

Laser Activation of Aquatine Endodontic Cleanser: A Novel Approach to Root Canal Disinfection

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ABSTRACT

Aim: To evaluate and compare the antimicrobial efficacy of 2.5% sodium hypochlorite (NaOCl) and Aquatine Endodontic Cleanser (EC) with and without laser-activated disinfection against *Enterococcus faecalis* in the root canals of primary teeth.

Materials and methods: A total of 45 human primary teeth were selected and inoculated with *E. faecalis* and divided into three groups as per intervention. In group I, irrigation was done using 2.5% NaOCl, in group II using Aquatine EC solution, and in group III with Aquatine EC activated by 810 nm diode laser.

Results: Intragroup comparisons showed a decrease in colony-forming units in all three groups. Intergroup comparisons showed a statistically significant difference between group I and group II ($p = 0.024$) and between group I and group III ($p = 0.03$).

Conclusion: Aquatine EC showed maximum antimicrobial efficacy under laser activation.

Clinical significance: Aquatine EC can be considered a suitable alternative to NaOCl in light of its known toxic effects.

Keywords: Aquatine endodontic cleanser, Diode laser, *Enterococcus faecalis*.

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INTRODUCTION

Intracanal irrigation has a primary role in endodontic treatment. The root canal is shaped mechanically using hand and rotary instruments or a combination of both and cleaned by flushing with various irrigants to remove any diseased and inflamed pulpal tissue and other debris.¹ Among many irrigants used for the above purpose, NaOCl remains to be the gold standard due to its excellent tissue dissolution and antimicrobial activity contributing to its proteolytic effect.²

However, due to the anatomic complexities of root canals, especially of the primary teeth, the deep invasion into the dentinal tubules by microorganisms, such as *E. faecalis*, results in the formation of resistant biofilms that makes the complete cleaning of the root canal system difficult using standard irrigants alone.^{2,3} Therefore, to increase the efficacy of the irrigating solutions, methods like laser-activated irrigation have been considered effective. The laser radiation energy is strongly absorbed by the irrigant solution leading to its transitory cavitation due to optical disintegration.^{2,4,5}

Despite these advancements, there are several drawbacks of using NaOCl as an irrigating solution due to its associated risks of allergic potential, tissue damaging properties at high concentrations, and the possibility of emphysema on overfilling.² Thus, there is an ongoing search for an irrigant that has the desirable properties of NaOCl without any risk associated with its use.

The United States Food and Drug Administration, in 2006, gave its clearance for Aquatine EC introduced by Sterilox Dental, for its use as a root canal irrigating solution. Hypochlorous (HOCl) acid, an antimicrobial, which is also produced endogenously by the immune system of humans via the oxidative burst pathway, is the active component of this solution.⁶

Hypochlorous (HOCl) acid is more bactericidal than hypochlorite. It is less toxic to vital tissues.⁷ Furthermore, using a safer irrigant for

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root canal procedures to reduce the risk associated with NaOCl will be highly beneficial in children who might be apprehensive and uncooperative during the treatment procedure.⁸

Therefore, the aim of this study was the comparative evaluation of the antimicrobial efficacy of NaOCl and Aquatine EC against *E. faecalis* under laser activation.

MATERIALS AND METHODS

The study was conducted after obtaining ethical approval from the Institutional Review Board.

Freshly extracted primary teeth for therapeutic reasons were used. These sterilized tooth specimens were kept at 37°C post-incubation with *E. faecalis* (American Type Culture Collection 2) in brain heart infusion broth to allow bacterial growth. The apical root ends were sealed with Cavit, and the excess broth was removed by sterile paper points to allow access to irrigants. Bacterial colony counts were obtained before and after intervention using blood

agar plates streaked with paper points that had soaked the canal's contents.² Aquatine EC was freshly prepared (Fig. 1).⁶

The specimens were divided into three groups, which are as follows:

- Group I: The root canals of the teeth while being irrigated with 2.5% of 30 mL NaOCl for 20 seconds three times at an interval of 10 seconds using the disposable luer lock syringe.²
- Group II: Same as group I, using Aquatine EC as the irrigant.²
- Group III: Laser-activated irrigation with Aquatine EC (Fig. 2).

The physical parameters—wavelength: 810 nm, output power: 1.5 watts, and output energy: 20% (Picasso Dental diode laser).

Laser-activated irrigation with Aquatine EC—the canal chamber was filled with Aquatine EC, and the optical fiber was introduced into the root canal 1 mm short of its working length, following which laser irradiation was done for a period of 20 seconds by using rotational motion to move the optical fiber along the entire length of the canal from the apical to the coronal end. This procedure was repeated three times at an interval of 10 seconds between each.^{2,4}

Statistical analysis was done by using a one-way analysis of variance test for comparisons between the interventional groups,

paired *t*-test for pre and postintervention comparison, and *post hoc* Tukey's test for numerous comparisons.

