Original Article

Antimicrobial efficacy of 0.5% Iodine potassium iodide as intracanal irrigant against Enterococcus faecalis at apical third of canal

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ABSTRACT

Background: Persistent infection within the root canal and periapical area is a source of concern in endodontics . Inadequate disinfection of the infected root canal and associated periapical lesion can lead to persistence of the infection. Failed root canal treatments have been attributed to viable bacteria that exist within the root canal and periapical system.

Materials and methods : A total number of 32 single rooted extracted teeth were sterilized by autoclaving. *Enterococcus faecalis* was inoculated into the root canals for 24 hours. Teeth were then divided into 3 groups (n=8) and a control group. Root canals were prepared with Hand Protaper, and irrigated with 3% Sodium hypochlorite (NaOCl) in group I, 0.2% Chlorhexidine (CHX) in group II, and 0.5% Iodine potassium iodide (IKI) in group III. Canals of control group was irrigated with 0.9% Normal saline (NaCl). Dentinal shavings from apical third were collected from specimens; and cultured on brain heart infusion agar plates. Colony Forming Unit (CFU) of treated teeth and control specimens were counted and results were statistically analyzed by Mann Whitney 'U' test.

Result: The result of the following study suggested that 0.5% IKI was the most effective at eliminating *E. faecalis* than the other irrigant solutions. However the result showed non-significant when compared with each other 0.5% IKI, 3% NaOCl and 0.2% CHX The result showed there was no statistically significant difference between the 0.5% IKI, 0.2% CHX& 3%NaOCl

Conclusion: IKI is very good antimicrobial irrigating solution against *E .Faecalis* amongst the experimental irrigants. The antimicrobial action of IKI is comparable with antimicrobial action of 0.2%CHX and 3%NaOCl which is proved best till date against *E. faecalis.*

Keywords: chlorhexidine, colony forming unit, *enterococcus faecalis,* iodine potassium iodide, sodium hypochlorite

INTRODUCTION

Antimicrobial activity during irrigation in endodontic therapy to disinfect the root canal system has been well documented. Facultative bacteria which have been associated with chronic endodontic treatment failure are usually enterococci, esp *E. faecalis.*[1]

Strict anaerobes, though, predominates in primary endodontic infections, they are more easily eliminated by endodontic procedures; whilst, facultative anaerobes particularly *Enterococcus faecalis*, though are usually in the minority, prevail in therapy-resistantcases.[2,3] As they are able to survive in environments with sparse nutritional supply, when opportunities prevail by alteration of the ecological prerequisites, enterococci may thrive and multiply even in a low-nutrient environment.[4]

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Numerous measures have been described to reduce the number of root canal microorganism, including the use of various instrumentation techniques, irrigation regimens, and intracanal medicaments. The favorable protocol is to use antimicrobial agents that exert its antimicrobial activity quickly against the majority of microorganisms found in the root canal and in dentinal tubules. This is favored by shaping the canals and opening the complex canal space for the action of irrigant.[4]

Various chemicals have been tried to disinfect the root canal system. Sodium hypochlorite (NaOCl), at different concentrations, has been used in endodontic as a convenient irrigant for more than 70 years.[5] It is an effective antimicrobial agent, has excellent solvent properties for vital, necrotic, and fixed tissues. But, it is known to be highly mal-odorous and caustic, irritant for periapical tissues, especially at high concentrations.[6] Chlorhexidine gluconate (CHX) is a wide spectrum antimicrobial agent. It is unique in its ability to bind oral tissues for extended period from which it is released slowly (substantively) and it is relatively nontoxic.[7]

Iodine compounds are among the oldest disinfectants still actively used. They are best known for their use on surfaces, skin and operation fields. It kills rapidly and has bactericidal, fungicidal, viricidal, and even sporicidal activity. Iodine potassium iodide (IKI) has been successfully used in tooth surface disinfection. Potassium iodide is used to dissolve iodine in water. It is also a very potent antibacterial agent of low toxicity. IKI is a biocompatible, antibacterial agent which exhibits a long distance bactericidal effect due to its evaporation and sublimation. IKI effectively penetrates the dentinal tubules and kills bacteria.[8]

There are no known reports of comparing the antimicrobial efficacy of IKI with commonly used irrigant Sodium Hypochlorite and CHX. Hence, the present study was undertaken to determine the antimicrobial efficacy of 0.5% IKI as an intracanal irrigant at the apical third of canal against *Enterococcus faecalis* and to compare it with 0.2% CHX and 3% NaOCl.

MATERIALS AND METHODS

32 single rooted extracted human teeth with type I canal anatomy were selected. Access cavity was prepared using diamond points with high speed airotor hand piece. Root canals were prepared with crown down technique using ProTaper hand instruments (Dentsply/Tulsa Dental) up to 25 size apically. Canals were treated with 17% EDTA for 1 min to facilitate removal of smear layer. Root apices were sealed with nail varnish and teeth were sterilized. A turbid suspension of *Enterococcus faecalis* was placed into the canal using a sterile 27 gauge needle with syringe and incubated at 36.5 ^{0}C for 24 hours. The teeth were randomly divided into three experimental groups (n=8) and a control group (n=8).

