White Paper

January 2016

Multi Radiance Research Series: ACTIVet Pro Laser

Increasing Power without the unwanted Photothermal Effects

Multi Radiance Medical®

ACTIVET PRO

The ACTIVet PRO Laser White Paper

Increasing Power without the unwanted Photothermal Effects

Multi Radiance Research Series
January 2016

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Executive Summary:

The ACTIVet PRO, a cordless, ultra-portable laser therapy system and successor to the ACTIVet, sets a new standard for veterinary laser therapy. The synchronous use of high power Super Pulsed Laser (GaAs 905 nm), and ultra-bright infrared, red and blue LEDs (875 nm, 640 nm and 465 nm) optimizes the biological effects of the entire phototherapeutic window to accelerate healing and reduce pain.

Designed with optimal parameters from the Proof of Concept process (POC), a 300% increase in power over the prior generation significantly reduces treatment time while providing consistent, reproducible outcomes experienced in the original. Separate studies detailing the depth of penetration time profile (DPTP) and thermal time profile (TTP) were used to optimize the device for clinical use and validates the rationale behind the upgrades in the ACTIVet PRO model. The purpose of this white paper is to detail the clinical testing used to validate the new proposed parameters for the ACTIVet PRO. Safe and without risk of tissue damage due to the optimal DPTP and favorable TTP, treatment with the ACTIVet PRO results in healthier pets and satisfied clients.

The ACTIVet PRO is superior to Class IV lasers in Depth of Penetration Time Profile (DPTP), Thermal Time Profile (TTP), Controlling Pain and Inflammation, Infection Control and Wound Care.

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Validated:

The ACTIVet, with its ultra-portable design and ease of use, became an instant success. Since its introduction in 2012, luminaries in both the equine and companion veterinary world have endorsed the device for delivering safe and reliable outcomes seen in clinics, barns, and the home. Since not all light devices are not inherently effective, it is critically important to perform the proof of concept (POC) process to validate device parameter selection.

Multi Radiance Medical (MRM) embarked on the POC in early 2012 to evaluate the core combination of multi-wavelengths from magnetic laser and LEDs found in their therapeutic light devices. The POC confirmed that a synergistic effect exists between the different light sources (laser and LEDs) and was able to measure the amount of light entering the body (depth of penetration time profile DPTP) and calculate the amount of heat generated on the skin surface (thermal time profile TTP). Published in 2014, The Pillars Paper documents the MRM POC process and suggests optimal treatment parameters and doses necessary for the safe delivery of consistent, clinically relevant outcomes.

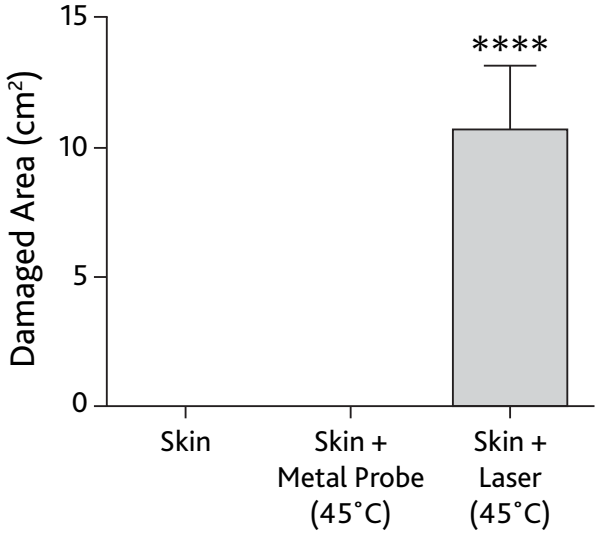
Optimized:

The successor to the ACTIVet began the product design and testing phase in early 2014. The ACTIVet PRO was the first device created with the recently identified optimal parameters from the many studies performed in the POC. In theory, all things can be possible, but not until testing is complete can you be certain. Two additional experiments were carried out at the Laboratory of Phototherapy in Sports and Exercise (Sao Paulo, Brazil) under the direct supervision of Dr. Ernesto Leal, Junior.

