Recent trends in irrigation in endodontics

Madhulika Singh[1], Asheesh Sawhny[2], Annu Kushwaha[3], Prateek Singh[4] , Richa Singh[5]

[1]Post Graduate Student, Department of Conservative Dentistry and Endodontics,Rama Dental College, Kanpur UP India

[2]Principal &Professor, Department of Conservative Dentistry and Endodontics, Rama Dental College Kanpur UP India

[3]Reader, Department of Conservative Dentistry and Endodontics, Rama Dental College Kanpur UP India

[4]Reader, Department of Conservative Dentistry and Endodontics, Rama Dental College Kanpur UP India

[5]Reader, Department of Conservative Dentistry and Endodontics, Rama Dental College Kanpur UP India

Abstract

Local wound debridement within the diseased pulp space is a crucial step in root canal treatment to prevent the tooth from becoming a source of infection. The success of root canal therapy relies on a combination of proper instrumentation, irrigation, and obturation of the root canal. Among these essential steps, irrigation plays the most significant role in promoting the healing of periapical tissues. During the procedure, the root canal is shaped under continuous irrigation to remove inflamed and necrotic tissues, microbes, biofilms, and other debris. However, no single irrigating solution can fulfill all the required functions. Optimal irrigation is achieved through the combined use of two or more solutions in a specific sequence to ensure safe and effective results.
This article explores various irrigants, their ideal properties, and the latest advancements in irrigation solutions.

Keywords:

Root canal treatment, Irrigation , Sodium hypochlorite

Introduction

The success of endodontic treatment relies on eliminating microbes (if present) from the root canal system and preventing reinfection. The root canal is prepared using hand and rotary instruments, accompanied by continuous irrigation, to remove inflamed and necrotic tissue, microbes or biofilms, and other debris from the canal space. The primary objective of instrumentation is to enable efficient irrigation, disinfection, and filling. The cleanliness of the root canal is significantly influenced by the design of the cutting blades on rotary instruments. Numerous studies utilizing advanced techniques have explored this aspect Techniques such as microcomputed tomography (CT) scanning have revealed that a significant portion of the main root canal wall remains untouched by instruments (Peters et al., 2001; Jeon et al., 2003). This highlights the critical need for appropriate instruments, such as nickel-titanium rotary reamers for straight root canals, along with chemical methods to thoroughly clean and disinfect all areas of the root canal. Any new concepts or techniques introduced into clinical practice should ideally undergo evaluation through randomized controlled clinical trials, comparing them to established gold standards. This approach ensures... However, this poses a significant challenge in endodontic research. A successful outcome of root canal treatment is typically defined by the reduction of radiographic lesions and the absence of clinical symptoms in the treated tooth after a minimum observation period of one year (Ørstavik, 1996). Alternatively, surrogate outcome variables, such as the microbial load remaining in the root canal system after various treatment protocols, can provide quicker results. However, these variables do not always correlate with the "true" treatment outcome (Peters et al., 2002).

Local wound debridement within the diseased pulp space is a critical step in root canal treatment to prevent the tooth from serving as a source of infection. While sodium hypochlorite (NaOCl) is the recommended primary irrigant (Zehnder, 2006), ethnobotanical treatments have identified alternatives to chemical irrigants. Notably, Morinda citrifolia juice (MCJ) is among the first fruit juices proposed as a potential alternative to NaOCl for intracanal irrigation (Murray et al., 2008).

Endodontic success depends on various factors (Ørstavik et al., 2004), allowing for compensation in cases where one treatment step is suboptimal. For instance, if cultivable microbiota persist after inadequate canal disinfection, they may theoretically be sealed within the canal system by an ideal root canal filling, potentially still resulting in clinical success (Saleh et al., 2004; Peters and Wesselink, 2002).

To enhance irrigation effectiveness, many compounds have been chemically modified, and several mechanical devices have been developed to improve penetration and efficacy. The success rate for retreatment of endodontically failed teeth remains between 50–70%. However, recent advancements and innovative approaches in pulp regeneration, including the isolation and characterization of pulp stem/progenitor cells and partial... regeneration of pulp tissue offers promising possibilities for improving outcomes. Complete pulp regeneration using tissue stem cells has also been explored (Nakashima and Iohara, 2014).

