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Research Article

A Comparative Evaluation of Disinfection of the Root Canals with Manual Dynamic Agitation, Ultra X and Laser: An *In Vitro* Study

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Abstract

Aim: The aim of the study is to evaluate the disinfection efficacy of the root canals with three different irrigation systems namely, Manual Dynamic Agitation, Ultra X and Laser.

Materials and Methods: Forty extracted mandibular premolar teeth were decoronated at cemento-enamel junction and root canals were prepared till #30k file and saline was used as irrigant. Two coats of nail varnish was applied to seal the apex. The teeth were sterilized and inoculated with bacterial strains of E. faecalis and incubated for 21 days at 37°C. The samples were randomly divided into 4 groups (n = 10) according to the irrigation systems used, 5.25% NaOCl was used as irrigant in experimental groups, and control group received no irrigation. After root canal disinfection, the paper points were used to collect the samples from the teeth and were placed in Brain Heart Infusion Broth for 24hours. Then the samples were transferred to Muller-Hilton media for 24 hours to evaluate the colony forming units.

Statistical Analysis: Statistical analysis performed using chi-square test.

Results: According to the results obtained, Laser irradiation resulted in better disinfection of the root canal system. Ultra X resulted in significant disinfection as compared to Manual Dynamic Agitation.

Conclusion: Within the limitations of the study, Laser irradiated group showed better disinfection than Ultra X and Manual Dynamic Agitation when used in conjunction with 5.25% sodium Hypochlorite.

Keywords: Laser; Ultra X; Manual Dynamic Agitation; Disinfection

Introduction

The main objective of endodontic treatment is the elimination of micro-organisms and contaminated and necrotic pulp tissue remnants from the canal space. The debridement of the canal space in conjunction with manual or rotary instrumentation achieves this purpose [1].

Sodium Hypochlorite is considered the principal irrigant because of its higher antimicrobial efficacy, used in 0.5-6% concentration and has the property of tissue dissolution [2].

Two categories of root canal agitation methods are manual and machine-assisted agitation techniques.

Conventional manual irrigation with syringes and needles is a widely accepted method for activating irrigants. This technique requires repeatedly inserting a gutta-percha cone that is well-fitted to the working length of a previously shaped canal. It has been proved that the flushing action of the irrigant is insufficient to clear the debris from the canal imperfections [3].

According to Huque., *et al*. Ultrasound has been shown to enhance the flushing effect of irrigant solutions. Acoustic streaming occurs as a result of the transmission of energy from a freely oscillating file to the irrigant in the root canal during ultrasonic irrigation. The term "passive ultrasonic irrigation" refers to an ultrasonically activated file with non-cutting action, whereas "active ultrasonic irrigation" refers to dynamics and flow within the fluid, thereby improving canal disinfection [4].

Lasers are progressively finding their way into the dental practice, including Endodontics. Recent research demonstrated that the laser does have a bactericidal impact when put into the root canal, increasing root canal disinfection [5].

In unsuccessful root canal therapy, Enterococcus faecalis, anerobic gram-positive cocci, is frequently discovered. They form intra and extra radicular biofilms that are hard to remove and cause reinfection [5].

Root canal disinfection is more successful when irrigation solutions and activation are used together. The study aims to compare the effectiveness of various irrigation delivery systems in conjunction with 5.25% NaOCl in root canal disinfection.

Materials and Methods

Forty extracted single-root human mandibular premolar teeth with a single root canal with completely formed apices were chosen. The study excluded teeth with decay and open resorbed apices. Digital radiographs of teeth were taken at various angulations to confirm the presence of a single canal.

The samples were sterilized in an autoclave and decoronated at CEJ using a high-speed diamond disc, and the tooth length was standardized to 15mm up to the apex. The working length was established with a size #15 k-file and was kept 1mm short of the anatomic root apex. The root canals were prepared with Protaper gold rotary files up to F3 size with saline as the irrigant, then biomechanical preparation using size #30 k-file. The root apex is sealed with two coats of nail polish, and the samples were sterilized in an autoclave.

Cultivation and inoculation of bacteria

Enterococcus faecalis (ATCC29212) was plated on the Brain heart infusion broth complemented with 1.5% (wt/vol) blood agar and incubated anaerobically at 37^0C for 24 hours. A single colony of E. faecalis from the BHI agar plate was collected and placed in sterile BHI broth and then incubated at 37^0C for 24 hours in the Department of Microbiology, Navodaya Medical College, Raichur.

The McFarland turbidity scale, which equates to $3X10^8$ CFU per ml and an optical density of 550nm was used to modify the inoculums concentration. After the incubation, the purity of the culture was examined by gram staining, which established the presence of Enterococcus faecalis.

The root canals were inoculated with the bacterial suspension and incubated for 21 days at 37^0 C in an incubator. After incubation, the teeth were randomly divided into control and three experimental groups, with each group containing ten samples.

