Research Article

Antimicrobial activity of a novel sonic agitation device

S. Arun Kumar, P. Ajitha*

ABSTRACT

Objective: The aim of this study is to evaluate the antibacterial efficacy of 5.2% sodium hypochlorite (NaOcl) with sonic agitation devices.**Materials and Methods:** The protocol for the present study was approved by the Institutional Ethical Committee. 32 adult patients aged between 18 and 60 years, requiring root canal therapy in anterior and premolar teeth with non-vital pulp were selected for this study. The teeth with vital pulp, periapical cyst, calcified canals, and immature apices were excluded from the study. These teeth were analyzed by pre-operative radiographs and electric pulp test for monitoring their pulpal and periapical status. A detailed medical and dental history was taken. Patients were explained about the procedure, and written consent was taken before treatment. 20 permanent teeth were randomly divided into groups corresponding to the disinfection protocol. Local anesthesia (Lox 2%, Neon Laboratories Ltd., India) was administered, and isolation was done with rubber dam. The tooth and surrounding area were disinfected by swabbing with 5% iodine tincture. The root canal was accessed with size 10 K-file (Mani, Inc., Tochigi, Japan). Then, initial pretreatment root canal culture sample was taken with presterilized paper points. Two paper points were placed in the canal for 60 s and then transferred into two separate presterilized tubes of 2 ml brain heart infusion broth (marked as aerobic and anaerobic sample). This was designated as the first sample (S1). These tubes were transferred in 10 min for culturing under aerobic and anaerobic conditions. The working length was determined using electronic apex locator (Root ZX mini, JMorita Corp.) which was kept 0.5 mm short of the apex. This was confirmed by radiograph. Cleaning and shaping was done using conventional step-back technique. Master apical size was kept three sizes larger than the initial binding instrument. 5 ml of sterile water was used for irrigation during cleaning and shaping. Final sample (S2) was taken after agitating the sodium hypochlorite. Group 1 was agitated with EndoActivator, Group 2 was agitated with Waterpik Power Flosser, and Group 3 - positive control was not subjected to any agitation. **Results:** Canals agitated with EndoActivator and Waterpik Power Flosser showed antibacterial action against aerobic and anaerobic bacteria.

KEY WORDS: Antimicrobial activity, Waterpik Power Flosser, EndoActivator, CFU (Colony-forming unit)

INTRODUCTION

The main goal of endodontic therapy is complete elimination of the infectious agent as well as its products which are responsible for the development and perpetuation of the pulpal and periradicular diseases. There are numerous obligate anaerobic bacteria associated with the development of the pulpal diseases, but few facultative strains, such as *Enterococcus faecalis*, are found to be involved in persistent infections. Failure to eliminate these bacteria may lead to poor outcome of the treatment. As root canal is an area not easily accessed by the defense mechanism of the body, elimination of this infection should be achieved by mechanical procedures along with chemical adjuvants and endodontic irrigants. Numerous irrigants have been introduced and are still being innovated to achieve completed infection. Sodium hypochlorite (NaOCl) is not only a bleaching, deodorizing, and tissue dissolving agent but also an effective disinfectant.[1] Normal anatomy of the root canal is very complex with morphological irregularities which provide a perfect niche for the microorganisms to colonize and perpetuate. In addition to these areas, the microorganisms also infiltrate into the dentinal tubules, making the procedure of complete disinfection a clinical mirage.[2] A study compared the microcomputed tomography scans before and after mechanical instrumentation and found that regardless of the instrumentation technique, 35% or more of the root canal surfaces remained uninstrumented.[3] Therefore, disinfection of the uninstrumented surfaces depends mainly on the use of irrigants.

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It has been demonstrated that meticulous instrumentation with copious irrigation only reduces the bacterial load.[4] Ideally, the endodontic irrigants are delivered into the canal system to flush out loose debris, dissolve organic tissues, kill microbes, remove microbial byproducts, and remove the smear layer even with the usage of modern nickel–titanium instruments, it was observed that more than 35% of the canal remained uninstrumented.[5] The bacteria load may adversely affect the outcome of treatment. Studies have demonstrated that almost 40–50% of cases exhibited negative cultures after chemomechanical preparation with different instrumentation techniques and instruments and conventional irrigation with different irrigants.[6] Hence, in this regard, many different irrigation protocols, solutions, and delivery systems have been recently introduced in endodontics, with the promise of optimizing disinfection of the root canal.[5] The phenomenon of acoustic microstreaming and cavitation inside the irritant filled root canals has been investigated. When cavitation bubbles are produced by acoustic waves, they eventually collapse, and the energy released is transferred to the root canal wall, liberating any debris found thereon. Microstreaming then carries the debris coronally so that it can be removed from the canal. Acoustic cavitation has been shown to remove and destroy the biofilm.

In the present study, two sonic agitation devices, namely EndoActivator (Advanced Endodontics, Santa Barbara, California) and Waterpik Power Flosser (Waterpik, Inc., Fort Collins, Colorado), have been selected to compare their antibacterial efficacy.

Waterpik Power Flosser is an activation device used for flossing the interdental areas. It has a mechanism of action very similar as that of the EndoActivator; moreover, the tips of the EndoActivator and those of the Power Flosser system are interchangeable. This has led us to the idea of comparing the antibacterial efficacy of the commercially available, EndoActivator with that of Waterpik Power Flosser system.

The aim of this study is to evaluate the antibacterial efficacy of 3% sodium hypochlorite (NaOCl) using the commercially available EndoActivator and Waterpik Power Flosser.

