COMPARATIVE EVALUATION OF SONIC AND LASER-ACTIVATED IRRIGATION IN ROOT CANAL DISINFECTION USING 3D-PRINTED-TOOTH-REPLICAS

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INTRODUCTION

Major challenges in endodontics include complex root canal anatomy and the resilience of microbial biofilms. Following mechanical shaping, irrigation plays a critical role by combining mechanical and chemical actions to enhance canal disinfection [1]. To this end, various irrigation protocols have been developed to improve the removal of necrotic tissue, smear layer, and bacteria, thereby increasing treatment success [2].

AIMS: This study aimed to compare the effectiveness of sonic activation (EDDY) and Er,Cr:YSGG laser activation (2780 nm) in eliminating *Enterococcus faecalis* biofilms using a standardized *in vitro* model.

MATERIALS AND METHODS

Forty 3D-printed mandibular molar replicas with two mesial and one distal canal were used to simulate natural root canal morphology. The canals were inoculated with *E. faecalis* and incubated for 21 days to allow mature biofilm development. Three irrigation protocols were evaluated: conventional needle irrigation (CNI), sonic activation using the EDDY system (SA), and laser activation using an Er,Cr:YSGG laser (LA) (Fig. 1). A control group received phosphate-buffered saline (PBS) without activation. Two independent experiments were performed, each using 20 replicas (n=5 per group). Biofilm collection followed a previously published protocol [3].

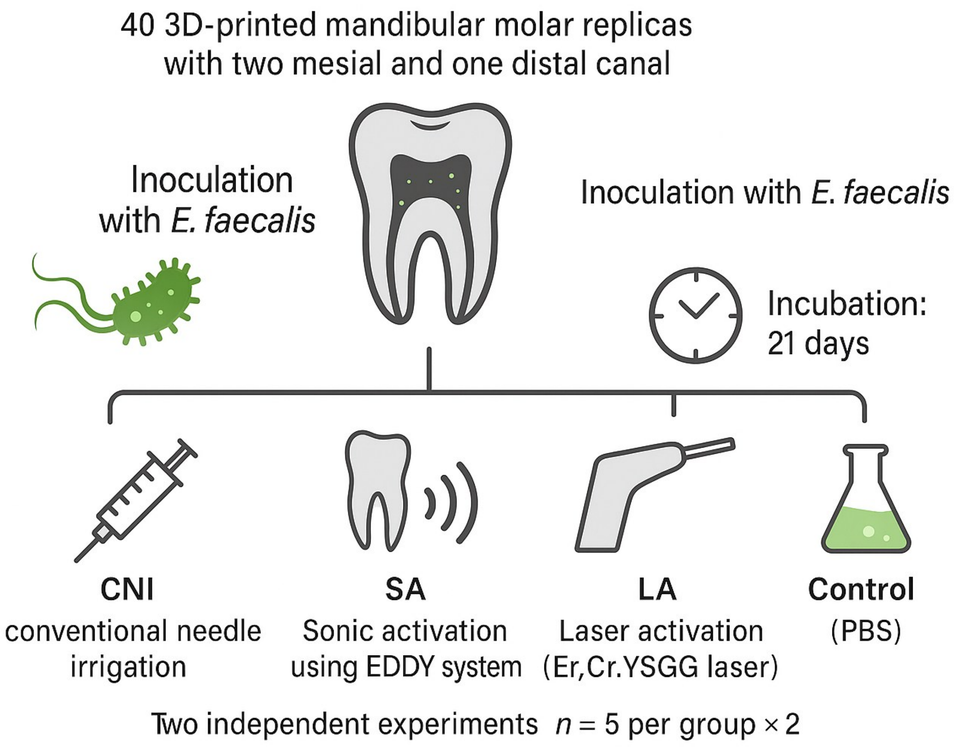

FIG. 1: *Schematic illustration of the 3D model inoculation with E. faecalis, biofilm formation, and treatment groups.*

RESULTS AND DISCUSSION

- The bacterial load was quantified by colony-forming unit (CFU) counts. Descriptive and inferential statistical analyses revealed that the CNI, SA, and LA groups had significantly lower CFU levels than the control ($p < 0.001$).
- In the first experiment (Fig. 2a) only the LA group reached the detection limit, indicating near-complete bacterial elimination.
- In the second experiment (Fig. 2b), both SA and LA achieved this threshold.

