Evaluation of Smear Layer Removal by A New EDTA Formula on Root Canal Dentin : A Scanning Electron Microscopic Study.

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Description of project

Relevance of project:

The key to endodontic success is to get rid of bacteria in the root canal and to provide a very good seal of root canal filling materials. It was shown that after instrumentation of the root canal, smear layer was found covering the root canal walls. A number of studies have shown that smear layer removal would facilitate the cleaning, disinfecting of the dentinal tubules, and improve the sealing of the root canal filling materials (Gettleman et al.,1991, Garberoglio and Becce, 1994, Panighi and Jacquot 1995, Taylor et al., 1997, Liolioa et al., 1997). Therefore, removal of the smear layer from the root canal is important. Many formulas of EDTA have been used for this purpose such as 17%EDTA, REDTA, and EDTAC. Recently, a new EDTA solution (Smear Clear) has been developed. The formula contains 17%EDTA, cetrimide and a special surfactant. The surfactant is claimed to reduce the contact angle of the EDTA solution when placed on dentin surface and enhance cleaning

efficacy. However, there is no comparative study providing the information of this new EDTA formula on smear layer removal.

Aims of project:

The aim of this study was to investigate the debris and smear layer remaining following root canal preparation and irrigation with various formulas of EDTA solution.

Detailed descriptions of the material and methods:

- Selection and preparation of teeth

Twenty five human mandibular single canal premolars extracted for orthodontic reason were used in this study. All teeth were stored in thymol solution at 4° C until used. Crowns of all teeth were removed at the level of CEJ using slow speed diamond saw with water coolant system. The root canal working length was measured using #15 K file. The canals were instrumented using crown down technique with a series of rotary instrument (K3, SybronEndo, CA, USA). After each instrument was changed, 2 ml of 5.25% Sodium hypochlorite was irrigated in the root canal with 27-gauge needle during instrumentation. The total volume of Sodium hypochlorite was 15 ml. The canals were enlarged to size .06/40.

- Test conditions

Twenty teeth were randomly distributed into 5 groups for the different irrigation solutions and final flush with various solution; 17%EDTA (Unit Dose EDTA, Vista Dental Products, WI, USA), 17%REDTA (Roth International LTD, IL, USA) and SmearClear (SybronEndo, CA, USA) as follows;

Group (n)	Irrigating solution (15 ml)	Final rinse (2 ml) for 1 min
I positive control (15)	distilled water	distilled water
II (15)	5.25% NaOCl	5.25% NaOCl
III (15)	5.25% NaOCl	17% EDTA
IV (15)	5.25% NaOCl	17% REDTA
V (15)	5.25% NaOCl	SmearClear

All specimens were rinsed with 10 ml of distilled water and dried with a paper point before being prepared for SEM.

- SEM specimen preparation

The roots were pregrooved and spited longitudinally into two halves. All specimens were fixed in buffered formalin for 24 hours. The specimens then were dehydrated in a graded series of ethanol solutions, critical point dried, attached to coded stubs, and coatedd with gold. The specimens were examined under a scanning electron microscope for debris and smear layer coverage. Three photographs filmed at ×1000 and ×2000 were taken randomly at the coronal, middle, and apical level. Each field was graded from 0 to 4 as follows (Figure 1 A-F):

0 = No smear layer and smear plug; no smear layer on the surface of the root canals. All dentinal tubules were cleaned and opened.

1 = No smear layer but mild smear plug; no smear layer on the surface of the root canals, small amount of smear plug in some dentinal tubules.

2 = No smear layer but moderate smear plug; No smear layer on the surface of the root canals. Most of the dentinal tubules had smear plug.

3 = Moderate smear layer; moderate smear layer covered the surface of the root canals; only few dentinal tubules were opened.

