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PRIMARY TOOTH ROOT CANAL IRRIGANTS - A REVIEW

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ABSTRACT:

Before beginning root canal therapy, one should know about the basic difference between primary and permanent teeth. Primary teeth are smaller in dimension and the thickness of enamel and dentin coronal to the pulp chamber is also thinner in primary teeth than permanent teeth. Pulp chambers in children when observed have more degree of cellularity and vascularity compared to adult dentition. Success in primary teeth is mainly achieved by complete removal of the debris and necrotic tissue. However, complete removal of the debris and necrotic tissue is done by the root canal irrigants along with mechanical instrumentation. Studies have shown that combination of two or more irrigating solutions in a specific sequence will help to achieve optimal irrigation. This review article mainly deals about the mechanism of action, safety and biocompatibility of the currently used root canal irrigants and also about other materials that can be used as potent irrigants , their advantages and limitations in future of endodontics . The aim of the study is to know about the root canal irrigants used in primary teeth.The chances of a favourable outcome with root canal treatment are significantly high if infection is destroyed effectively before obturation. Hence irrigating solutions play a key role in the success of endodontic treatment of primary teeth.

Keywords: primary tooth, irrigants, root canal , bacteria,EDTA.

INTRODUCTION:

Preservation of primary teeth is also important as permanent teeth as it is an integral for the harmonious development of occlusion, maintenance of arch length, optimum function of chewing and speech and preservation of healthy oral environment. Considering the fast development of caries in primary teeth, and consequently the pulp damage due to the pulpal tissue contamination by bacteria and their derived toxins, the endodontic treatment can be necessary. Retention of the primary teeth can be made possible by performing root canal procedure. [1]The high rate of tooth-decay derives from bad eating habits. This concept in association with deficient oral hygiene has had great influence on the premature loss of primary teeth. The aim of primary teeth treatment with large caries lesions enveloping pulp is to maintain the teeth in the arch, and to re-establish the healthy condition of the tissues affected by the pulp infection, preserving the normal development of the permanent successor teeth. [2] Treating the primary teeth endodontically is considered highly complicated as the primary teeth exhibits bizarre internal geometry and other features like furcational connections and horizontal anastomoses which is uncommon in permanent teeth. [3] And Primary and permanent teeth present its own characteristics. The basic differences between them are concerning their function in life. Primary teeth have less mineralized tissue, short dimensions, and behave different from their successor permanent when they receive similar endodontic therapy. [4] Successful endodontic treatment necessitates combination of diversity of factors, such as a precise diagnosis, thorough cleaning, a disinfection protocol achieved with the help of various intracanal medicaments and irrigation solutions followed by obturation of the pulp space and adequate final restoration. [5] A considerable portion of infection is located deeper, in the lateral canals, apical ramifications and dentinal tubules. In clinical practice instrumentation and irrigation of canal in endodontic treatment is time-consuming and the most demanding treatment phase in children.[6]Therefore, it is imperative to use auxiliary solutions that promote disinfection of these areas, mainly because infected primary teeth can harbor micro-organisms inside the dentinal tubules, in the same way permanent teeth. [7,8]

Irrigation is presently the best method for lubrication, destruction of microbes, the removal of tissue remnants, and dentin debris during instrumentation. The simple act of irrigation allows the flushes away loose, necrotic, contaminated materials before that they are involuntarily pushed deeper into the canal and apical tissues, compromising the periapical tissue and permanent bud. The use of cleansers in the irrigation process is essential [.9] It is important to

avoid harming the germ of the permanent successor tooth because the physiologic root resorption allows the apical extrusion. [10] To achieve this various intra canal irrigants are used either singly or with combination. Intracanal irrigants can augment mechanical debridement by flushing out debris, dissolving tissue and disinfecting the root canal system .[11] Irrigants play a major role in paediatric endodontics because of the bizarre internal geometry and features like internal connections and horizontal anastomoses seen in primary teeth. [12] Hobson verified that ¾ of the root dentin of necrotic primary teeth are infected. This fact confirms the importance of instrumentation and irrigation endodontic to eliminate the root canal infection, to increase the root dentin permeability and to maintain the asepsis of the canals. [13]

The aim of this review article here is to discuss the role of bacteria in the root canal infection, efficacy and other associates of various root canal irrigants used in paediatric dentistry and also to provide an update with regard to recent advancements for the disinfection of infected root canals.