To validate the new proposed parameters for the ACTIVet PRO and further optimize the device for clinical use, the new data adds further evidence to the previously published Pillars Proof of Concept and establishes and validates the rationale behind the upgrades in the ACTIVet PRO model.

Unrivaled:

The ACTIVet PRO provides a 300% increase in power over the previous model. An increase in power can shorten treatment times and provide powerful pain relief. However, unlike high powered Class IV lasers, the ACTIVet PRO increases power without the unwanted photothermal effect, avoiding the production of excessive ROS that can lead to photocytotoxicity and apoptosis.[1] Laser, like ultrasound, at low levels, can stimulate while at higher levels it becomes destructive.[2]



Apoptosis is normally mediated by caspases, which trigger cell death.[3] Isman, et al[4] found evidence that the increased heat accumulation from high powered laser also stimulated apoptotic pathways of cell death. However, this damage was not induced by the heat alone[5]. Khan, et al.[6] observed that the larger doses provided by high powered lasers also generates ROS that when combined with accumulating heat in the skin resulted in phototoxic tissue damage. Therefore, it can be argued that a higher powered laser that generates superficial tissue heating in the skin does not provide photobiomodulation as we currently understand it, but rather trigger apoptosis pathways.

Since a high dose given in a quick amount of time can yield photobioinhibitory or photothermal effects within the tissue, laboratory trials were performed with the new ACTIVet PRO to assess the thermal impact of the higher powered laser and LEDs and measure if the light core continues to operate synergistically.

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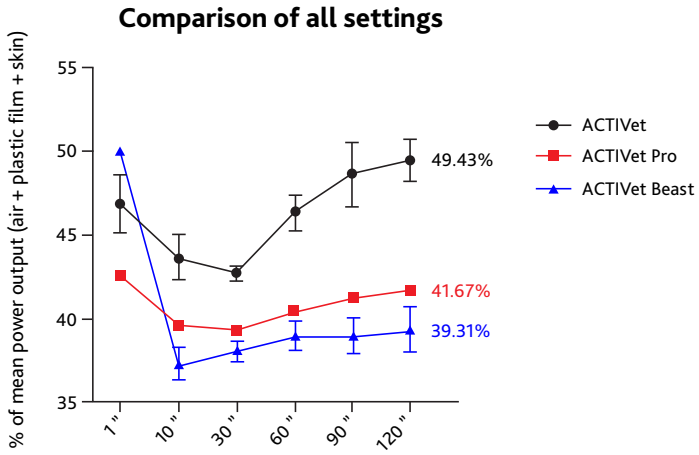
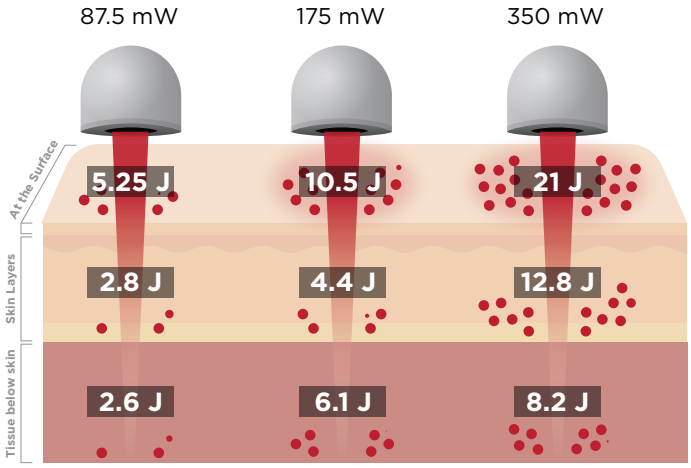
Depth of Penetration Time Profile (DPTP):

Leal-Junior [7] and Albuquerque-Pontes evaluated the DPTP of the original ACTIVet for inclusion in the Pillars Paper. The study evaluated the depth of penetration through the dorsal skin of rats to determine the effects of concurrent multiple wavelengths of 640nm Red LED, 875nm IRED and 905nm SPL with a total average of approximately 100 mW of power. The original data suggests and demonstrates a pattern of linearly increasing penetration of the light over time with a 43% of the available light penetrating beyond the skin. This represented a 100% increase when compared to the actual summative total of the individual light sources. The study concludes that a combination of multiple wavelengths creates a "synergism" that enhances each individual wavelength's ability to penetrate the skin.

