

## Ex vivo analysis of root canal cleaning using Endo-PTC associated to NaOCl and different irrigant solutions

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**Abstract:** The aim of this study was to assess qualitatively, by means of SEM images, the cleaning of the dentin walls of root canals after chemical-surgical preparation using Endo-PTC cream with 0.5% and 1% sodium hypochlorite and different final irrigating solutions. Seventy-two single-rooted human teeth were divided into eight groups and prepared using Endo-PTC cream with sodium hypochlorite (NaOCl) at different concentrations, and irrigated with NaOCl at different concentrations. Final irrigation was performed with either EDTA-T or EDTA-C. The best results were obtained with Group 1, followed by Groups 5, 2, 7, 8, 3, 6 and 4. We can conclude that the use of 0.5% NaOCl during instrumentation and final flush of the root canals was more efficient in cleaning than was 1% sodium hypochlorite. EDTA-T was more efficient in removing smear layer than EDTA-C, and the cervical third presented better cleaning of the root canal walls than did the middle third, which showed cleaner dentin walls than the apical third.

**Descriptors:** Root canal therapy; Microscopy, electron, scanning; Root canal irrigants.

### Introduction

Smear layer is formed during endodontic instrumentation by adhering to the instrument and being compacted against canal walls, thereby covering dentin tubules' entrances. The presence of the smear layer may compromise the success of the endodontic therapy.<sup>1-3</sup> Considering the cleaning of root canal walls, large numbers of chemical substances and various combinations of them have been tested to seek the best protocol to bring together all the necessary requirements.

In addition to all the irrigating solutions, there is Endo-PTC cream which acts as a lubricant and thus reduces friction between the instrument and the root canal wall. This cream is a mixture of Tween 80 detergent, urea peroxide and carbowax as a lubricant. Because of the antimicrobial action of Endo-PTC, when used along with 0.5% sodium hypochlorite it becomes effective even in the presence of organic material.<sup>4-6</sup> Due to its antibacterial and chemical properties, sodium hypochlorite at different concentrations is the substance of choice around the world. It is known that the greater the concentration of sodium hypochlorite, the greater will be its power to dissolve tissue and its capacity to deactivate toxic products within the root canal system. However,

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its cytotoxicity will also be greater when in contact with periapical tissues. In association with chelating agents, it results in cleaner root walls that are free from smear layer.<sup>2,7-13</sup>

Based on the above, this study aimed to evaluate qualitatively, through SEM image analysis, the cleaning of the inner root canal walls as evidenced by the presence or not of smear layer, promoted by different irrigation protocols.

## Material and Methods

After receiving approval from the Ethics Committee of the Dental College of the University of São Paulo, 72 single-rooted human teeth were opened and emptied with #10 K files (Dentsply Maillefer, Ballaigues, Switzerland) in the presence of 0.5% sodium hypochlorite (Fórmula e Ação, São Paulo, SP, Brazil). The working length of each tooth was established to be 1 mm short from the apical foramen. The specimens were randomly divided into eight groups of nine teeth each. During instrumentation of the root canals, all apices were covered with wax to allow the reflux of the substances, simulating clinical conditions. The instrumentation was made up to a #35 file and apical preparation with a #40 file, using Endo-PTC cream (Fórmula e Ação, São Paulo, SP, Brazil) associated with 0.5 or 1% sodium hypochlorite (Fórmula e Ação, São Paulo, SP, Brazil) (Table 1). It is important to state that the sodium hypochlorite was renewed during instrumentation in order to maintain the effervescent reaction with Endo-PTC until all lubricant was

dissociated.

After preparation, the final flush was done using 20 ml of the irrigating solution corresponding to each group (Table 1), either EDTA-T or EDTA-C (Fórmula e Ação, São Paulo, SP, Brazil). After introducing each 5 ml of irrigant solution, mechanical agitation was performed inside the root canal using a #15 K file to enable greater contact between the irrigation solution and the root canal walls.

