

Review of Literature on Herbal Irrigants

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Abstract

The success of endodontic treatment is directly related to the reduction in the number of root canal microorganisms which depends on combination of appropriate instrumentation, effective irrigation and decontamination of root canal spaces to apices, and obturation of the root canals. Irrigation of the root canal system is paramount in determining periapical tissue healing. Irrigating solutions are very important during root canal preparation because they aid in the cleaning of root canal, lubricate the files, flush out debris, have antimicrobial effect, provide tissue dissolution without damage to the periapical tissues. The Irrigants currently used are Sodium hypochlorite, Chlorhexidine and Ethylenediaminetetraacetic acid. But all these irrigants have their own drawbacks and toxicity. Neither of these are totally effective and safe. Moreover, due to the constant increase in antibiotic resistance, the researchers are looking for herbal irrigants. These natural plant extracts have good antimicrobial and therapeutic effects and minimal or no cytotoxicity suggesting their potential to be used as an endodontic irrigant.

Key Words: Root canal irrigants, Sodium hypochlorite, Herbal irrigants, Allium sativum, Azadirachta indica.

1.Introduction

Bacteria are the primary etiologic factors in the development of pulp and periapical lesions. (Kakehashi, Stanley and Fitzgerald, 1965; Baumgartner and Falkler, 1991; Sjögren *et al.*, 1997). They were first demonstrated by Miller in diseased pulp. William Hunter proposed that focal oral infection could disseminate and can cause systemic disease. Similarly many other authors have proposed the theory that localised or circumscribed infection could initiate damage in the distant sites. (Davis, 1912; Daland, 1916; Gilmer, 1916) This concept was known as the Focal Infection Theory. (Murray and Saunders, 2000).

Endodontic infection results from invasion of microbes into pulpal space. There are two types of endodontic infection, primary and secondary. Primary infection occurs in untreated canals. Secondary infection in the root canal occurs due to the failure of the previous endodontic treatment. (Sundqvist, 1994) Studies have reported various species in the pulp of necrotic teeth and therefore, one or multiple species of bacterial pathogens can be isolated from an infected root canal. The microflora will vary with type of endodontic infection. In primary root canal infection with necrotic pulpal tissue, 4-7 species were isolated, predominantly gram negative anaerobes. Facultative bacteria such as Enterococci, are more likely to survive chemo-mechanical instrumentation and root canal medication due to their ability to survive with or without oxygen in the environment. (Suresh and Shailaja, 2014)

Root canal treatment is designed to eliminate bacteria from the infected root canal, prevent reinfection of the tooth and save the natural tooth. The inflamed or infected pulp is removed, cleaned and disinfected, then permanently obturated and sealed. The success of endodontic treatment is directly related to the reduction in the number of root canal microorganisms which depends on combination of appropriate instrumentation, effective irrigation and decontamination of root canal spaces to apices, and obturation of the root canals. Irrigation of the root canal system is paramount in determining periapical tissue healing. (Jena, Sahoo and Govind, 2015) Irrigating solutions are very important during root canal preparation because they aid in the cleaning of root canal, lubricate the files, flush out debris, have antimicrobial effect, provide tissue dissolution without damage to the periapical tissues. (Zehnder, 2006)

Previously our team has a rich experience in working on various research projects across multiple disciplines (Soh and Narayanan, 2013; Campeau *et al.*, 2014; Christabel, 2015; Thamaraiselvan *et al.*, 2015; Christabel *et al.*, 2016; Kumar and S, 2016; Ramesh *et al.*, 2016; Thangaraj *et al.*, 2016; Govindaraju and Gurunathan, 2017; Kumar and Rahman, 2017; Sridharan, Ramani and Patankar, 2017; 'Fluoride, fluoridated toothpaste efficacy and its safety in children - review', 2018; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Mehta *et al.*, 2019; Ponnulakshmi *et al.*, 2019) Now the growing trend in this area motivated us to pursue this project.