This article provides an overview of the chemistry, biology, and techniques for safe and effective irrigation in endodontics. Additionally, it highlights the latest advancements and cutting-edge developments in this field, offering valuable insights for improving clinical outcomes.

Goals of irrigation

Irrigation plays a vital role in endodontic treatment. During and after instrumentation, irrigants facilitate the removal of microorganisms, tissue remnants, and dentin debris from the root canal through a flushing mechanism (Box 1). They also help prevent the compaction of hard and soft tissue within the apical root canal and the extrusion of infected material into the periapical area. Certain irrigating solutions can dissolve organic or inorganic tissues in the root canal, while others possess antimicrobial properties that actively kill bacteria and yeasts upon direct contact.

However, many irrigating solutions exhibit cytotoxic potential and may cause severe pain if they infiltrate periapical tissues (Hülsmann and Hahn, 2000). An ideal irrigant should exhibit all or most of the beneficial properties listed in Box 1 without causing any adverse effects. Unfortunately, no single irrigating solution meets all these criteria. Therefore, using a combination of products in the appropriate sequence is essential for achieving successful treatment outcomes.

Box 1: Desired Functions of Irrigating Solutions

- Washing action (aids in debris removal)
- Reduces instrument friction during preparation (acts as a lubricant)
- Facilitate dentin removal (acts as a lubricant)
- Dissolve inorganic tissue (e.g., dentin)
- Penetrate to the canal periphery
- Dissolve organic matter (e.g., dentin collagen, pulp tissue, biofilm)
- Eliminate bacteria and yeasts (including within biofilm)
- Avoid irritation or damage to vital periapical tissues; no caustic or cytotoxic effects
- Preserve tooth structure without causing weakening.

Irrigating solutions

Sodium hypochlorite

Sodium hypochlorite (NaOCl) is the most commonly used irrigating solution in endodontics. When dissolved in water, NaOCl ionizes into sodium (Na^+) and hypochlorite (OCl^-) ions, establishing equilibrium with hypochlorous acid (HOCl). At acidic and neutral pH, chlorine primarily exists as HOCl, whereas at higher pH levels (around 9 and above), OCl^- predominates (McDonnell and Russell, 1999). Hypochlorous acid is responsible for the solution's antibacterial activity, while the OCl^- ion is less effective than HOCl. HOCl disrupts several essential functions within microbial cells, leading to cell death (Barrette et al., 1989; McKenna and Davies, 1988).

Hypochlorite solutions are both sporicidal and virucidal and exhibit significantly stronger tissue-dissolving effects on necrotic tissues than on vital ones. These properties have made aqueous sodium hypochlorite the primary irrigant in endodontics since as early as 1920. However, there has been considerable debate regarding the ideal concentration of hypochlorite solutions for endodontic use. The antibacterial efficacy and tissue dissolution capacity of aqueous hypochlorite depend on its concentration, as does its toxicity (Zehnder, 2006). Most American practitioners appear to use "full-strength" 5.25% sodium hypochlorite, as it is commonly sold in the form of household bleach, leading to... root canal system. However, it is not without its drawbacks. High concentrations of sodium hypochlorite, such as the commonly used 5.25% solution, can cause adverse reactions like irritation and a reduction in the flexural strength of dentin. Additionally, the reduction in microbiota was not significantly improved with this high concentration. It's important to note that during irrigation, fresh hypochlorite continuously reaches the canal system, meaning the concentration of the solution may not be the most crucial factor in its effectiveness (Zehnder, 2006).

One method to enhance the efficacy of sodium hypochlorite is to use it in a heated form, which improves its tissue-dissolution capacity. Heated hypochlorite solutions also more effectively remove organic debris from dentin shavings compared to unheated solutions (El Karim et al., 2007).

Despite its benefits, NaOCl has several weaknesses, including its unpleasant taste, toxicity, and inability to remove the smear layer on its own since it only dissolves organic material (Spångberg et al., 1973). Its antimicrobial effectiveness in vivo is also limited, likely due to difficulties in reaching the most peripheral parts of the root canal system, such as fins, anastomoses, apical canal, lateral canals, and dentin canals. Furthermore, substances that inactivate NaOCl, such as exudate from the periapical area, pulp tissue, dentin collagen, and microbial biomass, can reduce its effectiveness (Haapasalo et al., 2000).

