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Calcium Hydroxide Intracanal Dressing Removal with Different Rotary Instruments and Irrigating Solutions: A Scanning Electron Microscopy Study

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This study evaluated the efficacy of 2 types of rotary instruments employed in association with sodium hypochlorite (NaOCl) or EDTA in removing calcium hydroxide (CH) residues from root canals dentin walls. Forty-two mandibular human incisors were instrumented with the ProTaper System up to F2 instrument, irrigated with 2.5% NaOCl followed by 17% EDTA and filled with a CH intracanal dressing. After 7 days, the CH dressing was removed using 4 techniques: NiTi rotary instrument size 25, 0.06 taper (K3 Endo) and irrigation with 17% EDTA (Group 1), NiTi rotary F1 instrument (ProTaper) and irrigation with 17% EDTA (Group 2), NiTi rotary instrument size 25, 0.06 taper and irrigation with 2.5% NaOCl (Group 3) and NiTi rotary F1 instrument and irrigation with 2.5% NaOCl (Group 4). Two roots without intracanal dressing were used as negative controls. Teeth were evaluated by scanning electron microscopy, in the cervical and apical canal thirds. None of the techniques removed the CH dressing completely. In the apical and cervical thirds, F1 instrument was better than instrument size 25, 0.06 taper in removing CH residues ($p<0.05$), regardless of the final irrigating solution. No difference was found between the irrigating solutions in the groups of F1 instrument and of instrument size 25, 0.06 taper ($p>0.05$). The negative controls had no CH residues on the dentin walls. In conclusion, the ProTaper F1 instrument was better than K3 Endo instrument size 25, 0.06 taper in the removal of CH intracanal medication, regardless of irrigating solution used.

Key Words: calcium hydroxide, intracanal dressing, rotary instruments, sodium hypochlorite, EDTA.

INTRODUCTION

Presence of microorganisms in the root canal system plays a fundamental role in the pathogenesis of apical periodontitis (1,2). The use of intracanal dressing to disinfect the root canal system has been advocated to enhance the success of root canal treatment (3-5). An ideal root canal dressing must have antimicrobial efficacy causing no harm to the periapical tissues. Hence, calcium hydroxide (CH) has been considered to be the material of choice as an intracanal medicament (6).

However, if this medication is not completely removed, its presence on the dentin walls could compromise the endodontic treatment (7). Persistence of CH residues may interfere with sealing ability of endodontic sealers (8,9), and affect the adhesion of endodontic sealers to the canal walls (10). Moreover, there is evidence that these residues may react with zinc oxide and eugenol-based cements, forming calcium eugenolate, which hinders the penetration of cement into the dentin tubules (8).

Some methods (9,10) and/or irrigation substances (8) have been proposed for removal of CH dressing. Studies have showed that irrigation with sodium hypochlorite alone is not efficient to remove CH medication (11,12). Alternatively, irrigation with EDTA and recapitulation of the instrumentation with the last file used in the apical preparation (12,13) as well as the use

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of rotary instrument or ultrasonic points in conjunction with irrigation has been recommended (11,14).

Considering the importance of the complete removal of intracanal dressing before root canal filling, this study aimed at evaluating the efficacy of 2 types of rotary instruments, in association with NaOCl or EDTA, in removing CH residues from root canal dentin walls, using scanning electron microscopy (SEM).

MATERIAL AND METHODS

After approval by the Research Ethics Committee (13/2010), 42 extracted human permanent mandibular central incisors measuring 19 to 21 mm in length, stored in 1% thymol solution, were obtained from the tooth bank for this study. After coronal access with a #4084 diamond bur (KG Sorensen, São Paulo, SP, Brazil), the cervical third was prepared using S1 and SX instruments (ProTaper System; Dentsply Maillefer, Baillagues, Switzerland). The working length was established 1.0 mm short of the total tooth length and confirmed radiographically.

Biomechanical preparation of the root canal was performed with ProTaper System, under irrigation with 2.5% NaOCl, using the technique proposed by Guelzow et al. (7). All root canals were instrumented up to a F2 instrument and a final rinse with 5.0 mL of 2.5% NaOCl and 5 mL of 17% EDTA (Biodinâmica, Ibiporã, PR, Brazil) solutions were performed. The solution was removed by aspiration (Navitip; Ultradent, South Jordan, UT, USA) and the canals were dried with paper points. Then, the canals were filled with a pasted of CH (Biodinâmica) propylene glycol (Científica, Santa Fé do Sul, SP, Brazil) at a powder to liquid ratio of 1:1 (15), using a lentulo spiral (Dentsply Maillefer). Radiographs were taken in mesiodistal and buccolingual directions to confirm complete filling of the root canals. The coronal access cavities were sealed with a layer of gutta-percha followed by Coltosol (Coltène, WhaleDent, Switzerland). All specimens were kept in a closed box, with the roots placed in moist environment for 7 days at room temperature. After this period, the coronal access was opened and the canal was irrigated with 5 mL of 2.5% NaOCl solution.