In control group (C), canals were passively irrigated with 0.9% saline using a sterile 27 gauge syringe for 30 sec. In group I, Canals were passively irrigated with 3% sodium hypochlorite using a sterile 27 gauge syringe for 30 sec; in group II, Canals were passively irrigated with 0.2% Chlorhexidine using a sterile 27 gauge syringe for 30 sec.; and in group III, Canals were passively irrigated with 0.5% Iodine potassium iodide a sterile 27 gauge syringe for 30 sec.

With the sterile round bur of diameter 1 mm, a hole was drilled from the proximal surface of the tooth into the root canal in the apical third. The dentinal shavings were allowed to fall on the Agar plate containing brain heart infusion agar culture medium. The plates were then incubated for 48 hours at 36^{0}C. The viable organisms were expressed as colony forming units (CFU/ml). Statistical analysis was done by Mann Whitney 'U' test.

RESULTS

The comparison of mean CFU among four different groups and it indicates that 0.5% IKI was the most effective at eliminating *E. faecalis* than the other irrigant solutions (Table 1). 0.5% IKI, 3% NaOCl and 0.2% CHX are non-significant when compared to each other and to control (Table 2).

Table 1: Comparison of mean CFU among four different groups.

Group	N	Minimum	Maximum	Median	Mean	St. Dev.
Gr. I	8	o	7	3	3.25	2.37
Gr. II	8	0	6	2	2.25	2.37
Gr. III	8	0	3	2	1.87	1.03
C	8	0	31	3.5	8	10.7

Table 2: Pair wise comparison of four groups with respect to CFU using Mann Whitney 'U' Test

Groups	Z	p	Inference
Gr. I vs Gr. II	-0.904	0.366	NS
Gr. I vs Gr. III	-1.239	0.215	NS
Gr. I vs C	-0.476	0.634	NS
Gr. II vs Gr. III	-0.275	0.783	NS
Gr. II vs C	-1.162	0.207	NS
Gr. III vs C	-1.390	0.165	NS

DISCUSSION

In this study, *Enterococcus faecalis* was chosen as the test organism because its prevalence has been a conspicuous finding in a high percentage of root-canal failures that has been attributed to its high resistance and its ability to survive as a single organism in monocultures.[1,9] It has been used in previous studies testing the efficacy of irrigant solutions. The characteristics of *E. faecalis* which relate to its prevalence include its ability to endure nutritional deprivation, bind to dentin and invade dentinal tubules, compete with other bacteria, suppress lymphocytes, and produce toxins.[9] In the present study, the teeth were incubated with *E. faecalis*. The bacterial sample introduced in the canal with syringes after instrumentation of the canal space.

Ando and Hoshino[10] demonstrated the presence of bacteria 500 to 2000 µm in tubules in teeth with heavily decayed crowns. Culturing of the dentin shavings and canal contents, as was done in the present study, at a greater depth allowed determination of the efficacy to the test irrigants at penetrating and disinfecting deeper layers of dentine.[11]

Iodine potassium iodide has been successfully used in tooth surface disinfection. IKI is biocompatible and has antibacterial effect due to its evaporation and sublimation. IKI effectively penetrates the dentinal tubules and kills bacteria with less tissue toxicity.[8] Though not significant, 0.5% IKI, in this study, is most effective against *E. faecalis*. Similar results of IKI demonstrating more potent in eliminating *E. faecalis* than NaOCl or CHX in studies by Hancock et al.[12] and Orstavik D and Haapasalo M.[13] Orstavik and Haapasolo[13] also reported that IKI was able to penetrate the dentinal tubules to eliminate *S. Sanguis* to a depth greater than 1000 µm within 5 min. Similarly, Safavi et al.[14] reported that IKI eliminated *Streptococcus faecium* from infected tubules, in 10 minutes when compared to $Ca(OH)_2$ which took 24 hours. Peculiene et al.[15] reported that IKI improved the antimicrobial effect in retreatment cases when used after canal instrumentation and irrigation with sodium hypochlorite. Whereas, a study by Spratt DA et al.[16] showed that NaOCl was most effective agent, followed by iodine. However, the disadvantages of iodine are that it causes staining and may be allergic to the patient.[8]

0.5%IKI, 3% NaOCl and 0.2% CHX, in this study, are equally effective but their results were not significant when compared to Control (saline). The reduction of colonies with saline can be attributed to its flushing action more than its antibacterial action. This may be because the teeth were incubated for 24 hours in this study. The incubation is to be done for 4 weeks to ensure adequate penetration of the bacteria into the dentinal tubules.[13] The dentinal shaving collected for this study might not have been contaminated effectively. Findings suggested that bacteria in biofilms undergo a process of phenotypic diversification that decreases their susceptibility;[17] multiple cell types in single species biofilms might ensure population survival against one particular antimicrobial

agent. Thus, treating biofilms with various antimicrobial agents as well as combinations of distinct antimicrobials might be an effective strategy to kill different cell types.[18]

Based on the above findings, we can conclude various chemical as root canal irrigant can be tried and tested against the endodontic microflora. The antibacterial effectiveness of irrigants ex vivo may be quite different from mixed cultures present in a dynamic biological system in vivo.

Further research is required regarding the efficacy of antimicrobial agents, their concentration and their combination on dentine and on single and multiple species biofilms.

CONCLUSION

The present study concludes that 0.5% Iodine potassium iodide is the most effective antimicrobial agent as a root canal irrigant, although it is not significantly different from 3% sodium hypochlorite, 0.2% chlorhexidine and saline.

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