ENDODONTIC IRRIGATION: AN UPDATE

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ABSTRACT
Irrigation has a key role in successful endodontic treatment. The identification and elimination of bacteria, removal of other necrotic products from the canal with appropriate irrigating solutions with proper technique ensures definite fulfillment of one of the objectives of root canal therapy.

KEYWORDS Endodontic Irrigation, Disinfection, Root Canal Treatment, Sodium Hypochlorite

INTRODUCTION
Debridement of the root canal system is essential for endodontic success. Irrigation is a vital part of root canal debridement. Unfortunately, many studies have shown that currently used chemomechanical methods of root canal preparation do not effectively debride the entire root canal system. Irrigation has a central role in endodontic treatment. During and after instrumentation, the irrigants facilitate removal of microorganisms, tissue remnants, and dentin chips from the root canal through a flushing mechanism.

Desired functions of irrigating solutions are: Washing action (helps remove debris), Reduce instrument friction during preparation (lubricant), Facilitate dentin removal (lubricant), Dissolve inorganic tissue (dentin), Penetrate to canal periphery, Dissolve organic matter (dentin collagen, pulp tissue, biofilm), Kill bacteria and yeasts (also in biofilm), Do not irritate or damage vital periapical tissue, no caustic or cytotoxic effects, Do not weaken tooth structure.

None of the available irrigating solutions can be regarded as optimal. Using a combination of products in the correct irrigation sequence contributes to a successful treatment outcome.

CLASSIFICATION

<table>
<thead>
<tr>
<th>Type of chemical</th>
<th>Generic and brand examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chelating agents (EDTA containing)</td>
<td>EDTA, EDTAC, REDTA, Salvizol, Tublign, RCP; Prep; Glyde; EGTA</td>
</tr>
<tr>
<td>Halide complexes</td>
<td>Sodium hypochlorite, tincture of iodine, povidone–iodine, iodine potassium iodide, oxidative potential water (electrochemically activated water)</td>
</tr>
<tr>
<td>Acids (organic and inorganic)</td>
<td>Phosphoric acid, citric acid, lactic acid, polyacrylic acid, tannic acid, DMSA (dimercapto succinic acid)</td>
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<tr>
<td>Antibiotics</td>
<td>Tetracycline hydrochloride, doxycycline hydrochloride</td>
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<tr>
<td>Oxidizing agents</td>
<td>Hydrogen peroxide</td>
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<tr>
<td>Others</td>
<td>Cetrizine, barium (quaternary ammonium compound); tergesol (0.2% laurel sodium sulfate), chlorhexidine, MTAD (tetracycline isomer, an acid, detergent), ethylenediamine, methylene blue dye, titanium tetrafluoride, tetracycline hydrochloride (Syprine), Succimer (Chemet)</td>
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<tr>
<td>Organic solvents</td>
<td>Chloroform, halothane, xylene, eucalyptus oil, orange oil</td>
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**Sodium Hypochlorite**

Sodium hypochlorite appears to be most ideal irrigant, as it covers more of the requirements for endodontic irrigant than any other compound known. NaOCl is commonly used in concentrations between 0.5% and 6%. Effective against bacteria, bacteriophages, spores, yeast and viruses. It kills sessile endodontic pathogens organized in biofilms and in dentinal tubules as efficiently as CHX or iodine at comparable concentration.\(^1\)\(^-\)\(^2\)\(^0\) It dissolves necrotic and vital tissue. It dissolves organic component of smear layer.\(^2\)\(^1\) Inactivates endotoxin.\(^3\) Chlorine, is responsible for the tissue dissolving and antibacterial capacity of NaOCl, is unstable and is consumed rapidly during the first phase of tissue dissolution, probably within 2 min; therefore continuous replenishment is essential.

**EDTA and CA**

Complete cleaning of the root-canal system requires the use of irrigants that dissolve organic and inorganic material. As hypochlorite is active only against the former, other substances must be used to complete the removal of the smear layer and dentin debris. EDTA and CA effectively dissolve inorganic material, including hydroxyapatite.\(^2\)\(^3\)\(^-\)\(^6\) They have little or no effect on organic tissue and alone they do not have antibacterial activity, despite some conflicting reports on EDTA. EDTA is most commonly used as a 17% neutralized solution (disodium EDTA, pH 7), but a few reports have indicated that solutions with lower concentrations (eg, 10%, 5%, and even 1%) remove the smear layer equally well after NaOCl irrigation. Considering the high cost of EDTA, it may be worthwhile to consider using diluted EDTA. CA is also marketed and used in various concentrations, ranging from 1% to 50%, with a 10% solution being the most common. EDTA and CA are used for 2 to 3 minutes at the end of instrumentation and after NaOCl irrigation. Removal of the smear layer by EDTA or CA improves the antibacterial effect of locally used disinfecting agents in deeper layers of dentin.\(^2\)\(^7\)\(^-\)\(^8\)