RESULTS

The preoperative bacterial counts were similar in all groups (Table 1). Intragroup analysis showed that the mean bacterial count had decreased in all three groups postoperatively (Table 2). There was a statistically significant difference between all the groups, except between groups II and III, on performing intergroup analysis. However, the difference in the bacterial count between groups I and II and between groups I and III was highly statistically significant, with the *p*-value being 0.024 and 0.003, respectively (Table 3).

DISCUSSION

Sodium hypochlorite (NaOCl) is the most frequently used endodontic irrigant. It has numerous advantageous properties, such as its antimicrobial nature and tissue-dissolving trait that enables the dissolution of organic tissue inclusive of collagen, vital, and necrotic pulp remnants. However, it has disadvantages that cannot be overlooked, such as unpleasant taste, tissue toxicity, and inability to remove the smear layer.² Therefore, the search for the ideal root canal irrigant is on.

Aquatine EC was introduced as a root canal irrigant by Sterilox Dental. It has HOCl acid as its active ingredient.⁶

In the present study, intergroup comparisons between all three interventional groups prior to intervention showed no statistical difference, with *p*-values being 0.876, allowing valid comparisons. There was a statistically significant difference between all the groups except between groups II and III. However, the difference in the bacterial count between groups I and II and between groups I and III was highly statistically significant, with the *p*-value being 0.024 and 0.003, respectively.

According to a study by Rossi-Fedele et al., solutions with antimicrobial properties showed a difference in efficacy at different pH values, with the maximum antibacterial action being exerted at a lower pH. The antimicrobial action of HOCl (hypochlorous ion) was 80–100 times $>\text{ClO}^-$ (hypochlorite ion) against waterborne pathogens in laboratory conditions.

For optimal disinfection, a pH value around 6 for HOCl has been proposed as ideal. As Aquatine EC has a pH of 6 and uses HOCl acid



Fig. 1: Freshly prepared Aquatine EC with pH adjusted to 6

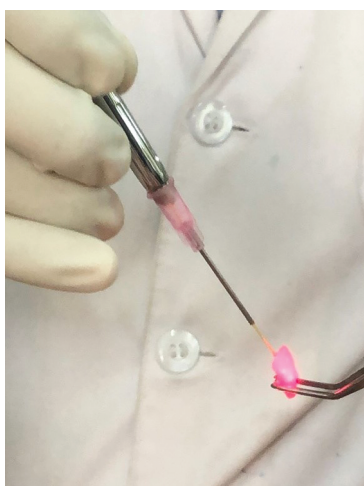


Fig. 2: Laser-activated disinfection of Aquatine EC

Table 1: No statistically significant difference in the microbial count between the three interventional groups preoperatively

Group	Procedure	Mean \pm Standard deviation (SD)	<i>p</i> -value
I	2.5% NaOCl	335.8667 \pm 27.10263	0.876
II	Aquatine EC	332.00 \pm 32.63653	
III	Aquatine EC + laser-activated irrigation	330.5333 \pm 27.79997	

Table 2: Intragroup analysis showing statistically significant difference in the microbial count before and after intervention

Timing of intervention	Mean \pm SD	<i>p</i> -value
Preoperative	332.8000 \pm 28.70033	0.0000
Postoperative	0.8667 \pm 1.157538	

Table 3: Intergroup analysis showing statistically significant difference between groups I and II and between groups I and III

Groups		Mean difference	p-value
A	B	(A–B)	
2.5% NaOCl (I)	Aquatine EC (II)	1.40000	0.024
2.5% NaOCl (I)	Aquatine EC + laser-activated irrigation (III)	1.80000	0.003
Aquatine EC (II)	Aquatine EC + laser-activated irrigation (III)	0.40000	0.716

as its active agent, the lower colony-forming units can be attributed to the above reasons.⁹

Moreover, there is an increase in the efficacy of the disinfecting solutions by the absorption of laser radiation energy. The lower colony-forming units in group III can be attributed to the combined efficacy of Aquatine EC and laser-activated irrigation.²

Ring et al. compared various endodontic irrigants and found that the Aquatine EC/ethylenediaminetetraacetic acid (EDTA) combination had a low lactate dehydrogenase absorbance, suggesting that Aquatine EC/EDTA is the safest of all the treatments examined. The dental pulp stem cell (DPSCs) attached to root canals after the Aquatine EC/EDTA treatments displayed morphologies varying from oblong to flattened, thereby making the combination the most favorable of the irrigating solutions to help maintain the survival and attachment of DPSCs.¹⁰

CONCLUSION

Within the limitations of the present study, Aquatine EC Solution can be considered to be a safer alternative for use as an endodontic irrigant rather than NaOCl with or without laser-activated irrigation. However, further *in vivo* studies should be conducted to establish the efficacy of Aquatine EC over NaOCl.

Clinical Significance

Against the background of the limitations of NaOCl, this study proves that Aquatine EC can be a safer and more effective irrigant, which under laser activation, shows maximum antimicrobial efficacy.

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