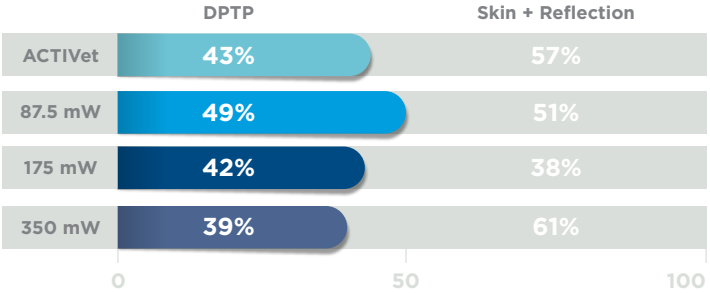


Albuquerque-Pontes, et al. [8] performed the same study with the new ACTIVet PRO to evaluate the proposed increase in power on the previously reported synergy. The dorsal skin of rats was again used in this study to evaluate the depth of penetration time profile. Three groups including the original settings of the ACTIVet were compared. There was a noted increase in the skin DPTP to 49% in ACTIVet mode, this represents over 15% improvement from the original ACTIVet. This efficiency can be attributed to the higher efficacy of the new ultra-bright red and infrared LEDs of the ACTIVet PRO model.



The newer generation of light emitting diodes can produce mean output of power similar to low level lasers. Therefore, two additional proposed settings were tested for the ACTIVet PRO. A 100% and 300% increase in power respectively from the original model established the effect of increased power on the DPTP.

While not surprising, there was an expected linear decrease in DPTP when the mean output of power was increased. A 57% increase in the loss of light when the power is doubled compared to original and a 357% increase when the power is doubled again. This can be attributed to greater amount of light scattering at the surface and also an increase in the absorption of light in the superficial layers of the skin. However, there is a net increase in the amount of light delivered below the surface of 135% when the power is doubled and over 215% when the power is increase by a factor of 4.



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The favorable DPTP, created by the core of multiple wavelengths, allows a greater percentage of light energy to penetrate sub dermal reducing the amount of energy being transformed into heat. However, any decrease in the DPTP can contribute to an increase in skin surface temperature which can lead to a reduction in the phototherapeutic effects and a dangerous rise in tissue temperature. A TTP study was necessary to establish if the increased power outputs in the ACTIVet PRO were tissue safe.

The Thermal Time Profile (TTP):

The North American Association for Photobiomodulation Therapy (NAALT) has recognized that photobiomodulation (PBM) is a non-thermal process. [9] However, most continuous wave lasers/LEDs and all high powered Class 4 lasers produce a considerable amount of unwanted heat that may limit the phototherapeutic response or cause tissue damage. Khan, et al [10] established a correlation between a rise in surface temperature (> 45 °C) and phototoxic tissue damage. An evaluation of thermal response to skin absorption for all high powered devices can provide an insight into the safe use of the device by measuring the thermal response at the skin surface. [11] Testing ranges should include small and large doses, but also measure the dose rates over time known as a Thermal Time Profile (TTP).

