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NaOCl and EDTA irrigating solutions for endodontics: SEM findings

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SUMMARY

Premolars roots of humans were manually instrumented with K-type files and irrigated with different solutions to evaluate the rate of cleaning of endodontic surface. Root canals irrigated with 0.9% saline solution or H_2O_2 (10 volumes) showed the presence of predentin and amorphous smear layer. Thick smear layer was always present on endodontic walls rinsed with 5% solution of NaOCl. Specimens treated with 0.2% solution of EDTA showed partially clean dentinal tubules orifices and remnants of a thin smear layer. Occasional uninstrumented areas of the same roots presented smear layer remnants and predentin with calcified bacteriae. The root canals irrigated with NaOCl and EDTA solutions alternated after each instrument showed at the dentin surface thick smear layer: only few dentinal tubules orifices were visible. Endodontic surface of root canals irrigated with NaOCl during instrumentation and finally rinsed with EDTA solutions showed the most homogeneous ultrastructural pictures: partially clean dentinal orifices were detectable in the whole canals.

KEY WORDS:

Endodontic irrigation - NaOCl - EDTA - SEM.

RÉSUMÉ

Les canaux de la racine dentaire des prémolaires humaines ont été instrumentés manuellement avec files K type et ensuite irrigués avec différentes solutions pour évaluer les conditions de netteté de la surface endodontique. Les canaux irrigués avec une solution saline à 0,9% ou de H_2O_2 (10 volumes) ont démontré la présence de prédentine ou d'une couche de tissu salie. Cette couche était toujours présente sur la paroi endodontique lavée avec une solution de NaOCl à 5%. Les exemplaires traités avec une solution de EDTA à 0,2% ont démontré une netteté partielle des orifices tubulaires dentinaires et seulement un mince résidu non propre. Les zones non instrumentées de la même racine présentaient au contraire des résidus et une prédentine avec nombreuses bactéries calcifiées. Les canaux irrigués avec une solution de NaOCl et EDTA alternée ont démontré la présence d'une épaisse couche non propre et la visualisation de quelques orifices tubulaires. La surface endodontique des canaux de la racine irriguée avec NaOCl pendant l'instrumentation et ensuite lavée avec EDTA a démontré les images ultrastructurales les plus homogènes: les orifices dentinaires partiellement nettoyés pouvait être visualisés sur toute la surface du canal.

MOTS CLÉS:

Irrigation endodontique - NaOCl - EDTA - SEM.

INTRODUCTION

Complete remotion of endodontic debridment is recommended for successful long-term root canal therapy (Baker et al., 1975; Goldman et al., 1979; Goldman et al., 1981; Abou Rass et Piccinino, 1982; Chow, 1983; Baumgartner et Ibay, 1987). However currently used biomechanical and chemomechanical methods of root canal preparation are not satisfactory to cleanse completely the root canal system (Baker et al., 1975).

NaOCl chemomechanical irrigation can dissolve organic material in the endodontic space (Dakin, 1915; Taylor et Austin, 1918; Grossman et Meiman, 1941; Grossman, 1943; Less, 1949; Shih et al., 1970; Bystrom et Sundqvist, 1983), but in the instrumented canals is always present a smear layer (Mc Comb et Smith, 1975; Rome et al., 1985) that can limit the disinfection effect of some irrigant solutions (Orstavik et Haapasalo, 1991).

EDTA irrigant solution can remove the smear layer from the canal surfaces, but is not able to dissolve organic debridments (Mc Comb et Smith, 1975; Fraser et al., 1976; Goldberg et Abramovich, 1977; Goldman et al., 1981; Baumgartner et Mader, 1987; Gettleman et al., 1991).

As no single irrigant can be usefull to remove both organic and inorganic endodontic materials (Baumgartner et Ibay, 1987), different combined irrigant systems of NaOCl and EDTA solution have been tested in this research to evaluate cleaning capability on endodontic surfaces.

