Original Article

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AN IN VITRO STUDY OF CHLORINE DIOXIDE AS A ROOT CANAL IRRIGANT

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ABSTRACT

Introduction: NaOCl is a widely used endodontic disinfectant, which is shown to have both antimicrobial and necrotic tissue dissolution properties. Since NaOCl is also known to be cytotoxic to the vital tissues, it has to be used with caution. ClO_2 has been considered as a root canal irrigant because of its antimicrobial activity and compatibility with living tissue. **Material and Methods:** Thirty extracted human single rooted teeth which had obvious pulpal pathosis were collected. Only the root portion used for the study was stored in saline and used within two weeks time. The canals were instrumented using step-back technique with hand k-files and prepared at least upto 40 size master file for all samples. Three different irrigants were used for 10 samples each (n=10). Gp I: 0.9% normal saline (negative control). Gp II: 3% sodium hypochlorite (positive control). Gp III: 10% of ClO_2. **Results:** All 10 samples in the control group showed growth, while only 4 and 5 samples showed growth in Gp II and Gp III respectively. The growth of micro-organisms was found to be significantly less in NaOCl (40% vs 100%) and in ClO_2 (50% vs 100%) when compared to the control (p=0.011 and 0.033 respectively). The growth pattern of micro-organisms is statistically similar in both NaOCl and ClO_2 (p>0.05). **Conclusion:** The antimicrobial efficacy of 10% ClO_2 is as good as that of the routinely used 3% NaOCl though it is highly corrosive, highly combustible and needs to be freshly prepared.

KEYWORDS: Sodium hypochlorite; Chlorine dioxide; Root canal disinfection

INTRODUCTION

One of the most important and often neglected phases of root canal therapy is the thorough cleaning and shaping of all the root canals. Irrigation solutions are required to eradicate microorganisms, dissolve necrotic tissue, lubricate the canal, remove the smear layer and be least irritating to the tissues.

Sodium hypochlorite (NaOCl): Sodium hypochlorite (NaOCl) is an effective biocidal irrigant but unfortunately it is corrosive to metals, irritating to skin and eyes, has a strong odor, discolors operatory items tends to be unstable and causes tissue irritation.[1] NaOCl is known for its strong antibacterial activity, effective against gram-positive and gram-negative aerobes & anaerobes, *C. albicans* and *E. faecalis* to a lesser extent.[2] Its action is mainly through hypochlorous acid, HOCl (at pH 4-7) and hypochlorite ion, Ocl^- (at pH >9).

Chlorine dioxide (ClO_2): Chlorine dioxide (ClO_2) is currently used as a water purifier, surface disinfectant, and in some commercial mouth rinses and pastes. ClO_2 has bactericidal activity and is toxic to both enveloped and non-enveloped viruses.[3] It has been considered as a root canal irrigant, but little is known about its antibacterial efficacy against the root canal microbes. Hence, this study aims at comparing the antibacterial efficacy of ClO_2 against the widely used NaOCl (positive control) and saline (negative control).

MATERIALS AND METHODS

Thirty extracted human single rooted teeth which had obvious pulpal pathosis were collected from the Department of Oral and Maxillofacial surgery of DAPMRV Dental College. The teeth were sectioned transversely at the CEJ and crowns were discarded. Only the root portion used for the study was stored in saline and used within two weeks time.

Fig. 1: The samples were left in the irrigation solutions for a period of 15 mins before microbial testing

