May 8th, 2:15 PM - 5:00 PM

Does the Root Canal Preparation Size Influence the Microbial Reduction by Multisonic Irrigation System

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OKU Sutro Excellence Day Project Cover Sheet

Project Title

Does the root canal preparation size influence the microbial reduction by multisonic irrigation system?

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

DDS/IDS - Clinical Awards: Endodontics

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Objective: This study aims to assess the efficacy of GentleWave (GW) systems against Enterococcus faecalis biofilm in small, medium, and large canal models in comparison ultrasonic activation (PUI).

Materials & Methods: Distobuccal roots of maxillary molars, single-canal mandibular premolars and palatal roots of maxillary first molars were instrumented to size 20/.04, 30/.04 and 50/.04 respectively and autoclaved. Canals where then incubated with E. faecalis for 21 days. Teeth were randomly divided into 2 groups (15 teeth/group) and disinfected with either PUI or 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, 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 in PUI and GW of 99.2% and 97.8% in canals prepared to size 20/04; 99.9% and 99.9% in canals prepared to size 30/04; and 99.1% and 99.4% in the canals prepared to size 50/04. CLSM demonstrated various bacterial penetration capability among the coronal, middle and apical segments of the canals.

Conclusion: Both disinfection methods successfully reduced the number of viable bacteria in all three canal preparation sizes.

PO140

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Arthur A. Dugoni School of Dentistry

Does the root canal preparation size influence the microbial reduction by a multisonic irrigation system?

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INTRODUCTION

Irrigation is a key part of successful root canal treatment. Elimination of microbial biofilms from root canals critically depends on chemo-mechanical debridement to disrupt surface-adherent biofilms and to reach anatomic complexities within the root canal system[1,2]. Root canal system disinfection is complicated further due to anatomic complexities (microanatomy like lateral / accessory canals and dentinal tubules)[2]. To tackle this challenge, numerous irrigant activation strategies such as ultrasonic, multisonic and lasers have been developed. Despite the weak evidence (low level of certainty) that increasing the apical size of preparation may improve disinfection, such evidence from the context of newer irrigation approaches including activated irrigation is lacking.

Ultrasonically activated irrigation (UAI) induces acoustic streaming and/or cavitation, generating sufficient shear stresses to dislodge adhered biofilms and improving irrigant penetration into the microanatomy. Since UAI works with a single frequency, newer multisonic systems (eg. GentleWave), which work using multiple frequencies were introduced, claiming that it could improve irrigant penetration in a wide range of canal anatomies [3,4].

The effect of apical preparation sizes on root canal and dentinal tubule disinfection of the only commercially available multisonic system (GentleWave/GW) remains unclear. The aim of this study was to test the null hypothesis that there is no significant difference between UAI and GW in canals prepared to small (20/.04), medium (30/.04) or large (50/.04) sizes.

MATERIALS AND METHODS

Extracted human distobuccal roots of maxillary molars, single-canal mandibular premolars and palatal roots of maxillary first molars were instrumented by using rotary files (Vortex Blue Dentsply Sirona) to sizes 20/04, 30/04 and 50/04 respectively and autoclaved. The canals were then incubated with 1 x 108 cells/ml suspension of ***Enterococcus faecalis*** (ATCC 47077) for 21 days at 37˚C to allow biofilm formation.

Teeth were randomly divided into 2 groups (n = 15). Two teeth were used as positive and two as negative controls.

Group 1 : *Ultrasonic activated irrigation (UAI)*
Group 2 : *GentleWave (GW)*

Bacterial sampling was performed before (S1) and after disinfection (S2). Bacterial log reduction was calculated from the colony forming units (CFU)/ml. Each root was then sectioned at 3, 6 and 9 mm 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). Qualitative description was done based on the distribution and proportion of dead bacteria (stained red) within the dentinal tubules.

Log reduction data were statistically analyzed using Kruskal-Wallis test (followed by Dunn's test for multiple comparisons). *P* <.05 was set to be statistically significant.

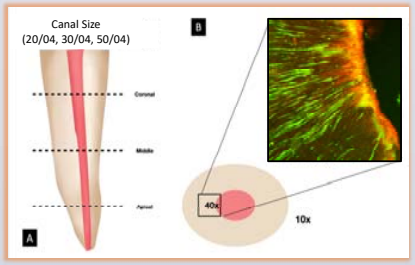
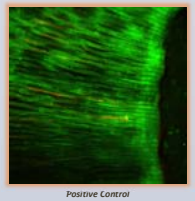


Figure 1A: Representation of the sectioning of the root at the apical, middle and coronal third.
Figure 1B: 40x confocal laser scanning microscopy image was taken.