MATERIALS AND METHODS

Thirty-six roots of premolars extracted for orthodontic and periodontal problems were stored in 0.9% saline solutions (3 to 8 days) and divided into 6 groups to evaluate by SEM the effect of different root canal irrigant solutions during endodontic manual preparation. After root scaling the roots were separated from the crowns with diamond disks. Longitudinal tracks were prepared to fracture the specimens after endodontic treatment. These roots were then divided into 6 groups for different endodontic irrigations. Group n.1: 0.9% saline solution; Group n.2: 10 volumes H_2O_2; Group n.3: 5% solution of NaOCl; Group n.4: 0.2% solution of EDTA containing Benzethonium Chloride and Phenoxyethanol (Rocanal Irrigation, Denit); Group n.5: 5% solution of NaOCl and 0.2% solution of EDTA used alternately after each instrument; Group n.6: 5% solution of NaOCl after each instrument and final irrigations with 0.2% solution of EDTA.

Root canals of all groups were instrumented with K-type files in sequential order (sizes 10-15-20-25-30-35-40-45-50) and irrigated as above. After mechanical longitudinal fracture the roots were processed for SEM analysis to observe endodontic surfaces.

RESULTS

Endodontic canals prepared and irrigated with 0.9% saline solution (Group n.1) or H_2O_2 (Group n.2) showed the presence of predentin in uninstrumented dentin areas and amorphous smear layer on instrumented canal walls.

When 5% NaOCl solution was used as irrigant (Group n.3) during manual instrumentation no pulp debris or predentin were observed: the dentinal tubules were not visible because a thick layer of amorphous smear layer was always present. Only casually uninstrumented few limited areas showed clean dentinal tubules in exposed calcospherites (Fig. 1). The mentioned irregular smear layer was always present in the apical third of the roots.

Fig. 1: Manually instrumented root canal irrigated with 5% solution of NaOCl. The endodontic surface shows thick smear layer. Barr = 100 μm.
Fig. 1: Canal de la racine dentaire instrumenté manuellement rt irrigué avec une solution de NaOCl à 5%. La surface endodontique montre la présence d'une couche de smear layer.

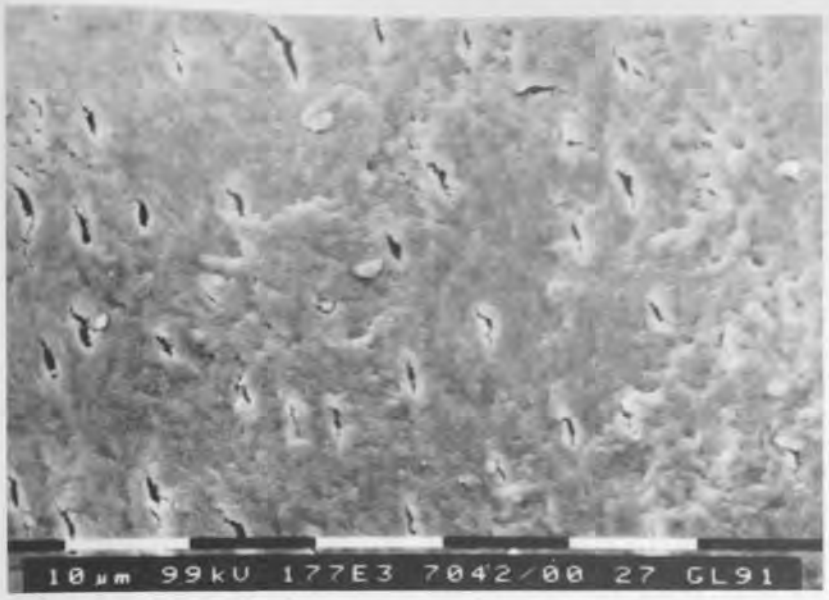

Fig. 2: Manally instrumented root canal irrigated with 0.2% solution of EDTA. Remnants of thin smear layer partially mask dentinal tubules orifices. Barr = 10 µm.
Fig. 2: Canal de la racine dentaire instrumenté manuellement et irrigué avec une solution de EDTA à 0,2%. Résidu d'une mince couche de smear layer qui partiellement ferme les orifices tubulaires dentinaires.

