ROOT CANAL IRRIGATION – REVIEW

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Abstract- The goal of endodontic treatment is to remove all the vital and necrotic tissues, microorganisms and microbial byproducts from root canal system and this can be achieved by chemical and mechanical debridement of root canals. Sodium hypochlorite has organic tissue dissolution capacity and broad antimicrobial properties. On the other hand, chelation solutions are recommended as auxiliary solutions to remove the inorganic components of smear layer. This Irrigation solutions can removes the smear layer completely in the coronal and middle third but is less effective in the apical third. Direct contact of irrigating solutions with the entire root canal wall surfaces is necessary for effective action particularly for the apical portions of small root canals and this can be achieved with the help of irrigant activation devices. This article reviews the new irrigants and irrigant activation devices which can be used in future endodontic practice.

Key words- Root canal irrigation, Irrigants, Irrigation devices.

Introduction

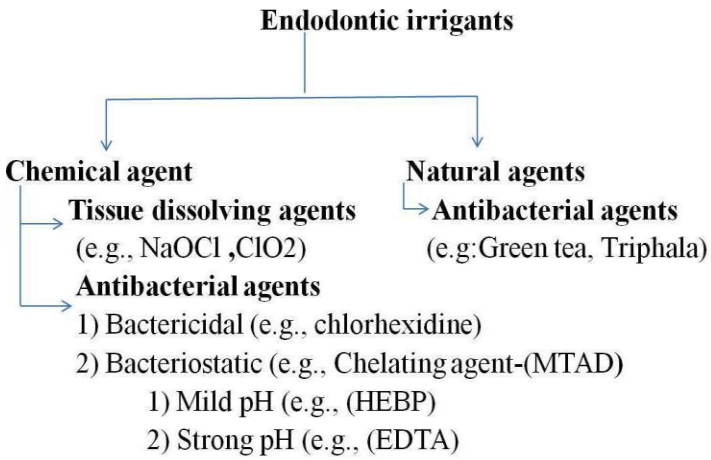
The success of endodontic therapy depends upon the disinfection of the entire root canal system, which requires elimination of microorganisms and their by-products and prevention of its re-infection. The disinfection of the root canal is achieved by biomechanical preparation along with the help of irrigation solutions.[1] During cleaning and shaping procedure with various root canal instruments, an amorphous, granular, and irregular layer covering root dentin consisting of inorganic and organic materials known as smear layer is left behind.[2] Removal of the smear layer after root canal instrumentation and before

Canal obturation improves the adaptation of root filling material to the canal walls, resulting in superior seal.[3] the conventional syringe irrigation method is 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 within the root canal system particularly at the level of apical third of the root canal.[4]

Ideal properties of root canal irrigants

1. The root canal irrigant should have broad antimicrobial spectrum [5]
2. High efficacy against anaerobic and facultative microorganisms organized in biofilms.[5]
3. Ability to dissolve necrotic pulp tissue remnants.[5]
4. It should have ability to inactivate endotoxin.[5]
5. It should have ability to prevent the formation of smear layer during instrumentation or to dissolve the latter once it has formed.[5]
6. Systemically nontoxic when they come in contact with vital tissues, noncaustic to periodontal tissues, and with little potential to cause an anaphylactic reaction.[5]

Classification [5]



Abbrevation- NaOCl- Sodium hypochlorite, ClO2- Chlorine Dioxide, MTAD- Mixture of Tetracycline Isomer Acid and Detergent**,** HEBP- Hydroxyethylidene, Bisphosphonate, Ethylenediaminetetraacetic Acid (EDTA)

Irrigants

Sodium Hypochlorite (NaOCl)

NaOCl has a unique property to dissolve necrotic tissues. Its activity increases with the concentration, temperature, and duration of application. When NaOCl is used as the first irrigant, its dentinal organic tissue-dissolving effect is not very strong, as hydroxyapatite in the NaOCl is the most widely used irrigation solution. It is ideal compared with other irrigation solutions because it is the only solution that possesses most required properties. NaOCl has a broad antibacterial spectrum and is sporicidal and viricidal[5] its tissue-dissolving activity is greater for necrotic tissue than for vital tissue [8].

