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Review Article

Role of Irrigants in Endodontics: A Comprehensive Review

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Abstract

It has been amply demonstrated in both human and animal research that different microorganisms behave in different ways in the development of pulpal and peri apical disorders. Endodontic treatments last longer when using various tools such endodontic files, rotatory endodontics, chelating agents, intracanal irrigating solution, and medications. If the infection is eliminated before the three-dimensional obturation, the odds of the endodontically treated tooth lasting longer are increased. If not treated or cleaned adequately some root canals with anastomoses, the presence of culde sacs, and/or deltas are found to be exceedingly difficult to obturate in three dimensions. The success of endodontic procedures depends on several variables, including biomechanical preparation, sterilization, or disinfection of the pulp space, and last but not least, obturation of the canal to allow for disinfection of the prepared canal space. Instrumentation is the only aspect that is insufficient. The use of additional tools like endodontic intracanal irrigant is very important and necessary for the same.

Keywords: *Endodontic irrigation, Root canal irrigation, Endodontic treatments.*

Introduction

The root canal system is made up of branches that connect to the attachment apparatus apically, laterally, and often furcally. Thus, perfect microorganism removal from the root canal is necessary for successful endodontic treatment. While the mechanical goal of irrigation is to encourage the three-dimensional cleaning and obturation of the intricate root anatomy, the biological goal is to remove the root canal environment as a cause of irritation to the apical area. [1]

The irrigating solution and the irrigant delivery system are key components of effective irrigation. Sodium hypochlorite, chlorhexidine, ethylenediaminetetraacetic acid (EDTA), citric acid, MTAD, and alcohol are a few of the widely used irrigants. [2] According to Haapasalo, the optimal root canal irrigant should be biocompatible with the surrounding tissues, have a broad range of action, perform lubrication, dissolve organic and inorganic waste, and have good washing activity. Current irrigation solution cannot be considered ideal since it lacks some or all the aforementioned characteristics. As a result, they are all utilized in conjunction with one another in the proper order to produce the greatest cleaning effectiveness. [3,4] Aim of the present review of literature is to discuss current trends in irrigation in endodontic treatment.

Ideal Requirements of Root canal Irrigant [5]

1. It should be anti-microbial.
2. Should have tendency to flush out the debris from the canal.
3. It should be biocompatible.
4. Should have the tendency to dissolve the necrotic pulp as well as vital pulpal tissue.
5. Must act as a lubricant.
6. Have the tendency to remove the smear layer.
7. Should have the ability to penetration into dentin tubules.

Classification of root canal irrigants [6]

Endodontic irrigants			
Chemical agents			**Natural agents**
Tissue dissolving agents	**Antibacterial agents**	**Chelating agents**	**Antibacterial agents**
(e.g., NaOCl, ClO2)	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)

Conventional irrigating solution

Normal Saline:

The bodily fluids are isotonic with normal saline. Due to its safety, especially when pushed into the apex of the tooth, it is the irrigating solution most frequently used in endodontic operations.7 It should ideally be used in conjunction with another solution or between irrigations with another solution, such as sodium hypochlorite. [8]

Sodium hypochlorite:

The most used endodontics solution is sodium hypochlorite. When sodium hypochlorite interacts with water, sodium and hypochlorite ions are produced, bringing hypochlorous acid and the antibacterial activity into equilibrium. Additionally, it has the capacity to dissolve organic materials like collagen and pulp byproducts. The smear layer created during instrumentation cannot be removed using NaOCl. Hypochlorous acid, a component of NaOCl solution, functions as a solvent when it comes into contact with organic tissue. It also releases chlorine, which reacts with the amino group of proteins to generate chloramines. Amino acid hydrolysis and degradation are caused by hypochlorous acid and hypochlorite ions. [6]

Chloramines, which disrupt cellular metabolism, are created via the chloramination reaction between chlorine and the amino group. Chlorine has an antibacterial effect that prevents bacterial enzyme activity and causes the SH groups of vital bacterial enzymes to irreversibly oxidise. Thus, the antibacterial effect and tissue dissolving process are caused by the saponification, amino acid neutralization, and chloramination processes that take place in the presence of microbes and organic tissue. [5,9]

EDTA:

A chelating compound that works as an emulsifier and lubricant is employed in quantities of 17% or 15% to navigate narrower canals and eliminate the inorganic portion of the smear layer.[10] While negotiating through canals, it maintains a suspension of the debris. It has little or no anti-microbial activity but works synergistically with other chemicals as it weakens the cell membrane. [11,12]

Chlorhexidine:

Since chlorhexidine digluconate has such strong antibacterial properties, it is frequently employed in disinfection. However, it is absolutely incapable of disintegrating tissue. Two symmetric 4-chlorophenyl rings, two biguanide groups, and central hexam-ethylene chains make up the synthetic cationic bis-guanide CHX. [13] Bacterial cell membrane phospholipids and lipopolysaccharides interact with the positively charged hydrophobic and lipophilic molecule CHX, which then enters the cell via an active or passive transport process.[14] Its effectiveness results from a contact between the molecule's positive charge and the negatively charged phosphate groups on microbial cell walls, which changes the osmotic balance of the cells. [15,16] This makes the cell wall more permeable, enabling the CHX molecule to enter the bacteria. Leakage of intracellular components, especially phosphate substances like adenosine triphosphate and nucleic acids, occurs after damage to this fragile membrane. There is a biphasic effect on membrane permeability as a result of the congealing of the cytoplasm, which reduces leakage. The ideal pH range for CHX antibacterial action is 5.5–0.7. [17,18]

