (0.39)	0,16 (0,03)	1.66 (0.27)	7.22 (0.40)	0.11 (0.04)
Cix + US	0.99 (0.17)	0,22 (0,05)	1.50 (0.80)	6.07 (0.32)	0.03 (0.01)
Water + US	1.59 (0.23)	0,32 (0,03)	2.05 (0.36)	7.31 (0.63)	0.40 (0.03)
p value	0.35	0.85	0.04*	0.35	0.46

Table IV. Weight percentage of remaining elements of the tooth after cleaning in all groups (Mean  $\pm$  SD).

Groups	Element				
	C	O	Ca	Mg	P
NaClO	28.44 (8.76)	28.75 (8.65)	14.86 (0.80)	1.11 (0.08)	3.88 (0.32)
Cix	28.15 (10.19)	33.96 (11.39)	18.09 (1.06)	0.52 (0.14)	5.54 (0.45)
Water	24.34 (4.93)	33.25 (6.18)	22.09 (0.77)	0.51 (0.07)	7.51 (0.35)
NaClO + US	22.67 (5.17)	35.44 (7.31)	21.99 (0.85)	0.31 (0.11)	6.97 (0.36)
Cix + US	23.30 (5.26)	35.45 (7.31)	22.85 (1.15)	0.42 (0.09)	7.30 (0.38)
Water + US	31.86 (6.70)	29.82 (6.37)	15.17 (0.63)	0.00 (0.00)	4.23 (0.24)
p value	0.01 *	0.004 *	0.001 *	0.55	0.0002 *

Table V. Weight percentage of each element of filling material (gutta-percha and sealer), with and without the association to ultrasound.

Element	Ultrasound	Mean ( $\pm$ SD)	p value
Zn	Yes	1.32 (0.26)	0.005 *
	No	5.65 (0.82)	
Si	Yes	0.26 (0.04)	0.006 *
	No	0.35 (0.07)	
W	Yes	2.40 (0.59)	0.06
	No	2.33 (0.68)	
Zr	Yes	8.39 (0.45)	0.71
	No	7.61 (0.52)	
Fe	Yes	0.18 (0.05)	0.17
	No	0.16 (0.08)	

## DISCUSSION

The null hypothesis that there is no difference between irrigating solutions used to clean the post space was accepted. However, the other two null

hypotheses, the use of ultrasound does not influence the cleaning of post space and, the association between ultrasound and irrigating substances does not influence the post space cleaning, were rejected.

The smear layer is a cluster of dentin shavings, irrigants and organic and inorganic tissues, generated after root canal instrumentation. Since it is poorly adhered to dentin walls, its removal is performed by the chelating action of EDTA, before root filling (Castagna *et al.*, 2013; Lui *et al.*, 2007). According to the literature, the presence of remnant smear layer on dentin surface is considered a negative factor in terms of adhesion on root canal, since it acts as a physical barrier between the filling material and the dentin walls (Eldeniz *et al.*, 2005; El-Ma'a'ita *et al.*, 2013).

Moreover, the sealer, which has adhesion impaired by the presence of smear layer, weak adhesion might occur between resin cement and the dentinal walls after post space preparation. This is in

