Light Interaction with the Peripheral Nervous System: In Vivo and In Vitro Models of Neuropathy

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Peripheral neuropathies are common, debilitating disorders linked to diverse origins and degeneration of peripheral nerves. Using an in vitro diabetic model, we found that high glucose concentrations significantly suppressed rat cortical and dorsal root ganglion (DRG) neurite extension. Irradiation of these hyperglycemic neurons with 980 nm wavelength light at a power density of 10 mW/cm^2 and a fluence of 50 mJ/cm^2 significantly promoted cortical neurite extension but did not improve DRG neurite extension. We hypothesized that the differential response of the cortical and DRG neurons to light was due to DRG mitochondrial hyperglycemic mediated injury. Based on these data, we hypothesized that 980 nm wavelength light applied transcutaneously along the course of a neuropathic peripheral nerve would be an effective therapy for peripheral neuropathy. A spared nerve injury model of neuropathic pain was used and all procedures were under an approved IACUC protocol. Sixteen anesthetized rats underwent surgery and were randomly divided in two groups: Control (no treatment) and Laser treated. On the 7th post-surgery day, treatment was begun. Two transcutaneous treatment sites were used: the DRG at the T13-L1 vertebral level and the lateral surface of the involved hind paw. At the DRG site, the probe was placed directly on the skin for 19 seconds at an output power of 1.25 W and at the lateral surface of the paw, the probe was 11 cm above the paw (20 sec, output power 1 W). Von Frey measurements for mechanical allodynia were taken before surgery, 7 days after surgery, and two days following each light treatment. On days 11 and 15 after the start of the treatment, the treated group had significantly higher pressure thresholds compared to controls indicating an improvement in touch sensitivity. Based on these data, transcutaneous laser irradiation has the potential to revolutionize the control of neuropathic pain.