**Chlorhexidine Digluconate**

Chlorhexidine digluconate (CHX) is widely used in disinfection in dentistry because of its good antimicrobial activity.\(^2\)\(^9\)\(^-\)\(^3\)\(^3\) it has gained considerable popularity in endodontics as an irrigating solution and as an intracanal medicament. CHX does not possess some of the undesired characteristics of sodium hypochlorite (ie, bad smell and strong irritation to periapical tissues). However, CHX has no tissue-dissolving capability and therefore it cannot replace sodium hypochlorite. CHX permeates the microbial cell wall or outer membrane and attacks the bacterial cytoplasmic or inner membrane or the yeast plasma membrane. In high concentrations, CHX causes coagulation of intracellular components.\(^3\) One of the reasons for the popularity of CHX is its substantivity (ie, continued antimicrobial effect). Because CHX binds to hard tissue and remains antimicrobial. However, similar to other endodontic disinfecting agents, the activity of CHX depends on the pH and is also greatly reduced in the presence of organic matter.\(^3\)\(^1\) Several studies have compared the antibacterial effect of NaOCl and 2% CHX against intracanal infection and have shown little or no difference between their antimicrobial effectiveness.\(^3\)\(^2\)\(^-\)\(^3\)\(^5\) although bacteria may be killed by CHX, the biofilm and other organic debris are not removed by it. Residual organic tissue may have a negative effect on the quality of the seal by the permanent root filling, necessitating the use of NaOCl during instrumentation.

**Other Irrigating Solutions**

Other irrigating solutions used in endodontics have included sterile water, physiologic saline, hydrogen peroxide, urea peroxide, and iodine compounds. All of these except iodine compounds lack antibacterial activity when used alone, and they do not dissolve tissue either. Therefore there is no good reason for their use in canal irrigation in routine cases. In addition, water and saline solutions bear the risk of contamination if used from containers that have been opened more than once. Iodine potassium iodide (eg, 2% and 4%, respectively) has considerable antimicrobial activity but no tissue dissolving capability.\(^3\)\(^6\)\(^-\)\(^3\)\(^7\) and it could be used at the end of the chemomechanical preparation like CHX. However, some patients are allergic to iodine, which must be taken into consideration.

**Combination Products**

Although some of the main irrigating solutions cannot be mixed without loss of activity or development of potentially toxic by-products, several combination products are on the market, many with some evidence of improved activity and function. Surface active agents have been added to several different types of irrigants to lower their surface tension and to improve their penetration in the root canal. In the hope of better smear-layer removal, detergents have been added to some EDTA preparations (eg, SmearClear\(^3\)\(^8\)) and hypochlorite (eg, Chlor-XTRA). Detergent addition has been shown to increase the speed of tissue dissolution by hypochlorite.\(^3\)\(^9\) recently, a few studies have been published in which the antibacterial activity of a
chlorhexidine product with surface-active agents (CHX-Plus) has been compared with regular CHX, both with 2% chlorhexidine concentrations. The studies have shown superior killing of planktonic and biofilm bacteria by the combination product. MTAD (a mixture of tetracycline isomer, acid, and detergent, Biopure, Tulsa Dentsply, Tulsa, OK, USA) and Tetraclean are new combination products for root-canal irrigation that contain an antibiotic, doxycycline. MTAD and Tetraclean are MTAD (a mixture of tetracycline isomer, acid, and detergent, Biopure, Tulsa Dentsply, Tulsa, OK, USA) and Tetraclean are new combination products for root-canal irrigation that contain an antibiotic, doxycycline. MTAD and Tetraclean are designed primarily for smear-layer removal with added antimicrobial activity. Both contain CA, doxycycline, and a detergent. They differ from each other in CA concentration and type of detergent included. They do not dissolve organic tissue and are intended for use at the end of chemomechanical preparation after sodium hypochlorite. Although earlier studies showed promising antibacterial effects by MTAD, recent studies have indicated that an NaOCl/EDTA combination is equally or more effective than NaOCl/MTAD. Comparative studies on MATD and Tetraclean have indicated better antibacterial effects by the latter. Although a mixture containing an antibiotic may have good short-term and long-term effects, concerns have been expressed regarding the use of tetracycline (doxycycline) because of possible resistance to the antibiotic and staining of the tooth hard tissue, which has been demonstrated by exposure to light in an in vitro experiment. However, no report of in vivo staining has been published.