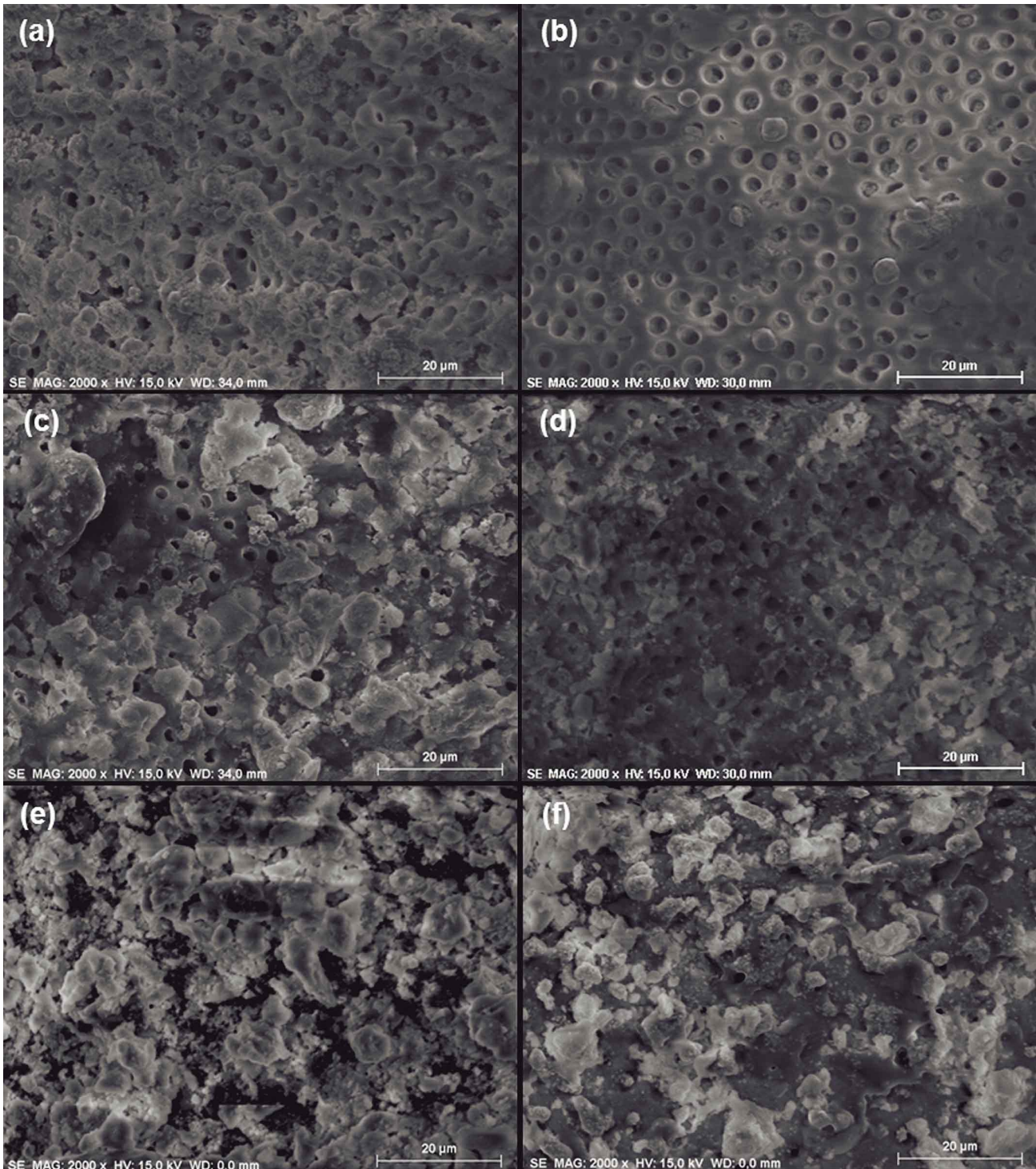


Fig. 1. Scanning electron microscopy (SEM) images of dentin walls of post spaces without association to ultrasound (a: NaClO; c: Chlorhexidine; e: Water) and with association to ultrasound (b: NaClO; d: Chlorhexidine; f: Water).

part attributed to the presence of remnants of filling material (Bitter *et al.*), including gutta-percha, which is a solid material, unable to penetrate in dentinal tubules. The permanence of gutta-percha attached to root ca-

nal walls in the present study can be verified by the presence of zinc (one of its main components), observed at similar concentration/distribution in all groups.

