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Irrigants in Endodontics

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Abstract

Root canal therapy is based on the combination of proper instrumentation, irrigation, and obturation of the root canal. Out of these three essential steps of root canal therapy, irrigation of the root canal is the most significant factor in the healing of the periapical tissues. Sodium hypochlorite(NaOCl) and EDTA are the most widely used irrigants because of their broad antimicrobial spectrum. But many new techniques have been evolved such as sonic/ultrasonic instruments, shaping files, laser to increase the efficiency of these irrigants. This article reviews the potential irrigants with their advantages and limitations and role in endodontic irrigation.

Keywords: - *Root canal, irrigants, EDTA, organic, inorganic, antibacterial*

Introduction

A successful endodontic therapy is predicated on the elimination of bacteria and their toxins from the root canal system as well as necrotic and viable pulp substrates.[1] For teeth with intricate internal anatomy, such as fins or other anomalies where instruments might not work, chemical debridement is especially necessary.[2] The desirable characteristics of root canal irrigants include cleaning and lubricating endodontic tools and the root canal system, dissolving organic and inorganic materials, acting as an antibacterial, being free of cytotoxicity, and being ineffective in changing tooth microstructure.[3][4]

Classification of Endodontic Irrigants[5]

The irrigants are divided into bactericidal and nonbactericidal irrigants based on their mode of action.

A. *Non bactericidal irrigants*

1. Saline
2. Local anesthetics
3. Distilledwater.

B. *Bactericidal irrigants*

1. Sodium hypochlorite (with 0.5%, 1%, 1.5%, 2.5%, 5.25%, and 6%concentrations)
2. Chlorhexidine (CHX) (2%)
3. Iodine
4. Hydrogen peroxide (H2O2)(3%).

C. *Chelatorsolutions*

1. Ethylene diamine tetra acetic acid (EDTA, 17%)
2. Citric acid (10-50%)
3. Mixture of tetracycline, acid and detergent (MTAD)
4. Tetraclean
5. Maleicacid.

D. ***Herbal irrigants***

1. Electronically activated water(EAW)
2. Bis-dequalinium acetate (BDA)
3. Photo-activated disinfection(PAD)
4. Ozone

E. ***Laser***

Sodium Hypochlorite

In both medicine and dentistry, sodium hypochlorite (NaOCl) has a long history and is still widely used today. Henry Drysdale Dakin, a chemist, and Alexis Carrel, a surgeon, expanded the use of buffered 0.5% NaOCl solution to the irrigation of infected wounds during World War I.[6]

According to Pécora et al, NaOCl reacts with water to reach the dynamic equilibrium depicted below.[7]

$NaOCl + H_2O \leftrightarrow NaOH + HOCl \leftrightarrow Na^- + OH^- + H^+ + OCl^-$

NaOCl's impact is lessened in root canals with organic material. Higher NaOCl concentrations have more effective tissue-dissolving properties. When utilised in large quantities, low concentrations have the same potency as high concentrations.[8]

It has been reported that 5.25% at 40 minutes is the most effective irrigation plan.[9] In cases of root canal infection, NaOCl was only modestly effective against bacteria and ineffective against endotoxins.[10]

EDTA (Ethylenediamine tetraacetic acid)

Chelating compounds were first used in endodontics in 1957 when Nygaard-Ostby suggested using 15% EDTA at pH 7.3 to help prepare narrow and decalcified canals.The calcium ions in dentine react with EDTA to produce soluble calcium chelates. According to reports, EDTA decalcified dentin to a depth of 20 to 30 μm in about five minutes.[11]

30-minute cycles of irrigation with 5% NaOCl alone or in combination with 17% EDTA significantly enhanced tooth surface strain. When compared to NaOCl alone, the alternating regimen dramatically increased variations in tooth surface strain. The tooth surface strain was not significantly changed by irrigation with either 3% NaOCl or 17% EDTA alone or in combination.[12]

Chlorhexidine

Strong antiseptic chlorhexidine is frequently used to treat chemical plaque in the mouth.[13] Gram-positive and Gram-negative bacteria, bacterial spores, lipophilic viruses, yeast, fungus, and dermatophytes are all susceptible to the effects of CHX.[14] But it does not have any tissue dissolving capability[15]

