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A LITERATURE REVIEW ON VARIOUS IRRIGATING MATERIALS USED IN ENDODONTICS PRACTICE

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Abstract:
The goal of root canal treatment either surgical or non-surgical is to remove all the vital & dead non vital tissues, microbes, and their toxic products from root canal system. Removal of irritants and prevention of recontamination of the root canal after treatment are the essential elements for successful outcomes. There are many irrigants that are used in the endodontic practice and in this article, we are trying to narrates the properties and requirements of the different irrigants.

Keywords: irrigants, root canal system, sodium hypochlorite, turmeric, etc.

Introduction:

The goal of root canal treatment either surgical or non-surgical is to remove all the vital & dead non vital tissues, microbes, and their toxic products from root canal system. And this goal can be achieved by the bio mechanical preparation of the root canal system which include the mechanical as well as chemical cleaning of the canals which include the use of hand or rotary files along with the use of chemical irrigants having lubrication, antibacterial and cleansing properties.

There are different types of irrigants sodium hypochlorite, chlorohexidine, EDTA, hydrogen peroxide, natural agents like turmeric, etc.

Properties of irrigants that make them ideal for use are (1,2) –

1. Antimicrobial effect i.e., Bactericidal, germicidal, and fungicidal.
2. Irrigant must provide the lubrication during instrumentation.
3. Solution should dissolve organic tissues as like pulp tissue, collagen, and biofilm as well it should possess the ability to dissolve inorganic dentinal tissues.
4. It should be non-irritating to periapical tissues.
5. Solution stability is necessary for the solution.
6. Prolonged and sustainable antibacterial activity after use.
7. Ability to remove the smear layer completely.
8. Low surface tension.
9. It should not interfere with healing of the periapical tissue.
10. It should not stain tooth.
11. Irrigant should not has the triggering action for the cell-mediated immune response.

12. It should be non-antigenic, nontoxic, or non-carcinogenic.
13. No negative effect on the physical properties of the exposed dentin.
14. No negative effect on the sealing abilities of sealers.
15. It should be easy to apply and should have low cost and long shelf life.

History –
The first listed literature about the need for frequent irrigation of the root canal was advocated by Taft and He recommended the use of a deodorizing agent like chloride of sodium (3). The early literature describes various methods for obtaining a clean canal using a variety of flushing agents and medicaments. In 1893, Schreir introduced potassium and sodium metals into canals for removal of necrotic pulp (4). In the late 20th century, Grossman and Meiman conducted a study which led to the introduction of the combined use of double strength sodium hypochlorite and hydrogen peroxide to wash out fragments of pulp tissue and dentinal shavings after mechanical instrumentation and later in 1943 this was published later by Grossman (5). At present sodium hypochlorite have been recommended for day-to-day clinical practice.

Classification of irrigants (6) –
1. Based on mechanism of action the irrigants are classified into non bactericidal and bactericidal irrigants.
a. Non bactericidal irrigants
- Saline
- Local anesthetics
- Distilled water.

b. Bactericidal irrigants
- Sodium hypochlorite
- Chlorhexidine
- Iodine
- Hydrogen peroxide

2. Based on Chelation action
a. Ethylene diamine tetra acetic acid (EDTA, 17%)
b. Citric acid (10-50%)
c. Mixture of tetracycline, acid, and detergent (MTAD)
d. Tetraclean
e. Maleic acid

3. Herbal irrigants
a. Turmeric
b. Garlic
c. Triphala
d. Green tea

4. Others
a. Electronically activated water (EAW).
b. Photo-activated disinfection (PAD)
c. Ozone
d. Laser

Individual properties of irrigant solutions –
Here in this section, we are going to discuss about different irrigants that are useful in endodontic practice along with their properties, mechanism of action, advantages and dis advantages in brief.

1. Sodium hypochlorite –
Sodium hypochlorite also known as household bleach is the most used root canal irrigant and it act as an antiseptic and inexpensive lubricant. It is used in concentration of 0.5% to 5.25% in endodontic practice as an irrigant (7). Free chlorine in sodium hypochlorite dissolves vital as well as necrotic tissue by breaking down proteins into amino acids and decreasing the concentration of the solution reduces its toxicity, antibacterial effect, and ability to dissolve tissues and on increasing its concentration or warming it increases its effectiveness as a root canal irrigant (8). So, merits of NaOCl include its ability to dissolve organic substances present in the root canal system and its affordability, low cost, antimicrobial action. But, the major disadvantages of this solution are its cytotoxicity, when extruded into peri radicular tissues, it may lead to damage to peri radicular tissues causing bleeding or hemolysis, death of the affected adjacent cells, swelling, pain etc.; it also has foul smell and taste, and it bleaches clothes and cause corrosion of metal objects. Mechanism of action of sodium hypochlorite via three reactions –

1. Saponification reaction.
Fatty acid + Sodium hydroxide ↔ Soap + Glycerol
Thus, the sodium hypochlorite has the tissue dissolving property by which fatty acids gets degraded into the soap and glycerol or alcohols.

2. Amino acid neutralization reaction.
Amino acid/protein + Sodium hydroxide ↔ Salt + Water
Also, NaOCL buffers the amino acids with the production of salts and water; and hydroxyl ion production reduces the pH.

3. Chloramination reaction.
Amino acid + Hypochlorous acid ↔ Chloramine + Water
The third mechanism of action of sodium hypochlorite is that hypochlorous acid combines with proteins or amino acids and this reaction leads to the formation of chloramine which interferes with the metabolism of the cell and thus acting as a bactericidal.