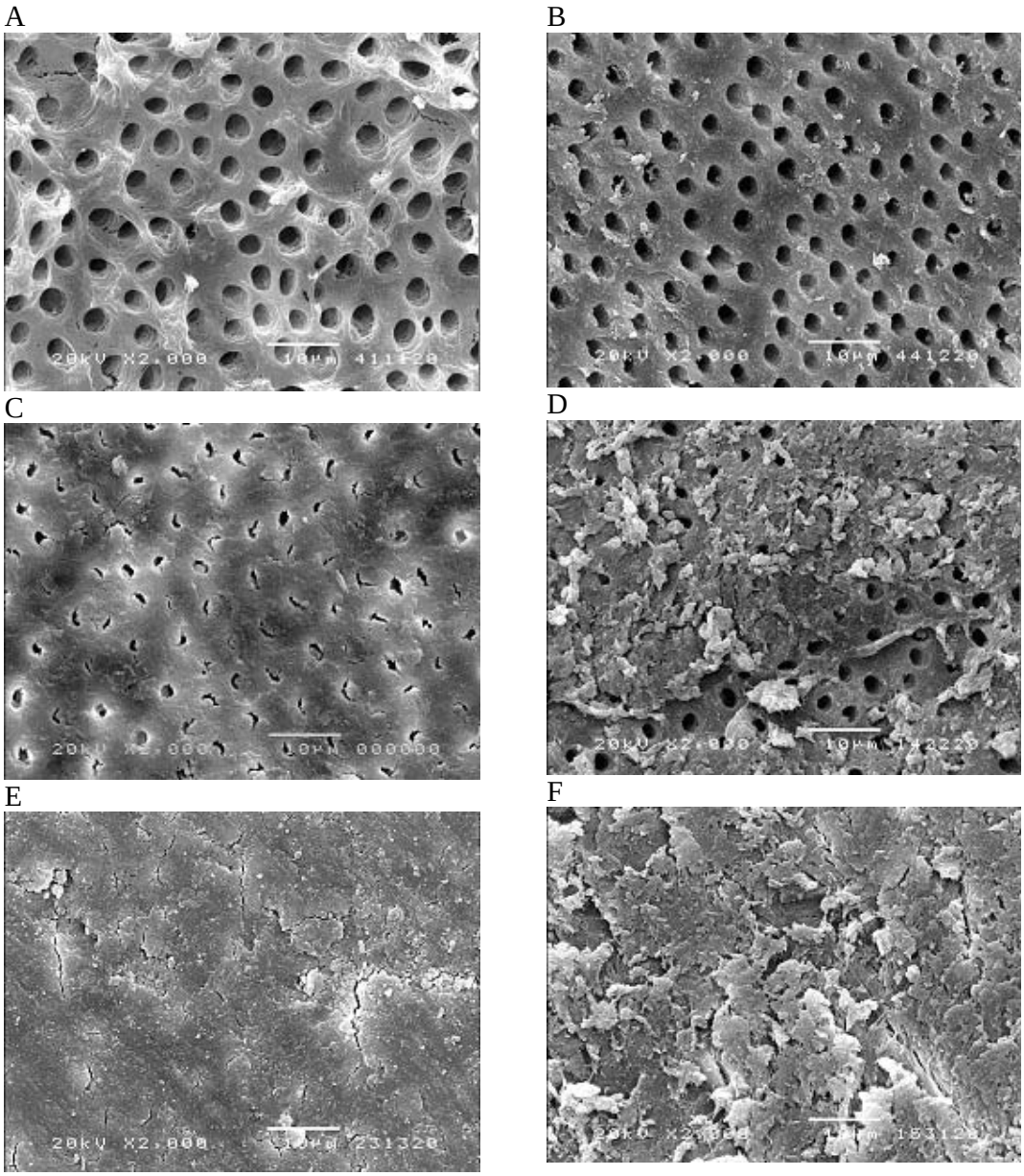
4 = Heavy smear layer; complete root canal wall covered by a homogenous or heavy non-homogenous smear layer, no opening of the dentinal tubules.

A total of 450 SEM pictures were scored and analyzed.

- Data analysis

To assess the difference in score between five solutions (i.e., water, NaOCl, EDTA, REDTA, SmearClear) in each level of canal (i.e., coronal, middle, apical) and in all three levels combined, Cochran-Mantel-Haenszel (CMH) correlation statistic was used since both solution and score are ordinal variables. For the difference in score between three levels of canal in each type of solution and in all types of solution combined, CMH row mean score was employed since level of canal is nominal variable whereas score is ordinal variable. A 2-sided p-value of 0.05 was used whereas Bonferroni's inequality was applied for pairwise comparison. All statistical analyses were performed using SAS 8.0.

