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COMPARATIVE EVALUATION OF SMEAR LAYER REMOVAL AFTER THE USE OF NAOCL WITH 17% EDTA VERSUS SILVER CITRATE AS ROOT CANAL IRRIGANT – A SEM STUDY

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ABSTRACT

This study was aimed at evaluating the efficacy of a novel silver-citrate solution (BioAKT) compared with NaOCl and EDTA on smear layer removal. Single-rooted teeth were endodontically treated and irrigated using: Group I: 5.25% sodium hypochlorite (NaOCl) with 17% EDTA as final rinse; Group II: BioAKT (Silver Citrate solution). Smear layer removal at apical portion of each canal were analyzed using scanning electron microscopy (SEM). Chi-square test was applied to associate the grades of smear layer with the groups. At the apical portion novel silver citrate solution performed significantly better compared to NaOCl + 17% EDTA in smear layer removal ($p=0.31$). In conclusion, novel silver citrate solution represents a suitable smear layer removal agent.

KEYWORDS: Endodontic irrigants, Smear layer, BioAKT, NaOCl, EDTA.

1. INTRODUCTION

One of the most challenging tasks in endodontic treatments is the accomplishment of comprehensive elimination of indwelling microorganisms.[1] Mechanical instrumentation of the root canal produces a smear layer that covers the dentinal tubules.[2] The smear layer is an amorphous irregular layer containing inorganic dentin debris as well as organic materials like pulp tissue, odontoblastic process, necrotic debris, microorganisms, and their metabolic products.[3] There is a controversy over whether to remove or maintain the smear layer, but a recent micro leakage studies concluded that the removal of the smear layer improves the fluid tight seal of the root canal system.[4] It has been shown that the smear layer itself may be infected and may protect the bacteria within the dentinal tubules.[3] The smear layer has also been shown to hinder the penetration of intracanal medicaments and sealers into the dentinal tubules.[5,6] However, if one considers the anatomical complexity of root canals (e.g., lateral/accessory canals, apical ramifications and severe curvatures), comprehensive decontamination of the root canal system would be quite a challenge, unless specific irrigation/disinfection protocols are properly employed.[7]

Sodium hypochlorite (NaOCl) is commonly used irrigating solution in concentrations between 0.5% and 6%. It is a potent antimicrobial agent, killing most bacteria instantly on direct contact.[8] It dissolves pulpal tissue remnants and collagen, the main organic components of dentin. NaOCl is the only root-canal irrigant in general use that dissolves necrotic and vital organic tissue. NaOCl alone does not remove the smear layer, it affects the organic part of the smear layer, making its complete removal possible by subsequent irrigation with EDTA or citric acid (CA). EDTA and CA effectively dissolve inorganic material, including hydroxyapatite. They have little or no effect on organic tissue and alone they do not have antibacterial activity. EDTA is commonly used as a 17% neutralized solution (disodium EDTA, pH 7). NaOCl is the main proteolytic irrigation agent in endodontics, it must be used with extreme caution as it is highly cytotoxic.[9] and presents potential side effects and safety concerns. Another disadvantage of NaOCl is its ability to induce peritubular and intertubular erosion by proteolytic degradation, especially when used in combination with EDTA.[10] When NaOCl is used in combination with EDTA, EDTA reduces the availability of the hypochlorite anion in solution, making NaOCl less effective in removing the necrotic pulp tissue, as well as reducing its antibacterial activity.[11]

To overcome the disadvantages of NaOCl in combination of EDTA an innovative irrigating agent is required in endodontics. BioAKT is an new irrigating solution containing Silver citrate dihydrate particles dispersed in aqueous solutions with powerful biocidal properties upon contact on many microorganisms.[12,13] that could be ideal for an innovative root canal irrigant.

The aim of this in vitro study was to evaluate the efficacy of an innovative silver-citrate endodontic metabolic substrate on smear layer removal after endodontic instrumentation compared to 5.25% NaOCl and 17% EDTA. The first tested hypothesis was that such a novel irrigation agent would be able to remove more efficiently the smear layer compared to EDTA and NaOCl.

2. MATERIALS AND METHODS

Evaluation of Smear Layer Removal through Scanning Electron Microsopy (SEM)

To standardize the study, single-root teeth with intact crowns and roots, extracted for periodontal and orthodontic reasons were collected from Department of Oral and Maxillofacial Surgery in SJM Dental College and Hospital was used in this study. Teeth with curved roots or endodontically treated were excluded from the study. After extraction, teeth were cleaned by removing the remaining soft tissue using a manual scaler and stored in distilled water solution at no longer than three months.

Endodontic access opening was made on each tooth using a round diamond bur. A size 10 K-file was placed into the root canal until the tip was just visible at the apical foramen, then the working length was set at 1 mm from the apex and confirmed with radiographs. Chemo-mechanical preparation was performed according to the conventional step-back preparation using K files from size #15 to #45. During instrumentation, the canals were only irrigated with 3 mL normal saline solution between every instrument.

