Elimination of Intracanal Tissue and Debris through a Novel Laser-activated System Assessed Using High-resolution Micro–computed Tomography: A Pilot Study

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Abstract

Introduction

Laser-activated irrigation to remove organic debris from canal isthmuses was investigated using x-ray microfocus computed tomographic imaging.

Methods

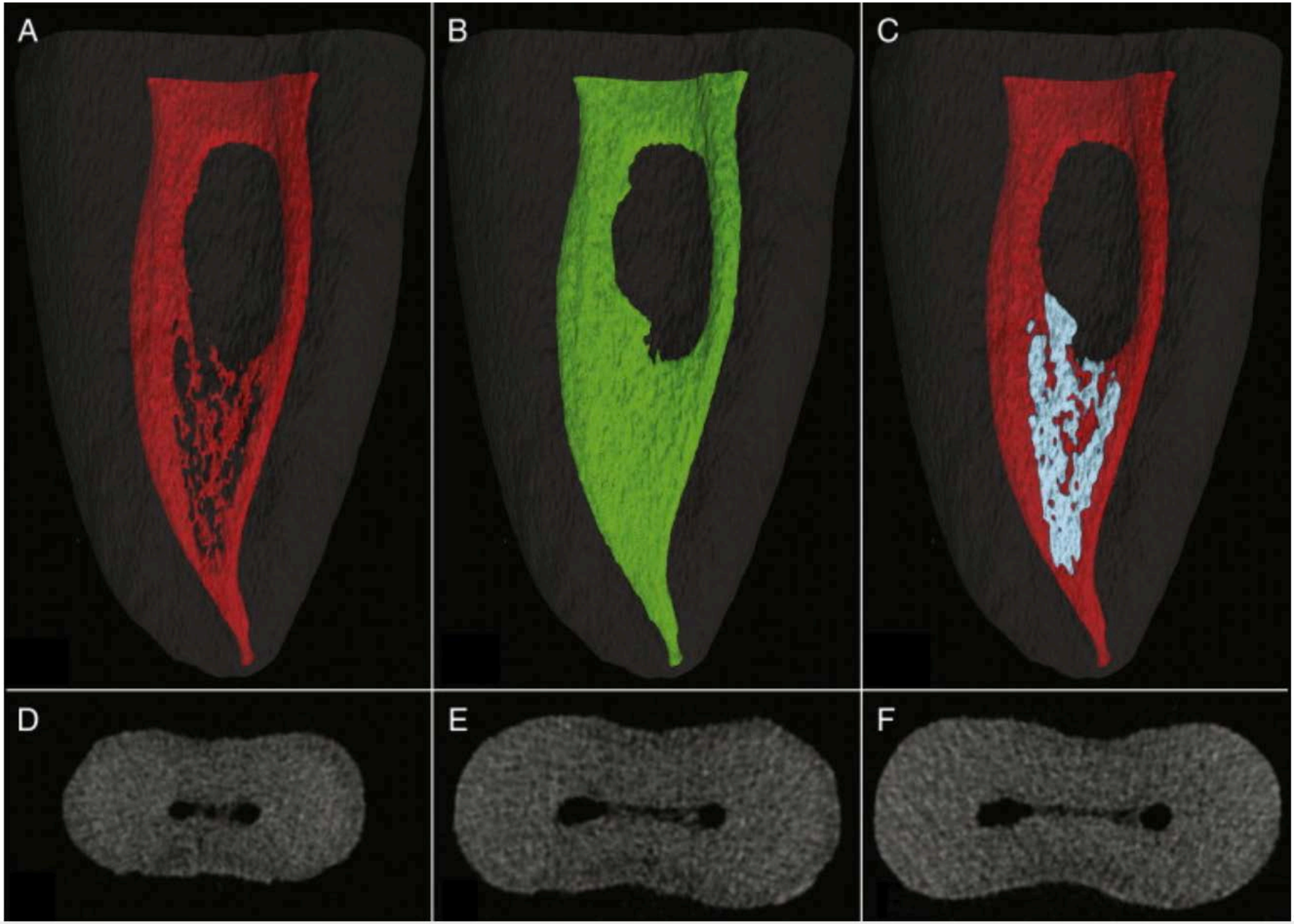
A total of 14 extracted human mandibular molars were used. The mesial canals were prepared using a standardized instrumentation protocol. Two groups ($n = 7$) underwent final irrigation using either standard needle irrigation (SNI) or photon-induced photoacoustic streaming (PIPS). After enlarging canals to 30/.06, canal volumes were reconstructed from micro–computed tomographic scans before and after irrigation to assess removal of organic tissue and inorganic debris by quantitative analysis of the superimposed volumes. Comparisons of the volumes were made using 2-way analysis of variance and Tukey method, with statistical differences considered significant at the alpha = 0.05 level.

Results

Debris removal and an increase in root canal system volume for the laser-activated PIPS group was more significant ($P < .001$) than for the SNI group ($P = .04$). Irrigation using PIPS increased the canal volume and eliminated debris from the canal system 2.6 times greater than SNI.