Recent in vitro studies have shown that long-term exposure of dentin to high-concentration sodium hypochlorite can negatively affect dentin elasticity and flexural strength (Sim et al., 2001; Marending et al., 2007). While there are no clinical data to confirm this, it raises concerns about whether prolonged use of hypochlorite may increase the risk of vertical root fractures.

In summary, sodium hypochlorite remains the most important irrigating solution in endodontics due to its unique ability to dissolve organic tissue, including biofilm and the organic components of the root canal system. However, its use must be carefully managed to avoid potential drawbacks. Sodium hypochlorite should be used throughout the instrumentation phase due to its ability to dissolve organic tissue and remove the smear layer. However, it is advisable to avoid using hypochlorite as the final rinse following EDTA, as it can cause rapid and severe erosion of the canal-wall dentin (Niu et al., 2002). This combination may result in undesirable damage to the dentin structure, which should be considered when planning irrigation protocols.

Chlorhexidine

Chlorhexidine was first developed in the late 1940s at the research facilities of Imperial Chemical Industries Ltd. (Macclesfield, England). Initially, the salts used were chlorhexidine acetate and hydrochloride, both of which have limited solubility in water (Zehnder, 2006). As a result, chlorhexidine digluconate has replaced them. Chlorhexidine is a powerful antiseptic, widely used for controlling plaque in the mouth. Aqueous solutions with concentrations of 0.1 to 0.2% are recommended for this purpose, while 2% is typically used in root canal irrigating solutions in endodontic studies (Zehnder, 2006). While it is often believed that chlorhexidine is less caustic than sodium hypochlorite, this is not always the case (Zehnder, 2006). A 2% chlorhexidine solution can cause skin irritation (Zehnder, 2006). Similar to sodium hypochlorite, heating a less concentrated chlorhexidine solution could improve its local effectiveness in the root canal system while minimizing systemic toxicity. However, despite its usefulness as a final irrigant, chlorhexidine should not be used as the primary irrigant in typical endodontic procedures because (a) it cannot dissolve necrotic tissue, and (b) it is less effective against Gram-negative bacteria compared to Gram-positive bacteria.

EDTA

Although sodium hypochlorite seems to be the most preferred single endodontic solution, Sodium hypochlorite is considered the most effective single irrigant for endodontic procedures; however, it cannot dissolve inorganic dentin particles, which prevents the formation of a smear layer during instrumentation (Garberoglio and Becce, 1994). To address this, demineralizing agents like ethylenediamine tetraacetic acid (EDTA) and citric acid are recommended as adjuncts in root canal therapy (Garberoglio and Becce, 1994; Ayad, 2001). These agents are highly biocompatible and frequently used in personal care products. While citric acid may be slightly more potent than EDTA at similar concentrations, both are highly effective at removing the smear layer (Zehnder, 2006). In addition to their cleaning properties, these chelating agents can also detach biofilms from root canal walls. A treatment regimen alternating between sodium hypochlorite and EDTA may be more effective in reducing bacterial loads in the root canal system compared to sodium hypochlorite alone (Zehnder, 2006). To enhance antimicrobial action, antiseptics like quaternary ammonium compounds (EDTAC) or tetracycline antibiotics (MTAD) are sometimes added to EDTA and citric acid irrigants, respectively, although the clinical benefits of this addition are uncertain (Torabinejad et al., 2003; Baker et al., 1983). In general, antibiotics are not recommended for local wound debridement since they were designed for systemic use and have a narrower spectrum than biocides like hypochlorite or chlorhexidine. Moreover, both citric acid and EDTA immediately reduce the available chlorine in sodium hypochlorite solutions, rendering them ineffective against bacteria and necrotic tissue. Therefore, citric acid or EDTA should never be mixed with sodium hypochlorite (Zehnder, 2006). Calt and Serper (2002) found that 10 mL of 17% EDTA irrigated for 1 minute effectively removed the smear layer. While a 1-minute application of 17% EDTA effectively removed the smear layer, a 10-minute application resulted in excessive erosion of both peritubular and intertubular dentin. It has been demonstrated that increasing the contact time and concentration of EDTA from 10% to 17%, as well as lowering the pH from 9.0 to 7.5, enhances dentin demineralization.