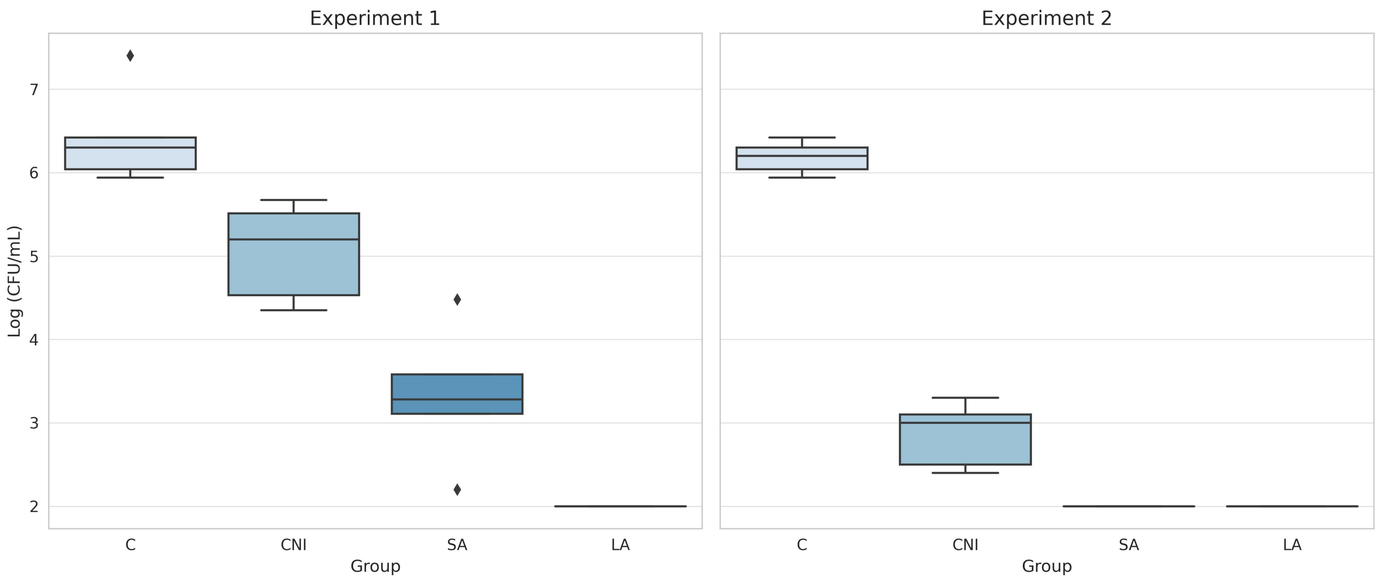

FIG. 2: *Comparison of E. faecalis count values (Log_{10} CFU) among the four experimental : Control, CNI, SA, and LA.; (**a**) First experiment (**b**) Second experiment*

CONCLUSIONS: These findings highlight the importance of using freshly prepared irrigants with reliable antimicrobial activity and support the premise that the effectiveness of sonic activation depends on the quality of the irrigating solution, whereas laser activation appears to be less affected by it. Overall, laser activation with Er,Cr:YSGG (2780 nm) demonstrated superior and more consistent performance in disrupting *E. faecalis* biofilms, highlighting its potential.

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Financiamento: Os autores agradecem à FCT/MCTES pelo apoio financeiro ao CiiEM (10.54499/UIDB/04585/2020) através de fundos nacionais.