MTAD:

Torabinejad et al. developed a irrigant with combined chelating and antibacterial properties. [19] MTAD is a mixture of 3% doxycycline, 4.25% citric acid, and detergent (Tween-80). Three components of MTAD are believed to work together synergistically to combat microorganisms. [20] When used against E. faecalis biofilms, MTAD had a less effective bactericidal impact than 1%–6% NaOCl. The buffering effect of dentin and the serum albumin present in the root canal may also prevent MTAD's antibacterial activity.

Smear layer removal has been credited to MTAD as being successful. Citric acid may help to eliminate the smear layer in the MTAD preparation, enabling doxycycline to reach the dentinal tubules and work as an antibacterial agent. The most recent revision to the protocol for the clinical use of MTAD suggests performing a 20-minute initial irrigation with 1.3% NaOCl and a 5-minute final rinse with MTAD. [20-22]

Citric Acid:

In place of EDTA, citric acid has been used as a final rinse to eliminate the smear layer. It has a long history in root canal irrigation, with frequent use of 1% to 10% concentration. Compared to EDTA, it is a little more aggressive and causes dentine erosion that is more noticeable. [23]

Maleic Acid:

A moderate organic acid called maleic acid is utilised in adhesive dentistry as an acid conditioner. [89] According to Ballal et al., final irrigation with 7% maleic acid for 1 minute was more effective at removing the smear layer from the apical third of the root canal system than 17% EDTA. [24]

Current Trends in Endodontic Irrigation

Laser Pips:

A technique for irrigation of the root canals that makes use of lasers. Sodium hypochlorite absorbs the laser, causing it to vaporise and produce vapour bubbles. As these bubbles grow and burst, they cause additional cavitational effects. The lasers employed can include diode lasers, Er: YAG, and Nd: YAG, which exhibit photochemical effects due to their high peak power and brief pulse duration. The PIPS tip is 9 mm long, 600 microns in diameter, and 3 mm shorter at the head for lateral wave emission. The canal orifice is where the PIPS tip is stored. [25] According to Devito et al., PIPS is superior to traditional techniques. Noiri et al. and Llyod also demonstrated PIPS's ability to remove organic debris at a greater level but that the biofilm did not completely disappear. [26,27]

Photo Activated Disinfection:

Reactive oxygen species are released when a photosensitizer (non-toxic dye) is inserted into the dental canal and is activated by low-intensity light. The dye adheres to the cell, releasing nascent oxygen and damaging the cell membrane when exposed to a particular light source.

According to Komerik et al., the dye is believed to have reduced affinity for human cells. Besides being efficient against bacteria, photo activated disinfection (PAD) is also effective against fungus, viruses, and other organisms. [28] Toluidine blue is injected into the canal and let to sit for 60 seconds while being exposed to light for 30 seconds. Bunsor and Schlafer discovered that it effectively gets rid of micro-organism. It should be seen as an addition to irrigation rather than a replacement. [29,30]

Ozone:

The canals can be treated using ozonated water, ozonated olive oil, and ozone gas. Due to its triatomic makeup, it is unstable and readily dissociates into oxygen species that are cytotoxic. Commercial usage has been made of systems like the Neo Ozone water-S unit, HealOzone (kavo), and OzoTop. As it works best when there is little organic trash, it should be used towards the conclusion of cleaning the canal. According to Nagayoshi et al., it needs to be used in good concentrations and for a long enough period of time to be effective. Its inconsistent results highlight the need for additional research. [31]

Herbal Irrigant:

Constant increase in antibiotic resistant strains and side effects of chemical irrigants has led to the search for alternative herbal medicaments. Various herbal extracts, such as neem and Tulsi extracts, Aloe vera, Morinda centifolia, curcum longa, and turmeric, having antimicrobial, anti-inflammatory, and therapeutic effects are promising to be used as endodontic irrigants. [32-35]

Conclusion

Successful root canal treatment involves the complete elimination of microorganisms from the root canal and the three dimensional obturation of the canal space. Chemical irrigation of canals along with biomechanical preparation helps in the elimination of microorganisms. Because it lessens friction between the instrument and dentine, clears away organic and inorganic waste, dissolves tissue, and, most significantly, has an antimicrobial/antibiofilm action, irrigation is essential for a successful root canal procedure. The sole method for affecting the parts of the root canal wall that are unaffected by mechanical instruments is irrigation. Current irrigation solution cannot be considered ideal since it lacks some or all the characteristics. As a result, they are all utilized in conjunction with one another in the proper order to produce the greatest cleaning effectiveness.

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