Review Article

Applications of Antiseptics in Endodontics

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ABSTRACT

In endodontics, antiseptics are a subject of great concern for the dentist as the objective of root canal treatment is elimination of microbiota and their spores, removal of necrotic and infected pulp tissue remnants and the sealing of disinfected root canals. To achieve this goal, several antiseptics are used in endodontics namely sodium hypochlorite, calcium hydroxide, chlorhexidine, phenolic compounds, quaternary ammonium compounds in addition to other antimicrobial agents. This articles highlights several antiseptics which are of major importance in endodontics.

Keywords: Endodontics, antiseptics, sodium hypochlorite, chlorhexidine, calcium hydroxide, phenols, quaternary ammonium compounds.

INTRODUCTION

Joseph Lister, the father of the concept of antiseptics, was concerned over the importance of cleanliness and its beneficial effects in surgical theaters after discovering that formation of pus was directly attributed to the presence of bacteria (through Louis Pasteur's research), and proceeded to develop his antiseptic surgical methods [1]. The word "antiseptic" is derived from the Greek words (anti and septikos) that directly translates as "against putrefaction or rotting". Antiseptics are defined as agents which can be used to prevents putrefaction, usually by inhibiting growth and corresponding actions of microorganisms [2].

When the pulp is injured or diseased, treatment is provided to prevent progression of infection to the periradicular tissue, and if the periradicular tissues are already infected, to heal these tissues. A positive outcome with root canal treatment is achieved only if infections are eradicated before obturation [3]. This process of root canal disinfection is not simple considering the numerous intercanal and intracanal communications within root canal systems. Furthermore, the complex network of root canals makes this objective difficult to achieve, if not impossible. Infact, most research in contemporary endodontics focuses on evaluating newer antimicrobial agents and methods of increasing the potency of these materials.

During the procedure of root canal treatment, irrigants are routinely used. In cases of chronic infections, intracanal antiseptics are applied to achieve optimal disinfection. Intracanal medicaments are basically antiseptic agents applied to canal walls to prevent bacterial recolonization, for the disinfection of root canal, suppression of post-operative pain by reducing inflammation, and for the facilitation of periapical healing[4]. Disinfection of root canal helps achieve the objective of cleaning and shaping by eradicating pathogenic microorganisms. This review discusses the role of antiseptics as intracanal medicaments in root canal treatment.

Antiseptics used as irrigants and intracanal medicaments

1. Halogens - Sodium Hypochlorite, Iodides (KI-potassium Iodide), Chloramine T

2. Calcium Hydroxide

3. Bisbiguanides- Chlorhexidine Biguanate

4. Combinations of corticosteroids and antibiotics

5. Phenolics - Phenol, Eugenol, Cresatin, Formocresol, Glutaraldehyde 2 %

6. Cationic detergents - Quartenary Ammonium Compounds, Aminoacridine

7. Antibiotics - PBSC (Grossman's polyantibiotic paste), Sulfonamide, Sulfathiazole, Triple antibiotic paste (Metronidazole, Ciprofloxacin and minocycline) [5]

Sodium hypochlorite

In the human body, chlorine compounds are part of the nonspecific immune system driven by the generation of neutrophils [6]. During World War I, chemist Henry Drysdale Dakin and surgeon Alexis Carrel applied 0.5% sodium hypochlorite solution to infected wounds. It was found that sodium hypochlorite (NaOCl) is a highly active cytotoxic oxidant against pathogenic microorganisms [7]. Sodium hypochlorite is also an effective non-specific antimicrobial agent and is commonly used irrigation solution used for root canal therapy [8]. They cause inhibition in the synthesis of DNA therefore retards multiplication of bacteria. The high pH of sodium hypochlorite results in irreversible enzymatic inhibition, disruption in cellular metabolism and phospholipid degradation.[9]

Sodium hypochlorite has been used as an antiseptic agent in dentistry for more than a century. Moreover, it is used at concentrations ranging from 1.0%-5.25%[3]. Hypochlorite preparations have tissue dissolving properties on necrotic tissues. Hence, the use of aqueous sodium hypochlorite in endodontics as the main irrigant was as early as 1920[10]. During irrigation, fresh hypochlorite consistently reaches the canal system. Untreated areas may be a result as the inability of solutions to reach these areas. Majority of American practitioners use 5.25% sodium hypochlorite in the form of bleach which could lead to decrease in flexural strength of dentin and irritation.[6]

Calcium hydroxide

Introduced by Hermann in 1920 on amputated vital pulps for apexogenesis. this material is now the most commonly used intracanal medicament as they have antimicrobial and tissue dissolving nature. Calcium hydroxide has its antibacterial effect when the pH is maintained at levels between from 10-12 [11]. The nature of its alkalinity disallows endodontic microorganism to survive in such conditions. Calcium hydroxide is available either in a single paste form or powder form [4].