Role of bacterium:

The root canal system is complex and addition structures, such as fins, cul de sacs, and intercanal communications, are occupied by microorganisms once the tooth becomes infected. [14, 15] Self-aggregates of mono bacterial morphotypes and coaggregates of different bacterial morphotypes are also found adhering to teeth. The interbacterial spaces are engaged by an amorphous material, spirochetes like structures that are suggestive of fungi. [16, 17] Costerton et al. used the term “biofilm” to describe this clustering of bacteria. Microbial biofilm is defined as a sessile, multicellular microbial community characterised by cells that are firmly attached to a surface and enmeshed in a self-produced matrix of extracellular polymeric substances.[18] Bacteria within a biofilm have more resistance to a diversity of external hostile influences, such as the host defence responses, antibiotics, antiseptics, and forces, compared with isolated bacterial cells. [19]

In primary tooth root canal infections, the largest number of microorganisms can be found in main root canal and elimination of microorganisms from infected root canals is a complicated task. Therefore, the effectiveness of files, rotary instrumentation, irrigants, and chelating agents to clean, shape, and disinfect root canals governs the success, longevity, and reliability of modern endodontic treatments in eliminating the microorganisms. The role of

microorganisms in the development and continuation of pulp and periapical diseases has clearly been demonstrated in animal models and human studies. [20-23]

Elimination of microorganisms from infected root canals is a difficult task. The probabilities of a favourable result with root canal treatment are significantly higher if infection is eradicated effectively before the root canal system is obturated. However, if microorganisms continue at the time of obturation, or if they penetrate the canal after obturation, there is a high risk of treatment failure. [24,25]

The microorganisms related with endodontic infections contains of a complex combination of bacterial species. It has been reported that the root canal bacteria recovered from asymptomatic teeth is different from that recovered from symptomatic teeth .[26] Both aerobic and anaerobic microorganisms as well as facultative microorganisms can be found in the root canal. But primary root canal infections are polymicrobial, typically dominated by obligatory anaerobic bacteria. [27] The most frequently isolated microorganisms before root canal treatment include Gram-negative anaerobic rods, Gram-positive anaerobic cocci, Gram-positive anaerobic and facultative rods, Lacto bacillus species, and Gram-positive Facultative Streptococcus species. [28] The obligate anaerobes are slightly easily removed during root canal treatment. On the other hand, facultative bacteria such as non mutans Streptococci, Enterococci, and Lactobacilli, once established, are more likely to survive chemo mechanical instrumentation and root canal medication .[29] Enterococcus faecalis has increased attention in the endodontics, as it can regularly been seen in root canals in cases of failed root canal treatments. [30,31] In addition, yeasts may also be found in root canals associated with therapy-resistant apical periodontitis. [33]Cogulu et al found that the most predominant species of bacteria in primary teeth root canal were Enterococcus faecalis, Porphyromonas gingivalis and Treponema denticola. [33,34] Although E. faecalis is occasionally found in the initial root canal infections in permanent teeth, it was found to be present in 63% of the necrotic primary teeth. Necrotic teeth are clinical features commonly seen in early childhood caries, a form of dental caries largely predominant in children. [35]Hu et al isolated 240 strains of bacteria from 22 infected primary root canals. Among 240 strains, 200 strains were obligate anaerobes, belonging to genera Peptostreptococcus, Bacteroides, Veillonella, Eubacterium, Propionibacterium, Actinomyces and Fusobacterium. Bacteroides and Fusobacterium Especially P. gingivalis and F. nucleatum probably were related to acute periapical inflammation and Veillonella parvula from chronic periapical inflammation of primary teeth. (36)

Root canal irrigants:

The choice of an irrigant in the pulpal therapy of primary teeth should consider the differences among the dentin substrata, and not be irritating to the periapical tissues. Many researchers have studied the effect of several irrigants on the permeability of the dentine using methods that involve bacteria or radioisotopes, with different methodologies. Those irrigants have been used with the objective of eliminating pulpal remains and residues. In addition, they increase the dentin permeability (removing the smear layer), facilitate the instrumentation and promote the cleaning and disinfection of the root canals. [37-45] In addition, they should be soluble in water and biocompatible to the periapical tissues. [46] The currently used irrigants can be grouped into antibacterial and decalcifying agents or their combinations. Two or more irrigating solutions in a specific sequence contributes to a successful treatment outcome as no single irrigating solution is regarded optimal.

