

Measurement of Super-Pulsed Laser Penetration Through Equine & Canine Tissue

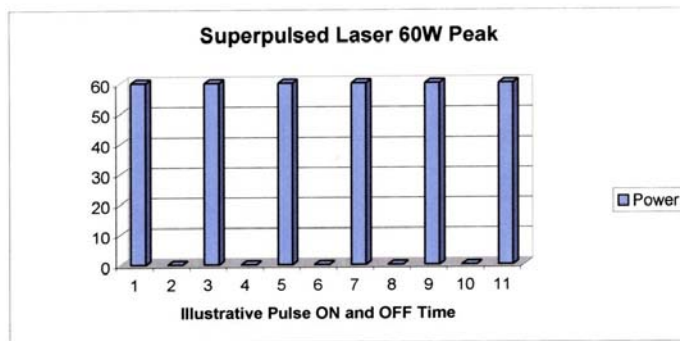
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Introduction

A common question asked by veterinary practitioners is whether or not laser energy will penetrate through skin, bone and other tissue to reach the intended target of injury. A study conducted by Respond Systems, Inc. (Study to Measure Laser Light and LED Penetration into Tissue) examined the penetration characteristics of laser and LED light into a 8.625" section of beef tissue, and found that laser light could be detected up to 8" into the tissue. In this new study, we present evidence of the depth of penetration of super-pulsed laser energy in-vivo, which will be of great value to clinicians evaluating the suitability of laser therapy as a treatment modality.

Materials and Methods

This study was conducted at Race Hill Farm in Madison Connecticut on a 14 hand pony using a Respond 2400XL ultra wide head as the laser source. Laser energy was applied to three treatment sites on the equine and one on the canine: the cannon bone, the knee, the hock, the neck and the stifle, and a detector was used to measure the amount of energy penetrating through the tissue. The laser was held in the contact mode against the skin of the animal and the detector was held in place on the side opposite the laser.



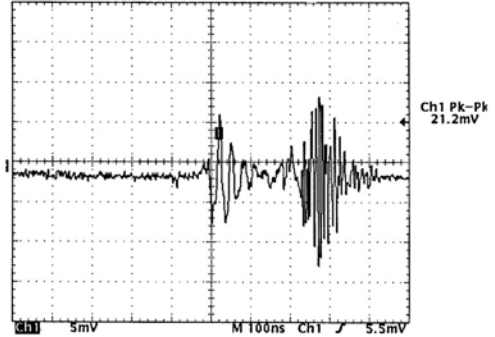
The Respond 2400XL laser system ultra wide head used in the study contains four lasers operating at a peak power of 36W for each diode, with 200 ns pulse width. The pulse frequency was set to 3500 pps, resulting in an average power for each laser diode of 25mW, for a total of 100mW for the four diodes. This chart illustrates

how a super pulsed laser diode works. The example shows a 60 Watt diode, on for a short period of time, and then off, back to 0 Watts, until it receives the next pulse of current, when it turns on to 60 Watts again.

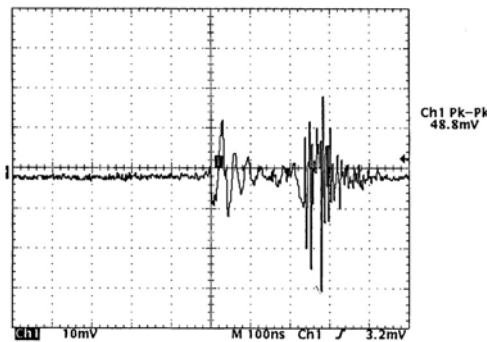
A Silicon Detector Corporation high frequency detector SD-444-11-21-171 was used, and operated in the photoconductive mode biased at 50VDC. The active surface area of the detector was 110 mm² and was designed to provide enhanced sensitivity between 600nm and 1000nm, the wavelength range of interest in this investigation. The detector output was compared to a known national standard to calibrate the detector so that accurate power measurements could be made.

The detector was impedance matched to a 50 ohm termination and connected to a Tektronix oscilloscope model TDS 350. The oscilloscope was connected via cable to a Hewlett Packard Desk Jet 870 CSE plotter. After each measurement the oscilloscope trace was sent to the plotter to record the outputs, which are reproduced here.

