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Review Article

Irrigants used in endodontics

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A B S T R A C T

Successful root canal therapy is always based on the combination of proper instrumentation, irrigation, and obturation of the root canal. Of these three essential steps of root canal therapy, irrigation of the root canal is the most important technique which aids in the healing of the periapical tissues. The root canal is shaped under constant irrigation to remove the inflamed and necrotic tissue, microbes, biofilms and other debris from the root canal space. There is no single irrigating solution that can alone cover all of the functions required from an irrigant. Optimal irrigation is based on the combined use of 2 or several irrigating solutions, in a proper sequence, to predictably obtain the goals of safe and effective irrigation. This article highlights various irrigants, ideal requirements of irrigants, newer irrigants and various devices and techniques used for irrigation.

Introduction

Irrigation has an important role in endodontic treatment. Irrigants prevent packing of the hard and soft tissue in the apical root canal. Many irrigants have antimicrobial activity when introduced in direct contact with the microorganisms. However, many irrigants are also cytotoxic .Irrigants are used in endodontic procedures not just as an antimicrobial agents but also to lubricate the dentinal walls. It helps in dislodging of the loosened and suspended debris from canal space and dissolve organic and inorganic components of the smear layer to clean dentine surface and so improve the bonding ability of sealers. The chemical action of irrigants further dissolves organic remnants and destroys microorganisms. An Ideal irrigant should be nontoxic, dissolve necrotic and vital pulp tissue, kill microorganisms, serve as lubricant, remove the smear layer and mechanically flushes out the debris from root canal. Apart from chemical nature of the irrigants, depth of delivery, gauge of irrigating needle, and volume used are critical factors that determine the efficacy of the irrigants.

Sodium Hypochlorite

Sodium hypochlorite (Hypochlorite) is most widely used irrigant in endodontics. It has been also used as wound irrigant since the beginning of 20th century and was introduced as a part of endodontic treatment in 1936 by Walker. Sodium hypochlorite is both an oxidizing and hydrolyzing agent. It is bactericidal and proteolytic. The tissue-dissolving capacity of Hypochlorite is well established Both vital and necrotic tissue are affected and dissolved in excess of Hypochlorite.[6]. Hypochlorite is commonly used in concentrations between 0.5% and 6%. The higher the concentration of the solution, the greater is the cytotoxicity (Chang et al, 2001). The efficacy of hypochlorite can be increased by various methods like altering pH (Abou Rass M, Oglesby SW, 1981) ,rise in temperature (Paragliola et al, 2010) and ultrasonic activation(Al-Jadaa et al, 2009).The limitations of Hypochlorite include the unpleasant taste, toxicity, and its inability to remove the smear layer by itself, as it dissolves only organic material. Extrusion of NaOCl into periapical tissues can cause severe injury to the patient. To minimize NaOCl accidents, the irrigating needle should be placed short of the working length, fit loosely in the canal and the solution must be injected using a gentle flow rate. Constantly moving the needle up and down during irrigation prevents wedging of the needle in the canal and provides better irrigation.

Mechanism of Action

Hypochlorite ionizes in water into Na^+ and the hypochlorite ion, OCl^-, establishing equilibrium with hypochlorous acid (HOCl). At acidic and neutral pH, chlorine exists predominantly as HOCl, whereas at high pH of 9 and above, OCl^- predominates. Hypochlorous acid is responsible for the antibacterial activity.

EDTA

EDTA(Ethylene Diamine Tetra Acetic Acid) is a chelating agent introduced by Nygaard - Ostby in 1957 . It reacts with the calcium ions in dentine and forms soluble calcium chelates .It effectively removes smear layer by chelating the inorganic component of the dentine .It has limited antimicrobial activity. EDTA is highly biocompatible. EDTA is often combined with citric acid, which can effectively remove the smear layer created during canal instrumentation and improves microbial activity(Sceiza et al, 2001)EDTA is used in 17% concentration and citric acid is used in the concentration of 10 to 20%. Some caution should be taken while using EDTA inside root canals because it may weaken dentine and thereby increase the risk of creating a perforation during mechanical root canal instrumentation.