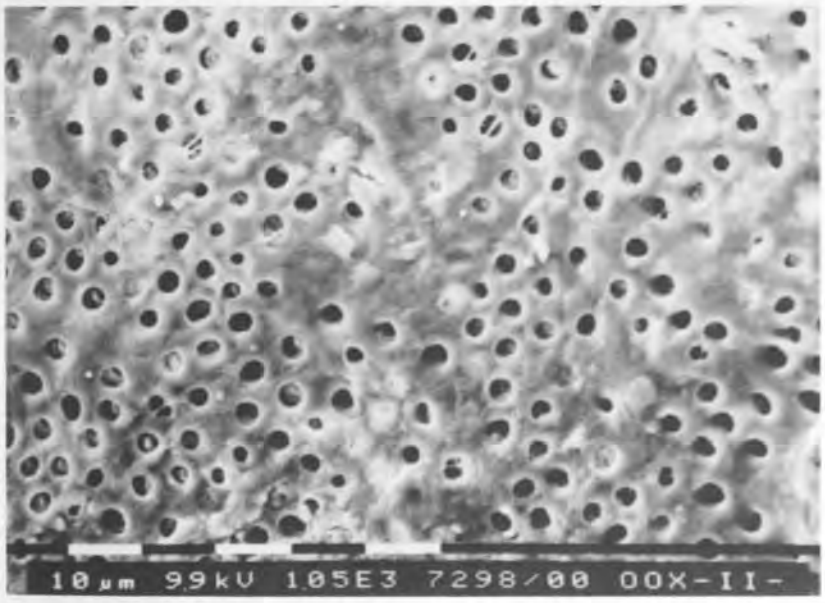

Fig. 3: Occasional uninstrumented areas of root canal walls irrigated with 0.2% solution of EDTA. Dentinal tubules orifices and predentin residual collagen fibres are visible. Barr = 10 µm.
Fig. 3: Zone occasionnellement non instrumentée de paroi endodontique irrguée avec une solution de EDTA à 0,2%. Sont visibles les orifices tubulaires dentinaires et les fibres collagènes résistantes de la prédentine.

In specimens irrigated only with 0.2% EDTA solution (Group n.4) some areas of endodontic surface showed dentinal tubules orifices partially masked by remnants of thin smear layer (Fig. 2). In other uninstrumented areas, dentinal tubules orifices and predentin residual collagen fibres were visible (Fig. 3). In the apical third of the roots, smear layer remnants or predentin with calcified bacteriae were often observed (Fig. 4).

When the roots were instrumented and irrigated with NaOCl and EDTA used alternately (Group n.5) after each instrument, the dentin surface was almost entirely covered by a smear layer; only few partially closed orifices of dentin tubules were recognized (Fig. 5). The apical third of the canals showed only the smear layer.

