MASTER RESEARCH PROPOSAL • DENTAL LASERS

N.I.L.E.S • Cairo University

Comparative Evaluation of Diode Lasers (450 nm & 1064 nm) Combined with Sodium Fluoride Varnish on Occlusion of Exposed Dentinal Tubules

An In-Vitro Controlled Laboratory Investigation Evaluating Dual Wavelength Photothermal & Chemical Occlusion Dynamics

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Academic Oversight

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Literature Review

Biological Structure & Dentin Hydrodynamics

Dentin Composition

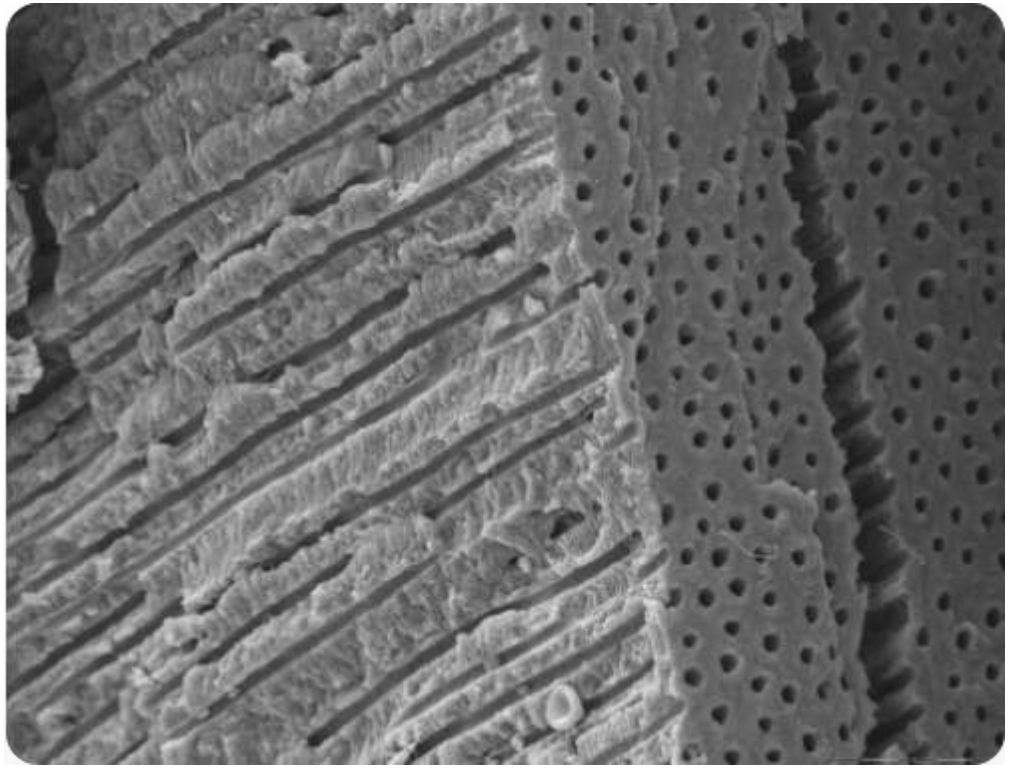
50% Hydrated Organic & Hydroxyapatite: Smaller crystallites than enamel with tubular fluid canals.

Tubular Architecture

0.5–0.9 µm at DEJ to 2.0–3.0 µm at Pulp: High fluid mobility containing nerve processes.

Hypersensitivity Pathophysiology

8× Open Tubule Density in Sensitive Teeth: Fluid movement creates shear force on odontoblasts.



Theoretical Model

Brännström's Hydrodynamic Pain Mechanism

1

External Stimuli

Thermal, osmotic, chemical, or tactile triggers.

2

Intratubular Fluid Shift

Rapid displacement of pulpal fluid within tubules.

3

Mechanoreceptor Trigger

Deformation of subodontoblastic nerve endings.

4

A-Delta Fiber Impulse

Sharp, acute, short-lasting pain transmission.

Study Focus

Research Rationale & Main Objective

The Clinical Challenge

Sodium Fluoride Varnish Limitation: Provides transient, short-term relief requiring frequent reapplication due to saliva dissolution.

Primary Research Objective

To quantify and compare the performance of dual-wavelength diode lasers (450 nm & 1064 nm) combined with 5% NaF varnish in achieving effective, deep dentinal tubule occlusion.

Biostatistics

Sample Size Calculation (G*Power 3.1.9.7)

0.40

Effect Size (f)

20% occlusion mean difference

0.80

Statistical Power (1-β)

α = 0.05 significance level

60

Retained Discs (N)

10 per group across 6 groups

80

Initial Prepared

20% extra for sectioning loss

Experimental Protocol

Specimen Selection & Processing Workflow

PHASE 01

Tooth Selection & Storage

60 extracted non-carious permanent human teeth stored in 0.1% thymol saline at 4°C.

PHASE 02

Sectioning & Smear Layer Standardisation

Coronal dentin discs (1-2 mm thick) polished with 600-grit SiC paper.

PHASE 03

Tubule Opening (Etching)

17% EDTA application for 5 minutes followed by distilled water rinse to expose patent tubules.

Study Allocation

Experimental Group Allocation (n = 10 per group)

Group 1

Negative Control

Baseline untreated dentin.

Group 2

450 nm Diode Laser

Blue laser irradiation only.

Group 3

1064 nm Diode Laser

Infrared laser irradiation only.

Group 4

NaF Varnish Only

5% Sodium fluoride varnish.

Group 5

450 nm + NaF Varnish

Combination dual therapy.

Group 6

1064 nm + NaF Varnish

Combination dual therapy.

Technical Specifications

Laser Operating Parameters

450 nm Diode Laser

Blue Wavelength

Fluence: 85 J/cm²

Power & Mode: 0.5 W Continuous Wave (CW)

Fiber Delivery: 320 µm Quartz Optical Fiber

Application: Non-contact scanning (1-2 mm distance, 10s)

1064 nm Diode Laser

Near-Infrared

Fluence: 35 J/cm²

Power & Frequency: 1 W, 10 Hz Pulsed

Fiber Delivery: 300 µm Quartz Optical Fiber

Application: Non-contact scanning (1-2 mm distance)

Analytical Assessment

Evaluation Methods & Primary Outcomes

Confocal Laser Scanning Microscopy (CLSM)

Specimens sectioned longitudinally and stained with **Rhodamine B fluorescent dye**.

Primary Outcome Variable

Percentage Dentinal Tubule Occlusion: Ratio of occluded to open tubule lumina.

Secondary Outcome Variables

Fluorescence Depth (µm): Dye penetration depth & surface recrystallization morphology.



Execution Plan

Statistical Plan & Project Schedule

Statistical Framework

Primary Test: One-Way ANOVA across 6 groups

Post-Hoc Test: Tukey's HSD for pairwise comparisons

Software: SPSS v26 / R Statistical Environment

Execution Milestones (2026)

April – June 2026: Study Initiation & Preparation

September 2026: Data Collection & Analysis Completion

December 2026: Manuscript Publication Target

Ethics: Approved for extracted human teeth

Thank You for Your Attention

Comparative evaluation of Diode lasers (450, 1064nm) combined with sodium fluoride varnish on occlusion of exposed dentinal tubules

Open for Discussion & Questions

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Image Sources



https://www.anatomicum.com/files/images/modified/fullsize/185.jpg

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