Need for newer root canal irrigant

All available irrigation solutions have their own limitations, and the quest for the perfect root canal irrigant continues, with ongoing advancements in materials and techniques. The following are some of the newer root canal irrigants being explored:

(1)MTAD

(2Tetraclean

(3) Ozonated water

(4) Electrochemically activated solutions,

(5) Photon-activated disinfection,

(6) Herbal irrigants.

The article examines the benefits and drawbacks of these newer irrigating agents and their potential role in endodontic irrigation in the near future.

MTAD

BioPure MTAD (Dentsply, Tulsa, OK) is a solution composed of a tetracycline isomer, acetic acid, and Tween 80 detergent. It was specifically developed for use as a final rinse in root canal treatment before obturation (Torabinejad et al., 2003). Tetracycline possesses distinct properties, including a low pH, which allows it to act as a calcium chelator, leading to enamel and root surface demineralization (Bjorvatn et al., 1985). Its ability to demineralize dentin is similar to that of citric acid (Wikesjo et al., 1986). Additionally, tetracycline exhibits substantivity, meaning it can be absorbed by tooth structures such as dentin and cementum and gradually released over time (Baker et al., 1983; Wikesjo et al., 1986). Furthermore, research has demonstrated that tetracycline has significant effectsTetracycline has been shown to promote healing following surgical periodontal procedures. According to the manufacturer's instructions, the recommended method for using this irrigant involves flooding the root canal with 1 mL of the solution and allowing it to soak for five minutes, followed by the gradual delivery of the remaining 4 mL through continuous irrigation and suction (Torabinejad et al., 2003).

MTAD offers several advantages over conventional root canal irrigants and solutions. It effectively removes the smear layer along the entire length of the root canal and eliminates both organic and inorganic debris without causing erosion or structural changes in dentin, unlike a combination of 5.25% sodium hypochlorite and 17% EDTA, which can lead to such alterations (Shabahang et al., 2003; Shabahang & Torabinejad, 2003; Torabinejad et al., 2003; Zhang et al., 2003).

Notably, the MTAD solution is particularly effective against Enterococcus faecalis and has lower cytotoxicity compared to various other endodontic medicaments, including eugenol, 3% hydrogen peroxide, EDTA, and calcium hydroxide paste (Shraev et al., 1993; Legchilo et al., 1996; Raab et al., 1900; Dougherty et al., 1998). Research by Torabinejad et al. indicates that MTAD's efficacy improves when used following a low concentration of sodium hypochlorite as an intracanal irrigant. Additionally, MTAD does not appear to cause significant structural changes to dentinal tubules (Torabinejad et al., 2003).

.***Tetraclean***

Tetraclean (Ogna Laboratori Farmaceutici, Muggiò, Italy), similar to MTAD, is a combination of an antibiotic, an acid, and a detergent. However, Tetraclean differs in its antibiotic concentration (doxycycline at 50 mg/mL) and the type of detergent used (polypropylene glycol) compared to MTAD [52]. Giardino et al. conducted a comparison of the surface tension of 17% EDTA, Cetrexidin, Smear Clear, 5.25% NaOCl, MTAD, and Tetraclean [52]. They found that NaOCl and EDTA exhibited the highest surface tension, while Cetrexidin and Tetraclean had the lowest values. In another study, the antimicrobial effectiveness of 5.25% NaOCl, MTAD, and Tetraclean was tested against an E. faecalis biofilm formed on cellulose nitrate membrane filters. Only NaOCl was able to disaggregate and remove the biofilm at all time intervals. However, treatment with Tetraclean resulted in significant biofilm disaggregation at each time interval when compared to MTAD [53].

Ozonated water

Ozone is a chemical compound made up of three oxygen atoms (O3), making it a higher-energy form than the typical atmospheric oxygen (O2). The molecules of these two forms differ in structure. Ozone is naturally produced in the following ways:

1. Electrical discharges: Ozone is created during thunderstorms when an oxygen molecule is split into two oxygen atoms by an electrical discharge. These individual atoms then combine with other oxygen molecules to form O3.