Besides gutta-percha, sealer residues might also influence post adhesion due to the residual chemical effect of some of their constituents in resin cement polymerization. Some studies have shown that the presence of eugenol and other components might affect the post retention (Mayhew *et al.*, 2000). The resin-based sealer used in our study is compatible with the dentin and penetrates deeply into the dentin tubules (Sevimay & Kalayci, 2005). This fact might explain the difficulty in totally cleaning dentin walls in the present study, since chemical components of sealer and gutta-percha were observed through EDS analysis.

An effective adhesion between resin cement and dentin walls is required for luting of aesthetic posts. Thus, post space free of remaining filling material, to the full, is very important (Perdigão *et al.*). Those remnants are not poorly adhered like the smear layer, and for improving their removal, some drills and irrigants can be used (Bitter *et al.*). In this study, we used some irrigant solutions, combined or not with ultrasound, seeking for an improved cleaning of dentin walls, possibly with complete removal of remnants.

The use of ultrasound in association with irrigants after instrumentation might assist in removing the smear layer, since the vibration produced contributes to a better cleaning of the channel system, in comparison with the irrigating solution alone (Haapasalo *et al.*, 2010; Mozo *et al.*; Plotino *et al.*; Salman *et al.*, 2010). This study, which tested the efficacy of irrigants associated to ultrasonic excitation for cleaning dentin walls of post space, detected improved cleaning aspect when associating ultrasound to irrigants.

Although the association of ultrasound with irrigating solutions, for improved cleaning of dentin walls of post space was effective, it did not lead to complete cleaning, once chemical components of filling materials were observed through EDS analysis. Thus, more studies should be conducted to understand the influence of those remnants in bonding of posts to dentinal walls, and also more investigations on effective approaches for complete cleaning of post space with no alterations on tooth structure.

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**JUNQUEIRA, R. B.; DE VASCONCELOS, R. A.; BRESCIANI, E.; MARINHO, R. M. M. & VALERA, M. C.** Influencia de irrigantes en asociación con ultrasonido para la limpieza de la superficie de la dentina radicular después de la preparación del espacio para postes: análisis de espectroscopia de energía dispersiva. *Int. J. Odontostomat.*, 10(1):35-40, 2016.

**RESUMEN:** Este estudio evaluó la limpieza de la preparación para el espacio de los postes después de diferentes protocolos de irrigación, asociados o no al uso de ultrasonido. Treinta y seis raíces unirradiculares de bovinos fueron instrumentados con sistema rotatorio, irrigadas con un 1 % de hipoclorito y rellenadas con el sellador Ah Plus y conos de gutapercha. Después de siete días en horno a 37 °C, dos tercios de la obturación del canal se removió por perforación y la preparación del espacio para los postes fueron irrigadas con 2,5 % de NaOCl (grupo NaOCl); Clorhexidina 0,2 % (grupo CLX); agua destilada (grupo agua); 2,5 % NaOCl + ultrasonido (grupo NaOCl - US); 0,2 % de clorhexidina + US (Grupo CLX - US); y agua + US (grupo Agua - US). Las raíces se cortaron en dirección mesiodistal y se prepararon para el microscopio electrónico de barrido (MEB) con el fin de evaluar el barrido dentinario y la presencia de restos; así como mediante el análisis de espectroscopia de energía dispersiva (EDS) para evaluar componentes químicos de la dentina después del tratamiento. Los datos fueron sometidos a análisis estadístico (pruebas ANOVA de dos factores y de Tukey al 5 %). El análisis EDS mostró la presencia de componentes químicos del material de relleno en las muestras de todos los grupos. Imágenes del MEB mostraron gran cantidad de túbulos dentinarios obliterados. El uso de la ultrasonido influyó en la eliminación de algunos de los componentes de material de relleno ( $p < 0,05$ ), pero no permitió la limpieza total. Se concluyó que ninguna de las soluciones de irrigación, asociadas o no a la utilización de los ultrasonidos fueron capaces de limpiar completamente el espacio para los postes.

**PALABRAS CLAVE:** endodoncia, espectroscopia de energía dispersiva, irrigación, preparación del espacio para postes.

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