The scope trace image to the right demonstrates the detection of laser light emitted through the cannon bone of the horse. The width of the limb lateral to medial was approximately 2". The Respond laser was held in contact medially and the detector was held laterally. The segments shown on the Y axis of the scope trace represent 100 ns. The segments on the X axis represent 5mV each.

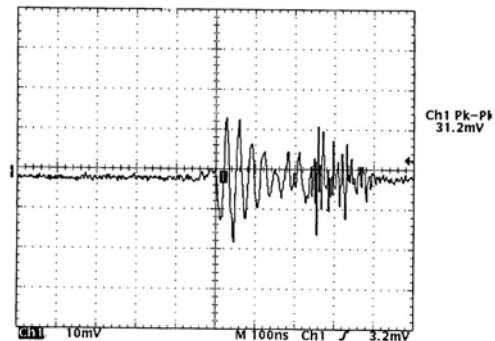


The left half of the image shows background noise (steady state) until the laser is operated. When the laser is operated there is measurable energy for about 400 ns of about 21mV from peak to peak.

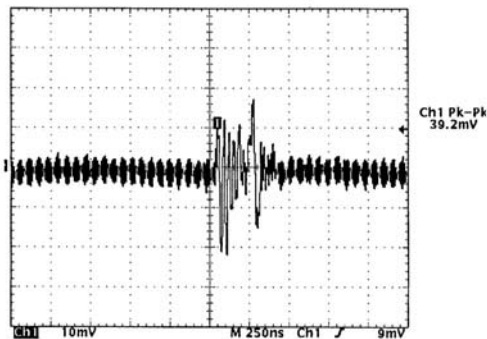


The image to the left records laser light treatment of the equine hock, with the laser placed medially and the detector placed laterally, as above, a distance of almost 4". The scale on the Y axis has been changed to 10mV per segment to accommodate the larger energy which was measured. We measured 48mV peak to peak during an approximate 350ns window.

We finished the equine study by measuring from one side of the neck to the other, about 6". A scale of 10mV was selected and is displayed on the image at the right. The laser triggered a pulse of activity which measured about 31mV over a 400ns time frame.



Canine Study



A 44 pound male Keeshond served as our subject for a single laser test of the canine. We measured the stifle joint medial to lateral at approximately 4". This breed has quite a bit of fur, which was not shaved for the measurement or for the experiment. We parted the hair and attempted to get as close to the skin as possible with both the detector and the laser. The Y axis has been changed to 250ns in this test, which measured almost 40mV.

Discussion

In this study a range of tissue types were irradiated to observe the penetration characteristics of super pulsed laser energy. These tissues included the bone and skin of the cannon bone area, the bony and ligamentous tissue of the stifle joint, and the thick muscles of the horse's neck. By measuring the signal strength produced at the opposite side of each treatment site, we observed that super pulsed laser energy successfully penetrated each of these tissue types. Differences in signal strength suggest the composition of tissue has significant effect on penetration. While it is difficult to quantify those differences in a live subject, this preliminary study offers clear evidence of the penetration of super pulsed Respond 2400XL laser energy through the various tissue types encountered in equine and canine injuries.

The effective penetration of super-pulsed laser into different tissue types examined in this study suggests beneficial use of the laser for common injuries suffered by equine and canine patients. Injured tissue is characterized by abnormal cellular metabolism which can be influenced by laser therapy. In the cells of the injured tissue, the resting electric potential can be provoked to achieve its activation threshold by a pulse averaging as little as 20millivolts (mV), thereby stimulating cellular metabolism. For example, the stifle joint is a very common site of canine injury that could benefit from super pulsed laser energy which in our experiment reached the joint, measuring 40mV. The equine hock is also a very common site of injury that could benefit from the application of laser energy. The equine neck is composed primarily of muscle tissue, and although blood readily absorbs laser light, there remained laser energy sufficient to be measurable at 31mV.

Conclusion

Laser light at 904nm, with a 36 W peak pulse, 4 diode configuration with a 200ns pulse width achieves measurable penetration in many types of equine and canine tissue.