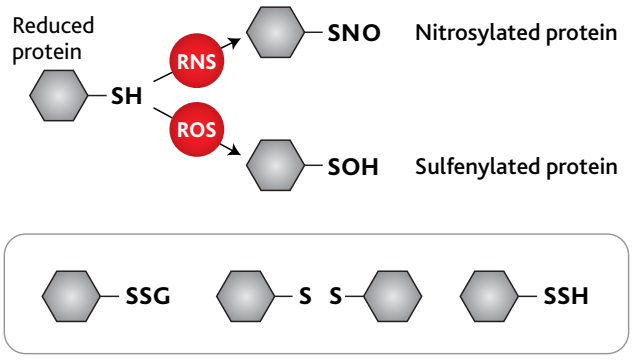
	Light	Intermediate	Dark
Baseline	33.84	34.74	34.48
72 sec	34.28	34.86	34.90
228 sec	34.54	35.45	35.21
380 sec	35.54	36.46	36.06

Vanin, et al.[12] replicated this study by Grandinétti, et al. [13] that evaluated the thermal impact of the ACTIVet PRO on light, medium and dark skin. Baseline measurements were taken prior to the start and skin temperatures were measured using a FLIR thermographic camera. Four doses were applied: placebo, 25 J, 80 J, and 133 J to the skin. The ACTIVet PRO was set to full power (350 mW and 50 Hz frequency).

There was a non-significant increase ($p>0.05$) in all skin types and with all doses. Therefore, no groups experienced excessive photothermal effects that may affect patient safety and comfort. The ACTIVet PRO TTP did not demonstrate an increase in skin temperature in any of the skin types tested therefore there is no threat or concern regarding cytotoxicity in clinical practice. The lack of accumulating skin temperature may be attributed to the ultra-short pulse structure related to the frequency of the super pulsed laser and pulsing of the LEDs and IREDs.

Blue Light: Infection Control and Wound Healing:

Several meta analyses have demonstrated the ability of light to accelerate wound healing.[14],[15] While most of the studies have been performed using red or infrared light, Adamskaya, et al.[16] recently demonstrated the effect of blue light (470 nm) significantly influences wound healing by affecting keratin expression via a photolytic release of NO from nitrosylated proteins. Non-coherent blue light penetrates rather poorly, due to the almost complete absorption in the superficial layers of the skin, however that makes it ideally suited to treat conditions of the skin. The 470nm Blue LED light retains some of the antibacterial properties of UV light, but without the risks associated with UV over exposure [17]. Evidence supports the use of blue LED to kill acne[18], MRSA[19], and the bacteria that cause periodontal disease [20].



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When Multi Radiance released the original ACTIVet in 2012, it launched with a revolutionary novel concept of adding 470 nm blue LEDs to supplement the wound healing ability of the red and infrared LEDs. This inclusion offered an entirely new approach to managing wounds by not only accelerating wound repair but also reducing bacterial burdens of infected wounds. The effects seen with blue LEDs is equal and on par with results seen with higher powered blue lasers. [21]

The ACTIVet PRO now includes 3 ultra-bright high powered 465 nm blue LEDs. A 900% increase in both power and density of the blue light in the ACTIVet PRO improves the efficacy of the therapy and shortens treatment times.

LaserPuncture and PhotoProbes:

The laser aperture of the ACTIVet PRO is threaded to allow the attachment of specific photoprobes. The ACTIVet PRO includes a set of 4 light bending or light focusing lenses, two for Laserpuncture [22], one for trigger point deactivation and one designed to facilitate wound healing, are used to increase the versatility of the device. The probes are constructed of non-toxic, optical organic glass and are polished to facilitate cleaning.

Conclusion:

Upgraded with the latest advances in light technology, the ACTIVet PRO is unrivaled and sets a new standard for veterinary laser therapy with synchronous high power Super Pulsed Laser (GaAs 905 nm), and ultra-bright infrared, red and blue LEDs (875 nm, 640 nm and 465 nm). The synergistic effect of the combined wavelengths in the light "core" optimize the biological benefits of the entire phototherapeutic window to accelerate healing and reduce pain.

The ACTIVet PRO is a cordless, ultra-portable laser therapy system designed to treat the wide array of conditions seen in almost any practice setting. With a 300% increase in power and a 900% increase in Blue Light, the ACTIVet PRO significantly reducing treatment times and provides consistent, reproducible outcomes. Safe and without risk of photothermal damage to tissue due to the optimal DPTP and favorable TTP, treatment with the ACTIVet PRO results in healthier pets and satisfied clients.

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Appendix:

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