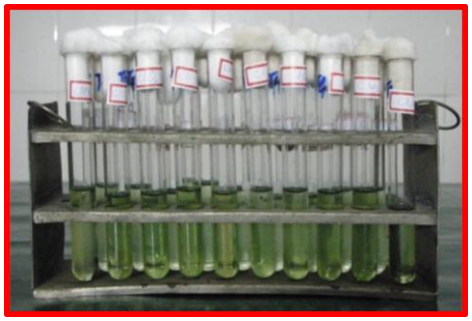


Fig. 2: Innoculated thioglycholate broth

Fig. 3: Innoculated thioglycholate broth being incubated at 37 ^{0}C

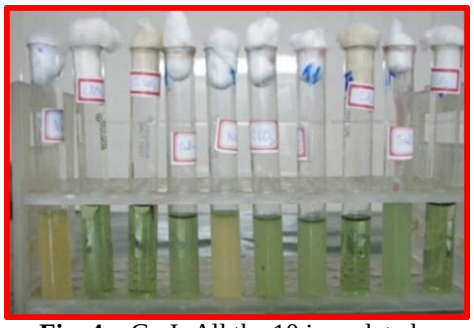


Fig. 4a: Gp I: All the 10 inoculated samples showed growth after 72hr incubation

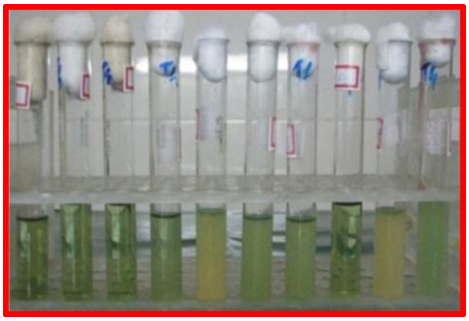


Fig. 4b: Gp II: 4 out of 10 inoculated samples showed growth

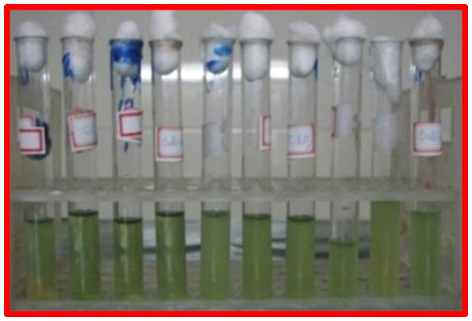


Fig. 4c: Gp III: 5 out of 10 inoculated samples showed growth

The canals were instrumented using step-back technique with hand k-files and prepared at least upto 40 size master file for all samples. Three different irrigants were used for 10 samples each (n=10).

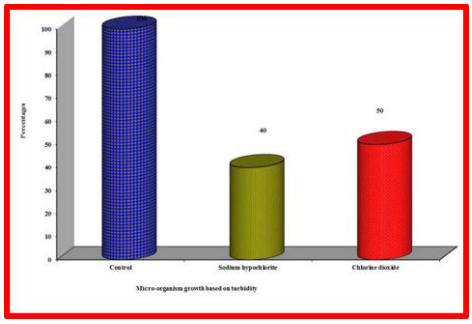
- Gp I: 0.9% normal saline (negative control).
- Gp II: 3% sodium hypochlorite (positive control)
- Gp III: 10% of ClO_2

The samples were left in the irrigation solutions (Fig. 1) for a period of 15mins before microbial testing. Microbiological samples were taken from the teeth in aseptic conditions. Thioglycholate broth was carried into the perpared root canal, aggitated with a k-file, aspirated and inoculated into freshly prepared thioglycholate agar medium (Fig. 2). A layer of sterile liquid paraffin was laid on the medium immediately to support the growth of anaerobic organisms and was incubated at 37 ^{o}C for 72hrs (Fig. 3). All the samples were assessed after incubation for the growth of micro-organisms as the presence of turbidity and recorded as positive (presence of turbidity in the thioglycholate broth) or negative (clear thioglycholate broth) (Fig. 4). The results were statistically analyzed and 'p' values were obtained based on Fisher exact test.

RESULTS

All 10 samples in the control group showed growth, while only 4 and 5 samples showed growth in Gp II and Gp III respectively. The

growth of micro-organisms was found to be significantly less in NaOCl (40% vs 100%) and in ClO_2 (50% vs 100%) when compared to the control (p=0.011 and 0.033 respectively). The growth pattern of micro-organisms is statistically similar in both NaOCl and ClO_2 (p>0.05).



DISCUSSION

NaOCl is a widely used endodontic disinfectant, which is used in a concentration of 0.5% to5.25%, is shown to have both antimicrobial and necrotic tissue dissolution properties. Studies have shown that NaOCl can dissolve pulp tissues as well as necrotic tissue. NaOCl is also known to be cytotoxic to the vital tissues.[4] Hence, has to be used with caution not to inadvertently extrude into the periapical areas. ClO_2 has been considered as a root canal irrigant because of its antimicrobial activity and compatibility with living tissue. In drinking water, chlorite (ClO^{2-}) is the predominant reaction end product, with approximately 50 to70 percent of the chlorine dioxide converted to chlorite and 30% to chlorate (ClO^{3-}) and chloride (Cl^-). ClO_2 is used as a disinfectant at a concentration of 0.1-15mM.[5] ClO_2 has bactericidal activity on plaque bacteria such as *Streptococcus constellatus*, *Streptococcus mitis*, *Eikenella corrodens*, *Fusobacterium nucleatum* and is toxic to both enveloped and non-enveloped viruses [Hepatitis A virus, feline calcivirus and coxsackie B5 strains]. Chlorinating agents, such as Cl_2 and NaOCl, used as disinfectants for drinking water react with natural organic matter to produce halogenated disinfectant by-products. Trihalomethanes and haloacetic acids are two most prevalent groups of disinfectant by-products formed during the chlorination of natural water. Levesque *et al*. have shown that trihalomethane is an animal carcinogen and a suspected human carcinogen. ClO_2 produces little or no trihalomethanes, and may be a better dental disinfectant than NaOCl. The findings suggest that ClO_2 is sufficient for use as a dental disinfectant compared with NaOCl. Further in vitro and in vivo studies are awaited to determine the clinical relevance of the cytotoxicity of NaOCl and Clo_2 since both have similar antimicrobial properties.[6]

CONCLUSION

Under the limitations of the study it can be concluded that the antimicrobial efficacy of 10% ClO_2 is as good as that of the routinely used 3% NaOCl though it is highly corrosive, highly combustible and needs to be freshly prepared. Further studies (both in-vitro and in-vivo) are needed to establish the results since NaOCl processes other significant pulp and necrotic tissue dissolving property.

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