

# Science and Research

Thursday, 2:00 p.m. – 2:20 p.m. Rooms 107-108

## STUDENT SCHOLAR

### The Effect of Pulsed Low-Level Laser Therapy on Rate of Tooth Movement and Pain Reduction in Orthodontic Patients: A Randomized Clinical Trial

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#### Objective

To determine the effect of pulsed low-level laser therapy (LLLT) on the rate of tooth movement and on pain experienced relative to no laser therapy in humans.

#### Materials and Methods

Eleven patients requiring extraction of maxillary first premolars were recruited and Nickel-Titanium (NiTi) coils were employed for bilateral canine retraction. In this split-mouth randomized clinical trial, one-half of the mouth was irradiated and served as the treatment group; the non-irradiated half was considered the control. A gallium-aluminum-arsenide semiconductor diode laser emitting infrared radiation at 810 nm with a power output of 0.2 W and a frequency of 2 Hz was used. The laser was applied to the buccal and palatal aspect of the tooth for 80 seconds weekly for 7 weeks. Tooth movement was measured on progress models and patients were asked to record the level of pain experienced on days one through seven following laser application using the Faces Rating Scale.

#### Results

The difference in rate of tooth movement between sides was greatest after initial activation of the NiTi coils. The rate of tooth movement in both treatment and control groups significantly decreased over time but there was no statistically significant difference in the trends between groups. Overall there was significantly less pain on the laser-treated side as compared to the non-laser side.

#### Conclusion

Although pulsed LLLT does not appear to increase the rate of canine retraction relative to no laser therapy over the time points tested, pain in orthodontic patients can be effectively reduced with the administration of LLLT.

**Note:** This presentation discusses investigational devices that have not yet received U.S. FDA approval or clearance for the specified clinical indications, or describes off-label uses.

#### Educational Objectives

1. Gain new knowledge in the use of low-level laser therapy (LLLT) in daily orthodontic practice.
2. Determine the effect of pulsed LLLT on the rate of tooth movement and on pain experienced relative to no laser therapy in humans.

Thursday, 2:20 – 3:00 p.m. Rooms 107-108

### Near-IR Laser Noncontact and Contact Tip-Tissue Thermal Interaction Differences

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The near-infrared (IR) wavelength absorption by oral mucosa is analyzed by melanin/water absorption spectra for the epithelium layer and by hemoglobin/water absorption spectra for the sub-epithelium medium. The noncontact (purely optical) laser-tissue interaction lacks spatial precision due to highly melanin-dependent absorption in epithelium, and due to extended penetration depth in sub-epithelium.

The heat transfer from the hot “initiated” near-IR laser tip through water-rich oral mucosa is analyzed by the heat transfer equation, and with boundary and initial conditions representing the contact mode of tip-tissue interaction. The heat penetration depth through the tissue is shown to be proportional to the root square of the tip-tissue contact time. Such (nonoptical, purely thermal) heat penetration depths controlled by tip-tissue contact time can be significantly smaller than the heat penetration depths controlled by the tissue’s near-IR absorption (purely optical and noncontact): e.g., 300-500  $\mu\text{m}$  for 0.5-1.5 second tip-tissue contact time vs. 1,000  $\mu\text{m}$ -range near-IR absorption depths (yet both exceed the 10  $\mu\text{m}$ -range CO<sub>2</sub> laser in water-rich oral mucosa).

The better spatially confined heat transfer from the hot “initiated” tip helps explain the proliferation of “nonoptical, contact” as opposed to “optical, noncontact” near-IR dental devices in everyday dental practice. Important for controlled spatial confinement of the heat are (1) tip-tissue contact time and (2) prevention of optically “leaky” tips, both of which are important in prevention of thermal side effects, such as excessive spread of soft tissue necrosis and hard tissue overheating.

#### Educational Objectives

1. Characterize the difference in tissue interaction between contact and noncontact near-IR lasers.
2. Understand heat penetration through epithelial and sub-epithelial tissue layers using contact and noncontact near-IR dental lasers.
3. Determine heat penetration depth in relationship to the square root of tip/tissue contact time.