2. History

Taft recommended chloride of sodium as a deodorising agent for irrigation. In 1893, Schreier *et al.* used potassium and sodium metals for the removal of necrotic pulp. (Schreier, 1893) In 1894, Callahan *et al.* used 5% sulphuric acid to seal the root canal. ("cascade" platinum concentrating still for sulphuric acid', 1894) Grossman and Meimann used a combination of double strength sodium hypochlorite and hydrogen peroxide for the removal of pulp tissue remnants and dentinal debris. (Grossman, 1943) (Abraham, Raj and Venugopal, 2015)

Berthollet *et al.* invented Potassium hypochlorite in France. This solution was commercialised in the name "Eau de Javel" by Percy. Hypochlorite solution was used as a bleaching agent. It was also used for prevention of childbed fever. By the late 19th century, it was proven to have disinfectant property by Koch and Pasteur. During world war I, buffered solution of sodium hypochlorite was used for the irrigation of infected wounds. (Cunningham and Balekjian, 1980) Sodium hypochlorite preparation is effective against a wide range of microbes and tissue dissolving effects on necrotic tissues. These features prompted its use as the main irrigant in endodontics. Sodium hypochlorite solutions are also cheap, easily available, and have good shelf life. Other chlorine-releasing compounds such as chloramine-T and sodium dichloroisocyanurate found to be less effective than hypochlorite at comparable concentration. So, they didn't gain wide acceptance in endodontics.

3. Ideal Requirements of Root Canal Irrigant (Schäfer, 2007; Basrani and Haapasalo, 2012)

1. Effective germicide and fungicide.
2. Non-irritating to the periapical tissues.
3. Stable in solution
4. Prolonged antimicrobial effect and a sustained antibacterial effect after use.
5. Active in the presence of blood, serum, and protein derivatives of tissue
6. Able to completely remove the smear layer.
7. Low surface tension.
8. Able to disinfect the dentin/dentinal tubules.
9. Does not interfere with repair of periapical tissues.
10. Does not stain tooth structure.
11. Inactivation in a culture medium.
12. Does not induce a cell-mediated immune response. Is non antigenic, non toxic, and non-carcinogenic to tissue cells surrounding the tooth.
13. Has no adverse effects on the physical properties of exposed dentin.
14. Has no adverse effect on the sealing ability of filling materials.
15. Easy to use/apply.
16. Inexpensive

4. Classification of Endodontic Irrigants

4.1 Classification of the commonly used irrigating solutions (Agrawal Vineet *et al.*, 2014)

A) Instrumentation auxiliary substances (used during instrumentation, do not need the optimal physical properties, only the chemical one)

- NaOCl (Sodium Hypochlorite)

- CHX (Chlorhexidine)

- EDTA (Ethylene Diamine Tetra Acetic Acid) - Qmix

B) Irrigating substances (Used during irrigation aspiration procedure, have optimal physical properties, such as lower surface tension and lower viscosity). - NaOCl, - Saline, - Distilled Water - MTAD (Mixture of Tetracycline, Acid and Detergent) - Tetraclean - Qmix - Herbal Alternatives – Green Tea, Triphala.

4.2 Based on the Composition (Kandaswamy and Venkateshbabu, 2010)

Chemical-Tissue dissolving, Antibacterial, Chelating

Natural-Antibacterial agents

5. Commonly used irrigants

The Irrigants currently used are (Gomes *et al.*, 2001):

1. Sodium hypochlorite

2. Chlorhexidine

3. Ethylenediaminetetraacetic acid (EDTA)

4. Mixture of tetracycline, an acid and a detergent (MTAD)

5.1 Sodium Hypochlorite

As Sodium Hypochlorite has excellent antimicrobial action. It has been the gold standard of all the irrigants. NaOCl is available as 1-15% aqueous solutions with alkaline pH. Sodium hypochlorite has several properties which facilitate chemomechanical debridement of infected root canals like it acts as a lubricant, flushes out debris from root canals. NaOCl is an effective detoxifying agent. It's effective in dissolving both vital and nonvital tissue. (Baumgartner and Cuenin, 1992) Sodium hypochlorite has the ability to degrade the fatty acids, transforming them into fatty acid salts (soap) and glycerol (alcohol). These compounds reduce the surface tension of the solution. The chloramination reaction between chlorine and the amino group (NH) forms chloramines that interfere in cell metabolism. Chlorine inhibits the bacterial enzymes leading to an irreversible oxidation of sulphydryl groups.

One important drawback of NaOCl is its inability for smear layer removal and lack of substantivity.