2. Ultraviolet rays from the sun: Ultraviolet radiation emitted by the sun acts like an electrical discharge in the stratosphere, resulting in the formation of the ozone layer, which absorbs most of the sun's ultraviolet radiation.

Ozone is a highly effective bactericide that can kill microorganisms effectively. It is an unstable gas with strong oxidizing properties, capable of damaging biological entities. Studies have shown that even at low concentrations, such as 0.1 ppm, ozone can inactivate bacterial cells, including their spores [65]. It is naturally present in the air and can be easily produced using an ozone generator. When introduced into water, ozone dissolves and dissociates quickly. The concentration of ozone in ozonated water can be measured with a dissolved ozone meter. While ozonated water is a powerful antimicrobial agent against bacteria, fungi, protozoa, and viruses, there has been less focus on its antibacterial activity against bacterial biofilms, particularly in relation to root canal infections [66, 67]. Cavitation refers to the formation of vapor-filled bubbles within a fluid, which generate pressure waves or shockwaves characterized by rapid pressure changes and high amplitude [68]. The forced collapse of these bubbles causes implosions that impact surfaces, creating shear forces, surface deformation, and removal of surface material [69]. In the context of root canal treatment, such shockwaves could potentially disrupt bacterial biofilms, rupture bacterial cell walls, and aid in the removal of the smear layer and debris. The generation of shockwaves can also enhance the breakdown of agents like hydrogen peroxide and ozone dissolved in water, improving their disinfecting and debriding effects [70, 71].

Nagayoshi et al. found that the bacterial killing ability of ozonated water and 2.5% sodium hypochlorite was nearly identical when the specimen was treated with sonication [72]. However, a study by Hems et al. concluded that NaOCl was more effective than ozonated water in killing E. faecalis in both broth culture and biofilm [73]. Ibrahim and Abdullah found that 1.31% NaOCl could enhance the antibacterial effect when combined with ozonated water, suggesting a synergistic action compared to either solution alone [67].

Cardoso evaluated the use of ozonated water as an irrigant during endodontic treatment to eliminate Candida albicans and Enterococcus faecalis and to neutralize lipopolysaccharides (LPS) in root canals [16]. The study showed effective antimicrobial action after ten minutes of ozonization in the microbial suspension, with no residue found in samples taken seven days later. However, ozonated water was unable to neutralize E. coli and LPS in the root canals, and the remaining LPS could potentially contribute to conditions like apical periodontitis. Estrela et al. assessed the antimicrobial effectiveness of aqueous ozone, gaseous ozone, 2.5% sodium hypochlorite, and 2% chlorhexidine in human root canals infected with Enterococcus faecalis. They found that none of the tested solutions effectively eliminated the bacterial suspension [74, 75].

Further research and modifications to ozonated water are necessary before it can be considered a reliable root canal irrigant.

Electrochemically activated ssolution

Electrochemically Activated (ECA) solutions are created from tap water and low-concentrated salt solutions (Solovyeva and Dummer, 2000; Bakhir et al., 1986; Bakhir et al., 1989). The ECA technology represents a new scientific approach developed by Russian scientists at the All-Russian Institute for Medical Engineering in Moscow, Russia (CIS). The principle of ECA involves transforming liquids into a metastable state. The electrochemical process occurs in a unipolar (anode or cathode) manner through the use of an element/reactor known as a "Flow-through Electrolytic Module" (FEM). The FEM consists of an anode, which is a solid titanium cylinder with a special coating, and a cathode, a hollow titanium cylinder with another special coating. These two electrodes are separated by a ceramic membrane. The FEM is capable of producing solutions with bactericidal and sporicidal properties, yet they are odorless, safe for human tissues, and essentially non-corrosive to most metal surfaces (Solovyeva and Dummer, 2000).

In the electrochemical process, the anode and cathode chambers generate two types of solutions: the solution produced in the anode chamber is called Anolyte, while the solution produced in the cathode chamber is called Catholyte. Anolyte solutions, which contain a mixture of oxidizing substances, exhibit significant microbiocidal effectiveness against bacteria, viruses, fungi, and protozoa (Solovyeva and Dummer, 2000; Prilutskii et al., 1996). Anolyte has been referred to as Superoxidized Water or Oxidative Potential Water (Selkon et al., 1999; Hata et al., 1996). Depending on the type of ECA device incorporating the FEM, the pH of Anolyte can vary, ranging from acidic (Anolyte), neutral (Anolyte Neutral), to alkaline (Anolyte Neutral Cathodic). Initially, acidic Anolyte was used, but recent years have seen a shift toward using neutral and alkaline solutions for clinical applications.