Studies conducted both in vivo and in vitro have demonstrated that it is effective against C. albicans and E. faecalis. Large-scale bacterial cell destruction, cytoplasmic coagulation, and the precipitation of proteins and nucleic acids are all effects of higher concentrations. It exhibits enhanced antimicrobial efficacy against a variety of pathogens, including Streptococcus mutants, Porphyromonas endodontalis, Prevotella intermedia, E. faecalis, and C. albicans. It comes in either liquid or gel formulations.[16][17] CHX can occasionally cause a number of adverse effects, including desquamative gingivitis, tooth and oral pigmentation, and a metallic aftertaste.[18]

MTAD (mixture of Doxycycline, citric acid and a detergent)

MTAD, an irrigant with combination chelating and antibacterial characteristics was created by Torabinejad et al.[19] 3% doxycycline, 4.25% citric acid, and detergent (Tween-80) make up MTAD.[20] In the MTAD preparation, the citric acid may serve to remove the smear layer, allowing doxycycline to enter the dentinal tubules and exert an antibacterial effect.[21]

When MTAD is used as the final irrigation solution in a canal filled with gutta percha and AH Plus, the bond strength is dramatically decreased in comparison to when EDTA is used.[22]

Tetraclean

Doxycycline hyclate (in a lesser dosage than in MTAD), an acid, and a detergent constitute Tetraclean.[19][23] Tetraclean should be used after NaOCl at the end of chemomechanical preparation because it does not degrade organic tissue.[23] When 5.25% NaOCl, MTAD, and Tetraclean were compared for antibacterial activity against an E faecalis biofilm, it was found that only 5.25% NaOCl reliably separated and eliminated the biofilm at every time interval. However, when compared to MTAD, Tetraclean treatment resulted in significant biofilm segregation at every time point (5, 30, and 60 min at 20°C).[24]

HEBP (1-hydroxyethylidene-1, 1-bisphosphonate)

Since it exhibits no short-term reactivity with NaOCl, HEBP (1-hydroxyethylidene-1, 1-bisphosphonate), commonly known as etidronic acid or etidronate, has been suggested as a potential substitute for EDTA or citric acid.[25] Because HEBP stops bone resorption, it is administered systemically to treat Paget's disease and osteoporosis.[26]The bonding quality of Resilon/Epiphany® was improved by the mild chelating irrigation treatment (18% HEBP), as according De-Deus et al.[27]

Maleic Acid (MA)

In adhesive dentistry, MA is a moderate organic acid that is used to etch enamel and dentin surfaces. Compared to 17% EDTA, 7% Maleic Acid causes the most surface roughness on root canal walls. The effect of this surface roughness in the micromechanical bonding of resin sealers is significant.[28]

Chlorine Dioxide (ClO2)

Patients utilise ClO2, which chemically resembles NaOCl and chlorine, in their homes as a bleaching agent. Similar organic tissue-dissolving abilities of NaOCl and ClO2 were found in an in vitro investigation.[29]Trihalomethane is a known human carcinogen and an animal carcinogen, according to a study.[30]

Triphala

It is made up of the powdered and dried fruits of three different medicinal herbs. Emblica officinalis, Terminaliachebula, and Terminaliabellerica. At 6 minutes, this combination completely eliminated E. faecalis. Citric acid-rich fruits that are found in triphala help to remove the smear layer.[31] The primary benefits of utilising herbal substitutes are their accessibility, affordability, increased shelf life, minimal toxicity, and absence of microbial resistance.[32]

Conclusion

Irrigation and instrumentation are the most important and key parts of root canal treatment. Large quantities of the NaOCl solution should be used to irrigate the canals during instrumentation. Aqueous EDTA or citric acid might be used to properly clean the canals after the shaping technique is finished. The main issues with the use of irrigant solutions are their inability to reach the most intricate anatomical structures (isthmi and anastomosis) and the third from the top of the body; their efficacy is influenced by the presence of infected organic and inorganic debris; the clinical usage time; and their toxicity to the periapical tissues. Future research on irrigants should concentrate on creating a single solution that is biocompatible, has the ability to dissolve tissue, eliminates the smear layer, and has antibacterial qualities.

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