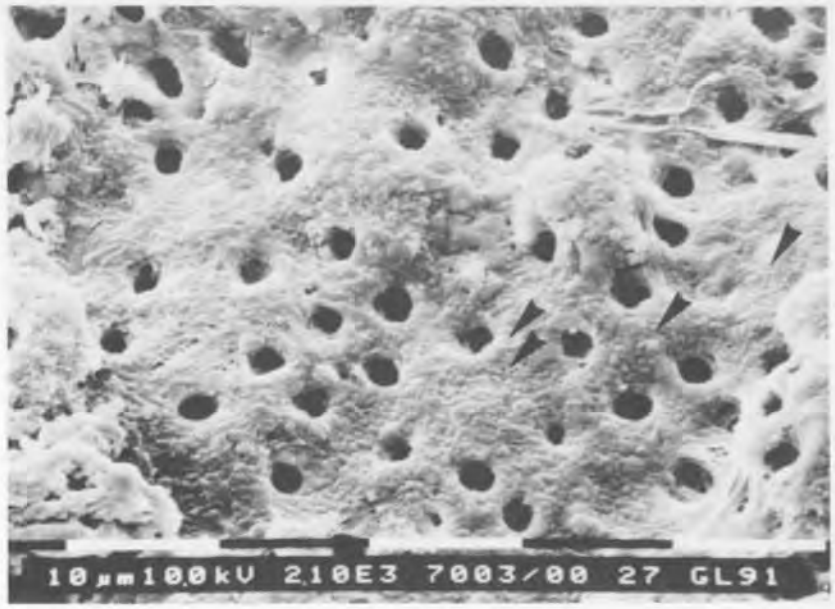

Fig. 4: Occasional uninstrumented apical third of root canal irrigated with 0.2% solution of EDTA. Remnants of smear layer and predentin with calcified bacteriae are present (arrows). Barr = 10 µm.
Fig. 4: Tiers apical du canal de la racine occasionellement non instrumenté et irrigué avec une solution de EDTA à 0,2%. Sont présents des résidus de smear layer et prédentine avec bactéries calcifiées.

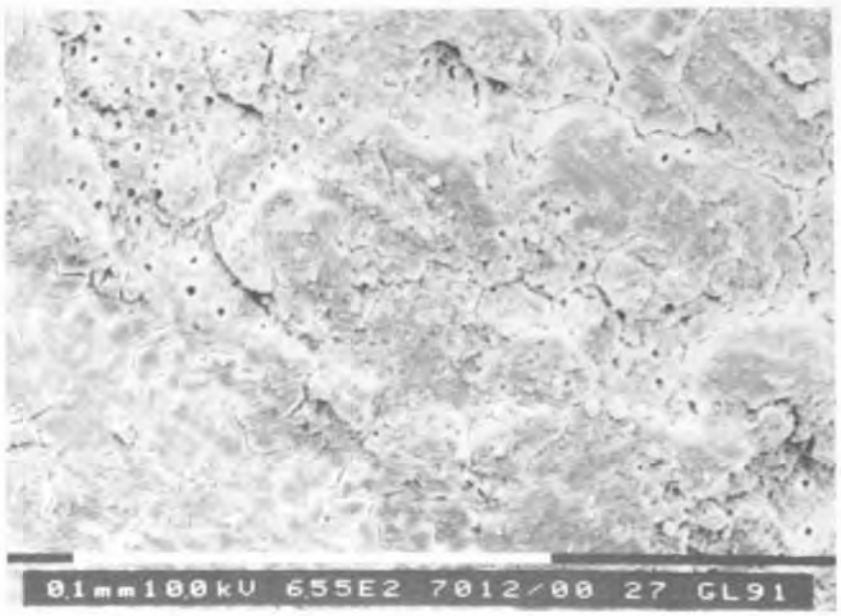

Fig. 5: Manually instrumented root canal irrigated with 5% NaOCl and 0.2% EDTA solutions used alternately after each instrument. Most part of endodontic surface is covered by smear layer. Few partially closed dentinal tubules orifices are observable. Barr = 100 µm.
Fig. 5: Canal de la racine dentaire instrumenté manuellement et irrigué avec une solution de NaOCl à 5% et EDTA à 0,2% employé tour à tour après chaque instrumentation. La plus grande partie de la surface endodontique est recouverte par smear layer. On observe quelques orifices tubulaires dentinaires partiellement fermés.