Chlorhexidine

Chlorhexidine was developed in the late 1940s in the research laboratories of Imperial Chemical Industries ltd. Chlorhexidine is widely used in disinfection because of its excellent antimicrobial activity (Zehnder M, 2006) Chlorhexidine is bacteriostatic at low concentrations and bactericidal at high concentrations. The antimicrobial action is related to type, concentration, and presentation form of the irrigants as well as the microbial susceptibility (Gomes et al, 2001). The concentration often used in endodontic therapy is 2%. In high concentrations, it causes coagulation of intracellular components. One of the reasons for the popularity of Chlorhexidine is its substantivity, because it binds to hard tissue and remains antimicrobial. Due to its cationic properties, can bind to dentine and enamel and is gradually released over time (White et al, 1999).

Hydrogen Peroxide

Hydrogen peroxide (H2O2) is widely used in dentistry in various concentration ranging from 1% to 30%.A concentration of 3% and 5% is preferred in endodontic treatment .It is chemically stable and effectively active against bacteria ,yeast and viruses due to production of hydroxyl free radicals. These free radicals attack several cell components such as protein and DNA. Hydrogen peroxide lacks antimicrobial activity and tissue dissolving capability (McDonnel .G, Russel. D, 1999).

Iodine Compounds

Iodine can penetrate into microorganism and attacks cell molecules like proteins, fatty acids and nucleotides, which ultimately results in cell death. Iodine compounds are bacteriocidals, fungicidal and virucidal (Haapasalo et al, 2000).Since aqueous iodine solutions are unstable, Iodine Potasium Iodine(2%iodine in 4% potassium iodine) used in endodontics. Even though it has considerable antimicrobial activity, it still lacks tissue dissolving capability. The other main problem associated with iodine compound is , it is a potent allergen.

newer irrigants

All the irrigation solutions at our disposable have their share of limitations and the search for an ideal root canal irrigant continues with the development of newer materials and methods. Newer root canal irrigants in the horizon are as follows.

MTAD

It is a mixture of tetracycline isomer(3%doxycycline),an id(4.25%citric acid), and a detergent(Tween 80) . It was introduced as an alternative to EDTA to remove the smear layer by Torabinejad et al. It has a combined chelating and antibacterial properties. In the MTAD preparation, citric acid helps in removing the smear layer allowing the doxycycline to enter the dentinal tubules and exert an antibacterial effect (Torabinejad et al, 2003).The solubilizing effects of MTAD on pulp and dentin are somewhat similar to those of EDTA. The major difference between the actions of these solutions is a high binding affinity of the doxycycline present in MTAD for the dentin .Doxycycline has many unique properties of low pH and thus can act as a calcium chelator and cause enamel and root surface demineralization (Giardino et al, 2007)

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Tetraclean

Tetraclean is mixture of an antibiotic, an acid and a detergent. However, the concentration of the antibiotic (doxycycline-50 mg/ml), and the type of detergent (polypropylene glycol) differ from those of MTAD. Citric acid acts as a chelating agent, assisted by a weak action of the antibiotic, while the surfactant should make its penetration in the root canal system easier. It removes the smear layer and opens up the dentinal tubule orifices. It has low surface tension which enables a better adaptation of the mixtures to the dentinal walls (Giardino et al, 2006).Tetraclean caused a high degree of biofilm disaggregation at each time interval when compared with MTAD (Giardino et al 2007)

Electochemically Activated Solution

Electrochemically Activated (ECA) solutions are produced from water and low-concentrated salt solutions (Solovyeva and Dummer, 2000).Principle of ECA is transferring liquids into a metastable state via an electrochemical unipolar (anode or cathode) action through the use of an element/reactor-through “FlowElectrolytic Module” or FEM solid titanium cylinder with a special coating that fits coaxially inside the cathode, a hollow cylinder

with another special coating. The electrodes are separated by a ceramic membrane. The FEM is capable of producing types of solutions that have bactericidal and sporicidal activity and essentially noncorrosive for most metal surfaces. ECA solutions have shown better clinical effect and were associated with lesser incidences of allergic reactions compared to other antibacterial Irrigants tested.Cleaning efficacy of electrochemically activated water in root canals has been found more superior to hypochlorite by producing cleaner surfaces and greater areas of smear layer removal.