Conclusions

Eliminating debris from complex canal spaces found in mandibular molars was achieved at a significantly greater level using laser-activated PIPS irrigation compared with SNI.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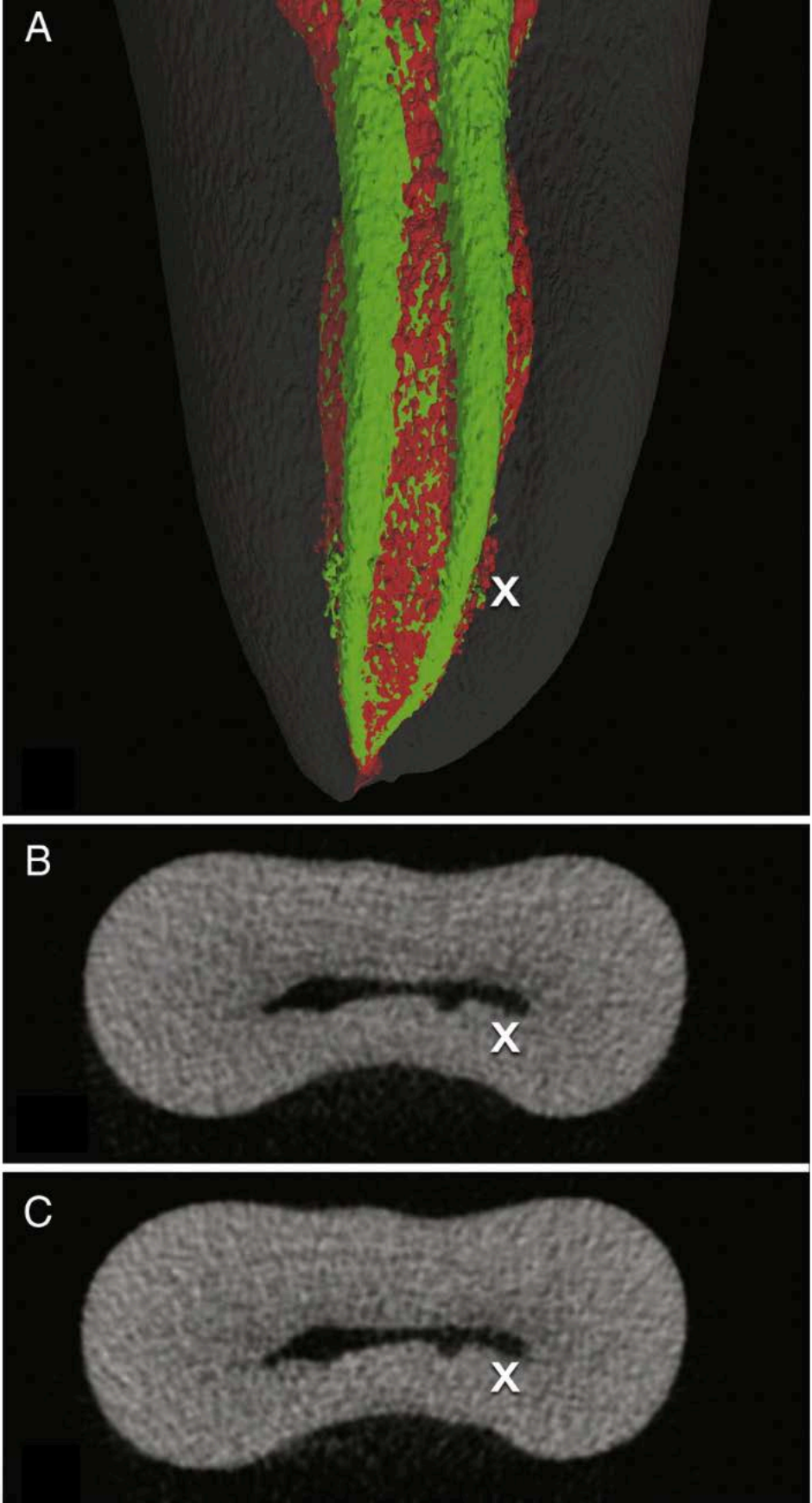
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Disinfection of Root Canals with Photon-initiated Photoacoustic Streaming

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Abstract

Introduction

This study set out to compare the efficacy of laser-activated and ultrasonically activated root canal disinfection with conventional irrigation, specifically its ability to remove bacterial film formed on root canal walls.

Methods

Seventy human premolars were shaped to an apical size #20, taper .07, sterilized, and contaminated *in situ* with oral bacteria for 1 week and incubated for 2 more weeks. Irrigation was done with 6% NaOCl (group 1), NaOCl ultrasonically activated with blunt inserts (group 2), or a pulsed erbium:YAG laser at nonablative settings (group 3) for a total of 60 seconds each. Positive and negative controls were also included. Aerobic bacterial sampling was performed, and the incidence of positive samples after 24 and 48 hours as well as bacterial counts (colony-forming units) were determined. Fixed and demineralized sections 1 mm and 4 mm off the apex were Brown-Brenn stained and assessed for remaining intracanal bacteria/biofilm and dentinal tubule penetration.

