



Recent innovation in irrigation in endodontics-A Review

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Abstract

The aim of endodontic treatment is to remove all the vital and necrotic tissues, microorganisms and microbial by-products from root canal system and this can be achieved by chemical and mechanical debridement of root canals. Irrigation play a vital role in endodontic treatment. Sodium hypochlorite is the goal slandered endodontic irrigant as it is an effective antimicrobial and has tissue-dissolving capabilities. The major disadvantages of this irrigant are its cytotoxicity when injected into periradicular tissues, foul smell and taste, ability to bleach clothes and ability to cause corrosion of metal objects. Researchers have introduced various irrigating solutions to overcome these problems. This review is aimed to bring some light over the advances in root canal irrigation solution and irrigation devices.

Keywords: endodontic treatment, irrigation, sodium hypochlorite

Introduction

The goal of endodontic treatment is to remove all the vital and necrotic tissues, microorganisms and microbial by-products from root canal system and this can be achieved by chemical and mechanical debridement of root canals [1]. 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. Irrigants can also help prevent packing of the hard and soft tissue in the apical root canal and extrusion of infected material into the periapical area [2, 3]. Some irrigating solutions dissolve either organic or inorganic tissue in the root canal. In addition, several irrigating solutions have antimicrobial activity and actively kill bacteria and yeasts when introduced in direct contact with the microorganisms [4]. Conventional syringe irrigation method is the mostly used in routine endodontics cases but it is found to be inadequate for complete cleaning of the complex anatomy of root canal system. Different irrigation devices have been introduced to enhance the flow and distribution of irrigation solutions [5]. This review is aimed to bring some light over the advances in root canal irrigation solution and irrigation devices.

Ideal requirements of root canal Irrigants [6]

1. Broad antimicrobial spectrum
2. High efficacy against anaerobic and facultative microorganisms organized in biofilms
3. Ability to dissolve necrotic pulp tissue remnants

4. Ability to inactivate endotoxin
5. Ability to prevent the formation of a smear layer during instrumentation or to dissolve the latter once it has formed.
6. Systemically nontoxic when they come in contact with vital tissues, Non-caustic to periodontal tissues, and with little potential to cause an anaphylactic reaction.

Classification of root canal Irrigants [6]

Table 1

Endodontic Irrigants			
Tissue dissolving agents	Chemical agents		Natural agents
	Antibacterial agents	Chelating agents	Antibacterial agents
(e.g., NaOCl, ClO ₂)	1) Bactericidal (e.g., CHX) 2) Bacteriostatic (e.g., MTAD)	1) Mild pH (e.g., HEBP) 2) Strong pH (e.g., EDTA)	(e.g., Green tea, Triphala)

Recent advancement in root canal irrigation solution

Sodium hypochlorite is the goal slandered endodontic irrigant as it is an effective antimicrobial and has tissue-dissolving capabilities. The major disadvantages of this irrigant are its cytotoxicity when injected into periradicular tissues, foul smell and taste, ability to bleach clothes and ability to cause corrosion

of metal objects. Researchers have introduced various irrigating solutions to overcome these problems.

