

ORIGINAL RESEARCH

Assessment of efficacy of different Irrigation Techniques for Removing Smear Layer and Debris from the Root Canal: A comparative study

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Received date: 11 February, 2024

Acceptance date: 13 March, 2024

ABSTRACT

Objective: The present study was conducted for comparing the efficacy of conventional needle irrigation, EndoVac, and EndoActivator in removing smear layer and organic debris from the root canal. **Materials and methods:** This study involved the use of 60 single-rooted human teeth without prior endodontic treatment and intact apices. Teeth with extensive restorations, root caries, fractures, immature apex, and root length shorter than 10 mm were excluded. Smear layer was assessed and results were evaluated. **Results:** The EndoActivator demonstrated superior performance in total smear layer and debris removal compared to the control group treated with saline solution, which showed the least favorable outcomes. **Conclusion:** The EndoVac system and the EndoActivator system showed significantly greater effectiveness in cleaning root canal walls compared to conventional needle irrigation methods.

Keywords: endodontic, irrigation, canal

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INTRODUCTION

Effective endodontic treatment relies on the complete removal of both necrotic and vital pulp tissues, along with microorganisms and their toxins from the root canal system. Research has shown that endodontic lesions cannot develop in the absence of bacteria.^{1,2} Primary infections in the endodontic space are predominantly caused by obligate anaerobic species, with *Enterococcus faecalis* being a chief culprit for treatment failure due to its resistance to various intracanal medications and its role in biofilm formation.³ The cleaning and shaping phases of endodontic treatment involve both chemical and mechanical cleansing. Mechanical cleansing eliminates pulp tissue but leaves behind a smear layer consisting of potentially infectious substances, necessitating the use of root canal irrigants to remove it from canal walls, dentin tubules, and root canal branches.^{4,5}

Chemical cleansing can be challenging in the presence of isthmi and anastomosis, as they can trap the smear layer.⁶ Ideal root canal irrigants should clean and lubricate the root canal system, dissolve organic and inorganic substances, have antimicrobial properties, be non-cytotoxic, and not alter the dental structure.⁷ The objective of this study was to evaluate and compare the efficacy of conventional needle irrigation, EndoVac, and EndoActivator in removing smear layer and organic debris from the root canal.

MATERIALS AND METHODS

This study involved the use of 60 single-rooted human teeth without prior endodontic treatment and intact apices. Teeth with extensive restorations, root caries, fractures, immature apex, and root length shorter than 10 mm were excluded. Radiographs were used to confirm the presence of a single canal. The external surfaces of the teeth were cleaned, and a flat occlusal

surface was established as a reference for determining the working length. A crown-down technique with rotary nickel-titanium ProTaper instruments was used to prepare the root canals, maintaining apical patency throughout the procedure. The teeth were randomly divided into three groups with 20 specimens in each group, and all procedures were conducted by a single operator to ensure consistency. In Group 1 (control group), saline solution was used as the sole irrigant. In group 2, a two-step irrigation strategy with macro and micro irrigation involving 5.25% NaOCl and 17% EDTA was implemented. In Group 3, a rinse sequence involving 17% EDTA and 5.25% sodium hypochlorite was performed, followed by sonication using the EndoActivator system. The presence of the smear layer was evaluated from images at 700× magnification. Score 1: a little or no smear layer covering up to 25% of the specimen; tubules visible and patent; Score 2: little to moderate or patchy amounts of smear layer covering between 25% and

50% of the specimen; many tubules visible and patent; Score 3: moderate amounts of scattered or aggregated smear layer covering between 50% and 75% of the specimen; minimal to no tubule visibility or patency; and Score 4: heavy smear layer covering over 75% of the specimen; no tubule orifices visible or patent. All the results were recorded in Microsoft excel sheet and were subjected to statistical analysis using SPSS software

RESULTS

The EndoVac system and the EndoActivator system showed significantly greater effectiveness in cleaning root canal walls compared to conventional needle irrigation methods. While assessing the smear layer and debris layer score, significantly better results were seen among patients of the EndoVac and Endoactivator group in comparison to conventional irrigation group.

Smear score	Conventional irrigation		EndoVac		Endoactivator	
	N	%	N	%	N	%
One	2	10	12	60	13	65
Two	2	10	7	35	7	35
Three	4	20	1	5	0	0
Four	12	60	0	0	0	0
Total	20	100	20	100	20	100
p-value	0.001 (Significant)					

DISCUSSION

Irrigation techniques play a crucial role in the successful eradication of smear layer and organic debris from the root canal during endodontic treatment. The root canal system can harbor a significant amount of bacteria, tissue remnants, and other debris, which can impede the success of the treatment if not adequately removed. In addition, the smear layer, composed of organic and inorganic materials, forms during instrumentation and can further complicate the disinfection process.^{8,9} The choice of irrigation techniques and irrigating solutions is essential in effectively removing the smear layer and debris. Irrigation serves multiple purposes, including flushing out debris, dissolving organic materials, and disinfecting the root canal system. Common irrigating solutions include sodium hypochlorite, EDTA, chlorhexidine, and hydrogen peroxide, among others.¹⁰

Endodontic instruments are utilized to clean and shape the root canal system during endodontic treatment, with the goal of effectively removing infected or damaged tissue. However, the use of these instruments can create a smear layer, comprising organic and inorganic materials, on the canal walls.¹¹ The EndoVac system and the EndoActivator system showed significantly greater effectiveness in cleaning root canal walls compared to conventional needle irrigation methods. While assessing the smear layer score, significantly better results were seen among

patients of the EndoVac and Endoactivator group in comparison to conventional irrigation group. Khaord Pet al compared smear layer removal after final irrigant activation with sonic irrigation (SI), manual dynamic agitation (MDA), passive ultrasonic irrigation (PUI), and conventional syringe irrigation (CI). Forty mesial canals of mandibular first molars (mesial roots) were cleaned and shaped by using ProTaper system to size F1 and sodium hypochlorite 3% and 17% ethylenediaminetetraacetic acid. The specimens were divided into 4 equal groups (n = 10) according to the final irrigation activation technique: Group 1, PUI; group 2, manual dynamic activation (MDA); group 3, SI; and group 4, control group (simple irrigation). Samples were split longitudinally and examined under scanning electron microscope for smear layer presence. Control groups had the highest smear scores, which showed the statistically significant highest mean score at $P < 0.05$. This was followed by ultrasonic, MDA, and finally sonic, with no significant differences between them. Final irrigant activation with sonic and MDA resulted in the better removal of the smear layer than with CI.¹² Iandolo Aet al assessed the difference in smear layer removal using the 3D cleaning technique and traditional syringe needle irrigation. The 3D cleaning technique includes the ultrasonic activation of intracanal-heated NaOCl. Their study used single-rooted human mandibular premolar teeth to test the earlier-mentioned technique (n = 30). Initially, an endodontic

access cavity was performed. Consequently, specimens were randomly distributed into three study groups according to irrigation protocol. The groups were Group 1, where the traditional syringe needle irrigation system was applied; Group 2, where the 3D cleaning technique was performed; and Group 3, in which teeth remained uncleaned as it was regarded as the control group. Once the experiment was completed, the teeth were decoronated at the cemento-enamel junction (CEJ) and examined using scanning electron microscopy (SEM). Debris and smear layers were viewed in 1000× magnification and scored. A statistically significant ($p < 0.05$) lower mean smear layer and debris score was observed in both study groups compared to the control group. Group 2 showed better results compared to Group 1.¹³

CONCLUSION

The EndoVac system and the EndoActivator system showed significantly greater effectiveness in cleaning root canal walls compared to conventional needle irrigation methods.

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