Ozonated Water

Ozonated water is a chemical compound consisting of three oxygen atoms (O_3– triatomic oxygen), a higher energetic form than normal atmospheric oxygen (O_2). Thus, the molecules of these two forms are different in structure. Ozone is produced naturally from electrical discharges following thunderstorms and from ultraviolet rays emitted from sun. Ozone is a powerful bactericide that can kill microorganism effectively (Nagayoshi et al, 2004).As a result of cavitation, A forced collapse of bubbles causes implosions that impact on surfaces, causing surface deformation, and removal of surface material. In the root canal environment, such shockwaves could potentially disrupt bacterial biofilms, rupture bacterial cell walls, and remove smear layer and debris.

Photon Activated Disinfection

Photon activated disinfection is based on photodynamic therapy (PDT).The use of photodynamic therapy (PDT) for the inactivation of microorganisms was first shown by Oscar Raab. PDT is based on the concept that nontoxic photosensitizers can be localized in certain tissues and subsequently activated by light of the appropriate wavelength to generate singlet oxygen and free radicals that are cytotoxic to cells of the target tissue. Soukos et al used the combined effect of methylene blue and red light (665 nm) exhibited up to 97% reduct potential of PDT to be used as an adjunctive antimicrobial procedure after standard endodontic debridement, but they also demonstrated the importance of further optimization of light dosimetry for bacterial photodestruction in root canals.

Herbal Irrigants

Murray et al. evaluated Morindacitrifolia juice in conjunction with EDTA as a possible alternative to Hypochlorite. Triphala (IMPCOPS Ltd, Chennai, India) is an Indian ayurvedic herbal formulation consisting of dried and powdered fruits of three medicinal plants, Terminaliabellerica, Terminaliachebula, and Emblicaofficinalis, and green tea polyphenols ; the traditional drink of Japan and China is prepared from the young shoots of tea plant Camellia sinensis(Murray et al, 2008) . Herbal alternatives showed promising antibacterial efficacy on 3- and 6-week biofilm along with MTAD and 5% sodium hypochlorite .Although Triphala and green tea polyphenols (GTPs) exhibited similar antibacterial sensitivity on E. faecalis planktonic cells, Triphala showed more potency on E. faecalis biofilm. This may be attributed to its formulation, which contains three different medicinal plants in equal proportions. In such formulations, different compounds may be of help in enhancing the potency of the active compounds resulting in an additive positive effect (Vani et al, 1997). Triphala is proven to be safe, containing active constituents that have beneficial physiologic effect apart from its curative property such as antioxidant, anti-inflammatory, and radical scavenging activity and may have an added advantage over the traditional root canal irrigant.

Irrigation devices and techniques

The effectiveness and safety of irrigation depends on the means of delivery. Traditionally, irrigation has been performed with a plastic syringe and an open-ended needle into the canal space. An increasing number of novel needle-tip designs and equipment are emerging in an effort to better address the challenges of irrigation.

Syringes

Plastic syringes of different sizes (1–20 mL) are most commonly used for irrigation. Although large-volume syringes potentially allow some time-savings, they are more difficult to control for pressure and accidents may happen. Therefore, to maximize safety and control, use of 1- to 5-mL syringes is recommended instead of the larger ones. All syringes for endodontic irrigation must have a Luer-Lokdesign. Because of the chemical reactions between many irrigants, separate syringes should be used for each solution.

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 (Desai P, Himel V, 2009).