The crowns of all of the teeth were cut using diamond disks. Following this, a groove was made longitudinally on the buccal and lingual faces of the specimens, using a diamond-tipped steel disk, to a depth of approximately 1 mm. Then, the roots were split into two halves using a stainless steel blade and a small hammer. Only one of the two sections of each root was selected, the one with the better integrity.

The teeth were then prepared for scanning electron microscopy analysis (EDAX CDU Leap Detector, Philips, the Netherlands) in their cervical, middle and apical thirds (9, 6 and 2 mm from the apex, respectively), equidistant from the lateral walls, at 1000x magnification.

To evaluate these photomicrographs, the Fotoscore program (developed by Guerisoli,<sup>8</sup> 2002) was utilized. Among the images obtained, three were selected as patterns for score's grades. Four calibrated professors in Endodontics blindly assessed the photomicrographs. These images were divided according to scores for the degree of cleaning of the dentin wall as follows:

**Table 1** - Protocols of instrumentation and final flush.

Group	Instrumentation			Final flush				
	Endo-PTC	NaOCl		NaOCl			EDTA-T	EDTA-C
		0.5%	1%	0.5%	1%	2.5%		
G1	X	X		X			X	
G2	X	X		X				X
G3	X		X		X		X	
G4	X		X	X				X
G5	X	X				X	X	
G6	X		X			X	X	
G7	X		X			X		X
G8	X		X	X			X	

- Score 1 = dentin surface free of smear layer and with dentin tubules visible.
- Score 2 = up to 50% of dentin surface with presence of smear layer and with dentin tubules visible.
- Score 3 = more than 50% of dentin surface with presence of smear layer and without visible dentin tubules.

The statistical analysis was made by means of the Kruskal-Wallis non-parametric test at a significance level of 1%.

## Results

The qualitative assessment data on root wall cleaning that the examiners obtained were converted into numerical values, using the scoring system adopted for this study, by the Fotoscore program. Figure 1 shows a sample of each group. Statistical

