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Mini-Review

Irrigating Solutions in Endodontics: A Brief Review

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Abstract:

In the last twenty years, endodontics has begun to appreciate the important role of irrigation in successful endodontic treatment. The goal of every root canal treatment is to clean the canal both mechanically as well as chemically to remove all the necrotic tissue, microorganisms, webs, fins etc. Sometimes, root canal spaces cannot be cleaned mechanically. The only way is through the effective use of irrigation solution. Sodium hypochlorite is the most commonly used solution due to its organic issue dissolving properties and broad anti-microbial property. This article reviews the various irrigants used for endodontic treatments, their advantages and limitations, and various newly introduced irrigating solutions.

***Keywords:** Irrigation solution, necrotic tissue, sodium hypochlorite, anti-microbial property*

Introduction

The main aim of the root canal treatment is the complete removal of connective tissue or the destruction of microorganisms and to enable an effective seal in order to prevent recolonization of the canal with bacteria.[1] This aim can be achieved by chemical and mechanical cleaning of the root canal system. The anatomy of a root canal is complex and accessory features such as fins, intercanal communications can sometimes make this cleaning difficult.[2] So irrigants solutions along with hand instruments or rotary systems are used to have maximum removal of bacteria. In order to get maximum efficiency from the irrigating solution, they must reach the apical portion of the canal. There are several factors associated with the efficacy of the irrigants such as contact time, the surface tension, temperature and concentration of the irrigant and presence of organic tissue.[3] The effect of irrigant depends directly upon contact time, the temperature of the irrigant, and concentration. However, depends irreversibly on the surface tension, age and presence of organic tissue.

Method of Root Canal Irrigation

1. The solution should be introduced slowly and passively into the canal.
2. Blunt needles are preferred usually of 27-28 gauge.
3. The needle should never be wedged into the canal and should allow adequate backflow.
4. Root canal must be enlarged to size 30 or larger
5. Irrigant should never be forced into the apical tissue rather gently placed in the canal.

6. Tip of the needle should be inserted until resistance is felt and then withdraw it 2-3mm away from the point and irrigate passively.

Various Delivery systems for irrigation:

1.	Needle with bevel
2.	Monojet endodontic needles(23, 27 gauge)
3.	Stropko irrigator
4.	ProRinse- 25, 28, 30 gauge probes
5.	Ultrasonic and sonic vibrations
6.	Agitation with brushes
7.	Manual dynamic agitation with files or gutta percha points.
8.	Irrigation using electronically activated water
9.	Ozone gas infiltration into the endodontic system
10.	Use of Laser light to induce lethal photosensitization

Significance of root canal irrigation

1. Irrigation perform physical and biological functions. It removes dentin shaving from the canal and prevents them from packing at the apex of the canal.
2. They act as a solvent of necrotic tissue, so they loosen debris, pulp tissue, and microorganism from irregular dentinal walls.
3. They also have bleaching action to lighten up the teeth discolored from extensive silver restorations or trauma.
4. They are germicidal and have antibacterial action.
5. They improve the efficiency of instruments by use in the wet canal. Instruments do not work effectively in dry canals.
6. They remove debris from lateral and accessory canals.
7. They open the dentinal tubules by removal of the smear layer.

Types of Irrigating Solutions

Broadly divided into two categories:

Chemically non active solution
1. Water
2. Normal Saline
3. Local Anesthetic

Chemically active solution	
Alkalis	Sodium Hypochlorite
Chelating agents	EDTA
Oxidizing agents	Hydrogen Peroxide
Antibacterial agent's	chlorohexidine
Acids	30% hydrochloric acid
Enzymes	Trypsin, streptokinase
Detergents	Sodium lauryl sulfate

Brief explanation of Various Irrigating Solutions

1. Normal Saline

Normal saline as 0.9% W/V is most commonly used in endodontics. It is very mild in action which causes gross debridement and lubrication of the root canal. It acts by flushing action. It can also be used as a final rinse for root canals to remove any chemical soft tissue irritating solution.

Advantages

Biocompatible: no adverse effect as osmotic pressure of normal saline is the same as that of the blood.

Disadvantages

1. Does not possess antimicrobial activity
2. Does not remove the smear layer
3. No disinfection property
4. Too mild to thoroughly clean the canals

Cannot clear microbial flora from the inaccessible area.

2. Sodium Hypochlorite

It is the most widely used irrigant. Concentration ranging from 0.5%-5.25% is widely used, but for clinical use concentration between 0.5% and 1% is recommended.

Advantages

1. Causes tissue dissolution
2. Remove an organic portion of dentin
3. Removes biofilm
4. Causes dissolution of pulp and necrotic tissue
5. Causes lubrication of canal
6. Antibacterial and bleaching action
7. Economical and easily available

Disadvantages[5]

1. If extruded periapically, it can result in cytotoxicity causing excruciating pain, periapical bleeding, and swelling.
2. Has high surface tension so its ability to wet dentin is less
3. Does not remove the smear layer
4. Can bleach clothes
5. Can corrode instruments
6. Bad odor and taste
7. If comes in contact with gingival, causes inflammation of gingival.
8. Its vapor can irritate eyes.
9. Exudates and microbial biomass inactivated sodium hypochlorite.
10. Should not be used as a final rinse before obturation.