5.2 Chlorhexidine

Chlorhexidine is a colorless pale straw-colored and odorless substance. Chlorhexidine is effective against a wide spectrum of microorganisms which includes Gram-positive and Gram-negative bacteria, facultative and strict anaerobes, yeasts and fungi, particularly *Candida albicans*. Ferraz *et al.* mentioned that Chlorhexidine produced the cleanest dentin wall surfaces when compared with other irrigants. It causes inhibition of Matrix metalloproteinase enzyme, resulting in lower degradation of collagen fibrils, thereby preserving the durability of the hybrid layer. It is a remarkable property because one reason for losing resin-dentin bonds integrity with time is the degradation of denuded collagen fibrils exposed in incompletely infiltrated hybrid layers. (Gomes *et al.*, 2013)

5.3 EDTA

EDTA is a polyamino carboxylic acid, widely used to dissolve limescale. It acts as a hexadentate ligand and chelating agent. EDTA is produced as disodium EDTA and calcium disodium EDTA. It was first prepared from ethylene diamine and chloroacetic acid in 1935 by Ferdinand Munz. EDTA is mainly synthesized from ethylene diamine, formaldehyde and sodium cyanide. EDTA reacts with the calcium ions of the dentine and forms soluble calcium chelates. It has been reported that EDTA decalcified dentin to a depth of 20-30 μm in 5 min. (Mohammadi, Shalavi and Jafarzadeh, 2013)

5.4 MTAD

BioPure MTAD contains citric acid and Tween 80. It is available in the concentration of 10% and 25%. Citric acid helps in removal of the smear layer, thus helping deeper penetration of doxycycline into the dentinal tubules and exerting its antibacterial action. Tween 80 which is polyoxyethylene sorbitan monooleate is a detergent present in MTAD and is a non-ionic surfactant. It helps in reducing the surface tension of irrigating solutions, thereby

enhancing the flow and penetration deeper into the dentinal tubules. It has a pH of 7.0 and is a biologically acceptable material.(Srikumar, Sekhar and Nischith, 2013)

6. Herbal Irrigants

6.1 Propolis

The propolis has been used in many conditions like viral infections, ulcers, burns. Propolis also suggested strengthening the immune system. Propolis has been shown to be good antimicrobial activity against various oral bacteria and inhibit the binding of *S. mutans* and *S. sobrinus* to glass. Awadeh et al, 2018, in an in vitro study compared the effectiveness of propolis with chlorhexidine, sodium hypochlorite and doxycycline against *Candida albicans* and found that Propolis was equally effective as Chlorhexidine.(Awawdeh, Jamleh and Al Beitawi, 2018)

6.2 Azadirachta Indica (Neem)

Azadirachta Indica also known as Neem is a tree in the mahogany family. It is widely used in Ayurvedic medicines and neem cream is prescribed for skin disease. The bark of neem was used to clean teeth in ancient times. The isoprenoid group of constituents of neem has a broad range of therapeutic and antimicrobial effects suggesting its potential as an endodontic irrigant.(Bohora, Hegde and Kokate, 2010; Ravishankar, Lakshmi and Kumar, 2011; Dutta and Kundabala, 2014) There are many advantages of using neem as an endodontic irrigant. It is an excellent antioxidant with a very high biocompatibility, and thus there is no risk of tissue toxicity with its use. Biocompatibility of neem has already been proved, and this favours its use as an intracanal irrigant in endodontics. But its characteristic bitter taste, which is because of the nimbidin makes it highly undesirable. This drawback is overcome by incorporating sweeteners into the neem extract.(Botelho *et al.*, 2009) Neem leaf extract has a good antimicrobial effect against *E. faecalis* and *C. albicans*. It is also shown to be effective against *Enterococcus faecalis* and *Candida albicans* compared to 5.25% sodium hypochlorite solution.

6.3 Aloe Vera (Aloe barbadensis miller)

"Aloe Vera" - the term Aloe is derived from the Arabic word "alloe" which means shiny and bitter while "Vera" from Latin word which means true.(Virdi, Jain and Sharma, 2012) Its history dates back to 1500 BC. Alexander used this plant as medicine for treating wounds. The Egyptians called Aloe Vera as the plant of immortality. Aloe Vera (*Aloe barbadensis*), is a perennial, xerophytic, arborescent succulent shrub belonging to the Liliaceae family. It mainly grows in the dry areas of Africa, Asia, Europe, and America. (Surjushe, Vasani and Sapale, 2008) Swati et al, 2015, compared the antimicrobial activity hydroalcoholic extract of Aloe vera, garlic, and 5% NaOCl against *E. faecalis* and found that Saturated hydroalcoholic extract of aloe vera showed the highest zone of inhibition against *E. faecalis*.(Karkare *et al.*, 2015)