A large number of substances have been used as root canal irrigants, including acids (citric and phosphoric), chelating agent (ethylene diaminetetraacetic acid EDTA), proteolytic enzymes, alkaline solutions (sodium hypochlorite, sodium hydroxide, urea, and potassium hydroxide), oxidative agents (hydrogen peroxide and Gly-Oxide), local anaesthetic solutions, Chlorhexidine Gluconate and normal saline .[47] The most widely used endodontic irrigant is 0.5% to 6.0% sodium hypochlorite (NaOCl), because of its bactericidal activity and ability to dissolve vital and necrotic organic tissue. [48,49]However, NaOCl solutions exert no effects on inorganic components of smear layer. Chelant and acid solutions have been recommended for removing the smear layer from instrumented root canals, including ethylene diaminetetraacetic acid (EDTA), citric acid, and phosphoric acid. [50,51]

Rationale:

While various chemical and physical irritants can cause irritation and even necrosis of the pulp, the most common causes for pulpal inflammation (pulpitis) are bacteria and/or their products entering the pulp through a deep caries lesion or a leaking filling, e.g. an inflammatory reaction in the pulp starts long before bacteria invade the pulp tissue. The inflammatory reaction is first initiated by bacterial antigens interacting with the local immune system. [52,53]Although no exact data are available, it is likely that the majority of bacteria in

most primary root canal infections are located in the main root canal, while a minority of the cells would have invaded further into the dentinal tubules and lateral canals. [54] In root canal treatment, cleaning is the removal of all contents of root canal system before and during shaping. Irrigation is presently the best method for lubrication, destruction of microbes, the removal of tissue remnants, and dentin debris during instrumentation. The simple act of irrigation allows the flushes away loose, necrotic, contaminated materials before that they are inadvertently pushed deeper into the canal and apical tissues, compromising the periapical tissue and permanent bud. In this context, the use of cleansers in the irrigation process is essential.

Ideal requirements of root canal irrigants:

Ideal Requirement for Root Canal Irrigants are [55]

(i) a broad antimicrobial spectrum and high efficacy against anaerobic and facultative microorganisms,
(ii) ability to completely dissolve necrotic pulp tissue remnants,
(iii) ability to inactivate endotoxin,
(iv) ability to prevent the formation of a smear layer during instrumentation or dissolve the latter once it has formed,
(v) should be systemically nontoxic when they encounter the vital tissues,
(vi) should be non-caustic to periodontal tissues,
(vii) should be little or no potential to cause an anaphylactic reaction.

Saline:

Normal Saline is isotonic to the body fluids. It is universally believed as the most common irrigating solution in all endodontic and surgical procedures. It is also found to have no side effects, even if pushed into the periapical tissues. [56]However, saline cannot be used as the only irrigant, it is preferably used in combination with or used in between irrigations with other solutions like sodium hypochlorite [57]

Sodium Hypochlorite:

Sodium Hypochlorite (NaOCl) have been used separately or associated with other medicines. Henry Drysdale Dakin and the surgeon Alexis Carrel popularized the use of buffered 0.5% NaOCl solution for the irrigation of infected wounds .[58]NaOCl is a weak alkaline/ base that acts on the albumin (remains of pulpal tissue, foods and microorganisms), denaturing them

