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Comparison of Four Disinfection Techniques Using a Small Root Canal Model

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OKU Sutro Excellence Day Project Cover Sheet

Project Title

Comparison of Four Disinfection Techniques Using a Small Root Canal Model

Full name(s) and class year(s) of all project collaborators

Example: Jane Smith, DDS 2022; John Smith, DDS 2022

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Project Category

Residents - Orthodontics

Enter your abstract text here (max 300 words)

Objective: This study aims to test the efficacy of 4 different irrigation systems against Enterococcus faecalis biofilm in a small root canal model.

Materials & Methods: Distobuccal canals of human maxillary molars were instrumented to a standard 20/.04 taper and autoclaved. Canals were then infected with E. faecalis for 21 days. Teeth were randomly divided into 4 groups (15 teeth/group) and disinfected with either standard needle irrigation (SNI), ultrasonic activation (PUI), LEAP (L), or Gentlewave (GW). Bacterial reduction from the root canals was calculated based on pre- and post-disinfection samples. 5 teeth were selected randomly from each group and sectioned at the coronal, middle and apical third. Dentin specimens were stained using live/dead bacteria stain and analyzed using confocal laser scanning microscopy (CLSM).

Results: All S2 samples showed significant bacterial reduction compared to S1 ($P<0.05$). Quantitative analysis demonstrated a bacterial reduction of: SNI (98.6%), PUI (99.2%), L (97.9%), and GW (97.8%). CLSM demonstrated various bacterial penetration capability among the coronal, middle and apical segments of the canals.

Conclusion: All four disinfection methods successfully reduced the number of viable bacteria within the distobuccal canal.

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Arthur A. Dugoni School of Dentistry

Comparison of Four Disinfection Techniques Using a Small Root Canal Model

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Introduction

Despite NaOCl's widespread use in endodontics, studies have shown that administering NaOCl through syringe-and needle-irrigation is inefficient in disinfecting the complex root canal system (1). Furthermore, it has been shown that syringe-and-needle has limitations in penetration of root canals prepared to apical size 20 (1).

Different irrigant activation approaches, such as UAI, GentleWave, and Laser-assisted irrigation (2, 3), have been introduced to enhance disinfection of the root canal system.

UAI relies on the transmission of acoustic energy from an oscillating file or smooth wire to an irrigant in the root canal, inducing acoustic streaming and cavitation of the irrigant (6).

GentleWave is a multisonic technology that uses fluid dynamics, acoustic energy, and tissue dissolution chemistry to disinfect the root canal system (5).

LEAP is a laser-assisted disinfection approach that does not rely on NaOCl and instead utilizes indocyanine green (ICG) as a photosensitizer that results in photothermal effects that could potentially damage the bacteria cell wall (4).

The purpose of this investigation is to test the efficacy of four different irrigation systems against Enterococcus faecalis biofilm to determine the most effective method for deep bacterial removal in a small canal model.

Materials & Methods

The distobuccal and palatal canals of extracted human maxillary molars with single canals were instrumented by using rotary files; 20/04 (Vortex Dentsply Sirona) was used in the distobuccal canal as the small canal model. Teeth were then autoclaved and incubated with 1 x 10^8 cells/mL suspension of E. faecalis (ATCC 47077) for 21 days at 37°C to allow colonization of the bacteria on the root canal walls.

Teeth were randomly divided into 4 groups (15 teeth/group). Two teeth were used as positive and two as negative controls.

Group 1: Standard Needle Irrigation (SNI)
Group 2: Ultrasonic Active Irrigation (UAI)
Group 3: GentleWave (GW)
Group 4: LEAP

Bacterial sampling was performed before (S1) and after disinfection (S2). Each tooth was then sectioned at 3mm, 6mm and 9mm corresponding to the apical, middle and coronal thirds. Dentine specimens were stained using live/dead bacteria stain and analyzed using Confocal laser scanning microscopy (Leica Microsystems, TCS SPE , Zeiss, Germany). The intensities of red (dead bacteria) and green (live bacteria) will be measured using Fiji image software to determine the bacterial viability and depth of irrigant penetration into dentinal tubules at 50, 100 and 150 um.