Endoactivator

Endoactivator 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 to the handpiece that creates the sonic vibrations. EndoActivator does not deliver new irrigant to the canal but it facilitates the penetration and renewal of the irrigant in the canal (Ruddle. C, 2008)

Vibringe

Vibringe 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 (Jiang et al, 2011).

Endo Vac

EndoVac system is based on a negative-pressure approach whereby the irrigant placed in the pulp chamber is sucked down the root canal and back up again through a thin needle with a special design.it lowers the risks associated with irrigation close to the apical foramen (Simran et al, 2011).

Ultrasound

The use of ultrasonic energy for cleaning of the root canal and to facilitate disinfection has a long history in endodontics. Many studies concluded that ultrasonic , together with an irrigant, contributed to a better cleaning of the root-canal system than irrigation and hand-instrumentation alone. Cavitation and acoustic streaming of the irrigant contribute to the biochemical activity for maximum effectiveness (Martin H, Cunningham W, 1985).

Summary

Irrigation has a key role in successful endodontic treatment. Although hypochlorite is the most commonly used irrigant, no single irrigant can accomplish all the tasks required by irrigation. Detailed understanding of the mode of action of various available solutions is important for optimal irrigation. New developments in the composition of the irrigating solutions and mechanical devices used for effective delivery of the solution in complex areas of the root canal system will help to advance safe and effective irrigation.

References

Abou-Rass M, Oglesby SW.The effects of temperature, concentration, and tissue type on the solvent ability of sodium hypochlorite.JEndod. 1981 Aug; 7(8):376-7

Al-Jadaa A, Paqué F, Attin T, Zehnder Acoustic hypochlorite activation in simulated curved canals J Endod. 2009 Oct; 35(10):1408-11.

Athanassiadis B, Abbott PV, Walsh LJ.Review The use of calcium hydroxide, antibiotics and biocides as antimicrobial medicaments in endodontics.Aust Dent J. 2007 Mar; 52(1 Suppl):S64-82.

Chang YC, Huang FM, Tai KW, Chou MY. The effect of sodium hypochlorite and chlorhexidine on cultured human periodontal ligament cells. Oral Surg Oral Med Oral Pathol Oral RadiolEndod 2001;92:446-450.

Cobankara FK, Ozkan HB, Terlemez A. Comparison of Organic Tissue Dissolution Capacities of Sodium Hypochlorite and Chlorine Dioxide. J Endod. 2010;36:272–4.

Desai P, Himel V. Comparative safety of various intracanal irrigation systems.J Endod 2009;35:545–9.

Dona BL, Grundemann LJ, Steinfort J, Timmerman MF, van der Weijden GA. The inhibitory effect of combining chlorhexidine and hydrogen peroxide on 3-day plaque accumulation. J ClinPeriodontol 1998;25:879-883.

Eto JN, Niu W, Takeda FH, Kimura Y, Matsumoto K. Morphological and atomic analytical changes of root canal wall dentin after treatment with thirty-eight percent $Ag(NH_3)_2F$ solution and CO_2 laser. J Clin Laser Med Surg. 1999;17:19–24

Frais S, Ng YL, Gulabivala K. Some factors affecting the concentration of available chlorine in commercial sources of sodium hypochlorite. IntEndod J 2001;34:206-215.

Giardino L, Ambu E, Becce C, Rimondini L, Morra M. Surface tension comparison of four common root canal irrigants and two new irrigants containing antibiotic. J. Endod 2006; 32:1091-3.

Gomes BP, Ferraz CC, Vianna ME, Berber VB, Teixeira FB, Souza-FilhoFJ.In vitro antimicrobial activity of several concentrations of sodium hypochlorite and chlorhexidinegluconate in the elimination of Enterococcus faecalis.IntEndod J. 2001 Sep; 34(6):424-8

Haapasalo M, Endal U,Zandi H, ColiJ. Eradication of endodontic infection by instrumentation and irrigation solutions. endodontic topics 2000;68:6785-6789HJ

Hulsmann M, Hahn W. Complications during root canal irrigation: literature review and case reports [review]. IntEndod J 2000;33:186–93

Harrison JW, Hand RE. The effect of dilution and organic matter on the antibacterial property of 5.25% sodium hypochlorite.JEndod. 1981;7:128–32

Jiang LM, Verhaagen B, Versluis M, van derSluis LW. Evaluation of a Volume 2, Issue 1, JULY-AUGUST 2011 sonic device designed to activate irrigant in the root canal. J Endod 2010;36:143-6.11

Martin H, Cunningham W. Endosonics–the ultrasonic synergistic system of endodontics. Endod Dent Traumatol 1985;1:201–6.