and turning them soluble in water. Like soap, it facilitates the removal of debris from the root canals and, in spite of being a necrosis agent (to act on organic matter) it is little poisonous or irritating to the live tissues.[59] When hypochlorous acid in NaOCl solution, comes in connection with organic tissue it acts as a solvent which releases chlorine and combines with the protein amino group to form chloramines. Hypochlorous acid (HOCl−) and hypochlorite ions (OCl−) lead to amino acid degradation and hydrolysis. The chloramination reaction between chlorine and the amino group (NH) forms chloramines that inhibits cell metabolism. Chlorine (a strong oxidant) has an antimicrobial action, inhibiting bacterial enzymes and leading to an irreversible oxidation of SH groups (sulphydryl group) of essential bacterial enzymes. Thus, the saponification, amino acid neutralization, and chloramination reactions that occur in the presence of microorganisms and organic tissue lead to the antimicrobial effect and tissue dissolution process. [60] NaOCl used in concentrations varying from 0.5% to 5.25% is a potent antimicrobial agent, and dissolves pulpal remnants and organic components of dentine. It is used both as an unbuffered solution at pH 11 in concentration 0.5– 5.25% and buffered with bicarbonate buffer (pH 9.0) usually as a 0.5% solution (Dakin's solution). [61] Contradicting earlier statements, Zehnder et al. reported that buffering had little effect on tissue dissolution, and Dakin's solution was equally effective on decayed (necrotic) and fresh tissues .[62]In addition, no differences were recorded for the antibacterial properties of Dakin's solution and an equivalent unbuffered hypochlorite solution. NaOCl is commonly known for its strong antibacterial activity; it kills bacteria very rapidly even at low concentrations. Waltimo et al showed that the resistant microorganism, Candida albicans, was killed in vitro in 30 s by both 5% and 0.5% NaOCl, whereas concentrations 0.05% and 0.005% were too weak to kill the yeast even after 24 h of incubation. [63] Recent laboratory experiments using three Gram negative anaerobic rods typically isolated from primary apical periodontitis, Porphyromonas gingivalis, P. endodontalis, and Prevotella intermedia demonstrated high susceptibility to NaOCl, and all three species were killed within 15 seconds with all concentrations tested (0.5– 5%). [64] The efficacy of NaOCl can be increased by altering the pH, temperature and method of irrigation. The antibacterial properties and tissue-dissolving properties of 5.25% NaOCl decrease when it is diluted.[65,66] A rise in temperature by 25°C increased NaOCl efficacy by a factor of 100. [67] The capacity of a 1% NaOCl at 45°C to dissolve human dental pulps was found to be equal to that of a 5.25% solution at 20°C. [68] The use of ultrasonic agitation increased the effectiveness of 5% NaOCl in the apical third of the canal wall. NaOCl has been criticized for its unpleasant taste, relative toxicity, and its inability to remove smear layer. [69,70] Parul et al reported that 1%

NaOCl is more effective irrigant in debris removal in deciduous root canals compared to NaOCl gel. [71] In primary teeth, overflow of irrigating solution through the apical region because of possible resorption areas could damage the underlying permanent tooth. The cytotoxicity of 5.25% NaOCl toward periapical tissues has been stated in the case reports .[72] Hence, 2.5% NaOCI was chosen for appropriate concentration at primary teeth root canal treatment.

Ethylenediamine Tetra Acetic Acid:

Ethylenediamine Tetra Acetic Acid (EDTA) is a chelating substance that has also been used. It can remove calcium ions of the dentin, giving rise to demineralization and as a consequence, increasing the dentin permeability of the root canals. EDTA is used in concentrations from 10 to 17% and in association with other drugs. [73] The efficiency of chelating agents generally depends on many factors, such as root canal length, penetration depth of the material, hardness of the dentin, application time, pH, and concentration. Serper and Calt´s study [74] compared the effects of EDTA (pH and concentration) on root dentin demineralization, and the results suggest that during prolonged cleaning and shaping of root canals lower concentrations of EDTA (10%) would rather than the neutral pH. It reduces erosive effects of EDTA solutions. In addition, Nakashima and Terata 75 observed that the permeability of root canal disinfectants increased to similar degrees in the 3% and the 15% EDTA groups. Comparing dentin properties, they propose that 3% EDTA is more useful for clinical applications. Zuolo et al.[76] found that the most effective combination to increase root dentin permeability was EDTA associated with Cetavlon (EDTAC). However, Tao et al. [77] verified that EDTA did not modify the root dentin permeability. They suggest that the absence of changes in the root dentin permeability with a conventional endodontic preparation was due to the fact that, even though endodontic preparation reduces dentin thickness, it also created a smear layer that compensated to the extent that there was no overall change in permeability.

Niu et al [78] studied the ultrastructure on canal walls after EDTA and combination of EDTA with NaOCl irrigation by scanning electron microscopy: more debris was removed by irrigation with EDTA followed by NaOCl than with EDTA alone. According to Saito et al. greater smear layer removal was found in the 1min EDTA irrigation group than the 30sec or 15-sec groups. [79,80] Hariharan et al [81] and Torabinejad VS et al [82] showed that EDTA when used as a root canal irrigant in primary teeth, it removed the smear layer but adversely

affected the dentinal tubules. The work by Marshall shows that there was a significant difference in the microstructure of primary dentin as compared to permanent dentin, significant differences with location, and the relatively common occurrence of micro canals [83]. These may be the reasons for the occurrence of erosion in primary teeth. Pitoni et al [84] compared EDTA and Citric acid solution for smear layer removal[129, 130] in primary tooth root canals. The authors concluded that there is no statistically significant difference between 17% EDTA solution and the 6% citric solution regarding smear layer removal efficiency.