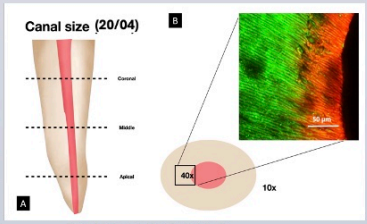


Figure 1.A representation of root sectioning
Figure 1.B. Dentin with 10X and 40X confocal scanning microscopy image

Results

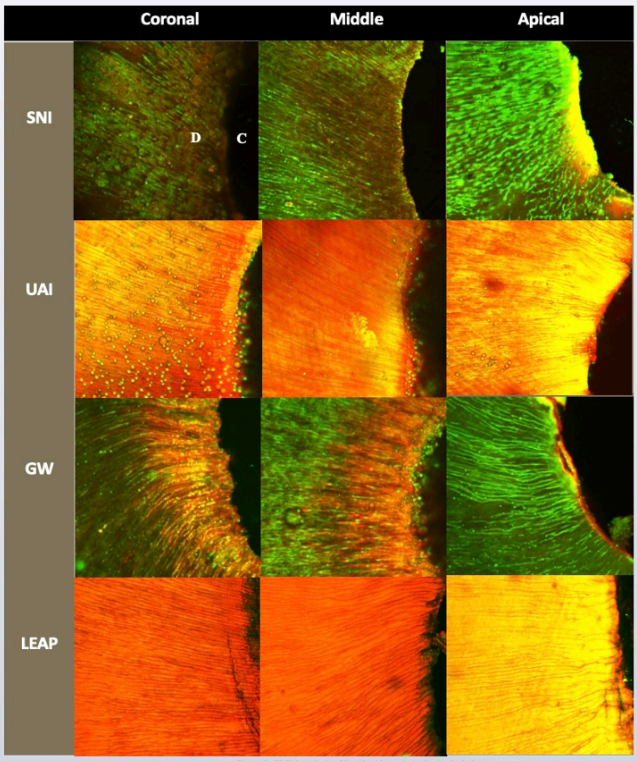
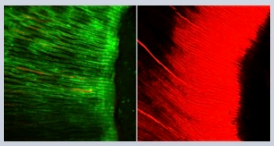


Figure 2. CLSM analysis of live/dead bacteria in dentinal tubules.



Positive Control Negative Control

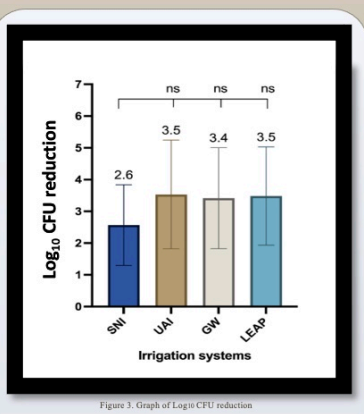


Figure 3. Graph of Log10 CFU reduction

	SNI	UAI	GW	LEAP
Median	2.383	2.857	3.114	3.461
Min- Max	1.108-5.511	1.309-6.587	1.095-5.775	1.347-6.645

Figure 4. Log10 CFU reduction values from S1 to S2

Discussion

The results showed all protocols decreased the bacterial load in the small canal model as measured by CFU count when compared to the initial bacterial load. The highest bacterial reduction was observed with LEAP compared to the other groups. However, the results showed no significant difference between the different irrigation systems in bacterial killing ($P > .05$)

Further CLSM analysis will be conducted to see if there is any difference in disinfection penetration between the groups in the coronal, middle or apical levels.

Conclusion

This study showed that there is no statistically significant difference among these 4 different irrigation groups for this small canal model. Further CLSM analysis will be conducted to see if there is a difference in reduction of bacteria at deeper levels within the dentinal tubules.

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