1. **Citric Acid (CA):** The use of 10% CA as a final irrigation solution yielded very good results in terms of smear layer removal. CA has shown slightly better performance than EDTA at similar concentrations, although both solutions are highly effective in removing the smear layer from root canal walls [7].
2. **Maleic Acid (MA):** MA is a mild organic acid used to roughen enamel and dentin surfaces in adhesive dentistry. It removes the smear layer effectively at concentrations of 5% and 7%. In addition, when used at concentrations of 10% or higher, it causes demineralization and erosion of the root canal wall [8].
3. **MTAD:** Torabinejad *et al.* developed an irrigant with combined chelating and antibacterial properties. MTAD is a mixture of 3% doxycycline, 4.25% citric acid, and detergent (Tween-80). This mixture acts as a chelator and has antimicrobial activity. As it has no organic tissue-dissolving effect, its use after NaOCl at the end of chemomechanical preparation is recommended [9].
4. **Silver Diamine Fluoride:** A 3.8% silver diamine fluoride solution was developed for use as an irrigation solution in root canal treatment. This solution is the 1:10-diluted form of the original 38% solution of SDF, which was developed for the treatment of root canal infection [10].
5. **Chitosan:** Chitosan is a natural linear polysaccharide obtained by the deacetylation of chitin, which is found in crab and shrimp shells. Biocompatibility, biodegradability, bio adhesion and lack of toxicity of chitosan are of a great importance in dental medicine as root canal irrigant because it help to remove the inorganic components of smear layer [11].
6. **Super oxidized Water /Electrochemically activated water** Super oxidized water, also called electrochemically activated water or oxidative potential water, is effectively saline that has been electrolyzed to form super oxidized water, hypochlorous acid, and free chlorine radicals. It is commercially available as Sterilox (Sterilox Technologies, Radnor, PA). This solution is nontoxic to biologic tissues yet able to kill microorganisms. The solution is generated by electrolyzing saline solution, a process no different than that used in the commercial production of NaOCl [12].
7. **Green Tea Polyphenols (GTP):** GTP are derived from fresh leaves of tea (*Camellia sinensis*), an important component of traditional Japanese and Chinese cultures. They have shown significant antibacterial activity in *E. faecalis* biofilms grown on dental culture, killing *E. faecalis* completely within 6 min [12].
8. **Triphala:** Triphala is a plant blend created by drying and pulverizing the fruit of three plants (*terminalia bellerica*, *terminalia chebula*, and *emblica officinalis*) used for medicinal purposes. Triphala kills 100% of *E. faecalis* within 6 min. When used at different rates, its effects can be increased synergistically [12].
9. **HEBP** HEBP (1-hydroxyethylidene- 1, 1-bisphosphonate), also known as etidronic acid or etidronate, has been proposed as a potential alternative to EDTA or citric acid because this agent shows no short-term reactivity with NaOCl. HEBP is

nontoxic and has been systematically applied to treat bone diseases [13].

10. **Propolis:** Propolis presents anti-inflammatory and antimicrobial actions. Duarte *et al.* showed its influence in the reduction of acid production by *S. mutans* in the dental biofilm, besides its inhibitory action over the F-ATPase activity of *S. Mutans* [12].

Recent advances in irrigation devices

1. **Manual irrigation techniques:** Manual irrigation system using needles is still widely accepted by both general practitioners and endodontist. In this technique the dispensing of an irrigant into a canal through needles/cannulas of variable gauges, either passively or with agitation. The agitation might be achieved by moving the needle up and down the canal space. The design of these needles can be closed-ended, side-vented channels [14].
2. **Endo Activator:** The EndoActivator System is a more recently introduced sonically driven canal irrigation system by Dentsply. It consists of a portable handpiece and 3 types of disposable polymer tips of different sizes. These tips are claimed to be strong and flexible and do not break easily. Because they are smooth, they do not cut dentin. Vibrating the tip, in combination with moving the tip up and down in short vertical strokes, synergistically produces a powerful hydrodynamic phenomenon. This might be operated 10,000 cycles per minute (cpm) has been shown to optimize debridement and promote disruption of the smear layer and biofilm [15].



Fig 1: Endo activator

Ultra X

Ultra X works at 45 kHz ultrasonic frequencies which utilize the principle of acoustic micro streaming, agitation and cavitation to reach difficult to instrument areas ($\geq 35\%$) of the complex root canal system. It can be applied endodontically to disrupt the smear layer and biofilm and open up the plugged dentinal tubules, removal of gross dentinal tubules, amplify the efficiency of Irrigants, gp removal during retreatment [16].



Fig 2: Ultra X

PATS

Recently, a new irrigating system Pro-Agitator Tip System (PATS) (Innovations Endo Ltd, Nasik, Maharashtra, India) has been launched in 2017, that contains a Hand Piece with an autoclavable polymer tip that agitates the Irrigant ultrasonically [17].