Figure 1 Representative scanning electron micrograph of root canal wall of score 0-4. (2,000X magnification).



(A) Score 0: No smear layer and smear plug.
(B) Score 1: No smear layer but mild smear plug.
(C) Score 2: No smear layer but moderate smear plug.
(D) Score 3: Moderate smear layer.
(E) Score 4: Heavy smear layer covered root canal wall by a homogenous and no opening dentinal tubule.
(F) Score 4: Heavy smear layer covered root canal wall by a non-homogenous and no opening dentinal tubule.

Result

The present of smear layer on the surface of root canals in 5 solution groups and levels of root canal were compared.

Table 1 Score of smear layer in each solution and level of canal (n=15 for each combination of solution and canal level)

	Score : Mean ± SD (Minimum, Maximum)			
Solution	Coronal	Middle	Apical	Total
Water	3.87 ± 0.35 (3, 4)	3.80 ± 0.41 (3, 4)	4.00 ± 0.00 (4, 4)	3.89 ± 0.32
NaOCl	3.20 ± 1.01 (2, 4)	3.40 ± 0.83 (2, 4)	3.67 ± 0.62 (2, 4)	3.42 ± 0.84
EDTA	2.13 ± 0.99 (1, 3)	1.60 ± 1.06 (1, 4)	2.40 ± 0.74 (1, 4)	2.04 ± 0.98
REDTA	1.27 ± 0.96 (0, 3)	1.53 ± 1.13 (0, 3)	2.87 ± 1.06 (1, 4)	1.89 ± 1.25
SmearClear	0.73 ± 1.03 (0, 3)	0.73 ± 1.03 (0, 3)	0.93 ± 0.96 (0, 3)	0.80 ± 0.99
Total	2.24 ± 1.47	2.21 ± 1.49	2.77 ± 1.32	

Table 2 Comparison of score between each pair of solution (using type I error of 0.005)

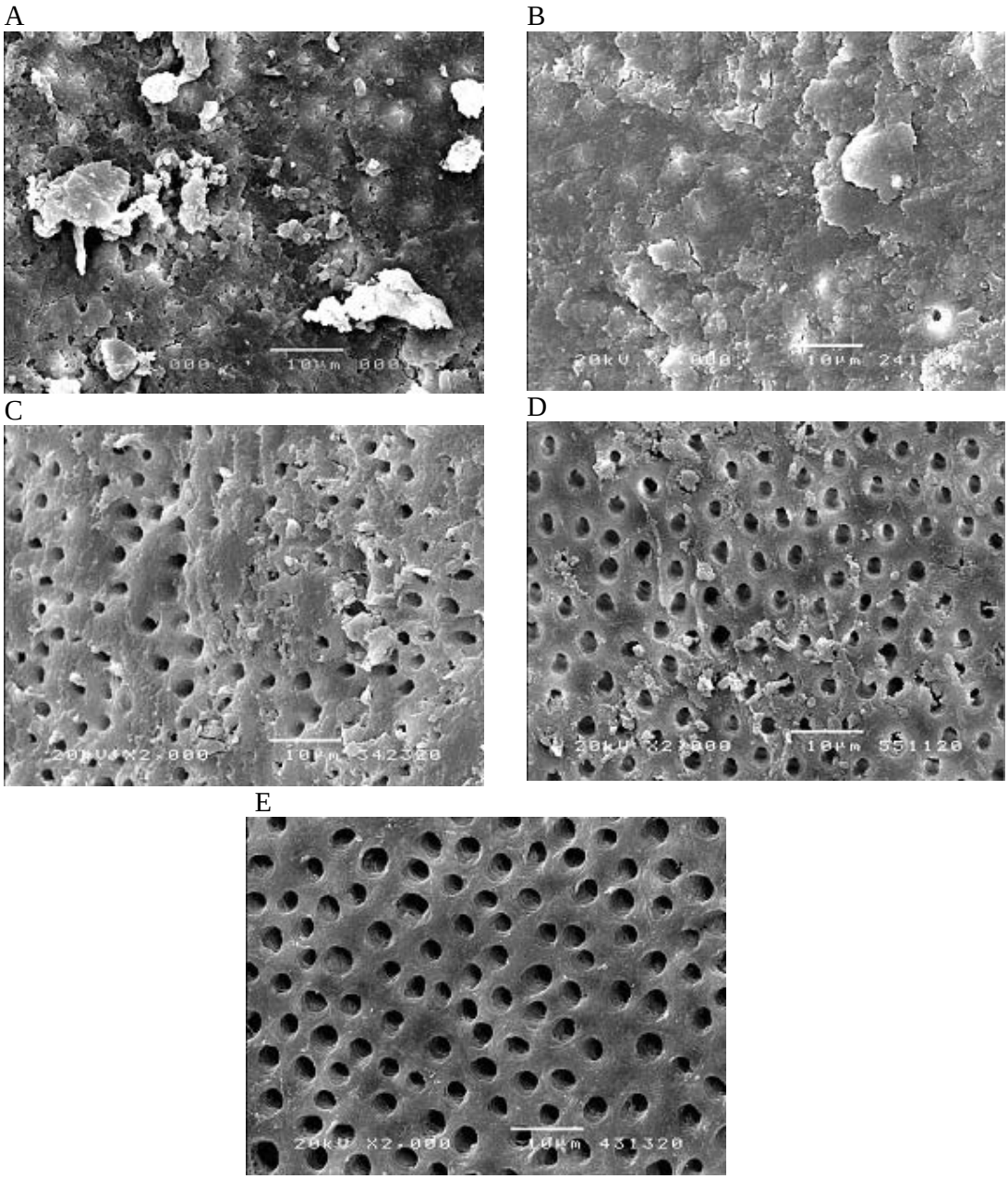
	Water	NaOCl	EDTA	REDTA
Water				
NaOCl	p = 0.0023			
EDTA	p < 0.0001	p < 0.0001		
REDTA	p < 0.0001	p < 0.0001	p = 0.6600*	
SmearClear	p < 0.0001	p < 0.0001	p < 0.0001	p < 0.0001