After Chemo-mechanical preparation, the root specimens were randomly divided into two groups (n = 15 teeth/group) based on the irrigation solution used in this study. Group I: 5.25% NaOCl with 17% EDTA as final rinse and Group II: BioAKT (Silver citrate dihydrate in water solution). All specimens received a standardized protocol for irrigation only at the end of the root canal instrumentation (10 mL for 1 min) and finally dried with paper points.[14]

Further the roots were split into two parts. Longitudinal guide grooves were made along the mesial and distal surfaces of the specimens with a double-sided diamond discs, and were split in two parts using cutting pliers to expose root canals. The specimens were mounted on a metallic stub using conductive glue, gold-sputtered, and examined at the apical portion of the root using scanning electron microscope (SEM: ESEM Quanta 200, FEI) at Department of Materials Engineering, Indian Institution of Science, Bengaluru. Five representative digital photomicrographs from each root portion were obtained in each root fragment. SEM images were evaluated by scoring criteria given by Rome et al.[15]

Smear layer removal - Scoring criteria.	
Score	**Criteria**
0	No smear layer, all dentinal tubules open with erosion of tubules.
1	No smear layer, most of the dentinal tubules open.
2	Minimum smear layer; >50% dentinal tubules visible.
3	Moderate smear layer; <50% of dentinal tubules open.
4	Heavy smear layer; outline of dentinal tubules obliterated.

3. RESULTS

The results for smear layer removal obtained during the SEM evaluation are depicted in Table 1 and 2. It was observed that BioAKT and NaOCl with EDTA presented no significant difference in removing the smear layer at the apical portion of the root canal ($p > 0.05$).

TABLE 1: SEM micrographs of root canal dentin treated with the irrigation solutions tested in this study

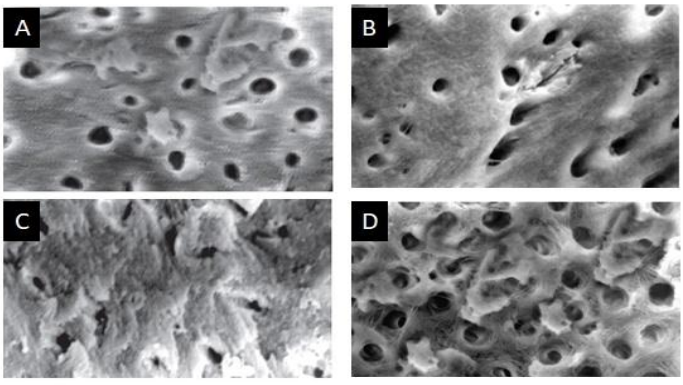

Fig (A & B) – Group BioAKT
(C & D) – Group NaOCl + 17% EDTA

Table 2: Comparison of the Grades Between The Groups.

		Groups		Total
		5.25% NaOCl with 17% EDTA	BioAKT	
Grade 0	Count	0	0	0
	Percent	0	0	
Grade I	Count	2	5	7
	Percent	13.3%	33.3%	23.3%
Grade II	Count	7	7	14
	Percent	46.7%	46.7%	46.7%
Grade III	Count	6	3	9
	Percent	40.0%	20.0%	30.0%
Grade IV	Count	0	0	0
	Percent	0	0	
Total	Count	15	15	30
	Percent	100.0%	100.0%	100.0%
Chi-square value- 2.28				
P value- 0.31				

Table 1 shows the distribution of the smear layer grades between the groups. Grade II was higher in both the groups- 46.7% in Group I (5.25% NaOCl with 17% EDTA) and Group II (silver-nitrate solution). Chi-square test was applied to associate the grades of smear layer with the groups. Chi-square test showed no statistical significant association ($\chi 2=2.28;p=0.31$).

4. DISCUSSION

In this study, we evaluated the efficacy of a novel silver-citrate solution (BioAKT) compared with NaOCl and EDTA on smear layer removal. The results revealed that BioAKT had a better smear layer removal ability than 5.25% sodium hypochlorite followed by 17% EDTA in the apical third of the root canal system. This finding is in agreement with various other studies that have reported EDTA to be not effective in smear layer removal in the apical third of the canal.[16,17,18] In this study, the apical part of canal preparation was performed up to ISO size no. 45. This is in accordance with several other studies that have stated that larger apical preparation produces a greater reduction in remaining bacteria and dentin debris as compared with smaller preparation.[19,20] Even though the apical preparation was performed up to ISO size no. 45, NaOCl with EDTA was not able to remove smear layer effectively when compared with BioAKT.

The samples used in this study are single-rooted teeth with relatively straight canal. Within the limitations of this study, a 1-minute application of BioAKT and Silver citrate dihydrate irrigating solution is an effective final irrigant for the removal of the smear layer from the root canal system in the apical third, which is a crucial area for the disinfection of the root canal system.

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