Glin Sonic Pro Endo Irrigator

The sonic irrigator is primarily designed for activation of liquids in the canal like NaOCl, 17% Liquid EDTA, Citric Acid, absolute alcohol or even solvents in retreatment cases. It can also be used to activate water based CaOH when placed at an intra-canal medicament. It can also be used for uniform application of sealers along the canal walls. The sonic irrigator has a simple single button operation a short press activates the high mode output of around 10000 htz, 2nd short press activates medium mode output of around 6,000 htz 3rd short press activates low mode output of around 4,000 htz [18].



Fig 3: Glin Sonic Pro Endo Irrigator

The EndoVac™ System

The EndoVac™ system was developed to safely and predictably deliver irrigants to the apical terminus thereby allowing a better penetration of the irrigation solution into the inherent anatomy and morphology of the root-canal system; such as isthmuses,

inter-canal and intra-canal communications, curvatures and oval shaped canals [19].

The Endo Vac™ apical negative-pressure irrigation system has three active component parts: the Master Delivery Tip (MDT), the macro cannula and the micro cannula. The MDT accommodates a syringe of irrigant, which is expressed through a 20-gauge needle. There is also a plastic suction hood attached around the 20-gauge needle that is connected to clear plastic tubing, which inserts into a multiport adaptor and then is inserted into the high volume suction. The macro cannula is used to draw irrigant by way of suction from the chamber to the coronal and middle segments of the canal while irrigant is simultaneously delivered to the pulp chamber directed towards an axial wall and never towards a canal orifice. The macro cannula or micro cannula is connected via clear plastic tubing to the high-speed suction of the dental unit by way of the multiport adaptor. The plastic macro cannula has an external diameter of ISO size 0.55 mm and an internal diameter of ISO size of 0.35 mm. It is made of blue translucent plastic, has a 0.02 taper and is meant for single patient use only. It is attached snug to an autoclavable aluminium handpiece and is used in an up and down pecking motion, while irrigant is simultaneously delivered passively to the pulp chamber in the manner mentioned above. It is used to remove the gross debris and tissue left behind during instrumentation [19].

Guidelines for Endodontic Irrigation [20]

1. Apical preparation ought to be at least size 35 and 30 gauge needle should be used.
2. After access cavity preparation flush the cavity and the canals with sodium hypochlorite. Canals must always be filled with sodium hypochlorite because this will increase working time available for the irrigant. At the same time, cutting efficiency of root canal instruments is enhanced due to the lubrication effect.
3. During instrumentation: 2-5 ml of sodium hypochlorite per canal should always be utilized throughout mechanical root canal preparation.
4. After shaping: 5-10 ml of sodium hypochlorite per canal. When the shaping procedure is finished, flush with a high volume of sodium hypochlorite.
5. After shaping: irrigation with 5 ml of EDTA for each canal for 1 minute (or with citric acid). After a final rinse of sodium hypochlorite, the canals should be irrigated with either EDTA or Citric Acid to remove the smear layer.
6. Final rinse with 2ml sodium hypochlorite for every canal to neutralise the acidic effect of EDTA and to permit sodium hypochlorite to penetrate into the opened tubules.
7. Optional: Final irrigation-especially in retreatment cases: chlorhexidine. Rinse with water to remove sodium hypochlorite and then with a 2% chlorhexidine solution.
8. Before root canal filling: rinse with 3 ml of alcohol per canal to dry the root canal.

Conclusion

Irrigation has a key role in successful endodontic treatment. Although hypochlorite is the most important irrigating solution, no single Irrigant can accomplish all the tasks required by irrigation. At present, there are no irrigating solutions capable of removing both the organic and inorganic elements of the smear layer. Using a combination of products in the correct irrigation

sequence and technique contributes to a successful treatment outcome. Future research on irrigants needs to focus on finding a single irrigant that has tissue dissolving capacity, smear layer removal property, and antibacterial efficacy.

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