Ethylenediaminetetraacetic Acid (EDTA)

As NaOCl effectively dissolves only organic tissue, other solutions should be used to remove the smear layer and debris from the root canal system. The use of demineralizing agents, such as EDTA and CA, as auxiliary solutions during root canal treatment is recommended. In 1957, Nygaart-Ostby proposed the use of chelating agents to aid in the preparation

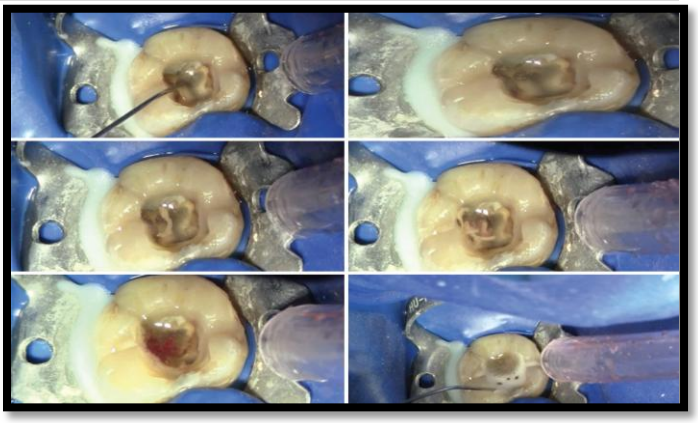


Fig 1-Sequence of sodium hypochlorite action on a necrotic tissue

of narrow and calcified root canals. The first recommended EDTA solution had a concentration of 15% and a pH of 7.3. EDTA is used most commonly as a 17% neutralized solution. The solution reacts with the calcium ions in the dentin and forms soluble calcium chelates.[6]

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.[8]

Chlorhexidine

Chlorhexidine (CHX), a cationic bisguanide, is stable as a salt although it dissociates in water at a physiologic pH, releasing the CHX component. It is frequently used at concentrations between 0.2% and 2% and exhibits an optimal antimicrobial activity at a pH of 5.5 to 7.0 depending on the buffering agent used and the under-study organism. [10]

Hydroxyethylidene Bisphosphonate (HEBP)

HEBP, also known as etidronic acid or etidronate, is a decalcifying agent that has little interaction with NaOCl. It has been proposed as an alternative to EDTA or CA. HEBP prevents bone resorption, and thus is used as a systemic drug in the treatment of osteoporosis and Paget's disease. [14]

Mixture of Tetracycline Isomer, Acid, and Detergent (MTAD)

Torabinejad et al. introduced a combination of 3% doxycycline, 4.25% CA, and detergent (Tween-80) as an alternative to EDTA to improve the smear layer removal property[8]. 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 .[17]

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%[6]. In addition, when used at concentrations of 10% or higher, it causes demineralization and erosion of the root canal wall. Ballal et al. reported that 1 min application of 7% MA as the final irrigation agent removed the smear layer more effectively than did 1 min irrigation with 17% EDTA, especially in the apical third of the root canal system[6].

Chlorine Dioxide (ClO2)

Patients use ClO2, which is chemically similar to NaOCl and chlorine, as a whitening agent in their homes. An in vitro study showed that the organic tissue-dissolving capacities of NaOCl and ClO2 were similar[13].

Tetraclean

Like MTAD, Tetraclean (OgnaLaboratori Farmaceutici, Muggiò (Mi), Italy) is a mixture of CA, doxycycline (at a lower concentration than MTAD), and detergent. The concentration of antibiotic (doxycycline-50 mg / ml) and the type of detergent (propylene glycol) differ from those in MTAD. Tetraclean does not dissolve organic tissue, and its use after NaOCl at the end of chemomechanical preparation is recommended. [15,17]

Triclosan and Gantrez

Triclosan is a Gram-positive and Gram-negative bactericide, as well as a broad-spectrum agent effective against fungi and viruses[15]. Nudera et al. investigated the minimum inhibitory and bacterial concentrations of triclosan and triclosan with Gantrez against Prevotellaintermedia, Fusobacteriumnucleatum, Actinomycesnaeslundii, Porphyromonasgingivalis, and E. faecalis[17]. The addition of Gantrez to triclosan increased bacterial activity. Both preparations showed bactericidal activity against the five major endodontic pathogens examined[15].

