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Root Canal Irrigants: Review

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I. Introduction

Irrigation comes from a Latin word, *irrigate "moistened",* from the verb *irrigare*. Prognosis of endodontic procedure highly depends on complete three-dimensional debridement of the root canal system. Because of the complex anatomical structure of root canal system like lateral canals, accessory canals, fins and apical delta(1), cleaning and shaping with mechanical instrument alone is insufficient to reach the goal(2). Hence chemical irrigating solution along with mechanical instrumentation is required to achieve the predictable prognosis.

IDEAL PROPERTIES OF IRRIGATING SOLUTIONS

- It should flush out debris.
- It should dissolve organic debris like pulpal remnant effectively.
- It should have good antimicrobial property against all microorganisms found in root canal.
- It should lubricate canal walls to facilitate instrumentation.
- It should remove smear layer effectively.
- It should be non-irritant to periapical tissue(3,4).

CLASSIFICATION OF IRRIGATING SOLUTION

I) Chemical agents:

a. Tissue dissolving agents: NaOCl
b. Antibacterial agents:
  i. Bacteriostatic: MTAD
  ii. Bactericidal: NaOCl, CHX
c. Chelating agents:
  i. Weak: HEBP
  ii. Strong: EDTA(5)

II) Natural agents:

a. Antibacterial agents: e.g. Green tea, Triphala. **(6)**

SODIUM HYPOCHLORITE

Sodium hypochlorite (NaOCl) is the most popular irrigating solution because of its ability to dissolve pulp tissue and antibacterial property. Dakin introduced 5.0% NaOCl solution to disinfect wound during World War I(4) . Crane introduced NaOCl in to endodontics as a root canal irrigant in 1920.

MECHANISM OF ACTION

Based on ph of NaOCL

1) At low ph, NaOCl dissociates in to Na^+ and $HOCl^-$ (hypochlorous acid)- antibacterial property.

2) At high ph, NaOCl dissociates in to Na^+ and OCl^- (hypochlorite)- tissue dissolving property.

Saponification: formation of fatty acid salts (soap) and glycerol (alcohol), which helps to reduce the surface tension.

Neutralization: Neutralizes amino acids to form salt and water, which helps to reduce ph.

Chloramination: HOCl releases Cl, which reacts with protein amino group to form chloramines. It has an antimicrobial action(7,8,9).

CHELATOR SOLUTIONS

Chelating agents such as ethylenediamine tetraacetic acid (EDTA) and citric acid have been recommended as decalcifying agents in root canal therapy by its chelating action with calcium ions of dentine.

The dentine thereby becomes more friable and easier to remove by instrument. Optimal working time of EDTA is 5 minutes. After this time no more chelating action can be expected (self limiting action) (10).

10% citric acid have been proven to be more effective in removing smear layer and dentine dissolution when compared with EDTA and also has antimicrobial effects (11,12). Antiseptics such as quaternary ammonium compounds (EDTAC) or tetracycline antibiotics (MTAD) have been added to EDTA and citric acid irrigants, to increase their antimicrobial capacity. MTAD is a mixture of tetracycline isomer, an acetic acid and Tween 80 detergent and it is effective against E. faecalis.

Hydroxyethylidene bisphosphonate (HEBP) (14), also called etidronate, is recently used as an alternative to EDTA, because it shows no precipitate formation with sodium hypochlorite.

CHLORHEXIDINE

CHX is a cationic bisbiguanide, with optimum antimicrobial action ranging from pH 5.5 to 7.0. It is active against a wide range of microorganisms such as Gram positive, Gram negative bacteria, bacterial spores, lipophilic virus, yeast and dermatophytes. It is bacteriostatic at lower concentration and bactericidal at higher concentration. CHX is having substantivity effect(15), so it remains in root canal for longer duration when compared to other endodontic irrigants(16).

MECHANISM OF ACTION

CHX because of cationic nature, gets attached to negatively charged cell wall of microorganism and causing leakage of intracellular components (fig.1), resulting in bacteriostatic effect(17).

