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Root canal disinfectants: Recent trends

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ABSTRACT

The combination of proper instrumentation, irrigation, and obturation of the root canal is essential for effective root canal therapy. The most important determinant in the healing of the periapical tissues is irrigation of the root canal, which is one of the three basic stages of root canal therapy. As a result, the main aim of endodontic therapy would be to improve root canal disinfection and avoid reinfection. Various irrigants and relationships between irrigants are explored in this analysis of the literature.

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1. Introduction

Apical periodontitis, the most prevalent endodontic infection, is caused by bacteria invading deep into the dentin and root canal space. As a result, endodontic treatment's short- and long-term effectiveness is dependent on removing microbes from the root canal system and preventing reinfection by coronal leakage.

Irrigation is crucial in removing bacteria from the root canal system, while root filling is important in preventing reinfection. Instrumentation, irrigation, locally applied disinfectants, and root filling (sealer) all help destroy and remove bacteria from infected root canals, with irrigation being the most important.[1]

2. Standard Root Canal Irrigants

It is widely assumed that mechanical canal enlargement must be supplemented by extensive irrigation in order to enable full microorganism elimination and ensure that the prepared canal is as bacteria-free as possible. If extruded into the periodontium, an irrigant can have a mechanical flushing operation, be microbiocidal, and remove organic tissue remnants without destroying the periradicular tissues.

Root canal irrigant has to meet the following criteria:[2]

1. Washing action (helps remove debris)
2. Facilitate dentin removal (lubricant)
3. Reducing instrument friction during preparation (lubricant)
4. Dissolve organic and inorganic tissue (dentin; dentine collagen, pulp tissue, biofilm)
5. Kill bacteria and yeasts (also in biofilm)
6. Do not irritate or harm essential periapical tissue; no caustic or cytotoxic results
7. Don't let the teeth's structure deteriorate.

The most commonly used irrigants are:

1. **Sodium Hypochlorite (NaOCl)** - Because of its antibacterial effects and capacity to remove organic tissues, sodium hypochlorite (NaOCl) is the most commonly used endodontic irrigant. During the instrumentation process, NaOCl is used to extend its time of operation within the canal as far as possible without being chemically changed by the involvement of other compounds. The concentration, temperature, pH solution, and storage conditions have all been shown to affect its effectiveness. Tissue-dissolving properties are enhanced by heated solutions (45-60°C) and higher concentrations (5-6%).

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2. **Ethylene-diamine-tetra-acetic Acid (EDTA)** - The failure of NaOCl to isolate the inorganic component of the smear coating is its biggest drawback. As a result, a mixture of NaOCl and EDTA is recommended. EDTA can decompose the inorganic portion of intracanal debris and is typically used at a concentration of 17 percent. Since EDTA seems to suppress hypochlorite's antibacterial and solvent function, these two liquids should not be in the canal at the same time.
3. **Chlorhexidine** - Due to its wide range of action and substantivity, a final flush of 2 percent CHX after NaOCl and EDTA has been suggested to ensure good outcomes in cases of chronic infection. CHX, on the other hand, is hampered by its association with NaOCl, which produces compounds that can discolor teeth and precipitates that are potentially mutagenic. As a result, CHX should not be used in conjunction with or right after sodium hypochlorite.[3–5]

3. Newer Root Canal Irrigants

3.1. MTAD

BioPure™ MTAD™, a combination of a tetracycline isomer, an acid (citric acid), and a detergent, is an alternative to EDTA for eliminating the smear coat. MTAD was created to clean the root canal system and clear the smear coating as a final rinse. When a low concentration of NaOCl (1.3 percent) is used as an intracanal irrigant before inserting 1 ml of MTAD in a canal for 5 minutes and rinsing it with an additional 4 ml of MTAD as the final rinse, the effectiveness of MTAD to fully dissolve the smear layer is increased. In terms of antimicrobial activity, it tends to be superior to CHX. It also has antibacterial action that lasts, is biocompatible, and improves bond strength.[6]

3.2. Tetraclean®

Tetraclean is a combination of doxycycline hyclate, an acid, and a detergent (at a lower concentration than MTAD). With a final 5-minute shower, it is able to remove microorganisms and the smear layer in the dentinal tubules of infected root canals. The antimicrobial effectiveness of 5.25 percent NaOCl, MTAD, and Tetraclean® against E. faecalis biofilm was compared, and it was found that only 5.25 percent NaOCl could reliably desegregate and eliminate the biofilm at all time intervals. In comparison to MTAD, Tetraclean® therapy resulted in a high degree of biofilm desegregation in all time intervals studied (5, 30, and 60 minutes at 20°C).