MATERIALS AND METHODS

The protocol for the present study was approved by the institutional ethical committee. 24 adult patients aged between 18 and 60 years, requiring root canal therapy in anterior and premolar teeth with non-vital pulp were selected for this study. The teeth with vital pulp, periapical cyst, calcified canals, and immature apices were excluded from the study. These teeth were analyzed by pre-operative radiographs and electric pulp test for monitoring their pulpal and periapical status. A detailed medical and dental history was taken. Patients were explained about the procedure, and written consent was taken before treatment. 24 permanent teeth were randomly divided into groups corresponding to the disinfection protocol.

Endodontic Protocol

Local anesthesia (Lox 2%, Neon Laboratories Ltd., India) was administered, and isolation was done with rubber dam. The tooth and surrounding area were disinfected by swabbing with 5% iodine tincture. The root canal was accessed with size 10 K-file (Mani, Inc., Tochigi, Japan). Then, initial pretreatment root canal culture sample was taken with presterilized paper points. Two paper points were placed in the canal for 60 s and then transferred into two separate presterilized tubes of 2 ml brain heart infusion broth (marked as aerobic and anaerobic sample). This was designated as the first sample (S1). These tubes were transferred in 10 min for culturing under aerobic and anaerobic conditions. The working length was determined using electronic apex locator (Root ZX mini, JMorita Corp.) which was kept 0.5 mm short of the apex. This was confirmed by radiograph. Cleaning and shaping was done using conventional step-back technique. Master apical size was kept three sizes larger than the initial binding instrument. 5 ml of sterile water was used for irrigation during cleaning and shaping. Final sample (S2) was taken after agitating the sodium hypochlorite.

- Group 1 (n = 8): 3% NaOCl agitated with EndoActivator for 3 min.
- Group 2 (n = 8): 3% NaOCl agitated with Waterpik Power Flosser for 3 min.
- Group 3 (n = 8): 3% NaOCl without subjected to any agitation.

RESULTS

Kruskal–Wallis analysis of variance (ANOVA) tests were used for comparison of the three groups with respect to CFU/mL in root canals [Table 1].

DISCUSSION

Irrigation by sonic agitation showed improved debridement of the root canal. The EndoActivator system has been reported to provide deeper penetration of an irrigant to all areas of the endodontic spaces.[9] Effectively clean debris from lateral canals, remove the smear layer, and dislodge clumps of simulated biofilm (Caron, 2007),[10] these results indicate that activation of the irrigant enhances the removal of dentin debris from the apical root canal. Recently, many studies found that sonic and ultrasonic systems improved smear layer removal only in the straight coronal portion of curved root canals (Rodig, 2009).[11]

Table 1: Comparison of the three groups with respect to CFU/mL in root canal by Kruskal–Wallis ANOVA and Mann–Whitney *U*-test

Tested groups	Pre-treatment samples (S1) log-CFU/ml-SD	Post-treatment samples (S2) CFU/ml-SD
Group 1 (EndoActivator)	10^8×1.07 (421)	1.28 (19)–2.7
Group 2 (Waterpik Power Flosser)	10^8×0.99 (396)	1.11 (13)–2.1
Group 3 (without any activation)	10^8×0.79 (296)	0.79 (10)–1.1

ANOVA: Analysis of variance, CFU: Colony-forming unit

NaOCl is a widely used endodontic irrigating solution in infected root canals.[12] Even though its antibacterial effects are recognized, the exact mechanism of microbial killing is not well elucidated. When NaOCl is added to water, hypochlorous acid (HOCl) is formed, which contains active chlorine, a strong oxidizing agent.[13] Substantial evidence suggests that chlorine exerts its antibacterial effect by their reversible oxidation of –SH groups of essential enzymes,[14] disrupting the metabolic functions of the bacterial cell.[8] Chlorine may also combine with cytoplasmic components to form N-chloro compounds, toxic complexes which destroy the microorganism. However, the first contact oxidation reactions of chlorine with bacteria may lead to the rapid killing of bacterial cells even before the formation of N-chloro compounds in the cytoplasm. It has been appreciated that the disinfecting action of NAOCl increases with a decrease in pH as the concentration of undissociated HOCl increases, but alkaline pH is necessary to maintain the stability of the solutions.[1]

Recently, the EndoActivator has been recommended to enhance the cleaning efficacy of irrigation of root canal systems.[15] Its proposed ability to create sonic waves in irrigating solutions deposited inside of the root canal might aid in the killing of bacteria and debridement of necrotic tissue.[7] Sonic energy only has the power to produce one node along the length of the instrument; hence, any constraint of the instrument will significantly decrease, if not eliminate, the acoustic streaming necessary to dislodge and carry away necrotic debris.[18]

The EndoActivator might not be powerful enough to disrupt bacterial biofilms,[7] but in contrast, the tip used in Group 3, due to its flute configuration, may cause an increase in the irrigant agitation and may aid in the removal of the bacterial biofilms.[16] However, the fluid dynamics of the irrigant with this tip is yet to be studied and no conclusion can be drawn as yet. The activator tip is moved along the canal walls in circumferential motion to allow the close adaptation of the tip to the walls so that the disruption of the biofilm is better.[19,20]

Vibrating the tip in combination with moving the tip up and down in short vertical strokes synergistically produced a hydrodynamic phenomenon which could be the reason for efficient performance of the sonic protocol.

CONCLUSION

Within the limitations of the present study, it could be concluded that the highly economical Waterpik Power Flosser system is as effective as the EndoActivator system pertaining to antibacterial efficacy. Further studies are warranted regarding the removal of the smear layer and hydrodynamics of the irrigant during agitation with these tips, before direct extrapolations in clinical conditions.

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