These all three reactions written above occur in the presence of microorganisms and organic tissue lead to the antimicrobial effect and tissue dissolution process (9). Further the activity of sodium hypochlorite can be increased by increasing the concentration used up to 5.25%, by warming and by use to ultrasonic irrigation that causes acoustic streaming as well as raises the molecular temperature. Increasing the volume of hypochlorite & using fresh solution also increases its activity.

2. Chlorhexidine –
CHX belongs to the family of biguanides with positive charge and this positive charged molecule aids in the antibacterial activity of the chlorhexidine as positive charged CHX reacts with the negatively charged bacterial cell surface causing the damage to bacterial cell wall, loss of cytoplasmic cell contents (10). It is mostly used in concentration of 0.12 % - 0.2% as an antiseptic solution but in case of endodontics the concentration of CHX that is used is 2% and it is mostly used as a final irrigant in root canal procedures. The advantage of CHX solution is that it is effective against E. faecalis but the disadvantages of CHX is that it neither dissolve organic content nor the inorganic content and so it can not be used as a main irrigant solution in endodontic practice. Also, CHX is highly cytotoxic to tissues although does not seem to cause pain as like sodium hypochlorite and it can not be used in case of regenerative endodontics. Several studies had been conducted for the comparison in the antibacterial activity of NaOCl and 2% CHX against intracanal infection and most of studies have

shown little or no difference between their antimicrobial effectiveness (11). The combination of sodium hypochlorite and chlorhexidine results in the formation of a precipitate.

3. EDTA –

The full form of EDTA is ethylene diamine tetra acetic acid, which is available in 17 % concentration for root canal procedures. It removes the inorganic smear layer by chelating action with calcium. The use of EDTA in the root canal procedures should be done for 1-5 min to get the optimum effect within the depth range up to 20 to 30 micrometers into dentin; And the use of EDTA for more than 10 minutes has been associated with the weakening of the dentinal structures (12). The use of 17% EDTA for 1 min ultrasonically is very effective in removal of the smear layer, especially from the apical third of the root.

4. Citric Acid –

Citric acid is a demineralizing solution that is available in market ranging from 10 – 50% used to remove smear layer with better biocompatibility, little bit higher efficacy than 17% EDTA, however, it may interfere with mechanism of action of sodium hypochlorite.

5. MTAD –

MTAD is a mixture of tetracycline isomer, acid & detergent with composition of doxycycline having percentage of 3, citric acid with percentage of 4.5 and detergent used is tween 80 and this combination of these three acts as chelating antimicrobial agent (13). The citric acid present in MTAD helps in removing the smear layer and thus facilitates doxycycline to enter dentinal tubules and thus act as antibacterial. The protocol for using MTAD is sodium hypochlorite for 20 mins followed by 5 mins use of MTAD. The disadvantage of MTAD is that it causes staining of the tooth due to presence of tetracyclines.

6. Tetraclean –

Tetraclean is like MTAD with only difference is that their presence of low concentration of doxycycline as compared to MTAD and detergent is replaced by propylene glycol. The concentration of tetracycline is 50mg/ml doxycycline and it shows high activity against anaerobic bacteria as well as for facultative anaerobic bacteria with more bactericidal activity against planktonic cultures of E. faecalis (14).

It can remove the smear layer and eliminates bacteria in to infected root canal system within 5 minutes of use as a final rinse followed by the sodium hypochlorite use as tetraclean does not has the ability to dissolve organic contents in root canal system.

7. LASERs

With the introduction of LASERs in the medical and dental field, various studies had been conducted which states that LASERs are very useful in the elimination of the smear layer as well as removal of bacterial debris from the root canal walls after biomechanical preparation and the useful LASERs in endodontics are carbon dioxide, Nd:YAG, argon, Er:YAG, etc (15).

8. PAD

PAD is photo activated disinfection in which dye is placed into the root canal system which then is activated by the LASER radiation which act as bactericidal and thus helps in killing the microbes in root canal system.

9. Turmeric –

Turmeric is obtained from the medicinal plant used in Indian history long ago that is Curcuma longa which is also used in Indian spices used in cooking well known for wound healing, rheumatic disorders, anticancer agent. Turmeric is insoluble in water but readily soluble in organic solvents with the possible mechanism of action of curcumin suggests the inhibition of assembly of a protein-

filamenting temperature-sensitive mutant Z and it also increases the guanosine triphosphatase activity of FtsZ which is lethal for the bacteria. Mandroli and Bhat conducted an in vitro study to check the antibacterial activity of curcumin and in that study, they found that turmeric potentiates the antimicrobial action of cefixime, vancomycin, and tetracycline; so, it can be used in combination with other drugs. And, there were questions about its antimicrobial action against E. faecalis and in study found in year 2015 is that turmeric is a weak agent against E. faecalis, but another study conducted by Kumar showed promising results against E. faecalis (16).

10. Others –

Other agents are like povidone- iodine solution which is a antiseptic, hydrogen peroxide which is bactericidal and its activity can be further enhanced on warming but the main demerit is it is unstable in presence of light and can be degraded if not stored in dark bottles, normal saline is also used in root canal procedures but the only action of NS that is acceptable is the flushing of dentinal and bacterial debris from canals with very mild antiseptic action.

Conclusion –

On the above discussions for different irrigating agents or solutions in this article, the conclusion can be made that no single irrigant solution have all the properties of an ideal irrigant solution and thus it is always advisable to use additional irrigants along with main irrigant solution. As sodium hypochlorite is good in dissolving organic content but not so effective in inorganic smear layer removal which is much better removed by the citric acid or EDTA, sodium hypochlorite extrusion can lead to hemolysis which shows that it is less biocompatible. As there are studies conducted on herbal agents too which show that it possesses antibacterial properties but its activity against E. faecalis is a controversial topic. So, it is always advisable to use two or more irrigants for better effects in root canal system.

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