Under clean conditions, freshly generated superoxidized solutions have been shown to be highly effective against various microorganisms, achieving a 99.999% or greater reduction in two minutes or less. This has led to the recognition of these solutions as potent microbiocidal agents (Selkon et al., 1999; Shetty et al., 1999). Moreover, they are non-toxic when in contact with vital biological tissues (Shraev and Legchilo, 1989). Clinical applications of Anolyte and Catholyte have been reported to be effective (Legchilo et al., 1996). ECA solutions showed more pronounced clinical effects and were associated with fewer allergic reactions compared to other antibacterial irrigants tested (Legchilo et al., 1996). Studies have demonstrated the cleaning efficiency and safety of ECA solutions for dental instruments and equipment surfaces. ECA shows promising results due to its ability to effectively remove debris and the smear layer, its non-toxicity, and its efficiency in the apical one-third of the canal. It holds significant potential as an effective root canal irrigant.

Photon-activated disinfection

Photodynamic therapy (PDT) for microorganism inactivation was first demonstrated by Oscar Raab, who described the lethal effects of acridine hydrochloride on Paramecia caudatum (Raab, 1900; Dougherty et al., 1998). PDT operates on the principle that non-toxic photosensitizers can localize in specific tissues and, when activated by light of a suitable wavelength, produce singlet oxygen and free radicals that are cytotoxic to target cells (Dougherty et al., 1998). Methylene blue (MB) is a well-known photosensitizer widely used in PDT to target various gram-positive and gram-negative oral bacteria. It has also been employed in studies examining PDT's role in endodontic disinfection (Harris et al., 2005; Soukos et al., 2006; Foschi et al., 2007; George and Kishen, 2007a; George and Kishen, 2007b; Fimple et al., 2008; George and Kishen, 2008; Lim et al., 2009). However, multiple studies have reported incomplete elimination of oral biofilms with MB-mediated PDT due to the limited penetration of the photosensitizer (Soukos et al., 2000; Ogura et al., 2007; Muller et al., 2007). Fontana et al. (2009) observed that the combined use of methylene blue (MB) and red light (665 nm) achieved up to a 97% reduction in bacterial viability. Their findings highlighted the potential of photodynamic therapy (PDT) as an adjunct antimicrobial treatment following standard endodontic chemomechanical debridement. However, they also emphasized the need for further optimization of light dosimetry to enhance bacterial destruction within root canals.

In addition to methylene blue, tolonium chloride has also been utilized as a photosensitizer. When applied to infected areas, it binds to bacterial cell membranes and, upon activation by a laser emitting the appropriate wavelength (e.g., 635 nm from SaveDent, Denfotex Light Systems Ltd., United Kingdom), causes membrane rupture. The laser light is delivered into root canals via a small flexible optical fiber attached to a disposable handpiece. Operating at a maximum output of 100 mW, the laser does not generate enough heat to damage surrounding tissues. Moreover, tolonium chloride is biocompatible and does not stain dental tissues. According to the manufacturer, this photoactivated disinfection (PAD) system exhibits antimicrobial efficacy (Williams et al., 2003).

However, Seal et al. (2002) reported that the combination of a helium-neon laser and tolonium chloride was unable to achieve complete elimination of Streptococcus intermedius biofilms in root canals. Similarly, Leticia et al. (2010) investigated the antibacterial effects of PDT using methylene blue (MB) or toluidine blue (TB), both at 15 mg/mL, as an adjunct to root canal instrumentation and irrigation in experimental Enterococcus faecalis infections. Their study found that PDT with MB or TB did not significantly enhance the antibacterial effects. Instrumentation and irrigation procedures alone have limited effectiveness in achieving intracanal disinfection, as adjustments to the photodynamic therapy (PDT) protocol are needed before its clinical application can be fully recommended. In contrast, irrigation with 3% sodium hypochlorite successfully eliminated the entire bacterial population. This difference might be attributed to improper positioning of the optical fiber in the root canals, which hinders light transmission through the tooth structure. As a result, photoactivated disinfection (PAD) may not achieve complete bacterial eradication in root canals with complex anatomy and polymicrobial biofilms of diverse characteristics.