3.3. Triclosan and Gantrez®

Triclosan is an antimicrobial agent that works against both gram-positive and gram-negative bacteria, as well as fungi and viruses. The minimum inhibitory concentrations (MIC) and minimum bactericidal concentrations (MBC) of triclosan and triclosan with Gantrez® against P intermedia, F nucleatum, A naeslundii, P gingivalis, and E faecalis were determined by Nudera et al. The MBC of triclosan was found to be between 12 and 94 g/ml. For Gantrez®, the MBC of triclosan ranged from 0.3 to 10.4 g/ml. The addition of Gantrez® increased the triclosan's bactericidal function. Both triclosan and triclosan combined with Gantrez® had bactericidal efficacy against the five endodontic pathogens studied.[7]

3.4. Nanoparticles

Magnesium oxide, calcium oxide, and zinc oxide nanoparticles are microscopic particles with antibacterial properties. Nanoparticles made from platinum, copper oxide, and zinc oxide powders are currently in use and have the potential to produce active oxygen species. The electrostatic interaction between positively charged nanoparticles and negatively charged bacterial cells is responsible for the antibacterial impact. Nanoparticles can also alter the chemical and physical properties of dentin, reducing the bacterial adhesion strength to the dentin.[3,8]

3.5. Chitosan nanoparticles

Chitosan is the second most common natural biopolymer after chitin. It is a deacetylated derivative of chitin. Chitosan nanopartcles have been developed for antibacterial and drug delivery purposes. Antibacterial, antiviral, and antifungal properties are all fantastic. The use of chitosan nanoparticles in combination with chlorhexidine will destroy E.faecalis, which may be useful in tissue regeneration using a membrane barrier in periapical surgery.

3.6. Silver nanoparticles

Silver has been shown to have antibacterial properties by interfering with the sulfhydryl groups of proteins and DNA, altering the hydrogen bonding/respiratory chain, unwinding DNA, and interfering with cell wall synthesis/cell division. For root canal disinfection, Ag-NPs with strong antibacterial activity may be used.

3.7. Bioactive glass

Bioactive Glass (BAG) has been studied to increase root canal disinfection in micro- and nanoforms. In vitro root canal disinfection tests revealed that BAG had a slightly lower antibacterial activity than calcium hydroxide in preventing bacterial development. When compared to biofilm bacteria, they killed planktonic bacteria considerably faster.[9]

3.8. Ozone

Ozone (O3) dissociates quickly in water, releasing a reactive source of oxygen that can oxidize cells, resulting in

antimicrobial activity without causing drug resistance. The results of available studies on its efficacy against endodontic pathogens, especially biofilms, are mixed.[3,10]

3.9. Apple vinegar

Various chemical irrigants have been recommended for smear layer elimination during root canal treatment, with EDTA, citric acid, maleic acid, and apple vinegar providing the most interesting outcomes. Thanks to its therapeutic properties, apple vinegar has been recommended as an antiseptic, with its use as an auxiliary solution in the chemo-mechanical preparation of root canals showing promising results when opposed to NaOCl and EDTA.

3.10. Uncaria tomentosa

Known as "cat's claw" due to the short-curved spines on the stem at the leaf juncture, this plant has anti-inflammatory, antiviral, antibacterial, antioxidant, and immunomodulatory properties. When used properly, it has a low toxicity, which is a significant benefit of medicinal plant therapies over more traditional approaches. Triterpens, vegetal steroids, and glycoides are found in U. Tomentosa, and these compounds may be linked to its antimicrobial function.

3.11. Castor oil detergent (Ricinus communis)

Castor oil detergent has shown antimicrobial activity and biocompatibility, as well as non-toxic effects and detergent properties, both of which are essential characteristics for an irrigant solution. Endodontic irrigation with castor oil extract can remove debris in the same way as 1 percent NaOCl can. During biomechanical preparation, root canal irrigation with castor oil reduces the number of Escherichia coli and E. faecalis.[9,11,12]

3.12. Herbal

1. **Triphala** - The dried and powdered fruits of three medicinal plants, Terminalia bellerica, Terminalia chebula, and Emblica officinalis, are used to make triphala. In just 6 minutes, Triphala killed E faecalis completely. This is due to its composition, which contains three separate medicinal plants in equal amounts; in such formulations, different compounds can help enhance the potency of the active compounds, resulting in an additive or synergistic impact. Triphala produces fruits high in citric acid, which can help with smear layer removal. Fast distribution, cost-effectiveness, longer shelf life, low toxicity, and lack of microbial resistance are all benefits of using herbal substitutes.
2. **Green tea** - Made from the young shoots of the tea plant Camellia sinensis, green tea polyphenols is a popular Japanese and Chinese beverage. Green tea polyphenols were found to have statistically important antibacterial efficacy against an E. faecalis biofilm that had accumulated on the tooth substrate. It takes 6 minutes to eliminate E faecalis completely.
3. **Morinda citrifolia** - Morinda citrifolia (MCJ) has antibacterial, antiviral, antifungal, antitumor, antihelmintic, analgesic, hypotensive, anti-inflammatory, and immune-enhancing properties. L-asperuloside and alizarin are antibacterial compounds found in MCJ. Murray et al. demonstrated that 6 percent MJC was as effective as 6 percent NaOCl in combination with EDTA as an intracanal irrigant for removing the smear layer. Since it is a biocompatible antioxidant, the use of MCJ as an irrigant can be beneficial because it is less likely to cause serious damage to patients than NaOCl accidents.[7,13]

4. Conclusion

The article discussed a modern irrigant that could be used instead of conventional endodontic irrigants. The literature and studies available show the benefits and drawbacks of each irrigant under consideration, and none of them fully meet the criteria of the ideal root canal irrigant. These newest irrigants could currently be used as a supplement to NaOCl, although the quest for the perfect root canal irrigant continues.

5. Source of Funding

NIL

6. Conflicts of Interest

There are no conflicts of interest.

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