- **Group A (n = 10):** The teeth in this group were not irrigated and served as the control group.
- **Group B (n=10):** A 30-gauge needle using a 10ml syringe is placed 1mm short of the working length to inject 5.25% NaOCI into this group. The GP cone was moved up and down for 10 seconds after each irrigant delivery to activate the irrigant. The sequence was carried out twice for a total of 60 seconds at a flow rate of 0.1ml/min.
- **Group C (n = 10):** For this group, an ultrasonic activator tip (Ultra X) that passively fits when placed 2-3 mm short of working length is chosen, and the solution is agitated using brief vertical strokes for three cycles lasting 20 seconds each.
- **Group D (n = 10):** In this group, 5.25% NaOCl was injected into the canal and intracanal radiation was delivered using an LX16 laser with a 200µm fiberoptic tip and a power setting of 2.5W. The diode was inserted in an oscillatory fashion, recessed in helicoidal movements at a rate of around 1mm/sec, and repeated four times with a 10-second interval between each repetition.

Samples from the teeth were taken and placed in BHI Broth in microtubes for one day after sterile paper points were inserted into the canal for 60-seconds. These samples were put using a nichrome wire loop onto Petri dishes with Muller-Hilton media to measure the CFU.

Statistical analysis

The chi-square test was employed for the statistical analysis.

Results and Discussion

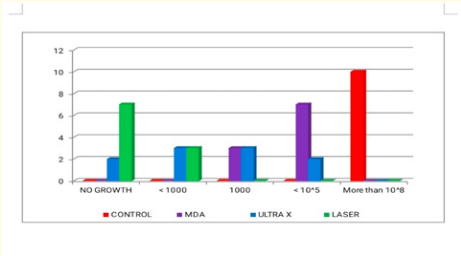

Figure 1

The mean CFU for all the groups were: Group 1 = more than 10 ml, Group 2 = less than 10^5 ml, Group 3 = 10^3 ml and Group 4 = 0. Statistical analysis demonstrated statistically significant differences between the laser irradiated group (Group 4) and Ultra X and MDA (Group 2 and 3 respectively) and control group.

Discussion

The nature of endodontic infections is polymicrobial. The infected root canal is populated primarily by bacteria like Streptococci, Staphylococci, Eubacterium, Peptococcus, Peptostreptococcus, and Fusobacterium. When root canal treatment fails, gram positive species especially facultative anaerobes like

E. faecalis, prevail in the canal's microbial ecology [9].

This study used E. faecalis as the test organism. Although it is rarely present in primary pulpal infections, it is frequently correlated with retreatment cases and persistent apical periodontitis. It is due to its ability to form biofilms that can abide inside root canals without the help of other organisms and infect the entire length of dentinal tubules within days [6].

Since a three-day incubation period may result in the production of immature planktonic cells, a 21-day incubation period was employed in this study as it allows for the penetration of microorganisms into the tubules [2].

The fundamental goals of endodontic treatment are the eradication of germs and the prevention of reinfection. These objectives were attained by using efficient mechanical devices, irrigants, and intracanal medications. Since sodium hypochlorite has hypochlorous acid, it has the strongest oxidative activity of all the antimicrobial irrigating solutions [2].

This study uses Manual Dynamic Agitation, Ultra X, and Laser to disinfect the root canals.

Manual Dynamic Agitation helps circumvent apical gas entrapment at 0 to 2mm of the apical seat by repeated gutta-percha insertions. At 100 strokes per minute, the gutta-percha point pushes and pulls, creating currents at a lower frequency (3.3 Hz), which physically stretches, folds, and cuts fluid laminas, increasing intracanal pressure and effectively breaking vapor lock to increase apical irrigant flow [3].

Ultrasonic activation increases the shear stress on the walls of the root canal to eradicate the intra-radicular biofilm. Additionally, they benefit from a synergistic effect on NaOCl's capacity to dissolve tissues. Rödig., *et al*. showed that PUI was more effective in the clearance of debris in canal irregularities than syringe and sonic systems [1]. Huque., *et al*. [14] showed there is superiority of Passive Ultrasonic Irrigation over syringe irrigation.

Diode laser light has a wavelength that permits water to absorb light more effectively than dental tissues. The ability to target microorganisms found in the dentinal tubules is made feasibly by high laser light penetration into the dentin with minimal interaction with dentin. The adequate distribution of laser light to the root canal is made possible by the small diameters of optic fibers(200-320μm), which helps to lessen bacterial contamination. The antimicrobial effect penetrates the dentin over 1mm deep, exceeding the range of chemical disinfectants such NaOCl [5].

The bactericidal effects of lasers in disinfection can be due to their increased depth of penetration (up to 1000 m into tubules) compared to chemical disinfectants, which can only penetrate 100 m. Light penetrates deeper into the dentinal tubules because of the features of laser irradiation, including light scattering, local intensity amplification, and attenuation [6].

According to Mithra., *et al*. [6] the diode employed in conjunction with traditional chemo-mechanical procedures exhibited a considerable eradication of E. faecalis in the root canals. When compared to ultrasonic activation of NaOCl, Neelakantan., *et al*. [13] found that laser activation was more efficient against E. faecalis biofilm. In an experiment, Kreisler., *et al*. found that the combination of sodium hypochlorite with a semiconductor diode laser significantly increased the bactericidal effects.

Conclusion

Within the constraints of the study, it is said that, when combined with 5.25% sodium hypochlorite, the Laser-irradiated group outperformed Ultra X and Manual Dynamic Agitation. The current root canal disinfection methods for the debridement of the canals may be supplemented with diode laser irradiation.

Acknowledgements

None.

Conflict of Interest

None.

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