Urea Peroxide:

Another widely used solution to support instrumentation is Urea Peroxide (Endo-PTC or Gly-Oxide). The peroxides are oxidizing agents that react chemically, liberating great amounts of nascent oxygen that explains their bactericidal action. The foam, due to the liberation of oxygen, contributes to the removal of pulp tissue remains and dentin particles during the chemic-mechanical preparation. In Brazil, the trade name of Urea Peroxide is Endo-PTC (10% Urea Peroxide, 15% Tween 80 and 75% Carbowax). International literature points out that Urea Peroxide is marked as GlyOxide commercial brand. It is anhydrous glycerol based, without any added detergent. Moura and Paiva [85] using Endo PTC as an auxiliary chemical substance, observed less dye penetration with instrumentation increasing, mainly in the apical area. The Urea Peroxide has several desirable characteristics for the irrigation of root canals in primary teeth. It presents detergent and haemostatic properties, besides not being irritating to the periapical tissues and non-allergenic. Stewart et al. [73] and Rome et al. [41] observed that the bactericidal activity of the Urea Peroxide (Gly-Oxide) was superior to 3% Hydrogen Peroxide in the preparation of infected root canals. The association of Urea Peroxide/NaOCl maintains the previously described properties.[39] According to Rome et al. [41], the use of Urea Peroxide is the first-choice cleanser in small curved canals. Its properties of lubrication without demineralization the dentin walls [39] avoid the risks of root perforation, common in primary teeth. The association of Urea Peroxide with NaOCl promotes significant more increase in the dentin permeability index to dye and drugs 73 than when used separately. [38] In spite of promoting increase in the dentin permeability, the association of Urea Peroxide/NaOCl showed less effectiveness in removing the smear layer (41. In contrast, it is known that the smear layer reduces dentin permeability, and prevents the penetration of root canal disinfectants into the deep area of the root canal wall .[86,87]

Hydrogen peroxide:

Hydrogen peroxide was used for many years as an endodontic irrigant. Hydrogen peroxide is a widely used biocide for disinfection and sterilization. It is a clear, colourless liquid that is used in a variety of concentrations in dentistry, ranging from 1% to 30%. When combined with sodium hypochlorite it creates effervescence, which was thought to facilitate debris removal. Hydrogen peroxide is active against viruses, bacteria, yeasts, and even bacterial spores. It has greater activity against Gram positive than Gram negative bacteria. H_2O_2 produces hydroxyl free radicals (-OH), which attack several cell components such as proteins and DNA.[88] In addition, the idea that peroxide acts as an oxidizing agent was extremely attractive to many dental professionals. Unfortunately, at high concentrations, Hydrogen peroxide is not well abided in the body and might play a role in the development of cervical resorption. There is not a great deal of evidence supporting the use of hydrogen peroxide as an endodontic irrigant.

Chlorhexidine Gluconate:

(CHX) Chlorhexidine 2% is also commonly used as root canal irrigant, but it completely lacks tissue dissolving capability .[89] CHX antimicrobial activity is pH dependent, with the optimal range being 5.5–0.7. 2% CHX is significantly effective against root canal pathogens like Actinomyces israelii and Enterococcus faecalis. [90,91] Two studies evaluating the antimicrobial activity of two forms of CHX (gel and liquid) of three different concentrations (0.2%, 1%, and 2%) found that the 2% gel and 2% liquid formulations of CHX eliminated Staphylococcus aureus and Candida albicans in about 15 seconds, whereas the gel formulation killed E faecalis within 1 minute. All the tested irrigants eliminated Porphyromonas endodontalis, Porphyromonas gingivalis and Prevotella intermedia in 15 seconds .[92] Antimicrobial substantivity depends on the number of chlorhexidine molecules available for interaction with dentine. [89]Because of its broad-spectrum anti collagenolytic activity, CHX can significantly improve the resin–dentine bond stability. In the clinically used concentrations, CHX has optimal biocompatibility. But in bactericidal concentrations it is lethal to canine embryonic fibroblasts while non-cytotoxic concentrations aids survival of bacteria. Khademi et al contradicts the use of CHX as a final irrigant in endodontic procedures stating its limited effect on gram negative bacteria compared to its effect on gram positive bacteria. Ruiz-Esparza et al [93] reported that 2% CHX showed a greater reduction of intracanal bacterial loading and suggested that this irrigating solution is an alternative for