Ultrasonic Activation of Sodium Hypochlorite

This method shows an accelerated chemical reaction, creates a cavitational effect, and thus achieves superior cleaning action.

3. Hydrogen Peroxide

It is a clear, odourless liquid that is used as an irrigating agent with a 3% solution. It is preferred against bacteria, viruses, and fungi.

Mechanism of Action

It is decomposed easily by heat and light and is highly unstable. It dissociates into water and nascent oxygen. This nascent oxygen comes in contact with organic tissue results in effervescence.[6] It also causes oxidation of bacterial enzymes thus interfering in their metabolism. Upon coming in contact with tissue enzymes, nascent oxygen produces a bactericidal effect.

4. Chlorohexidine

It is the most potent bisbiguanide. It should be used as 2% in concentration. It is a broad-spectrum antimicrobial agent. A combination of 0.2% chlorhexidine and 2% sodium hypochlorite is commonly used as an irrigant.

1. Mechanism of Action
2. It is a cationic bisbiguanide molecule.
3. This cationic molecule is absorbed by the negatively charged cell membrane.
4. It causes leakage of intracellular components.
5. At high concentration, it acts as bactericidal, and at low concentration act as bacteriostatic.
6. It also has a property of substantivity- a residual antimicrobial activity for up to 7 days.

Advantages

1. 0.2% is used in controlling plaque
2. 2% is used as a root canal irrigant
3. It is more effective against gram-positive bacteria
4. Used with calcium hydroxide in retreatment cases.

Disadvantages[6]

1. It does not dissolve necrotic tissue
2. Does not show an effect on biofilms
3. Less effective on gram-negative bacteria

4. Chelating Agents (EDTA)

Chelating agents are chemicals that combine with a metal to form a chelate. Chelating agents such as Ethylenediamine tetraacetic acid (EDTA) was introduced by Nygaard Ostby for cleaning and shaping the canal.[7] They are available in liquid as well as gel form.

Mechanism of Action:

It acts by the formation of chelates with the metallic ions in the medium. This lead to the starvation of microorganisms and inhibit their growth. EDTA has a self-limiting action. It dissolves dentin by forming a stable bond with calcium. When all the chelating ions are reacted, equilibrium is reached which prevents its further dissolution.

Advantages

1. It dissolves dentin
2. It helps in enlarging the narrow root canal
3. Reduces time for debridement.

Disadvantages

It does not dissolve inorganic dentin particles.

Newly Introduced Root Canal Irrigating Solutions

1. BioPure MTAD

A mixture of Tetracycline (3% doxycycline), Acid (Citric acid), and detergent (Tween-80) introduced by Torabinejad, was designed to be used as a final root canal rinse before obturation. It is an alternative to EDTA to improve smear layer removal. It is placed with a cotton-wrapped barbed broach to allow intimate contact in the apical region of the canal.

Mechanism of action

Tetracycline acts as a calcium chelator which causes enamel and root surface demineralisation[8], allowing it to enter the dentinal tubules and show its effect. It also shows that it has a substantive mechanism. Citric acid is bactericidal and removes the smear layer. Detergent decreases surface tension. It is effective against E.faecalis bacteria which is resistant to the action of the antimicrobial medication.[9]

Advantages

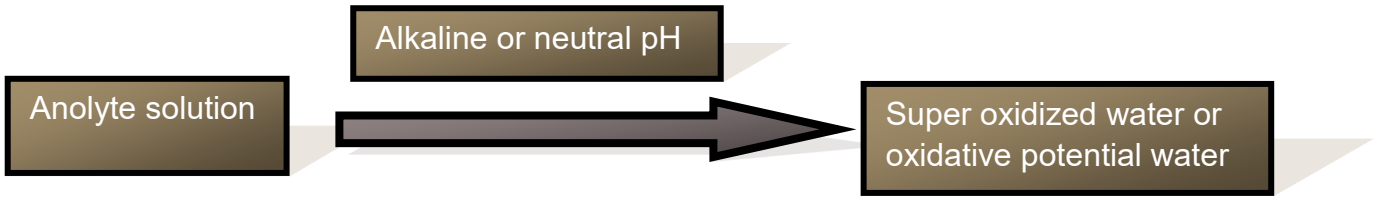
1. It kills most significant bacteria
2. Remove the smear layer along the whole length of the root canal
3. It is less cytotoxic than other endodontic medicaments
4. It has a prolonged antibacterial effect due to the high binding affinity of doxycycline for dentin.

Disadvantages

1. It is a very useful irrigant but is less effective against fungi and its value needs to assess in apical one-third of the canal.
2. It does not dissolve organic tissue hence, it is recommended to be used after sodium hypochlorite.

2. Electrochemically Activated Solutions

It consists of two components that is an anode (a solid titanium cylinder with a coating that fits inside the cathode) and a cathode (a hollow cylinder of titanium). They are separated from each other with a ceramic membrane. The solution produced at anode is Anolyte and at the cathode is known as Catholyte.



