Intended Effect of Therapeutic Laser: Photobiomodulation

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Therapeutic laser therapy is a noninvasive modality that can have effects on pain and tissue repair, in both acute and chronic states of healing. Laser equipment is often confused with being a simple heating modality, which is incorrect.

Laser therapy works via the process of photobiomodulation (PBM), which is "the process of having light absorbed by endogenous chromophores (at the mitochondrial level) that elicits photophysical and photochemical events at various biological scales leading to physiological changes and therapeutic effects."[1]

PBM is the goal of all laser devices that are intended for therapeutic applications. It is not unique to any single class of laser. There are differences on how effective different light sources are in treating various conditions, but the intended effect of a therapeutic laser or LED device should not be a topic of debate outside of the concept of wanting to create a stimulatory or an inhibitory effect on the tissue being treated. This is referred to as the "biphasic approach" to laser therapy[2] and is an important factor to consider when treating any condition.

An Important Distinction: Class 4 Lasers

Class 4 lasers are different from other classes of lasers because they have output power greater than 0.5 watts (500 milliwatts). This helps create higher power density (irradiance), which allows for the delivery of a larger concentration of photonic energy at depth for a given wavelength.[3] This is useful for a couple reasons.

PBM is very much a threshold phenomenon[4]—if enough energy is not provided to the target tissue, there will be no significant treatment effect. Higher irradiance is therefore important when treating larger individuals or when trying to impact deeper target tissues, as it is more challenging to get sufficient amounts of light to the intended target.

Treating with higher irradiance levels has unique effects on nerve tissue, specifically pain signaling from peripheral C and A-delta fibers[4,5,6] which are responsible for chronic and acute pain signals from the periphery. There are several mechanisms responsible for reducing pain levels when sufficient irradiance is applied to these nerves, but the net effect of treating these sensory nerves with higher irradiance is that true analgesia can be created via PBM in a matter of minutes.[4]

Short-term pain relief is the result of temporary neuroplastic changes to the axon,[4,6] whereas lasting pain relief involves general reduction of the "inflammatory soup" present at the peripheral nerve endings.[4,6] Treatment of peripheral nerves has also been shown to down regulate CNS factors involved with central sensitization such as increasing the levels of serotonin, decreasing NMDA activity (#), and increasing endogenous opioid levels at the dorsal horn.[4,] These findings are leading to an increased interest from the medical community in incorporating laser therapy into pain management plans of care.

If you are currently using a laser in your clinic to address pain and

inflammation, there are several things you can do to maximize your outcomes. Therapists should have an understanding of tissue dosing and how different energy and power levels impact tissue(s). Understanding the bi-phasic nature of PBM will help with making informed decisions when treating different conditions at different stages of the tissue-healing cycle.

Light Source Makes a Difference

Additionally, know your light source! Know the wavelengths being used, as this impacts depth of penetration. Is the light coming from a laser, a LED, or a combination of the two? There are significant differences between the two. Due to their physical characteristics, LEDs are generally not as effective at treating deeper tissues and do not have the ability to create irradiance levels that provide the quick analgesia mentioned previously.[7] Understanding some of these constraints will help shape treatment expectations.

Finally, it is beneficial to know, at a minimum, the power output of your equipment and how to calculate both the power density (irradiance) and total energy density (J/cm2) that is being provided by your device. This information is important as it correlates with the dosage required to maximize PBM for a given condition. Higher-quality PBM studies will clarify several treatment parameters which will include both the power and energy densities that were used in the study. Clinicians will need to know if their equipment can replicate the same parameters in order to expect the same outcomes.

As the research related to PBM grows, the question of "does it work?" is being replaced with "how exactly does it work?" and "what is the recommended dosage for that condition?" Knowing the basics regarding laser terminology and the associated physics will go a long way toward becoming an educated consumer about this topic.

References available online.