Forty specimens were randomly divided into 4 experimental groups (n=10), according to the rotary instrument and final irrigating solution used for removal of CH residues: G1- K3 Endo instrument size 25, 0.06 taper (Sybron Endo, Orange, CA, USA) and irrigation with 17% EDTA, G2 - ProTaper F1 instrument and irrigation with 17% EDTA, G3 - K3 Endo instrument size 25, 0.06 taper and irrigation with 2.5% NaOCl and G4 - ProTaper F1 instrument and irrigation with 2.5% NaOCl. Canal preparation was performed using an electric engine (X-Smart; Dentsply Maillefer) with constant speed of 250 rpm and rotational force of 1.6 N.cm, at the working length. The final irrigation was done with 5 mL of irrigating solution. Two roots without intracanal dressing were used as negative controls.

All substances were placed in sterile 10 mL syringes with a 30-gauge needle, calibrated at working length with rubber stop. The solutions were aspirated with a green Navitip point (Ultradent), and dried with absorbent paper points.

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. For SEM analysis, the specimens were dehydrated, fixed on aluminium stubs, sputter-coated with gold, and examined with a scanning electron microscope at 10 kV (JEOL, Tokyo, Japan). Magnification of ×1000 was used to evaluate cleaning of the canal walls at the apical and cervical root canal thirds (5 and 10 mm from the apex, respectively). Three previously calibrated examiners evaluated the cleanliness of root canal walls, by assigning each specimen with the following scores: 0 - absence of residues, 1 - small amount of residues (up to 20% of the surface covered), 2 - moderate amount of residues (20% to 60% of the surface covered), and 3 - large amount of residues (more than 60% of the surface covered). Figure 1 shows representative SEM micrographs of score attribution.

The obtained data were analyzed statistically by the nonparametric Kruskal-Wallis test and Dunn's post-test at a significance level of 5% using the BioEstat software.

RESULTS

None of the techniques removed the CH dressing completely. Table 1 shows scores and rank means of CH residues for each experimental group, in apical and cervical thirds of root canal. Table 2 shows the statistical comparison of groups. In the apical and cervical thirds, F1 instrument was more efficient than instrument size 25, 0.06 taper in removing CH residues ($p<0.05$), regardless of the final solution. No difference was found