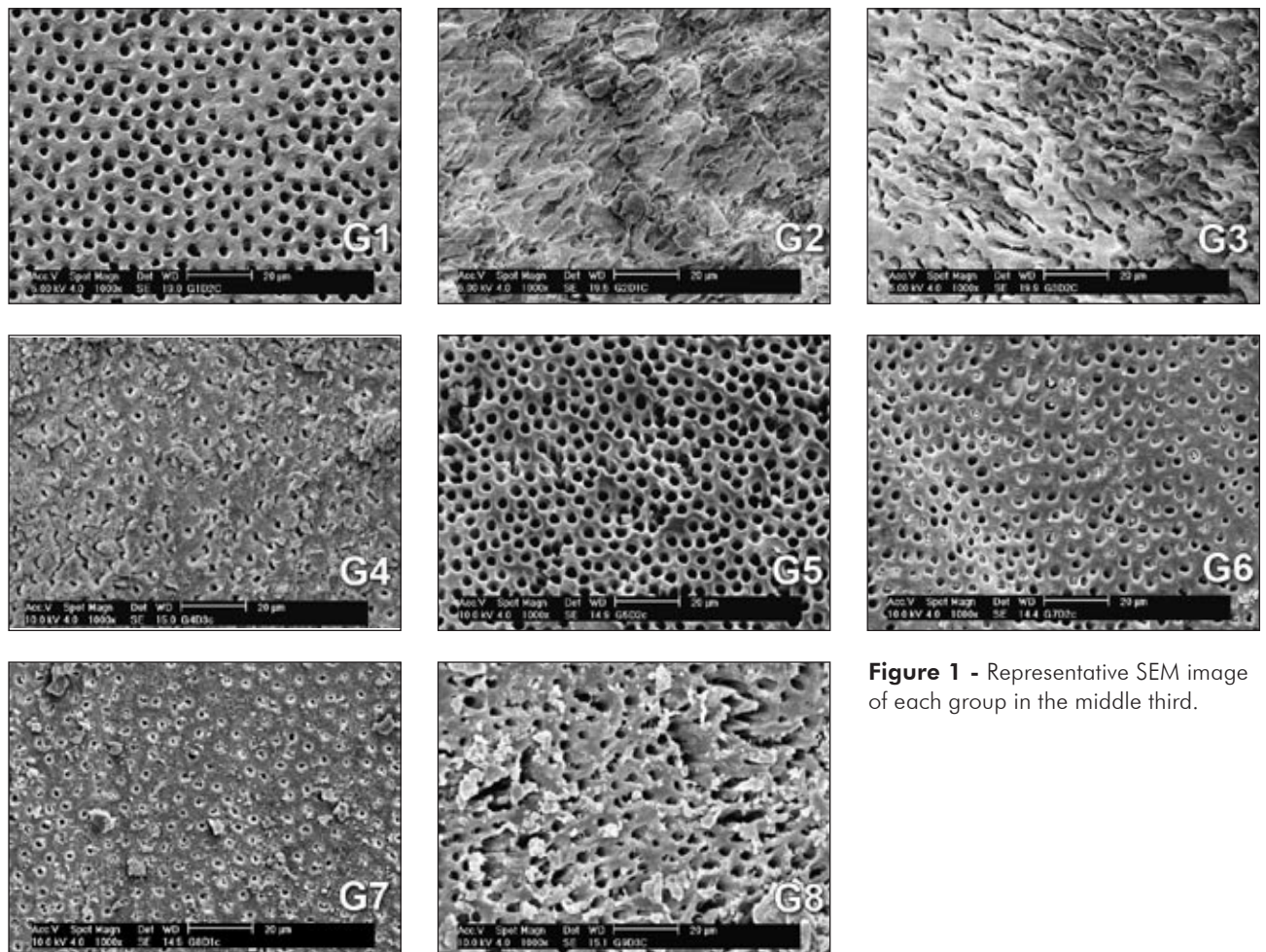
analysis showed that there was a significant difference at the 1% level between the eight experimental groups. (Table 2)

The best results regarding the cleaning of the dentin walls of the root canals were obtained from Group 1, followed by Group 5, Group 2, Group 7, Group 8, Group 3, Group 6 and Group 4, respectively.

## Discussion

A large number of studies have been conducted in the constant search for chemical substances, or combinations of such substances, or methods that would be capable effectively of removing this smear layer.<sup>8,14</sup>

Among the substances selected for intermittent use, sodium hypochlorite is the one most commonly utilized. Because of its characteristics, which favor



**Figure 1** - Representative SEM image of each group in the middle third.

**Table 2** - Mean values for the score readings for the cervical, middle and apical thirds in each experimental group.

Group	Third			Kruskal-Wallis*
	cervical	middle	apical	
G1	1.42	1.42	2.00	a,c
G2	1.92	1.83	2.67	a
G3	1.83	2.25	3.00	a,b
G4	2.17	2.25	3.00	b,d
G5	1.25	1.83	2.67	b,c,d
G6	1.67	2.58	2.92	d
G7	2.08	1.75	2.75	e
G8	2.25	2.17	2.58	e

\*Different letters show statistically significant differences ( $p < 0.01$ ).

disinfection of the root canal, this solution has been routinely studied at various concentrations in relation to toxification and dissolution of the pulp tissue.<sup>4,15-17</sup>

Although sodium hypochlorite meets most of the basic requirements for an auxiliary substance to achieve sanitization of the root canal system, it does not meet all of them. Used alone, therefore, it is insufficient to achieve this objective and needs to be used in combination with other chemical substances such that the characteristics of one solution complement the characteristics of the other.<sup>10,15</sup>

Gly-Oxide®, RC-PREP® and Endo-PTC are among the substances available for continuous use. These have a creamy or gel-like consistency and they aid in lubricating the root walls thereby diminishing friction through suspension of the detritus resulting from instrument use.<sup>4,10,13,15-19</sup>

