Can LLLT Help Put You in the Winner’s Circle?

Pre-conditioning by multiple modalities is a rapidly growing area of investigation in pathological conditions where tissue damage may be expected such as surgery, heart attack, or stroke can be mitigated by pre-treating the local or distant tissue with low levels of a stress-inducing stimulus, that can induce a protective response against subsequent major damage.

Low-level laser (light) therapy (LLLT) has been used for nearly 50 years to enhance tissue healing and to relieve pain, inflammation and swelling. The photons are absorbed in cytochrome(c) oxidase (unit four in the mitochondrial respiratory chain), and this enzyme activation increases electron transport, respiration, oxygen consumption and ATP production. A complex signaling cascade is initiated leading to activation of transcription factors and up- and down-regulation of numerous genes. Recently it has become apparent that LLLT can also be effective if delivered to normal cells
or tissue before the actual insult or trauma, in a pre-conditioning mode. Muscles are protected, nerves feel less pain, and LLLT can protect against a subsequent heart attack.

These examples point the way to wider use of LLLT as a pre-conditioning modality to prevent pain and increase healing after surgical/medical procedures and possibly to increase athletic performance. A novel treatment strategy to counter ischemic cardiac disease and stroke developed which was termed ischemic pre-conditioning IPC (Koch et al, 2014). IPC rests on the basic premise that brief durations of ischemia induce intrinsic cellular defense systems, and lead to the tolerance of vital organs to subsequent more severe ischemia. A primary mediator in IPC could be activation of hypoxia inducible factor 1(HIF1) which is the means by which tissue and cells can sense hypoxia.

Low-level laser (light) therapy or photobiomodulation has been known for almost 50 years. Part of the aim of this review is to draw comparisons between the hypothesized mechanisms of IPC and those of LLLT when used in a pre-conditioning or post-injury mode. It is in fact quite remarkable how many similarities that can be found between the two modalities. In acute conditions, skeletal muscle fatigue impairs the strength of muscle, its motor coordination and decreases the capacity of the muscle to perform work. Overall fatigue decreases the muscle function, which is believed to be a result of metabolic changes such as depletion of ATP and glycogen, oxidative stress, tissue hypoxia and blood acidification. Phototherapy has been shown to improve muscle fatigue and exhaustion. Studies have shown that pre-treatment with specific doses of phototherapy decreases inflammatory biomarkers and lactate levels in blood after strenuous upper and lower extremity exercise (Lopes-Martins et al, 2006b). On the basis of these studies we can infer that pre-conditioning the muscle with phototherapy increases
the contractile function, decreases exercise induced muscle fatigue and improvement in post exercise recovery.

There are two different phases of exercise-induced damage; one is primary and the other is secondary. The primary phase of muscle damage results from direct exercise-induced mechanical stress, and secondary muscle damage is due to the inflammatory response that follows after mechanical stress. Pre-conditioning with phototherapy protects the muscle both from primary as well as secondary damage, while phototherapy when administered after injury protects cells from secondary damage only. In vivo studies have shown that pre-conditioning phototherapy to injured muscles produces anti-inflammatory and antioxidant effects, thus protecting the muscle from secondary damage. Studies support the hypothesis that the ergogenic effects of phototherapy on muscles are due to increases in intramuscular microcirculation, decreases in the lactic acid production improved mitochondrial function, improved antioxidant ability of the exercising muscles, enhanced contractile function, prevention of exercise-induced cell damage, and improved post exercise recovery of strength and function,

Borsa et al (2013) critically evaluated these studies that address the ability of phototherapeutic devices, such as lasers and light-emitting diodes (LEDs), to improve skeletal muscle contractile function, decrease exercise-induced muscle fatigue, and enable post exercise recovery. The main outcome measures included total lapsed time to fatigue, number of repetitions to fatigue, overall work performed, maximal voluntary isometric contraction (strength), electromyographic activity, and post exercise biomarker levels. De Marchi et al (2011) observed that preconditioning with LLLT before exercise demented that pre-treatment with LLLT can protect skeletal muscle against exercise-induced damage in long-duration exercises. Baroni et al, 2010b demonstrated that pretreatment with LEDT [LLLT] increased the exercise
performance by producing higher isometric torque after high-intensity concentric isokinetic exercise.

LLLT has been implicated in reducing neuropathic pain by releasing local neurotransmitters such as serotonin (Walker, 1983), stimulating release of endorphins, and reduce inflammatory cells. (Albertini et al, 2007; Hagiwara et al, 2008; Lopes-Martins et al, 2005). As a mode of peripheral endogenous opioid analgesia, the opioid-containing immune cells migrate to inflamed sites and release endorphins to inhibit pain. Pre-conditioning of blood by LLLT on peripheral endogenous opioid analgesia in a rat model of inflamed paw tissue induces analgesia that was transiently antagonized by naloxone.

Millions upon millions of people globally of all ages compete in a broad spectrum of organized and recreational sporting venues. It is clear that a more fit competitor contributes to a better performance. This landmark multicenter study supports the conclusion that preconditioning muscles prior to mild and intense activities can produce an improved athletic performance with a multitude of favorable benefits.

Reference*

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