Principle: It is based on the principle of "Flow–through Electrolytic Module" or FEM which means transferring liquid into a metastable state via anode and cathode through the use of an element.[10] It is producing solutions (Superoxide water or oxidative potential water) that have high sporicidal or bactericidal activity.

Advantages

1. Nontoxic to biological tissues
2. Effective with a wide range of microbial spectra

Disadvantages

The quality of debridement is better in the coronal or middle part of the canal whereas the apical part has shown numerous contaminations.

3. Ozonated water

It is a newer irrigant solution that shows a powerful effect as an antimicrobial agent against bacteria, fungi, protozoa, and viruses at low concentrations (0.001ppm). It is produced easily with an ozone generator and dissolves rapidly in water.

Mechanism of action

These act through the Cavitation effect. It is the formation of vapor containing bubble inside fluid causing the formation of pressure or shockwave.[11] A collapse of these bubbles causing implosions that generate shear forces, surface deformation, and removal of surface material.

Advantages

1. Ease of handling
2. Rapid microbial effects
3. Lack of mutagenicity
4. Its potency

Disadvantages

They are effective against most of the bacteria but show no response against E.coil and on the amount of remaining lipopolysaccharides inside the root canal that have biological effects such as induction of apical periodontitis.

4. Photoactivated Disinfection (PAD)

It is a fast, effective, and minimally invasive disinfection system that is considered to kill more than 99.99% of bacteria in the endodontic biofilm. It was introduced by Oscar Raab.

Mechanism of Action

Low powered laser light (665nm) is transmitted through the fibreoptic tip of the disposable handpiece to activate the PAD antibacterial solution. Within 1-3 minutes, it eliminates bacteria from root canal.[12] Powdered uses are Methylene blue, Tolonium Chloride. The powder binds with the bacterial cell membrane and later ruptures it with laser light. Light generates single oxygen and cytotoxic free radicals.

Advantages

1. Most effective anti-microbial agent.
2. Overcomes the problem of antibiotic resistance
3. Non-toxic to the patient
4. Does not cause any sensitization
5. No thermal risk to the patient as it is low power.

Disadvantages

Expensive as disposable handpiece is used.

5. Herbal Irrigating Solutions

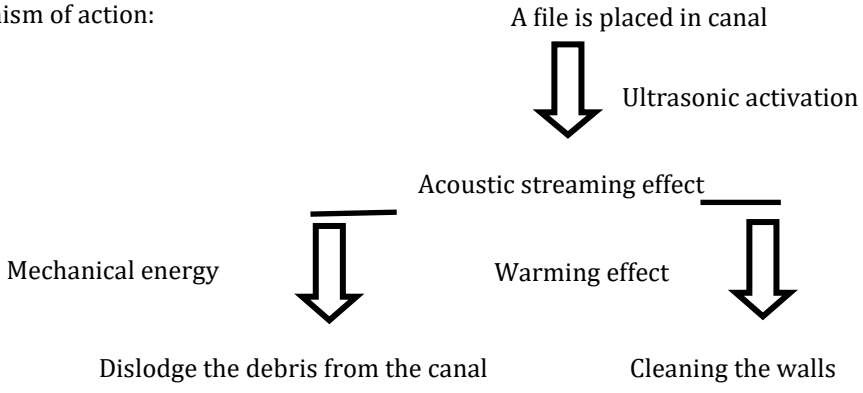
Many plant species have been used to disinfect the root canal.

1. Green Tea Polyphenols: They are derived from leaves of tea (Csmellia Sinensis). They show significant antibacterial activity in E.faecalis biofilms grown on dental culture and killing it within 6 minutes.[13]
2. Morinda Citrifolia: It has a very wide range of therapeutic effects, such as antibacterial, antiviral, antifungal, analgesic, anti-inflammatory, antitumor, hypotensive. It has smear layer removal capabilities. It is preferred as an irrigation solution as it is a biocompatible antioxidant.[14]
3. Triphala: It is a plant blend created by drying and pulverizing the fruit of three plants. Triphala kills 100% E.faecalis within 6 minutes. It helps in smear layer removal. When used with other irrigants its effect can be increased synergistically.[15]

6. Ultrasonic Irrigation

Ultrasonic Irrigation has been shown to clean the root canals to eliminate bacteria better than conventional methods. It causes a continuous flow of an irrigant in the canal, thus prevents the accumulation of debris in the canal.

Mechanism of action:



Advantages

1. Removes smear layer
2. Dislodge debris from the canal due to the acoustic effect
3. Clean root canal effectively

Disadvantages

1. Unpredictable
2. Leads to the excessive cutting of the canal walls

Conclusion

The success of endodontic treatment depends upon the elimination of microorganisms and removal of the smear layer during cleaning and shaping. The choice of irrigant varies from practitioner to practitioner. No irrigating solution till now provides 100% elimination of microorganisms. Future studies of irrigating systems should focus on the production of s single solution that is biocompatible, has tissue-solubilizing properties, removes the smear layer, and has antibacterial effects.

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