**Suggested regimen**

In summary, sodium hypochlorite is the most important irrigating solution and the only one capable of dissolving organic tissue, including biofilm and the organic part of the smear layer. It should be used throughout the instrumentation phase. However, use of hypochlorite as the final rinse following EDTA or CA rapidly produces severe erosion of the canal-wall dentin and should probably be avoided. CHX does not cause erosion of dentin like NaOCl does as the final rinse after EDTA, and therefore 2% CHX may be a good choice for maximized antibacterial effect at the end of the chemomechanical preparation. MTAD can be used as a final rinse for 5 min along with 1.3% NaOCl as main irrigant to provide better disinfection of the root canal. To accomplish objectives of irrigation, there must be an effective delivery system to working length. Working length may be defined as the distance from a coronal reference point to where the canal system is cleaned, shaped, and obturated to prevent recurrent infection. An improved delivery system for root canal irrigation is highly desirable. Such a delivery system must have adequate flow and volume of irrigant to working length to be effective in debriding the canal system without forcing the solution into periradicular tissues.

**Needles**

Although 25-gauge needles were common place for endodontic irrigation a few years ago, they were first replaced by 27-G needles, now 30-G and even 31-G needles are taking over for routine use in irrigation. As 27 G corresponds to International Standards Organization size 0.42 and 30 G to size 0.31, smaller needle sizes are preferred.

**EndoActivator**

EndoActivator (Advanced Endodontics, Santa Barbara, CA, USA) is a new type of irrigation facilitator. It is based on sonic vibration (up to 10,000 cpm) of a plastic tip in the root canal. The system has 3 different sizes of tips that are easily attached (snap-on) to the handpiece that creates the sonic vibrations (Fig. 1). EndoActivator does not deliver new irrigant to the canal but it facilitates the penetration and renewal of the irrigant in the canal. Two recent studies have indicated that the use of EndoActivator facilitates irrigant penetration and mechanical cleansing compared with needle irrigation, with no increase in the risk of irrigant extrusion through the apex.

**Vibringe**

Vibringe (Vibringe BV, Amsterdam, The Netherlands) is a new sonic irrigation system that combines battery-driven vibrations (9000 cpm) with manually operated irrigation of the root canal. Vibringe uses the traditional type of syringe/needle delivery but adds sonic vibration.

**RinsEndo**

The RinsEndo system (Durr Dental Co) is based on a pressure-suction mechanism with approximately 100 cycles per minute. A study of the safety of several irrigation systems reported that the risk of overirrigation was comparable with manual and RinsEndo irrigation, but higher than with EndoActivator or the EndoVac system.

**EndoVac system**

The EndoVac system (Discus Dental, Culver City, CA) is a novel new irrigation system.
delivery/evacuation tip is attached to a syringe of irritant and the high speed suction of the dental chair (Fig. 2A). A small tube attaches either a macro- or microcannula to the suction (Fig. 2B, C). The delivery/evacuation tip places irrigant in the chamber and siphons off the excess to prevent overflow (Fig. 2D). The macrocannula is plastic with an open end that measures International Standards Organization (ISO) size 55 with a .02 taper. The microcannula is stainless steel and has 12 small, laterally positioned, offset holes in 4 rows of 3, with a closed end measuring ISO size 32. As these cannulas are placed in the canal, negative pressure pulls irrigant from a fresh supply in the chamber, down the canal to the tip of the cannula, into the cannula, and out through the suction hose. The microcannula can be used at working length in a canal enlarged to ISO size 35 or larger. There is evidence that, compared with traditional needle irrigation and some other systems, the EndoVac system lowers the risks associated with irrigation close to the apical foramen considerably.\(^9\) Another advantage of the reversed flow of irrigants may be good apical cleaning at the 1-mm level and a strong antibacterial effect when hypochlorite is used, as shown by recent studies.\(^{10-11}\)

**Ultrasound**

The comparative effectiveness of ultrasonics and hand-instrumentation techniques has been evaluated in several earlier studies.\(^{11-14}\) Most of these studies concluded that ultrasonics, together with an irritant, contributed to a better cleaning of the root-canal system than irrigation and hand-instrumentation alone. Cavitation and acoustic streaming of the irritant contribute to the biologicchemical activity for maximum effectiveness.\(^{15}\) Analysis of the physical mechanisms of the hydrodynamic response of an oscillating ultrasonic file suggested that stable and transient cavitation of a file, steady streaming, and cavitation microstreaming all contribute to the cleaning of the root canal.\(^{16}\) Ultrasonic files must have free movement in the canal without making contact with the canal wall to work effectively.\(^{17}\) Van der Sluis and colleagues\(^{18}\) suggested that a smooth wire during ultrasonic irrigation is as effective as a size 15 K-file in the removal of artificially placed dentin debris in grooves in simulated root canals in resin blocks.

**CONCLUSION**

Irrigation has a key role in successful endodontic treatment. The identification and elimination of bacteria, removal of other necrotic products from the canal with appropriate irrigating solutions with proper technique ensures definite fulfillment of one of the objectives of root canal therapy.
REFERENCES