* no statistically significant difference

Table 1 shows mean score of smear layer and its standard deviation (SD) in each type of solution and each level of canal. It reveals that regardless of the level of the root canal, score is highest for water followed by NaOCl, EDTA, REDTA and SmearClear respectively (Figure 2). For a difference in score between three levels of canal, it seems that the difference depends on type of solution (Table 1). Thus, test of effect of canal level on score using row mean score statistic is summarized separately for each type of solution with p-values of 0.5888 for water and 0.2144, 0.4547, 0.0540, 0.0009 for NaOCl, EDTA, REDTA and SmearClear respectively. It shows that most solutions removed smear layer from the root canal walls in the same fashion at all levels. Only REDTA removed smear layer better at the coronal and middle level than the apical level. Water and NaOCl can not clean smear layer from root canal for all levels (score 3-4). SmearClear cleaned the root canal wall best at all levels.

Since effect of solution on score is in the same direction for all levels of canal, its effect can then be efficiently tested by combining data from all canal levels. This is done using a CMH correlation statistic to test a difference in score between five solutions adjusted for canal level. It demonstrates that there is a statistically significant difference in score between five solutions (p-value < 0.0001). To determine which solution differs, ten all possible pairwise comparisons is then performed using type I error of 0.005 (=0.05/10) to account for multiple testing. It shows that there is no difference in score only between EDTA vs. REDTA (Table 2). There is a significant difference in score in the remaining nine pairs of solutions ($p < 0.0001$). Both EDTA and REDTA were better significantly in smear layer removal than water and NaOCl. SmearClear had the best result in cleaning root canal walls in comparison to all solutions.

Figure 2 Representative scanning electron micrograph of root canal wall after instgrumentation and irrigated with different irrigants (2,000X magnification).



(A) Group I: Distilled water, most of canal wall covered by a non-homogenous smear layer, no opening dentinal tubule. (B) Group II: NaOCl, most of root canal wall covered by a homogenous smear layer. (C) Group III: 17%EDTA, most of the tubules were opened and moderate smear layer covered the surface of the root canals. (D) Group IV: 17% REDTA, small amount of smear layer on the surface of root canals; small amount of smear plug in some dentinal tubules. (E) Group V: SmearClear, most of the dentinal tubules were open.

Conclusion

SmearClear seems to be the best solution for removal of the smear layer after root canal instrumentation.

Reference:

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