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Laser focus

What to know about adding photobiomodulation therapy to your practice.

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ARE YOU CONFUSED BY MANUFACTURERS' CLAIMS ABOUT the best laser therapy devices? Are you skeptical of light therapy as a treatment modality? Your confusion is understandable—there have been mixed messages and unrealized claims about various medical light therapy devices. A look at the research will help you better understand light therapy.

Photobiomodulation

Shortly after the laser was invented in 1960, Endre Mester noticed that applying laser light to the backs of shaven mice caused their hair to grow back more quickly than in mice not exposed to laser.[1] He also observed that skin incisions appeared to heal faster on laser-treated animals. These findings initiated research to understand the effects of light on living cells and the mechanisms involved.

Hundreds of scientific studies have been conducted *in vitro* to characterize the dosages needed to achieve a cellular response with light.[2] These studies give a baseline for the amount of laser energy needed to achieve results at the cellular level.

Over the past 30 years, researchers have come to accept the term "photobiomodulation" to describe the process by which light stimulates or inhibits cell function. Many terms have been used to describe the therapeutic use of light devices.[3] One of the more frequently used terms has been low-level laser therapy (LLLT); however, devices that use light-emitting diodes (LEDs) are not included in the term even though an LED-based device may be able to deliver an LLLT response.

There was reluctance to adopt the term photobiomodulation because it was not a MeSH (Medical Subject Heading) search term. MeSH is contained in the National Library of Medicine's controlled vocabulary, which consists of terms that are used to index articles in the world's leading biomedical journals.[4]

In 2014, a consensus nomenclature meeting was held and subsequently the term "photobiomodulation therapy" was chosen to be added to the MeSH database as an indexing term.[3,5] Photobiomodulation therapy is defined as the therapeutic use of light, absorbed by chromophores found in the body, to

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trigger nonthermal, non-harmful biological reactions that result in beneficial therapeutic outcomes.[5]

Protocols for use

Appropriate dose selection is critical to the safety and effectiveness of photobiomodulation therapy. To get clinical results, sufficient light must reach the target tissue. There are various parameters to consider when calculating dose, including power density or irradiance, treatment time, wavelength, pulsing, and application technique.[6]

The therapeutic dose is measured in joules (J) delivered per square inch of surface area.[3] Much of the research conducted in the field has involved cell or small animal studies in which low power and small beam size were sufficient to treat the cells or muscles.

A recent study published by Anders, et al., reported the successful translation of *in vitro* results obtained in the petri dish by using those parameters to treat surgically repaired peripheral nerves *in vivo*.[7] The researchers found an optimal dose for nerve repair *in vitro* to be 97.5 percent less than that required when delivered on the surface of the skin.

Power and density

The FDA regulates lasers for medical use. Unlike surgical medical lasers, which use precisely focused light to treat or remove tissue, therapy lasers do not focus light and do not harm tissue. Therapy lasers typically have a lower power density or irradiance (i.e., the power is spread out over a larger area). The FDA designates these lasers as biostimulation lasers.[8]

The FDA also classifies lasers by their output power. Early FDA-approved therapy lasers were Class 3b lasers (maximum 0.5 watts). In 2003, the FDA approved the first Class 4 laser (greater than 0.5 watts) for the relief of minor muscle and joint pain. The higher powered lasers make it possible to not only apply the benefits of photobiomodulation superficially, but also to treat a greatly expanded range of conditions by delivering a clinically effective dose to target areas below the skin (e.g., hamstring muscles), and in a shorter period of time.[9]

Optimal wavelength

For light to produce beneficial therapeutic outcomes, it must be delivered at an appropriate wavelength and of sufficient intensity to the target tissue. One range of wavelengths has been referred to as the "optical window" for photobiomodulation therapy, where there is minimal absorption from different substances (e.g., water, hemoglobin, and melanin).

The current understanding is that light in the visible range (600 to 800 nanometers) is absorbed more by hemoglobin and melanin, so these visible wavelengths are better suited for superficial areas. To effectively treat deeper musculoskeletal conditions, therapy lasers should be in the near-infrared range (800 to 1,000 nanometers).

Understanding pulsed laser

Photobiomodulation therapy can be delivered in either continuous wave (CW) or pulsed mode. Typically there are two types of pulsing used in therapy lasers—superpulsed or gated.[10]

Various claims suggest the ideal pulsing frequencies; however, there are no published reports on the advantages of pulsed light in reducing pain and inflammation in humans. A review by Hashmi, et al., that looked at CW versus pulsed light concluded that more evidence is needed.

When the laser is used in gated mode, it is cycling its CW power on and off and consequently delivering a lower average output power. In general, the use of pulsing decreases light delivered to the target. On the other hand, in instances where there is a concern about heating tissue, such as in treatment of the brain, pulsing can be used to further control the output power of the laser. In a recent paper that looked at human cadaver brain tissue, there were no differences observed in light penetration between pulsed and CW laser light.[11]

Implementation and application

As with any complicated technology, even if you don't understand exactly how it works, you should have a basic grasp of the mechanisms involved. If you are using a laser that has preprogrammed protocols, understand the differences between treatments when your patient's skin color is light or dark, or their body size is small or large. For example, if the laser has a mix of 980 and 810 nanometer light for treatment of light skin, it may switch to only 980 nanometer light to treat dark skin. Protocols for larger bodies will deliver a larger dose compared to treatment of a patient with a smaller build.

Additionally, a significant amount of light is lost when you operate in non-contact mode due to reflection from skin and hair surfaces. Therefore, it is advantageous to treat on contact, and it is especially helpful if you are able to compress the tissue (and blood) to deliver even more light to deeper tissues.

A bright future

Scientifically sound research is advancing in the field of photobio-

modulation, and light-based devices can be used to address a variety of medical issues.[12] When a comprehensive treatment approach is used, laser therapy is an effective modality.[13-17] Lasers are being used with great success in chiropractic, veterinary medicine, professional sports, and rehabilitation clinics around the world.[18,19]

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