Pagonis et al. (2010) investigated the in vitro effects of poly(lactic-co-glycolic acid) (PLGA) nanoparticles loaded with methylene blue (MB) and activated by light on Enterococcus faecalis (ATCC 29212). Their study suggested that PLGA nanoparticles encapsulating photoactive drugs could serve as a promising adjunct in antimicrobial endodontic treatment. While PAD is not yet capable of guaranteeing 100% bacterial elimination, it remains a valuable supplementary technique for conventional root canal therapy.

Herbal

Murray et al. (2008) explored the potential of Morinda citrifolia juice combined with EDTA as an alternative to sodium hypochlorite (NaOCl) for root canal irrigation. Another herbal alternative, Triphala (IMPCOPS Ltd, Chennai, India), is an Ayurvedic formulation made from the dried and powdered fruits of three medicinal plants: Terminalia bellerica, Terminalia chebula, and Emblica officinalis. Additionally, green tea polyphenols (GTPs), derived from the young shoots of the tea plant Camellia sinensis—a traditional beverage in Japan and China—have also been investigated for their potential antimicrobial properties (Murray et al., 2008; Jagetia et al., 2002; Hamilton-Miller, 2001; Prabhakar et al., 2010). These herbal alternatives demonstrated promising results. Herbal alternatives, such as Triphala and green tea polyphenols (GTPs), have demonstrated promising antibacterial efficacy against 3- and 6-week biofilms, comparable to MTAD and 5% sodium hypochlorite (NaOCl) (Prabhakar et al., 2010). Although both Triphala and GTPs exhibited similar antibacterial effects on E. faecalis planktonic cells, Triphala proved more effective against E. faecalis biofilms. This enhanced potency may result from its formulation, which combines three medicinal plants in equal proportions, potentially creating an additive or synergistic effect by enhancing the activity of its active compounds.

According to Prabhakar et al. (2010), 5% NaOCl displayed excellent antibacterial activity against both 3-week and 6-week biofilms, whereas Triphala and MTAD achieved complete eradication only in 3-week biofilms. Triphala and GTPs are not only effective but also safe, offering additional physiologic benefits such as antioxidant, anti-inflammatory, and radical-scavenging activities. These advantages may provide an edge over traditional root canal irrigants (Vani et al., 1997; Rasool and Sabina, 2007; Jagetia et al., 2004; Zhao, 2003).

Conclusion

The article explored potential new irrigants that could serve as substitutes for traditional endodontic irrigants. Existing literature and studies highlight both the advantages and limitations of each option, but none fully meet the criteria for an ideal root canal irrigant. At present, these newer irrigants can be considered as adjuncts to sodium hypochlorite (NaOCl), while the search for the ideal root canal irrigant continues.

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AUTHOR DETAILS:

Madhulika Singh - [1]Post Graduate student, Department of Conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre, Kanpur,Uttar Pradesh, India

annuvarient18@gmail.com. 8957651725

Asheesh Sawhny- [2]Principal and Head, Department of Conservative Dentistry and Endodontics,Rama Dental College Hospital and Research Centre, Kanpur, Uttar Pradesh, India.

drasheeshmydentist@gmail.com 9838500100

Annu Kushwaha - [3]Reader, Department of conservative Dentistry and Endodontics,

Rama Dental College Hospital and Research Centre, Kanpur, UP, India

annusingh144@gmail.com 8400836432.

Prateek Singh- [4]Reader, Department of Conservative Dentistry and Endodontics,

Rama Dental College Hospital and Research Centre,Kanpur, UP, India

kushwahaprateek@gmail.com 9721628299

Richa Singh - [5]Reader, Department of Conservative Dentistry and Endodontics, Rama

Dental College Hospital and Research Centre, Kanpur, UP, India

drrichasingh.2804@gmail.com. 9838870041.

Corresponding Author:

Madhulika Singh –[1]Post Graduate Student, Department of Conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre, Kanpur, UP, India. s annuvarient18@gmail.com. 8957651725