Positive Control

Negative Control

RESULTS

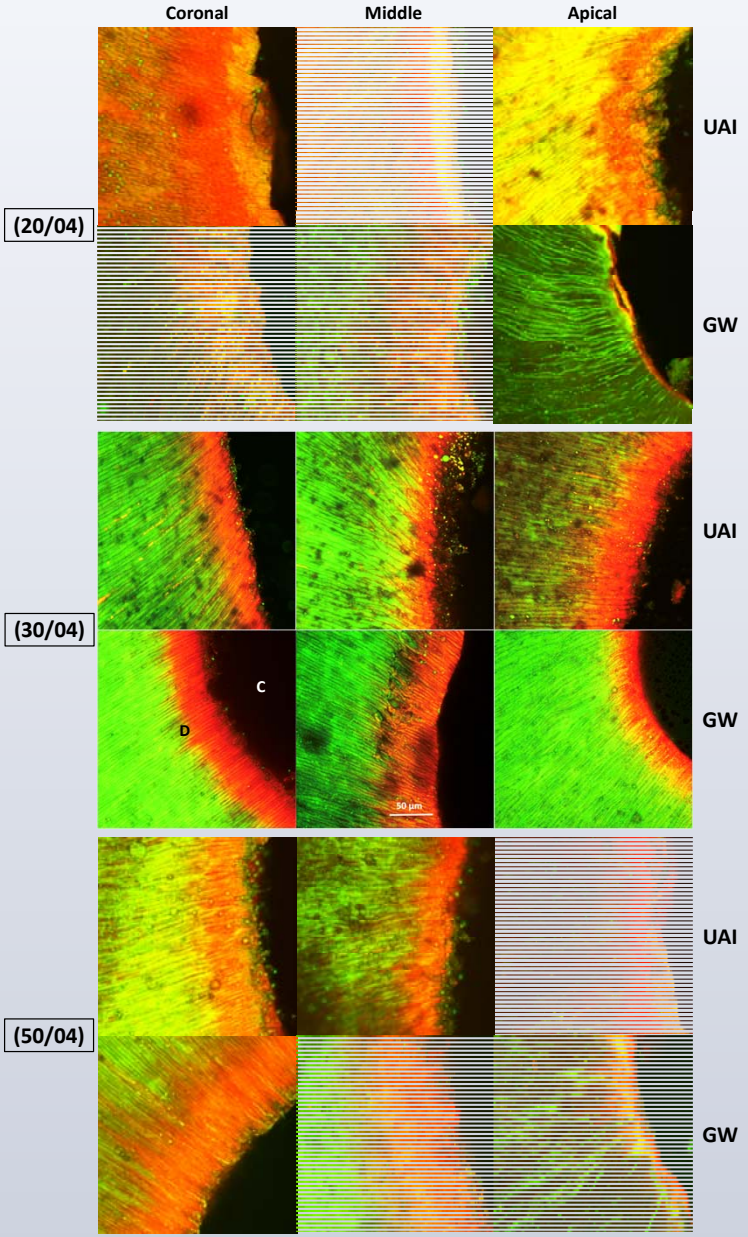


Figure 2: CLSM analysis of live/dead bacteria in dentinal tubules.

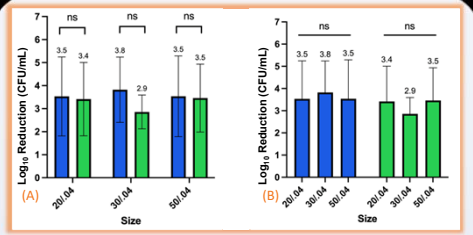


Figure 3: (A) Graph showing mean log_{10} CFU/ml reduction following UAI and GW irrigation for each canal size; (B) Graph showing effect of preparation sizes for each irrigation approach.

UAI	20/.04	30/.04	50/.04
Median	2.857	3.248	3.023
Min - Max	1.309 - 6.587	2.551 - 6.924	1.458 - 5.724

Table 1: Median, Minimum-Maximum log_{10} CFU/ml reduction following UAI Irrigation

GW	20/.04	30/.04	50/.04
Median	3.114	2.883	2.885
Min - Max	1.095 - 5.775	1.414 - 3.856	1.691 - 5.805

Table 2: Median, Minimum-Maximum log_{10} CFU/ml reduction following GW Irrigation

DISCUSSION

To the best knowledge of the authors, this is the first study to characterize the root canal and dentinal tubule disinfection of GW in canals prepared to different sizes (20, 30 and 50) providing a range of clinically possible preparation sizes. While bacterial culturing primarily shows outcomes only from the main root canal, this study additionally employed CLSM to characterize bacterial killing within dentinal tubules, serving as a "proxy" to demonstrate irrigant penetration into the tubules[5].

The results showed both protocols decreased the bacterial load in the main canal as measured by CFU count, when compared with the initial bacterial load. The results showed no statistically significant difference difference between UAI and GW for any apical preparation size (*P*>.05). Increasing the apical preparation size did not significantly increase bacterial killing for both the systems (P>.05). Based on these results, it appears that the type of sonic system does not significantly improve root canal disinfection when the apical size exceeds 20.

Both groups showed dentinal tubule penetration using CLSM analysis to some extent. Irrigation disinfection was consistent in both groups in coronal and middle third but varied in apical third. In the apical and middle third UAI disinfection was better due to the shear stresses generated. Given that the irrigant is delivered from the coronal region for GW, it is possible that sufficient shear stresses were not achieved in the apical third as shown in the CLSM analysis. Future studies should characterize irrigant penetration into dentinal tubules in canals prepared to different sizes to confirm this hypothesis.

CONCLUSION

The results of this study suggests that improving the apical size of root canal preparation does not significantly improve root canal disinfection of ultrasonic or multisonic systems. Our results also suggest a trend that increasing the apical sizes improved apical third dentinal tubule disinfection by UAI but not GW.

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