Scanning Electron Microscopic Preliminary Study of the Efficacy of SmearClear and EDTA for Smear Layer Removal after Root Canal Instrumentation in Permanent Teeth

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Abstract

This study aimed to evaluate the efficacy of SmearClear (SybronEndo, Orange, CA) and EDTA for smear layer removal from root canals of permanent teeth after instrumentation. Thirty extracted human permanent teeth ($n = 10$) were randomly assigned to the following groups: group 1 = 14.3% EDTA, group 2 = SmearClear, and group 3 = no smear layer removal procedure was undertaken (control). The specimens were submitted to scanning electron microscopy analysis. Magnifications of 200× and 750× were used to evaluate cleaning at the apical, middle, and cervical thirds according to a three-point scoring system. Data were analyzed statistically by the Mann-Whitney *U* test (5% significance level). Groups 1 and 2 differed significantly from group 3 ($p < 0.01$). However, there was no statistically significant difference ($p > 0.05$) between groups 1 and 2. In conclusion, SmearClear was able to remove the smear layer from the root canals of permanent teeth similarly as 14.3% EDTA, suggesting that both solutions may be indicated for such purpose. *(J Endod 2008;34:1541–1544)*

Key Words

EDTA, permanent teeth, scanning electron microscopy, Smear layer, SmearClear

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The presence of the smear layer produced during biomechanical preparation of root canals may prevent or delay considerably the penetration of antimicrobial agents, such as endodontic irrigants and intracanal medications, into the dentinal tubules (1, 2) as well as interfere with the adhesion of root canal sealers to the canal walls, thus compromising the quality of the obturation (3). Additionally, given that in teeth with pulp necrosis the success of the endodontic treatment depends on the elimination of bacteria and their byproducts from the root canal system, smear layer removal is of paramount importance (4).

Sodium hypochlorite (NaOCl) is the most widely used chemical solution in the biomechanical preparation of the root canal system, and it has been systematically used in endodontics in concentrations ranging from 0.5% to 5.25%. However, despite its excellent antimicrobial activity and capacity of dissolving organic materials, this solution alone does not effectively remove the smear layer (5). Because its physicochemical action is limited to the removal of organic particles, NaOCl has been used in association with EDTA, which acts on the inorganic debris formed in instrumented root canals (6, 7). Therefore, the combination of these substances is capable of removing the smear layer, mainly from the middle and cervical thirds (8, 9).

Recently, a new product containing 17% EDTA solution along with cetrimide and additional proprietary surfactants has been launched by SybronEndo (Orange, CA) under the brand name SmearClear. This endodontic irrigant is advertised as being specifically designed for smear layer removal and root canal cleansing, and little published data are available about its performance (10, 11). Therefore, the purpose of this scanning electron microscopic study was to evaluate the efficacy of SmearClear for removal of the smear layer from the root canals of permanent single-rooted teeth after instrumentation in comparison to EDTA.

Material and Methods

This research project was reviewed by the local ethics in research committee, and the study design was approved (Process #2007.1.73.58.8). Thirty extracted human permanent incisors and canines with a single straight root were obtained from the tooth bank of the School of Dentistry of Ribeirão Preto, University of São Paulo, Brazil. The teeth had their root surfaces carefully rinsed with sterile saline and were stored in 10% formalin solution at a ratio of 1:4 until use.

The teeth were radiographed to observe the pulp chamber and root canal system morphology. After coronal opening and manual exploration of the canals, teeth with any obstruction, excessive root curvature, length less than 10 mm, or a working length diameter less than a size 25 K-file were discarded. Warm wax was used to seal the apical foramen. The teeth were hand prepared by a single operator using K-files (Dentsply Maillefer, Ballaigues, Switzerland), according to a crowndown pressureless technique up to the tooth real length. At each change of instrument, the canals were irrigated with 3.6 mL 2.5% NaOCl followed by aspiration with endodontic needles of size compatible with the root canal diameter.

