STUDENT SCHOLARSHIP RECIPIENT

A Comparison of the Thermal Effects of Erbium Lasers and Rotary Diamond Instrumentation on Tooth Structure

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Abstract

Objective
The aim of this study was to compare facial-surface and pulpal-wall heat generation and time efficiency of Er,Cr:YSGG and Er:YAG lasers with diamond burs.

Materials and Methods
An Er,Cr:YSGG laser (Millennium 2, Biolase Technology, San Clemente, California), wavelength 2780 nm, pulsed, free running, pulse duration 140-200 µs, repetition rate 20 Hz, Zirconia quartz fiber delivery system, noncontact, G-6 delivery tip, tapered sapphire fiber size 600 µm, pulse energy 275 mJ per pulse, fluence 24.33 J/cm^2, average power 5.5 W, 70% water, 90% air), an Er:YAG laser (Opus20, OpusDent, Israel), wavelength 2830 nm, free-running, pulse duration 250-400µs, repetition rate 12 Hz, flexible hollow fiber delivery system, noncontact, sapphire delivery tip, tapered sapphire fiber size 1000 µm, pulse energy 750 mJ per pulse, fluence 22.27 J/cm^2, average power 8.4 W, 50ml/min water, air spray), and multi-use (Brasseler (B), Midwest (M)) and single-use (Henry Schein (HS), SS White Piranha (SSWP)) medium grit round-end taper diamond burs were used for tooth preparation of 60 intact third molars. Teeth with dentin thickness of 3.5-4 mm were randomly assigned to the groups. Preparation direction/distance (occlusogingival/4 mm), cross-sectional area (32 mm^2), depth (1.6 mm), surface properties (intact facial enamel surface), and coolant rate (30ml/min) were standardized for all instrument groups. Laser power, energy setting, and tip selection followed manufacturers' instructions. A standardized setup was used for burs to apply a constant load (101 gr) to the handpiece. An infrared thermal camera was used for measurements (ThermoVision® A20M, FLIR Systems, Boston, Massachusetts). A new technique was developed to provide indirect vision of the pulpal wall via a minimal-energy-loss mirror. Facial-surface and pulpal-wall temperatures were recorded simultaneously. Facial-surface/pulpal-wall heat generation and preparation duration were compared for each instrument using a Nested Least Squares Analysis.

Results
All the instruments generated less than 5.5 ˚C increase on the pulpal wall of the tooth. Results are displayed below. Levels not connected by the same letter are significantly different ($p < 0.005$).

	Facial-surface Temperature Increase (ºC)	Pulpal-Wall Temperature Increase (ºC)	Preparation Duration (sec)
Er:YAG	8.61 ± 0.81(D, E)	4.78 ± 0.87 (A)	112.00 ± 8.93 (H)
Er,Cr:YSGG	2.93 ± 0.94 (E)	1.32 ± 0.64 (B)	138.50 ± 33.43 (H, I)
SSWP	60.55 ± 15.56 (F)	0.46 ± 1.14 (B, C)	180.14 ± 50.85 (H, I)
HS	38.64 ± 19.75 (G)	0.06 ± 0.94 (C)	141.20 ± 68.69 (H, I)
B	31.57 ± 20.12 (D, G)	-0.18 ± 1.21 (C)	183.00 ± 60.54 (H, I)

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M	28.90 ± 11.87 (D, G)	-0.67 ± 0.53 (C)	189.70 ± 72.28 (I)

Conclusions
Lasers were found similar to burs in time efficiency. However, lasers produced less heat on the facial-surface but more on the pulpal-wall possibly due to the more concentrated nature of the laser beam diffusing through tooth structure. Further studies are needed to evaluate the heat diffusion behavior and clinical time efficiency of lasers.

Biography: *James Thomas is in his junior year at Nova Southeastern University College of Dental Medicine. He has been actively involved in biomaterials and laser research during dental school.*

Disclosure: *Mr. Thomas reported no commercial relationships relative to this presentation.*

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