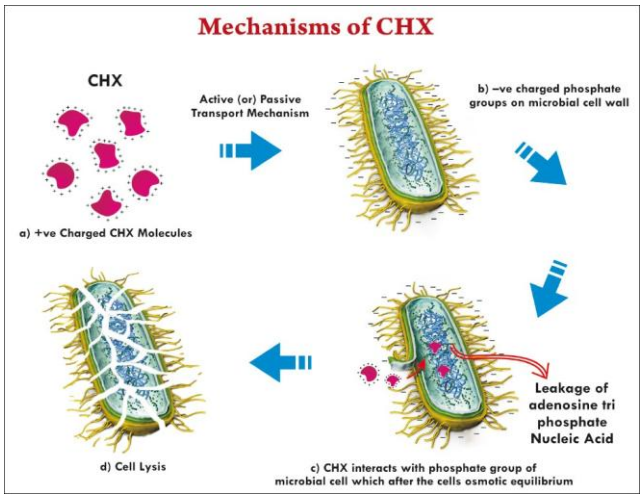

Fig. 1: Mechanism of CHX
Picture courtesy: Dr Deivanayagam kandhaswamy

RECENT ADVANCES

ANTIBACTERIAL NANOPARTICLES

The disinfection of root canals with nanoparticles(NPs) has gained popularity in the recent years due to the broad spectrum antibacterial activity(18).The most attractive factor of NPs as antimicrobial agent is, it not only disrupt the process of cell wall synthesis it also inhibit various enzymes like DNA-dependant RNA polymerase and DNA gyrase.

MECHANISM OF ANTIMICROBIAL ACTION

- Cell membrane disruption by electrostatic interaction.
- Reactive oxygen species production.
- Protein and enzyme dysfunction.
- Signal transduction inhibition.

The nanoparticles as root canal irrigants include chitosan with rose bengal, zincoxide and silver(19). The efficacy of chitosan(20–22) and zinc oxide nanoparticles against enterococcus faecalis has been attributed to their ability to disrupt cell wall. In addition these nanoparticles are also able to disintegrate the biofilms within the root canal system. Silver nanoparticles(23) are being evaluated for use as root canal disinfecting agents. It has been shown that 0.02% silver nanoparticles gel is able to kill enterococcus faecalis biofilm. Another revolutionary introduction in the field of endodontics is bioactive glass for root canal disinfection. The antimicrobial effect of bioactive glass is due to its ability to maintain an alkaline environment over a period of time.

ANTIMICROBIAL PHOTODYNAMIC THERAPY (APDT)

Photodynamic antimicrobial therapy (APDT) is based on the concept that a non-toxic dye, known as photosensitizer (FS), can be activated by low doses of visible light and an appropriate wavelength to generate singlet oxygen and free radicals, which are cytotoxic to bacterial cells(24). Blue dyes, especially toluidine blue and methylene blue, used with a low-intensity laser are effective in eliminating bacteria. APDT is a 2 step procedure that involves the application of a photosensitizer (step 1) followed by light illumination (step 2) of the sensitised tissue which will generate a toxic photochemistry on the target cell, leading to microbial killing.

PHOTON-INDUCED PHOTOACOUSTIC STREAMING (PIPS)

PIPS is based on the direct shock wave generated by Erbium: YAG LASER in a liquid irrigant. The laser system is equipped with a fiberoptic delivery tip and subablative parameters to produce the desired effect. When activated in the limited volume of the fluid, the high absorption of Er:YAG wavelength combined with the high peak power derived from the short pulse duration resulted in an enhanced bubble dynamics, which improve the irrigant flow dynamics within the root canal(25).

II. Conclusion

The ultimate objective of endodontic treatment is to eliminate the source of infection and inflammation from the root canal system. For complete disinfection of root canal, chemical debridement in the form of irrigation is must in combination with mechanical instrumentation.

IRRIGATION PROTOCOL(4,26,27)

- Sodium hypochloride 5.25 % 60 deg C for 30 sec
- 17 % EDTA for 5 min
- Final rinse with 2.5% Sodium hypochloride 30 sec
- Saline irrigation must be done between the above irrigants
- CHX 0.2%- 10 minutes

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