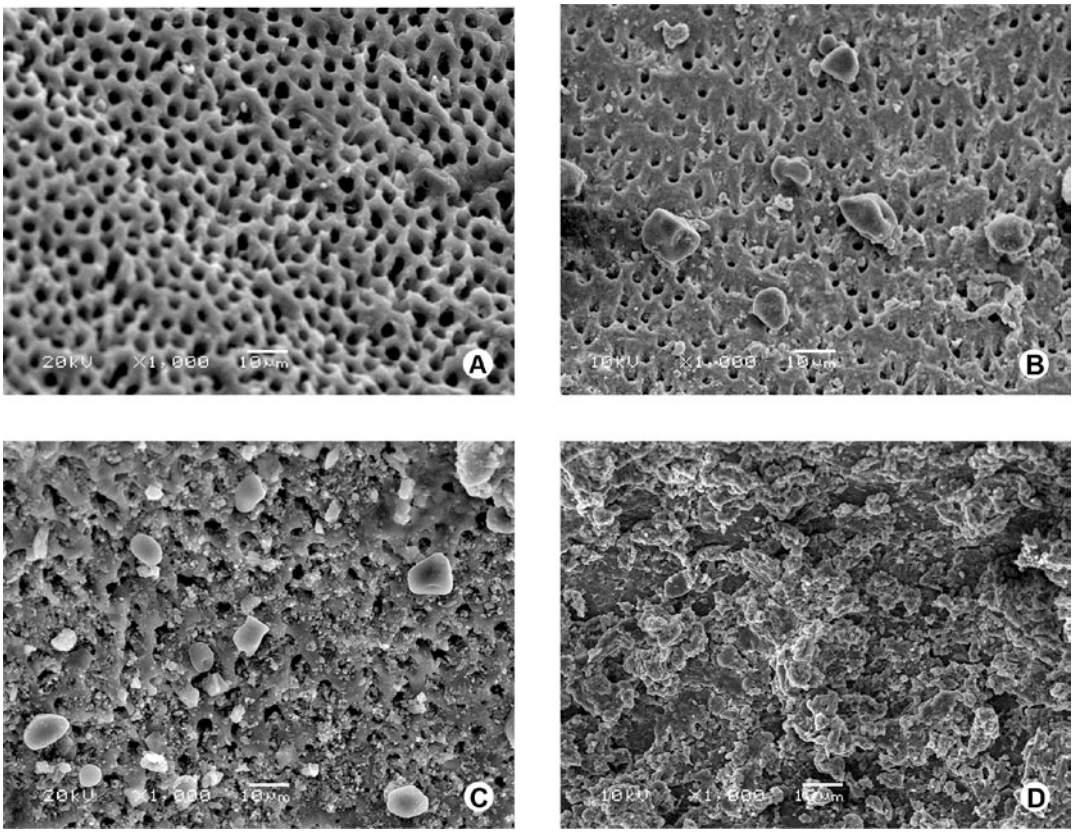

Figure 1. SEM images representative of scores attribution. A = Score 0: absence of residues; B = Score 1: small amount of residues; C = Score 2: moderate amount of residues and D = Score 3: large amount of residues.

Table 1. Score distribution and rank means in the groups, regarding the presence of CH residues at the apical and cervical canal thirds

Group/ Third	Scores				Rank means
	0	1	2	3	
G1					
Apical	1	2	5	1	30.20
Cervical	-	1	3	6	29.55
G2					
Apical	8	2	-	-	11.70
Cervical	5	4	1	0	10.50
G3					
Apical	-	8	2	-	26.80
Cervical	-	1	4	5	28.45
G4					
Apical	7	3	-	-	13.30
Cervical	3	4	3	-	13.95

Table 2. Intergroup comparison regarding presence of CH residues on root canals walls at the apical and cervical thirds.

Root canal third	Groups	Z_{obs}	Z_{crit}
Apical	G1 x G2*	3.3235	2.635
	G1 x G3	0.4412	2.635
	G1 x G4*	3.0181	2.635
	G2 x G3*	2.9614	2.635
	G2 x G4	0.3138	2.635
	G3 x G4*	2.6476	2.635
Cervical	G1 x G2*	3.7298	2.635
	G1 x G3	0.2104	2.635
	G1 x G4*	2.9839	2.635
	G2 x G3*	3.5194	2.635
	G2 x G4	0.7460	2.635
	G3 x G4*	2.7735	2.635

*Indicates statistically significant difference ($p<0.05$).

(p>0.05) between the irrigating solutions in the groups of F1 instrument and instrument size 25, 0.06 taper. The negative controls had no residues on the dentinal walls.

SEM images representative of CH residues in apical and cervical thirds of the experimental groups are shown in Figure 2.

DISCUSSION

K3 Endo and ProTaper systems are commonly used in endodontic treatment for cleaning and shaping root canals. ProTaper instruments are characterized by progressively increasing taper, a convex triangular cross-section, and a modified guiding tip. On the other hand, the K3 Endo system is a triple-fluted instrument with asymmetrical cross-section in combination with radial land relief, positive rake angle and a constant taper (16,17).

The best results of ProTaper F1 instrument in relation to K3 Endo instrument size 25, taper 06 could be explained because the biomechanical preparation was performed with the ProTaper System and consequently the F1 instrument had a better adaptation than instrument size 25, 0.06 taper to the root canal walls. However, the instrument size 25, 0.06 taper has in D0 and D16 similar taper to F1 instrument. The possible difference between results in CH removal could be in function of design and the variable taper present in F1 instrument.

The removal of CH residues has been investigated using various products such as NaOCl and chelants to dissolve inorganic particles of the smear layer and intracanal medication (9,18). EDTA-T is widely used as the best irrigant to remove the smear layer (19,20). In a previous study, irrigation with 0.5% NaOCl without use of instruments had the worst results of CH removal compared to other endodontic irrigants inclusive 17% EDTA-T (12). Roding et al. (13) using the master apical file and irrigation with different solutions showed that 20% EDTA performed significantly better than 1% NaOCl and water. The authors explain these results because NaOCl has limited ability to dissolve inorganic substances such as CH. In present study no difference was observed between 17% EDTA and 2.5% NaOCl in the groups of F1 instrument and instrument size 25, 0.06 taper, showing that the type of final rotary instrument has more influence in CH removal than final irrigation substances, regardless of the third.

None of the techniques used in this study removed completely the CH from the root canals. This is in agreement with results of the previous studies, which showed the presence of CH debris on the root canal walls, regardless of the removal technique (9,11,13,14).