Results

All 3 canal disinfection protocols significantly reduced bacterial counts ($P < .001$). None of the 3 techniques predictably generated negative samples, but laser-activated disinfection was superior to the other 2 techniques in this aspect ($P < .05$). Histologic sections showed variable remaining bacterial presence in dentinal tubules at the 4-mm level and significantly less bacterial biofilm/necrotic tissue remaining at the 1-mm level after laser-activated irrigation ($P < .05$).

Conclusions

Under the conditions of this combined *in situ/in vitro* study, activated disinfection did not completely remove bacteria from the apical root canal third and infected dentinal tubules. However, the fact that laser activation generated more negative bacterial samples and left less apical bacteria/biofilm than ultrasonic activation warrants further investigation.

Table 1

Microbiologic Counts before and after Root Canal Irrigation with Needle-delivered NaOCl, Ultrasonic Activation, and PIPS Activation (n = 20 each)

	Counts before			Counts after			% Reduction	
	Mean	Median	Range	Mean	Median	Range	Median	Negative culture
NaOCl	2.50×10^8	1.95×10^8	2.5×10^7–9.30×10^8	2.93×10^6	3.00×10^6	0–3.75×10^7	96.6	1/20
Ultrasonic activation	2.35×10^8	4.5×10^7	1.5×10^7–1.5×10^9	4.87×10^6	2.50×10^6	0–8.50×10^6	98.5	2/20
PIPS	3.13×10^8	2.63×10^8	3.0×10^7–1.13×10^9	2.22×10^6	1.75×10^6	0–1.25×10^6	99.5	10/20

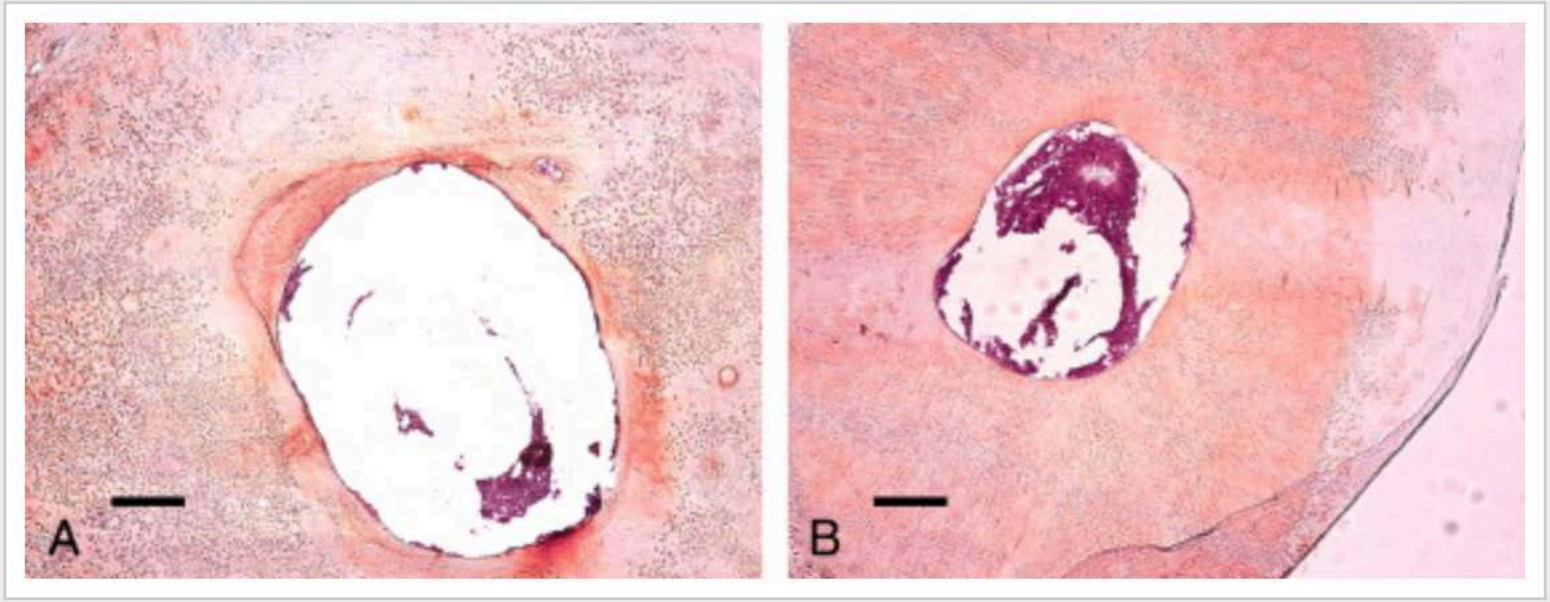

Figure 3

Cross sections at the 1-mm level with variable amounts of bacteria/biofilm after irrigation with PIPS-activated NaOCl (*A*) and ultrasonically activated NaOCl (*B*). Original magnification, 100×. For each image, the black bar represents 100 μm.