Silver Diamine Fluoride

A 3.8% silver diamine fluoride (Ag[NH3]2F) solution was developed for use as an irrigation solution in root canal treatment. This solution is the1:10-diluted form of the original 38% solution of Ag[NH3]2F, which was developed for the treatment of root canal infection[14,17].

Chitosan

Chitosan is a naturallinear polysaccharide obtained by the deacetylation of chitin, which is found in crab and shrimp shells. Biocompatibility, biodegradability, bioadhesion 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. [17]

Herbal irrigants

Triphala

*Triphala*consists of dried and powdered fruits of three medicinal plants *Terminaliabellerica*, *Terminaliachebula*, and *Emblicaofficinalis*.*Triphala* achieved 100% killing of *Efaecalis* at 6 min.[7]

Green tea

Green tea polyphenols, the traditional drink of Japan and China is prepared from the young shoots of the tea plant *Camellia sinensis*.Green tea polyphenols showed statistically significant antibacterial activity against *Efaecalis*biofilm formed on tooth substrate. It takes 6 min to achieve 100% killing of *E faecalis*[15].

Morindacitrifolia

Morindacitrifolia (MCJ) has a broad range of therapeutic effects, including antibacterial, antiviral, antifungal, antitumor, antihelmintic, analgesic, hypotensive, antiinflammatory, and immune-enhancing effects.MCJ contains the antibacterial compounds L-asperuloside and alizarin. Murray *et al*.proved that, as an intracanalirrigant to remove the smearlayer, the efficacy of 6% MJC was similar to that of 6% NaOCl in conjunction with EDTA[6].The use of MCJ as anirrigant might be advantageous because it is a biocompatible antioxidant and not likely to cause severe injuries to patients as might occur throughNaOCl accidents[7.]

Irrigation Agitation technique and devices

Manual irrigation techniques

Manual irrigation system using needles is still widely accepted by both general practitioners and endodontists. 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[16,25].

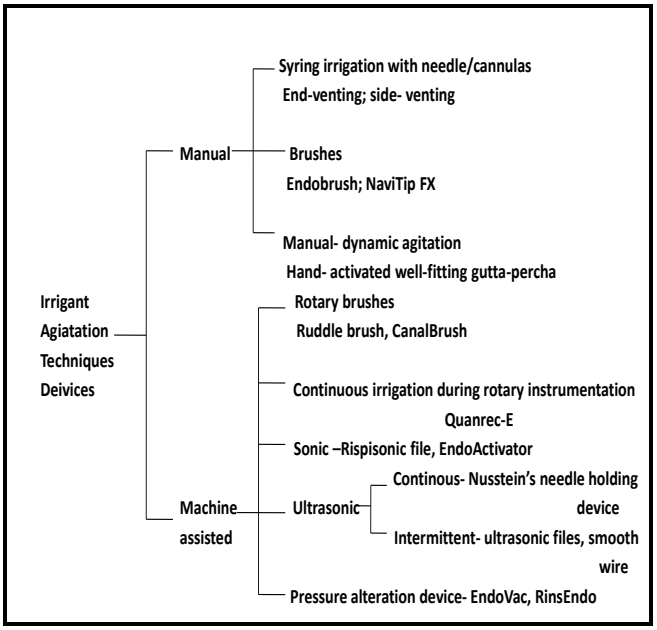


Fig 2- Irrigant agitation techniques

Max-i-probe

Max-i-probe is a modified design of regular manual irrigation needles with a well-rounded, close tip and side-port dispersal[25]. This needle is available is available in a wide range of gauges from 21 to 30 gauge. The luer lock connector provides a secure attachment and easy removal from any disposable syringe[16]. The manufacturer claimed that the rounded tip prevents the risk of perforating the apex and allows for safe irrigation of the entire length of the root canal. The dispersal of the irrigating solution through the side-port in the cannula creates a unique upward turbulent motion, which thoroughly irrigates the root canal preparation but prevents solution and debris from being expressed through the periapical foramen.[25]