McDonnell G, Russell D. Antiseptics and disinfectants: activity, action, and resistance. Clin Microbial Rev 1999;12:147-179

Mohammadi Z, Abbott PV Review The properties and applications of chlorhexidine in endodontics. IntEndod J. 2009 Apr; 42(4):288-302.

Moorer WR, Wesselink PR. Factors promoting the tissue dissolving capability of sodium hypochlorite. IntEndod J1982;15:187-196.

Murray P. E, Farber R. M,. Namerow K. N, Kuttler S, and. Garcia-Godoy F, "Evaluation o Morindacitrifolia asJournalanofEndodontics,vol.34,no.1,pp. Irrigant,"66–70,2008.

Nagayoshi M, Kitamura C, Fukuizumi T., Nishihara T, and Terashita. M, "Antimicrobial eff water on bacteria invading dentinal tubules,"–781,2004 Jou

Paragliola R, Franco V, Fabiani C, Mazzoni A, Nato F, Tay FR, Breschi L, GrandiniS.Final rinse optimization: influence of different agitation protocols.JEndod. 2010 Feb; 36(2):282-5

Peters OA, Shnonenenberger K, Laib A. Effects of four Ni-Ti preparation techniqueson root canal geometry assessed by micro computed tomography. IntEndod J 2001;34:221–30.

Rolla G, Loe H, Schiott CR. The affinity of chlorhexidine for hydroxyapatite and salivary mucins. J Periodontal Res 1970;5:90-95.

Ruddle C. Endodontic disinfection-tsunami irrigation. Endod Prac 2008;5: 8-17

Sceiza MF, Daniel RL, Santos EM, Jaeger MM, Cytotoxic effects of 10% citric acid and EDTA-T used as root canal irrigants. An in Vitro Analysis. J Endod 2001; 7: 741-3

Simran Sandhu, Vanita Keshav, Deepti Dhingra. Indian journals, Volume 2, Issue 1, JULY-AUGUST 2011 Sirtes G, Waltimo T, Schaetzle M, Zehnder M. The effects of temperature on sodium hypochlorite short-term stability,pulp dissolution capacity, and antimicrobial efficacy. JEndod 2005;31:669-671.

Solovyeva A. M. and Dummer P. M. H., "Cleaning effectiveness of root electrochemically activated anolyteInternational Endodonticand catholyteJournal, vol. 33, no. 6, pp. 494–504, 2000.

Torabinejad M, Khademi A A, Babagoli j, Cho Y, JohnsonW B, Bozhilov K, A new solution for removal of smear layer.JEndod 2003;29:170-5.

TomitaY.and ShimaA,"Mechanisms of impulsive pressure by bubbleThecollapse,"Journal of Fluid – 564,Mechanics,.1986 vol.

Vani T, Rajani M, Sark,**a** Shishoondr C.,J"Antioxidant properties o triphala andIni**t**ernationalsconstituents,"Journal of Pharmaco–317, 1997

Von Der Fehr FR, NygaardÖstby B. Effect of EDTAC and sulfuric acid on root canal dentine. Oral Surg Oral Med Oral Pathol. 1963;16:199–205

Vianna ME, Gomes BP, Berber VB, Zaia AA, Ferraz CC, de Souza-Filho FJ In vitro evaluation of the antimicrobial activity of chlorhexidine and sodium hypochlorite.Oral Surg Oral Med Oral Pathol Oral RadiolEndod. 2004 Jan; 97(1):79-84