pulpectomy treatment of necrotic primary teeth. Leonardo et al [94] concluded that CHX gluconate has been recommended as an irrigation solution because of its antibacterial effectiveness, substantivity and lower cytotoxicity compared with NaOCl. On the other hand, just a few investigations have studied the antimicrobial effectiveness of CHX as an irrigation solution in primary root canals.

Newer irrigants:

MTAD:

(Mixture of tetracycline isomer, acid and detergent) Torabinejad et al. developed an irrigant with combined chelating and antibacterial properties. MTAD is a mixture of 3% doxycycline, 4.25% citric acid, and detergent (Tween-80). In this formulation, the citric acid may serve to remove the smear layer, allowing doxycycline to enter the dentinal tubules and exert an antibacterial effect. The most recommended protocol for clinical use of MTAD advises an initial irrigation for 20 minute with 1.3% NaOCl, followed by a 5-minute final rinse with MTAD. MTAD has exhibited superior antimicrobial efficacy with significant reduction of E.faecalis, P.intermedia and T.forsynthenis and also eliminated bacteria from the root canals infected with whole saliva. MTAD has been shown to be less cytotoxic compared to intracanal irrigants like EDTA and hydrogen peroxide. [95-97] Balto H et al [98] concluded that MTAD was significantly more effective in smear layer removal than S. persica solution at the middle third of the canal wall in primary anterior teeth.

Chlorine dioxide:

Chlorine dioxide has recently come under consideration as a possible root canal irrigant. It is reported to be tuberculocidal, bactericidal, virucidal, and fungicidal. Chlorine dioxide can be more effective as a disinfectant when compared to sodium hypochlorite because HOCl(Hypochlorous acid) or OCl- (hypochlorite ions), two effective components of sodium hypochlorite, when come in contact with negatively charged bacterial cell wall might be repelled as both are negatively charged, thus causing less penetration and absorption of the disinfectant into the membranes, whereas chlorine dioxide irrigant, exists as gas in water, which enables it to permeate through bacterial cell membranes and bring about its destruction at a wide range of pH from 3 to 9.63 Brian D et al concluded that chlorine dioxide is less cytotoxic as compared to Sodium hypochlorite. [99] Sodium hypochlorite reacts with natural organic matter to produce trihalomethane and haloacetic acids both of which are animal carcinogens and suspected human carcinogens. Chlorine dioxide produces little or no

trihalomethane, and may be a better dental disinfectant than NaOCl. Singh et al compared the dissolution efficacy of chlorine dioxide and sodium hypochlorite on human pulp tissue. They concluded that 5% Chlorine dioxide is capable of dissolving human pulp tissue but sodium hypochlorite was more effective. [100]

Citric acid:

Citric acid in concentrations ranging from 1% to 50% has been used for smear layer removal. Though citric acid is found to be more biocompatible than other irrigants like EDTA it was found to be ineffective in eradication of biofilms of E faecalis after 1, 5, and 10 min of exposure. [101-103]

Maleic acid

Maleic acid is a mild organic acid used as an irrigant. Final irrigation with 7% maleic acid for 1 minute was more efficient than 17% EDTA in the removal of smear layer from the apical third of the root canal system. [104]

Etidronic acid:

HEBP (1-hydroxyethylidene- 1, 1-bisphosphonate) Also known as etidronic acid or etidronate. It is a potential alternative to EDTA or citric acid because this shows no short-term reactivity with NaOCl. [105]

Tetraclean

Tetraclean is a mixture of doxycycline hyclate (at a lower concentration than in MTAD), an acid, and a detergent.[94] It is recommended to be used as a final rinse after root canal preparation. It is similar to MTAD but with a reduced amount of doxycycline (50mg/5ml instead of 150mg/5ml for MTAD), with polypropylene glycol (a surfactant), citric acid, and cetrimide. This substance is supposedly capable of eliminating all bacteria and smear layer from the root canal system when used as a final irrigation. It is able to eliminate microorganisms and smear layer in dentinal tubules. MTAD, and Tetraclean® against E faecalis biofilm showed that only 5.25% NaOCl could consistently desegregate and remove the biofilm at every time interval. However, treatment with Tetraclean® caused a high degree of biofilm desegregation in every considered time interval (5, 30, and 60 min at 20°C) as compared with MTAD .[106]