Removal of the smear layer impregnated in the dentin walls of the root canals is also aided by the demineralizing and chelating action, respectively, of organic and inorganic acids such as citric acid and EDTA, with or without associated detergents.<sup>2,7,8,20,21</sup>

Adding a detergent solution to the original Fórulation of EDTA has led to increased surface tension for this substance, with the result that greater permeability of the dentin tubules and better cleaning of the dentin walls of the root canals has thereby been provided.<sup>10</sup> Tergensol is an anionic, tenso-ac-

tive detergent associated with EDTA in the EDTA-T solution, as well as Cetavlon, a cationic detergent present in EDTA-C.

The cleanest root dentin surfaces were seen in Group 1, in which Endo-PTC neutralized by 0.5% sodium hypochlorite and final irrigation using 0.5% sodium hypochlorite and EDTA-T were utilized. Among the sodium hypochlorite concentrations utilized during the final irrigation of the root canals (0.5%, 1% and 2.5%), the concentration of 0.5% presented the best result regarding dentin cleaning. The lowest quantities of smear layer were observed in Groups 1, 5 and 2 (in decreasing order of cleaning), in which the instruments in the root canals were used along with Endo-PTC neutralized by 0.5% sodium hypochlorite. However, there were no statistically significant differences at the 1% level between Groups 1, 2 and 5. A slower reaction between 0.5% NaOCl and Endo-PTC in comparison with 1% and 2.5% NaOCl could have led to a greater time for oxygen formation and, therefore, a better performance in smear layer removal.

There was a statistically significant difference at the 1% level between Group 2 and Group 5, in relation to the final irrigation. EDTA-C was used in Group 2 and EDTA-T was used in Group 5. EDTA-T presented better cleaning. Tergensol, being an anionic detergent, is more effective for dealing with calcium ions and oily residues, which results in a better removal of smear layer.

The experimental group that presented the greatest quantity of smear layer on the root dentin surface was Group 4, in which Endo-PTC, neutralized by 1% sodium hypochlorite and final irrigation with 0.5% sodium hypochlorite and EDTA-C, was utilized. However, Group 4 did not present a statistically significant difference at the 1% level compared with Groups 3 and 6.

Considering the chelating agents utilized in this study, EDTA-T and EDTA-C, EDTA-T showed cleaner dentin walls than did EDTA-C. There was a statistically significant difference at the 1% level in this respect between Groups 1 and 2 and Groups 4 and 8. This statistical difference at the 1% level did not occur between Groups 6 and 7, although in the middle third the two groups did present a statisti-

cally significant difference at the 1% level.

As was observed in this study, the apical third is the most critical region with regard to the characteristic of greatest accumulation of smear layer coming from the chemical-surgical preparation. Efforts need to be concentrated on this, in order to achieve more efficient action by the auxiliary chemical substance to combat microorganisms and clean the root dentin.<sup>14</sup>

It is clear that it is important to carry out new studies on dentin cleaning of root canal walls, with the aim of improving the cleaning of these walls. Given that in modern Endodontics resinous filling cements are used, that penetrate into the dentin tubules and thereby cause greater sealing of the root canal system, the more complete cleaning of canal walls becomes a decisive factor in endodontic success.

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## Conclusion

- The use of 0.5% sodium hypochlorite in association with Endo-PTC cream during the chemical-surgical preparation was shown to be more effective in dentin cleaning from root canal walls than was 1% sodium hypochlorite.
- Among the sodium hypochlorite concentrations utilized during the final irrigation of the root canals (0.5%, 1% and 2.5%), the concentration of 0.5% presented the best result regarding dentin cleaning.
- The final irrigation performed using EDTA-T provided a better result with regard to removal of smear layer than did EDTA-C.
- In relation to thirds of the root, the cervical third presented better cleaning of the dentin walls of the root canals than did the middle and apical thirds, while the middle third of the root showed cleaner dentin walls than did the apical third.

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