Under the tested conditions of this study, it was concluded that ProTaper F1 instrument was more effective than K3 Endo instrument size 25, 0.06 taper in the removal of CH intracanal medication. The irrigating solutions used as a final rinse did not play an important role in the removal of CH residues from the dentin walls. Further studies should be undertaken with other techniques of root canal preparation and irrigating

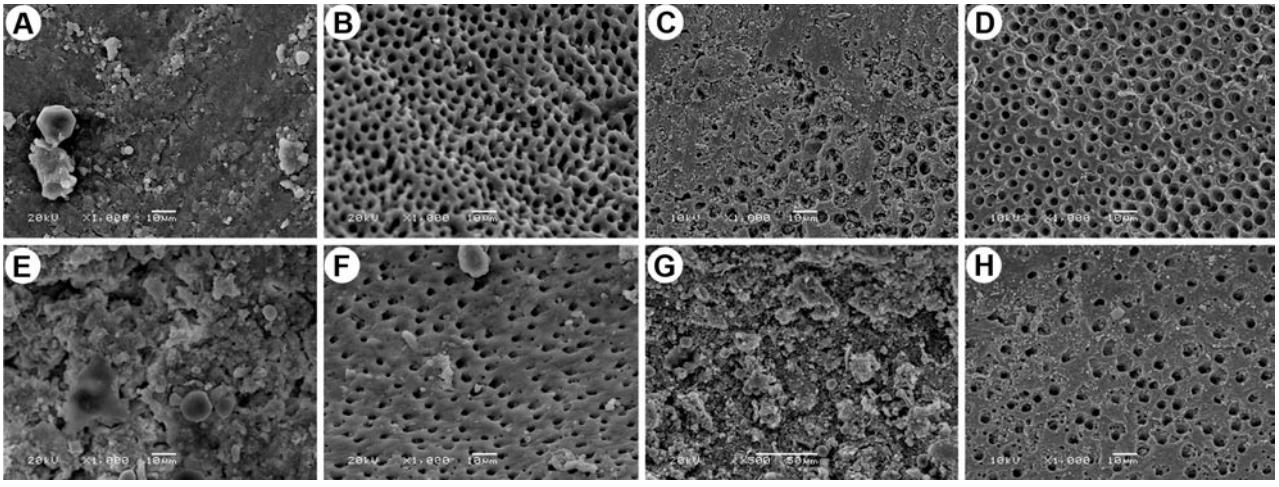

Figure 2. SEM micrographs representative of G1 (A = apical third; E = cervical third), G2 (B=apical third; F=cervical third), G3 (C = apical third; G = cervical third) and G4 (D=apical third; H = cervical third).

solutions to evaluate the removal of intracanal dressing from the root canal walls.

RESUMO

O objetivo deste estudo foi avaliar a eficácia de dois tipos de instrumentos rotatórios em associação à irrigação com hipoclorito de sódio (NaOCl) ou EDTA na remoção de resíduos de hidróxido de cálcio (HC) das paredes do canal radicular. Quarenta e dois incisivos inferiores de humanos foram instrumentados com o sistema ProTaper até o instrumento F2, irrigados com NaOCl a 2,5%, seguido de EDTA a 17% e preenchidos com medicação intracanal à base de HC. Após 7 dias, o HC foi removido utilizando 4 técnicas: instrumento 25/0.06 (K3 Endo) e irrigação com EDTA a 17% (Grupo 1), instrumento F1 (ProTaper) e irrigação com EDTA a 17% (Grupo 2), instrumento 25/0.06 e irrigação com NaOCl a 2,5% (Grupo 3) e instrumento F1 e irrigação com NaOCl a 2,5% (Grupo 4). Duas raízes que não receberam medicação intracanal foram utilizadas como controles negativo. Foram avaliados os terços cervical e apical dos canais radiculares por meio de microscopia eletrônica de varredura. Nenhuma das técnicas removeu completamente a medicação à base HC. Nos terços apical e cervical, o instrumento F1 foi melhor do que o instrumento 25/0.06 na remoção dos resíduos de HC ($p<0,05$), independentemente da solução irrigadora final. Não houve diferença entre as soluções irrigadoras nos grupos do instrumento F1 e do instrumento 25/0.06 ($p>0,05$). Os controles negativos não apresentaram resíduos de HC nas paredes dentinárias. Concluiu-se que o instrumento F1 do ProTaper foi melhor que o instrumento 25/0.06 do K3 Endo na remoção da medicação intracanal à base de HC, independentemente da solução irrigadora utilizada.

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