Calcium hydroxide is able to reduce gram positive and gram negative bacteria [12]. The effectiveness of calcium hydroxide is linked to the release of highly oxidizing hydroxyl ions to react with bacterial lipopolysaccharides (LPS) which denatures protein metabolism,destroys bacterial cytoplasm and DNA. Moreover, calcium hydroxide is able to combat the presence of endotoxins released by pathogenic microorganisms [11]. When used in weeping canal (canals with persistent non-purulent discharge), a stiff calcium hydroxide paste could be left for at least two weeks. Another important feature of calcium hydroxide is its ability to stimulate hard tissue formation as it enhances mineralization. Calcium hydroxide can be used in appexification (closure of apical foreman due to trauma), as a root canal sealer, in resorption cases, direct and indirect pulp capping, pulpotomy, non-surgical treatment for periapical lesion[4].

Chlorhexidine

Chlorhexidine (CHX) is a potent antiseptic, which is widely used for chemical plaque control in the oral cavity. Aqueous solutions of 0.1 to 0.2% are recommended for plaque control, while 2% is the concentration of root canal irrigating solutions.[6] Chlorhexidine permeates the microbial cell wall and attacks the bacterial cytoplasm. In high concentrations, it causes coagulation of intracellular components while low concentrations affect membrane integrity. The uptake of chlorhexidine by E. coli and S. aureus depended concentration and pH [4]. To add on, chlorhexidine is effective against wide range of gram postive and gram negative bacteria [7]. It is commonly held that chlorhexidine would be more effective when used in combination with calcium hydroxide. Studies have indicated that the Chlorxedine gel has a slightly better performance than Chlorhexidine liquid [14]. Chlorhexidine cannot be used as the main irrigant in standard endodontic cases as it is unable to dissolve necrotic tissue remnants and is less effective on Gram-negative than on Gram-positive bacteria.[10]

Extreme care must be advocated when using chlorhexidine in endodontics, especially when sodium hypochlorite is used. The combination of Chlorhexidine and sodium hypochlorite can result in formation of a reddish precipitate which contains para chloroaniline which has been proven to be carcinogenic and mutagenic[15]. One must always use a saline flush between chlorhexidine and sodium hypochlorite to prevent formation of this precipitate. Recently Alexidine has also been evaluated as a root canal irrigant [16]. Alexidine (ALX), a biguanide disinfectant similar to CHX, has greater affinity for bacterial virulence factors than CHX.

Phenols

Phenolic-type antimicrobial agents has been used for their antiseptic and disinfectant properties depending on the compound. Pulvertaft and Lumb demonstrated that low concentrations of phenols (about 0.032%) lysed cultures of E. coli, staphylococci, and streptococci rapidly[17]. Srivastava and Thompson proposed that action of phenol takes placed during the phase of separation of pairs of daughter cells of microorganisms . The younger bacterial cells are more sensitive compared to older bacterial cells to phenol [18, 19] Vapour releasing intracanal medicaments (such a formocresol) are placed with cotton pellets and should be renewed between every 3-5 days [4].

Quatenary ammonium composunds

The cationic agents (QACs), are useful antiseptics and disinfectants. They result in generalized bacterial membrane damage involving phospholipid bilayers. These compounds attract negatively charged microorganisms as they are positive charged in nature [4] They are bactericidal against gram postive bacteria and moderately active against gram negative bacteria. They basically attribute to denaturation of protein, disruption of cell membrane and inactivation of cell membrane (in Staphylococcus aureus)[20]. Aminiacridine is a mild antiseptic and mainly used as an irrigant[4]. However these agents are not commonly employed in endodontics.

Octenidine

This is one of the latest atiseptics proposed as an alternative to chlorhexidine and calcium hydroxide. Octenidine is a potent skin and wound disinfectant with a wide antimicrobial spectrum. It has also been used as mouthwash in clinical trials achieving similar results as CHX. E.faecalis is gram positive bacteria which is able to sustain itself in high alkalinity conditions[21] and even in nutritional deficiency states[22]. Octenidine, being a potent antimicrobial agent, is able to reduce amounts of E. Faecalis found in infected and failed areas of root canal treatment.[23] Hence, octenidine is effective against E. faecalis in dentinal disinfection[24].

The use of Octenidine gel is as produces results as effective as chlorhexidine as a root canal medicament in root dentine[25]. Octenidine also has the ability to produce a desired or intended results against dental plaque-associated bacteria, (such as Streptococcus mutans and Actinomyces viscosus)[26]. Octenidine hydro- chloride [N,N-(1,10decanediyldi-1[4H]-pyridinyl-4-ylidene)bis(1-octanamine)dihydrochloride] belongs to the bipyridines carrying two cationic active centres per molecule and demonstrates broad spectrum antimicrobial effects covering both Gram-positive and Gram-negative bacteria, fungi and several viral species. The mode of action is bactericidal/fungicidal by interfering with cell walls and membranes. Phenoxyethanol, an ethanol derivate, serves as a preservative component in Octenisept (commercial brand of Octenidine) which is also supposed to improve the antibacterial activity of octenidine synergistically.