TABLE 1. Results related to the scores attributed to the groups 1, 2, and 3 to each third

Specimen*	Root Third	Scores	Specimen*	Root Third	Scores
1	Apical	0	16	Apical	—
	Middle	0		Middle	—
	Cervical	0		Cervical	—
2	Apical	0	17	Apical	0
	Middle	0		Middle	1
	Cervical	0		Cervical	0
3	Apical	0	18	Apical	1
	Middle	0		Middle	0
	Cervical	0		Cervical	0
4	Apical	1	19	Apical	1
	Middle	1		Middle	1
	Cervical	1		Cervical	0
5	Apical	0	20	Apical	1
	Middle	0		Middle	1
	Cervical	0		Cervical	0
6	Apical	0	21	Apical	2
	Middle	0		Middle	2
	Cervical	0		Cervical	2
7	Apical	0	22	Apical	2
	Middle	0		Middle	2
	Cervical	0		Cervical	2
8	Apical	0	23	Apical	2
	Middle	0		Middle	2
	Cervical	0		Cervical	2
9	Apical	0	24	Apical	2
	Middle	0		Middle	2
	Cervical	0		Cervical	2
10	Apical	0	25	Apical	—
	Middle	0		Middle	—
	Cervical	0		Cervical	—
11	Apical	0	26	Apical	2
	Middle	1		Middle	2
	Cervical	0		Cervical	2
12	Apical	1	27	Apical	2
	Middle	1		Middle	2
	Cervical	0		Cervical	2
13	Apical	—	28	Apical	—
	Middle	—		Middle	—
	Cervical	—		Cervical	—
14	Apical	1	29	Apical	2
	Middle	1		Middle	2
	Cervical	0		Cervical	2
15	Apical	1	30	Apical	2
	Middle	0		Middle	2
	Cervical	0		Cervical	2

O, surface free of debris and totally exposed dentinal tubule openings; 1, root surface partially covered with debris; 2, root surface totally covered with debris with no visible dentinal tubule openings; —, specimens lost.

*Specimens: Group 1: 1–10; Group 2: 11–20; Group 3:21–30.

After instrumentation and drying of the root canals with absorbent paper points, the teeth were randomly assigned to 3 groups ($n = 10$). Group 1, the EDTA group (14.3% buffered EDTA solution at pH 7.4; Odahcan Herpo Produtos Dentários Ltda, Rio de Janeiro, Brazil), was delivered to the root canals with a long endodontic needle coupled to a Carpule syringe, left during 3 minutes under stirring with a K-file, and neutralized with 2.5% NaOCl. Group 2, the SmearClear group, was delivered to the root canals with a long endodontic needle coupled to a Carpule syringe, left during 60 seconds according to the manufacturer's instructions, and neutralized with 2.5% NaOCl. The root canals of groups 1 and 2 had the irrigants aspirated and were dried with sterile absorbent paper points. In group 3, the root canals were not submitted to any smear layer removal procedure (control).

Thereafter, grooves were prepared with a water-cooled diamond bur on the buccal and lingual surfaces, and the teeth were split along their long axis in a buccolingual direction using a surgical chisel. The obtained specimens were fixed in modified Karnovski's solution (2.5% glutaraldehyde, 4% paraformaldehyde, in 0.1 mol/L sodium cacodylate, pH 7.2–7.4). In preparation for analysis under scanning electron microscopy (SEM), the specimens were critical point dried with CO_2 and sputter coated with a 20-nm layer of gold. Magnifications of 200× and 750× were used to evaluate cleaning at the apical, middle, and cervical root canal thirds according to a 3-point scoring system indicating best to worst cleaning: 0 = surface free of debris and totally exposed dentinal tubule openings, 1 = root surface partially covered with debris, and 2 = root surface totally covered with debris with no visible dentinal tubule openings. In each root canal third, four areas were demarcated, analyzed, and scores were given. The scoring of the samples was performed at only one level of magnification, which was the same in all specimens. The mean of the four scores was calculated, and a single score was attributed to each third. The SEM evaluation was performed by one calibrated blinded examiner.

Data were analyzed statistically by the Mann-Whitney *U* test at a 5% significance level.