Thermal and Non-Thermal Laser-Trabecular Meshwork Interaction: A scanning electron microscopy Study in Human and Non-Human Primates eyes.

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Purpose: To evaluate the thermomechanical effect of different trabeculoplasty lasers.

Materials and Methods: Laser trabeculoplasty was performed on cadaver eyes with a commercially available quasi-CW high frequency Diode pumped Q-switched frequency-doubled Nd:YAG laser (532nm, 0.1s pulse duration, 50μm spot diameter, Coherent Novus Verdi), a frequency-doubled Q switched-Nd:YAG laser (Coherent Selecta 7000, 532nm, 3ns pulse duration, 400μm spot diameter), as well as an experimental short-pulse Titanium:Sapphire ($Ti:Al_2O_3$) laser (790nm, 7us pulse duration (200ns spike train), 150μm spot diameter, SOLX-I). One fresh human donor-eye, 2 fresh Rhesus (Macaca mulatta) and 2 Cynomologous (Macaca fascicularis) eyes where sectioned into 8 equal parts. The iris was sutured to the sclera to expose the trabecular meshwork (TM). The tissue was placed in a custom made PMMA holder affixed to the laser's slit lamp biomicroscope chin-rest. The holder has a rotating tilted dish allowing for aiming beam alignment. A single laser shot was applied in the center of each tissue sample. Treatment parameters were: 400, 600 and 800mW for the Novus Verdi laser, 1.1 to 2.4mJ for the Selecta SLT laser, and 10 to 130mJ for the $Ti:Al_2O_3$ laser. All laser events were video-recorded at 40x. The tissues were immediately fixed in 2% paraformalin/2.5% Glutaraldehyde, dehydrated, critical point dried then gold coated (Hummer V) and were systematically viewed and photographed on an JSM-35 scanning electron microscope at x39, x100 or x200 and x1000 or x2000.

Results: Clinical: Treatment thresholds were determined as a de-pigmentation in the area of the laser spot which were obtained at ~400mW for the Novus Verdi, ~1.5mJ for the Selecta, and ~15mJ for the $Ti:Al_2O_3$. When used above treatment threshold, all lasers produced gas bubbles. SEM: The diode laser produced shrinkage and thermal damage at all power levels that included contraction of the corneal collagen as well as of the TM's framework. The SLT produced a tissue elevation at the region of the laser spot at all energies but no observable TM structural damage. With the $Ti:Al_2O_3$, no damage could be detected until the energy reached was >80mJ where the TM lifted from its scleral wall anchors. At 135mJ, the iris was separated.

Conclusion: When used at threshold energy levels, the Ti:Al2O3 laser did not produce thermal or structural damage to the Trabecular Meshwork and, as with the SLT, treatment may therefore be repeated.