6.4 Morinda Citrifolia (Noni)

Morinda Citrifolia is commonly known as great morinda, Indian mulberry, nunaakai (Tamil Nadu, India), beach mulberry, and cheese fruit. The literature has shown that it has antimicrobial and therapeutic effects suggesting its potential to be used as an endodontic irrigant. Morinda Citrifolia Juice has a broad range of therapeutic effects, including antibacterial, antiviral, antifungal, antitumor, anthelmintic, analgesic, hypotensive anti-inflammatory, and immune-enhancing effects. It contains l-asperuloside and alizarin, compounds which possess antibacterial properties. An investigation confirmed some properties of noni such as antibacterial effect and removal smear layer allowing the use of noni as root canal irrigant.(Divia *et al.*, 2018) Podar et al, 2015, compared the antimicrobial efficacy of 6% Morinda citrifolia, Azadirachta indica, and 3% sodium hypochlorite as root canal irrigants and showed that there was no difference in the antimicrobial efficacy of 6% Morinda citrifolia, Azadirachta indica, and 3% Sodium Hypochlorite as root canal irrigants. (Podar *et al.*, 2015) Chandwani et al, 2017, evaluated the microbial reduction in deciduous molars using Morinda citrifolia juice as irrigating solution and concluded that Both 1% Sodium hypochlorite and Morinda citrifolia juice, were significantly effective in the reduction of total bacterial load postoperatively.(Chandwani *et al.*, 2017)

6.5 Triphala and Green Tea Polyphenols

Triphala is an Indian ayurvedic herbal formulation. It is a powdered form of three medicinal plants-Terminalia bellerica, Terminalia chebula, and Emblica officinalis. It has a potential of antibacterial activity against enteric pathogens. It also has antiinflammatory activity. Green tea polyphenols (GTPs, Ambe Phytoextracts) is the traditional and most widely consumed beverage of China and Japan, obtained from the young shoots of tea plant Camellia sinensis. The catechins and the flavins are considered as microbiologically active ingredients. (Vinothkumar *et al.*, 2013)(Pujar, Patil and Kadam, 2011)

6.6 *Salvadora Persica* Solution (Miswak-Siwak)

Miswak is a word which is traditionally known for the wooden stick used for cleaning teeth, and it's derived from a plant called "Arak". (Al-salman, Al-Shaekh Ali and Al-Nuaimy, 2005; Shingare and Chaugule, 2011) The use of sticks from the *Salvadora persica* plant to clean the teeth and mouth is widely known in traditional Arabic culture. This stick is known as Miswak or Siwak. The word miswak in Arabic means "stick to brush your teeth". Since around seven thousand years ago, the Babylonians have used miswak as a tool in cleaning the teeth. (Yasmin, Ramli and Alias, 2019)

The antimicrobial effect of *Salvadora Persica* is thought to be due to high chemical content of some components as chlorides, tannins, trimethylamine, salvadorine, nitrate, thiocyanate and sulphur. These anionic compounds have been shown to possess antimicrobial action against various bacteria. These components react with sulfhydryl groups in bacterial enzymes, which finally leads to bacterial death (Al-Sabawi, Al Sheikh Abdal and Taha, 2007)

6.7 *Allium Sativum* (Garlic)

Garlic (*Allium sativum*) is one of the most extensively investigated medicinal plants in use since ancient times due to its antibacterial, antifungal, and antiviral properties. Its extract has been shown to be effective against a wide spectrum of Gram-positive and Gram-negative bacteria. Elheeny et al, 2019, used *Allium sativum* extract as an intracanal irrigant for pulpectomy of primary molars and showed that the clinical and radiographic success rates of garlic extract at 3 months were 80% and 72.7%, which declined to 74.5% after one year. For Sodium hypochlorite group, clinical and radiographic success rates were 87.3% and 85.5% at 3 months, 87.3% and 87.3% at 6 months and 89.1% and 87.3% at 12 months. (Elheeny, 2019)

Our institution is passionate about high quality evidence based research and has excelled in various fields ((Pc, Marimuthu and Devadoss, 2018; Ramesh *et al.*, 2018; Vijayashree Priyadharsini, Smiline Girija and Paramasivam, 2018; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Ramadurai *et al.*, 2019; Sridharan *et al.*, 2019; Vijayashree Priyadharsini, 2019; Chandrasekar *et al.*, 2020; Mathew *et al.*, 2020; R *et al.*, 2020; Samuel, 2021)

7. Conclusion

But all of these irrigants have their own drawbacks and toxicity. Neither of these are totally effective and safe. Moreover, due to the constant increase in antibiotic resistance, the researchers are looking for herbal irrigants. Natural herbal extracts have good antimicrobial and therapeutic effects and minimal or almost nil cytotoxicity suggesting their potential to be used as an endodontic irrigant.

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