EndoVac System

The EndoVac system (Discus Dental, Culver City, Calif.) is a new irrigation system that consists of a delivery/evacuation tip attached to a syringe of irrigant and the high-speed suction source of the dental unit. As the cannulas are placed in the canal, negative pressure pulls irrigant from a fresh supply in the chamber down into the canal to the tip of the cannula, then into the cannula and finally out through the suction hose .[107]

Aqueous Ozone or ozonated water

Ozone is one of the new generations of the disinfectant and a powerful oxidizing agent used to eliminate bacteria in root canals (108). Ozone has shown antimicrobial efficacy against resistant pathogens by neutralizing them or preventing their growth (109). Even at as low concentrations as 0.1ppm ozone is capable of deactivating bacterial cells including their spores. One of the most advantageous properties of aqueous ozone is its nontoxicity to oral cells. However, the most important disadvantage of aqueous ozone is its unstable concentration in a long time.

Electrochemically activated solutions:

A mixture of tap water and low concentrated salt solutions forms the electrochemically activated (ECA) which results in synthesis of Anolyte, and Catholyte. the oxydizing substances of anolyte exhibits microbicidal activity against bacteria, viruses, fungi and protozoa and therefore termed Superoxidized Water or Oxidative Potential Water. Due to its various advantages like ease of removal of debris and smear layer even at the apical third as well as its nontoxic properties it can be used as a potent root canal irrigant. A study showed that OPW was as effective as the NaOCl when used as an irrigant in necrotic pulpectomized primary teeth and is suggested as an alternative for irrigating primary teeth. [110]

QMix

QMix 2 in 1 solution is a newly introduced irrigation solution developed and marketed by Dentsply Tulsa Dental Specialties, Tulsa, OK, USA. It contains a mixture of a bisbiguanide antimicrobial agent chlorhexidine (CHX), a polyaminocarboxylic acid calcium-chelating agent Ethylenediaminetetraacetic acid [ethylenediaminetetraacetic acid (EDTA) and a surfactant cetrimide mixed in distilled water with acceptable additional salt. It is recommended as final irrigant during root canal procedures. It eradicates bacteria, removes smear layer, and persists in biofilms. It has pH slightly above neutral. [111]

Herbal irrigants

Herbal irrigants are popular mainly due to their easy availability, cost effectiveness, increased shelf and low toxicity ([112]).

Azadiracta indica (Neem) [113-115], Curcuma longa (turmeric) [116-118], Myristica fragrans (nutmeg) [116, 119], Terminalia chebula (Myrobolan) [116], Aloe barbadensis (Aloe vera) [116, 119], Morinda citrifolia (Noni) [112], green tea [112], Spilanthes acmella (anti-toothache plant) [120], German chamomile , propolis , miswak [121] are some of the herbal products hat have been studied as intracanal irrigants. Triphala is an Indian herbal preparation consisting of dried and powdered fruits of three medicinal plants namely Terminalia bellerica, Terminalia chebula and Emblica officinalis. Triphala achieved 100% killing of E faecalis at 6 minutes [122]. Ethylene glycol bis [b-aminoethylether] N,N,N=,N=tetra acetic acid (EGTA), EDTA plus Cetavlon (EDTAC), tetracycline-HCl [123], carbolic acid solution and carisolv [124] have also been studied as potential irrigants for endodontic treatment of deciduous teeth.

Conclusion:

Elimination of microorganisms from infected root canals of primary teeth is a complicated task. The chances of a favourable outcome with root canal treatment are significantly high if infection is destroyed effectively before obturation. Hence irrigating solutions play a key role in the success of endodontic treatment of primary teeth.

Existing literature and researches shows advantages and disadvantages and limitations of each irrigant under contemplation and none of them satisfy the requirements of the ideal root canal irrigant completely. Presently these newer irrigants could be used as an adjunct to NaOCl, with the hunt for the indefinable ideal root canal irrigant continues.

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