CONCLUSION

Root canal disinfection is of paramount importance in success of root canal treatment. This is optimally achieved by using disinfectants within the root canal. A knowledge of the various intracanal antiseptics is important to choose the antiseptic for the case as required. More research and clinical trials are needed on the latest antiseptics

REFERENCES

1. Lister J, Antiseptic Principle of the Practice Of Surgery, Br Med J, 2,1967, 9-12.
2. Patterson AM, Meaning of “Antiseptic”,“Disinfectant” and Related Words, Am J Public Health, 22,1932, 465-472.
3. Sjogren U, Figdor D, Persson S, Sundqvist G. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with “apical periodontitis”. Int Endod J, 30,1997, 297-306.
4. Hedge J, Endodontics, Prep Manual for Undergraduates, 2008 Elsevier, Pages 145-150, ISBN 978-81-312-1056-7.
5. Walton RE, Intracanal Medicaments, Dent Clin North Am, 28,1984, 783-796.
6. Zehnder M, Root Canal Irrigants, J Endod, 32,2006,389-398.
7. Dakin HD, On the Use of certain Antiseptic Substance in Treatment Of Infected Wounds, Br Med J, 2,1915,318-320.
8. Mohammadi Z, Sodium Hypochlorite in Endodontics- An update review, Int Dent J, 58, 2008, 329-341.
9. Estrela C, Estrela CR, Barbin EL, Spano ACE, Marchesan MA, Pecora JD, Mechanism Of Action of Sodium Hypochlorite, Braz Dent J, 13, 2002,112-117.
10. Jaju S, Jaju PP, Newer Root Canal Irrigants In Horizon- A Review, International Journal of Dentistry, 2011, Article ID 851359.
11. Kohli A, Textbook of Endodontics, 2010 Elsevier, Pages 174-183, ISBN 978-81-312-2181-5.
12. Rathke A, Meisohle D, Bokelmann J, Haller B, Antibacterial activity of Calcium Hydroxide and Chlorhexidine containing points against Fusobacterium Nucleatum and Parvimonas Micra, Eur J Dent, 6,2012,434-439.
13. Mcdonnell G, Russell D, Antiseptics and Disinfectants, Activity, Action, and Resistance, Clin Microbiol Rev, 12,1999,147-179.
14. Feraz CCR, Gomes BPFA, Zaia AA, Teixeira FB, de Souza-Filho FJ, In vitro assessment of the antimicrobial action and the mechanical ability of Chlorhexidine gel as an endodontic irrigant, J Endod,27, 2001,452-455.
15. Basrani BR, Manek S, Sodhi RNS, Fillery E, Manzur A, Interaction between Sodium Hypochlorite and Chlorhexidine Gluconate. J Endod,33, 2007, 966-969.
16. Kim HS, Chang SW, Baek SH, Han SH, Lee Y, Zhu Q, Kum KY, Antimicrobial effect of alexidine and chlorhexidine against Enterococcus faecalis infection, Int J Oral Sci, 5, 2013, 26-31.
17. Pulvertaft RJV, Lumb GD, Bacterial lysis and antiseptics, J Hyg, 46, 1948, 62-64
18. Srivastava RB, Thompson REM, Influence of bacterial cell age on phenol action. C1965, Nature, 206, 216
19. Srivastava RB, Thompson REM. Studies in the mechanism of action of of phenol on Esterichia coli cells, Br J Exp Pathol, 47, 1966, 315-323.
20. Ioannou CJ, Hanlon GW, Denyer SP, Action of Disinfectant Quarternary Ammonium Compounds against Staphylococcus Aureus, Antimicrob Agents Chemother, 52, 2007, 296-306.
21. Haapasalo M, Orstavik D, In vitro infection and disinfectant of Dentinal Tubules, J Dent Res, 66, 1987, 1375-1379.
22. Hartke A, Giard GC, Laplace JM, Auffray A, Survival of Enterococcus Faecalis in an oligotrophic microcosm, changes in morphology, development of general stress resistance, and analysis of protein synthesis, Appl Environ Microbiol, 64, 1998,4238-4245.
23. Sundqvist G, Figdor D, Persson S, Sjogren U, Microbiologic analysis of teeth with failed endodontic treatment and the outcome of conservative re-treatment, Oral Surg Oral Med Oral Pathol, 85, 1988,86-93.
24. Tandjung L, Waltimo T, Hauser I, Heide P, E-M Decker, Weiger R, Octenidine in root canal and dentine disinfection ex vivo, Int Endod J,40, 2007,845-851.
25. de Lucena JMVM, Decker EM, Walter C, Boeira LS, Lost C, Weiger R, Antimicrobial effectiveness of Intracanal Medicaments on Enterococcus Faecalis, Chlorhexidine versus Octenidine, Int Endod J,46, 2013,53-61.
26. Slee AM, O’Connor JR, In vitro antiplaque activity of octenidine dihydrochloride (WIN 41464-2) against preformed plaques of selected oral plaque-forming microorganisms, Antimicrob Agents Chemother,23, 1983,379-384.

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