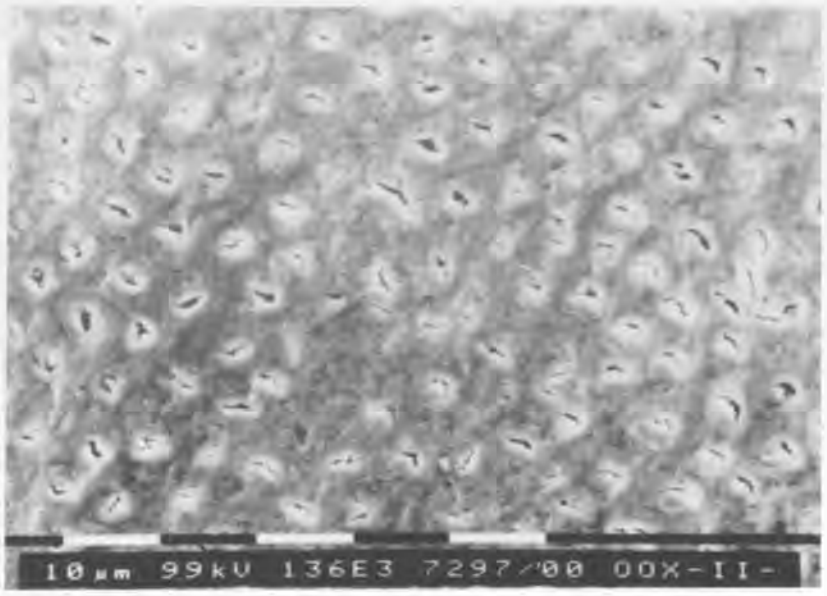

Fig. 6: Manually instrumented root canal irrigated with 5% solution of NaOCl during the canal preparation and finally rinsed with 0.2% solution of EDTA. Partially clean dentinal orifices are visible in the whole canal. Barr = 10 µm.
Fig. 6: Canal de la racine instrumenté manuellement et irrigué avec une solution de NaOCl à 5% pendant la préparation du canal et lavé ensuite avec une solution de EDTA à 0,2%. Sont visibles des orifices dentinaires partiellement propres sur toute la longueur du canal.

The endodontic surface of the roots irrigated with NaOCl during instrumentation and finally rinsed with EDTA solution (Group n.6) appeared more homogeneous: partially clean dentinal orifices were observed in the whole canals (Fig. 6). However, in the apical third of some specimens smear layer was detectable.

CONCLUSIONS

SEM analysis demonstrates that 0.9% saline solution or 10 volumes H_2O_2 do not completely remove predentin or smear layer from manually instrumented or uninstrumented canal walls.

NaOCl 5% solution causes dissolution of organic material, but can't remove the smear layer of manually instrumented endodontic canals (McComb et Smith, 1975; Rome et al., 1985; Orstavik et Haapasalo, 1991).

When 0.2% solution of EDTA is used as the only irrigant, dentinal tubules orifices are partially masked because smear layer is only partially removed. Moreover, using 15% solution of EDTA as the only irrigant some Authors (Baumgartner et Mader, 1987) have demonstrated a complete demineralization of the smear layer on the instrumented endodontic walls. However, the use of a high concentrated solution of EDTA may be dangerous if this fluid is injected into periapical tissues. In uninstrumented areas of endodontic walls the presence of predentin demonstrates that 0.2% solution of EDTA can't dissolve organic material such as predentin collagen fibres. Authors (Baumgartner et Mader, 1987) have demonstrated that also with 15% solution of EDTA neither pulpal remnants nor predentin may be removed from uninstrumented halves of root canal walls.

Using 5% solution of NaOCl and 0.2% solution of EDTA, alternately after each instrument, the canal walls show a thick smear layer similar to that observed in the roots irrigated only with 5% solution of NaOCl. It is probable that the effect of EDTA solution is inhibited by presence of 5% solution of NaOCl.

The specimens irrigated with 5% NaOCl during manual endodontic preparation and with 0.2% EDTA after the instrumentation present homogenous ultrastructural aspects: partially clean dentinal tubules orifices are observable being the smear layer partially removed. This combination of NaOCl and EDTA appears in this study the most predictable irrigant in removing both organic and inorganic endodontic material. The right combination of irrigant solutions in conjunction with ultrasonic instrumentations would be more effective to remove completely the smear layer (Walker et del Rio, 1991).

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