Fig 3- Manual irrigation needles [25]

Fig 4- Max-i-probe [25]

NaviTipFx

NaviTipFx is a 30-gauge irrigation needle covered with a brush was introduced commercially by Ultradent company[16]. Brush is an adjunct that has

been designed for debridement of the canal walls or agitation of root canal irrigant. NaviTip FX needle gave improved cleanliness in coronal third when compared to brushless NaviTip needle[19].

The Quantec-E irrigation system

The Quantec-E irrigation system was introduced by SybronEndo company is a selfcontained fluid delivery unit that is attached to the Quantec-E Endo System[25]. It uses a pump console, 2 irrigation reservoirs, and tubing to provide continuous irrigation during rotary instrumentation. [20]

Fig 5- NaviTipFxThe [19]

Fig 6- Quantec-E irrigation system [20]

The Vibringe System

The Vibringe System an irrigation device that combines manual delivery and sonic activation of the solution has been introduced by a Dutch company Vibringe B. V. The Vibringe is a cordless handpiece that fits in a special disposable 10-mL Luer-Lock syringe that is compatible with every irrigation needle[21]. The Vibringe allows delivery and sonic activation of the irrigating solution in one step. It employs a 2-piece syringe with a rechargeable battery. The irrigant is sonically activated, as is the needle that attaches to the syringe. [25]

Fig 7- The Vibringe System[21]

The EndoActivator System

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[25]. Because they are smooth, they do not cut dentin.[4] 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.[25]

Ultrasonic Irrigation

Fig 5- NaviTipFxThe [19]

Ultrasonic irrigation can be used as an intermittent irrigation or a continuous ultrasonic irrigation. In

Fig 8- TheEndoActivator System [4]

intermittent flushed ultrasonic irrigation, the irrigant is delivered to the root canal by a syringe needle. The irrigant is then activated with the use of an ultrasonically oscillating instrument[5]. During ultrasonic activation, a 25-gauge irrigation needle is used instead of an endosonic file.[4] This enables ultrasonic activation to be performed at the maximum power setting without causing needle breakage. In this continuous ultra sonic irrigation system the needle is simultaneously activated by the ultrasonic handpiece. Various studies demonstrated that 1 minute of continuous ultrasonic irrigation produced significantly cleaner canals and isthmi in both vital and necrotic teeth[15, 16]

The EndoVac System

The EndoVac apical negative pressure irrigation system has been introduced by Discus Dental Company. It has three components: The Master Delivery Tip, MacroCannula and MicroCannula. The Master Delivery Tip simultaneously delivers and evacuates the irrigant. The MacroCannula is used to suction irrigant from the chamber to the coronal and middle segments of the canal. The MacroCannula or MicroCannula is connected via tubing to the high-speed suction of a dental unit. The Master Delivery Tip is connected to a syringe of irrigant and the evacuation hood is connected via tubing to the high-speed suction of a dental unit[4],[16].

Fig 9- Ultrasonic Irrigation [4]

The RinsEndo System

The RinsEndo system irrigates the canal by using pressure-suction technology developed by Durr

Fig 10- The EndoVac System [4]

Dental Co. Its components are a handpiece, a cannula with a 7 mm exit aperture, and a syringe carrying irrigant. The handpiece is powered by a dental air compressor and has ansirrigation speed of 6.2 ml/min[9]. With this system, 65 mL of a rinsing solution oscillating at a frequency of 1.6 Hz is drawn from an attached syringe and transported to the root canal via an adapted cannula. During the suction phase, the used solution and air are extracted from the root canal and automatically merged with fresh rinsing solution. The pressure-suction cycles change approximately 100 times per minute[16].

Photo Activated Disinfection

Recently the concept of photo activated disinfection (PAD) in endodontic irrigation has been introduced in introduced in order to minimize or eliminate residual bacteria in the root canal[14]. PAD technique

employs a non-toxic dye, termed a photosensitizer (PS), and low intensity visible light which, in the presence of oxygen, combine to produce cytotoxic species. The principle on which it operates is that PS molecules attach to the membrane of the bacteria. Irradiation with light at a specific wavelength matched to the peak absorption of the PS leads to the production of singlet oxygen, which causes the bacterial cell wall to rupture, killing the bacteria.[11].

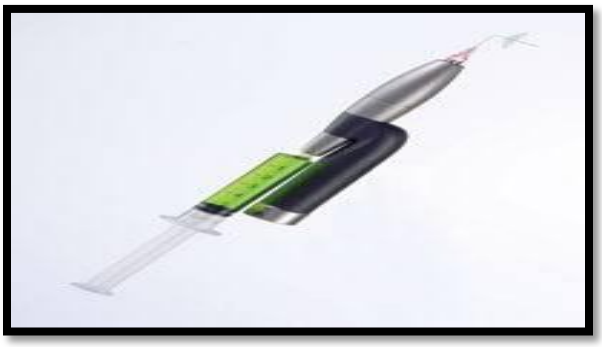


Fig 10-RinsEndo System

Ozone based Delivery System

Ozone is a triatomic molecule consisting of three oxygen atoms. It is applied to oral tissues in the forms of ozonated water, ozonated olive oil and

Fig 11- Photo Activated Disinfection [11]

oxygen/ozone gas. It is unstable and dissociates readily back into oxygen (O2), thus liberating so-called singlet oxygen (O1), which is a strong oxidizing agent which further impose the deleterious effect on microorganisms. Various delivery systems available for endodontic irrigation like Neo Ozone Water-S unit, HealOzone (Kavo) unit, the OzoTop unit.[23]

The VATEA system

The VATEA system is an irrigation device which is an integral part of Self Adjusting file rotary system (SAF). The VATEA system is a self-contained, fluid delivery unit intended to be attached to dental handpieces to deliver irrigation during endodontic procedures. During the endodontic treatment, irrigation solution is pumped from the VATEA's 400 ml reservoir. The irrigant is delivered via a disposable silicone tube to the endodontic file. The flow of irrigant is toggled using a foot pedal. The operator can adjust the flow rate from 1-10 ml/min by using the -/+ push buttons located on the control panel.[24]

Fig 12-Ozone based Delivery System [23]

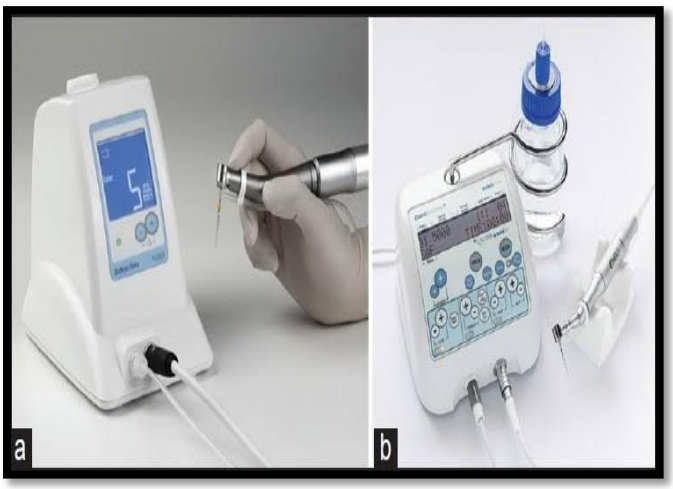


Fig 13- VATEA system [24]

Conclusion

There is no single irrigating solution that alone sufficiently covers all of the functions required from an irrigant. 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 studies should focus on determining the most appropriate irrigant and the irrigant activation devices which helps to maximum elimination of the smear layer.

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