Photobiomodulation (PBM) / Low Level laser Therapy (LLLT)

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Search criteria: Muscle fatigue, endurance, strength and recovery

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Notes: A selection of papers around PBMT and exercise, highlighting delayed onset muscle soreness (DOMS), fatigue, slowing of age-related muscle loss and an interesting look at epigenetics with evidence of upregulation of oxidative stress defence mechanisms.

Pre-Exercise Infrared Photobiomodulation Therapy (810 nm) in Skeletal Muscle Performance and Postexercise Recovery in Humans: What Is the Optimal Power Output

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BACKGROUND: Photobiomodulation therapy (PBMT) has recently been used to alleviate postexercise muscle fatigue and enhance recovery, demonstrating positive results. A previous study by our research group demonstrated the optimal dose for an infrared wavelength (810 nm), but the outcomes could be optimized further with the determination of the optimal output power. OBJECTIVE: The aim of the present study was to evaluate the effects of PBMT (through low-level laser therapy) on postexercise skeletal muscle recovery and identify the best output power. MATERIALS AND METHODS: A randomized, placebo-controlled double-blind clinical trial was conducted with the participation of 28 high-level soccer players. PBMT was applied before the eccentric contraction protocol with a cluster with five diodes, 810 nm, dose of 10 J, and output power of 100, 200, 400 mW per diode or placebo at six sites of knee extensors. Maximum isometric voluntary contraction (MIVC), delayed onset muscle soreness (DOMS) and biochemical markers related to muscle damage (creatine kinase and lactate dehydrogenase), inflammation (IL-1β, IL-6, and TNF-α), and oxidative stress (catalase, superoxide dismutase, carbonylated proteins, and thiobarbituric acid) were evaluated before isokinetic exercise, as well as at 1 min and at 1, 24, 48, 72, and 96 h, after the eccentric contraction protocol. RESULTS: PBMT increased MIVC and decreased DOMS and levels of biochemical markers ($p < 0.05$) with the power output of 100 and 200 mW, with better results for the power output of 100 mW. CONCLUSIONS: PBMT with 100 mW power output per diode (500 mW total) before exercise achieves best outcomes in enhancing muscular performance and postexercise recovery. Another time it has been demonstrated that more power output is not necessarily better.

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Low-Level Laser Therapy Improves Performance and Reduces Fatigue in Competitive Cyclists.

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Evidence supports that low-level laser therapy (LLLT) minimizes fatigue effects on muscle performance. However, the ideal LLLT dosage to improve athletes' performance during sports activities, such as cycling, is still unclear. Therefore, the goal of this study was to investigate the effects of different LLLT dosages on cyclists' performance in time-to-exhaustion tests. In addition, we looked at the effects of LLLT on the frequency content of the EMG signals to assess fatigue mechanisms. Twenty male competitive cyclists participated in a crossover, randomized, double-blind and placebo-controlled trial. They performed an incremental cycling test to exhaustion (on day 1) followed by four time to exhaustion tests (on days 2 to 5) at their individual maximal power output (POMAX). Before each time-to-exhaustion test, different dosages of LLLT (135, 270 and 405 J/thigh, respectively) or placebo were applied at the quadriceps muscle bilaterally. Power output and muscle activation from both lower limbs were recorded throughout the tests. Increased performance in time-to-exhaustion tests was observed with the LLLT-135J (~22 s; $p<0.01$), LLLT-270J (~13 s; $p=0.03$) and LLLT-405J (~13 s; $p=0.02$) compared to placebo (149 ±23 s). Although LLLT-270J and LLLT-405J did not show significant differences in muscle activation compared to placebo, LLLT -135J led to an increased high-frequency content compared to placebo in both limbs at the end of the exhaustion test ($p\leq0.03$). In conclusion, LLLT increased time-to-exhaustion in competitive cyclists, suggesting this intervention as a possible non-pharmacological ergogenic agent in cycling. Among the different dosages, LLLT-135J seems to promote the best effects.

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Is photobiomodulation therapy better than cryotherapy in muscle recovery after a high-intensity exercise? A randomized, double-blind, placebo-controlled clinical trial.

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This study aimed to determine the effectiveness of photobiomodulation therapy (PBMT) and cryotherapy, in isolated and combined forms, as muscle recovery techniques after a muscle fatigue-inducing protocol. Forty volunteers were randomly divided into five groups: a placebo group (PG); a PBMT group (PBMT); a cryotherapy group (CG); a cryotherapy-PBMT group (CPG); and a PBMT-cryotherapy group (PCG). All subjects attended four sessions at 24-h intervals, during which they were submitted to isometric assessment (MVC) and blood collection pre-exercise 5 min and 60 min post-exercise. The muscle fatigue induction protocol occurred after the pre-exercise collections and the remaining sessions were performed 24, 48, and 72 h later where further blood collections and isometric exersizes were performed. A single treatment with THOR LED PBMT and/or cryotherapy was applied 2 min after completing the isometric exersizes at the first session only. Comparing the results of MVCs between groups, we observed significant increases in the MVC capacity of all groups that included PBMT ($p < 0.05$) and a significant decrease in the concentrations of the biochemical markers of oxidative damage (TBARS and PC) and muscle damage (creatine kinase-CK) in the PBMT groups when compared with the PG and CG groups ($p < 0.01$). The clinical impact of these findings is clear because they demonstrate that the use of phototherapy is more effective than the use of cryotherapy for muscle recovery, additionally cryotherapy decreases PBMT efficacy.

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What is the best moment to apply phototherapy when associated to a strength training program? A randomized, double-blinded, placebo-controlled trial : Phototherapy in association to strength training.

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The effects of phototherapy (or photobiomodulation therapy) with low-level laser therapy (LLLT) and/or light-emitting diodes (LEDs) on human performance improvement have been widely studied. Few studies have examined its effect on muscular training and no studies have explored the necessary moment of phototherapy irradiations (i.e., before and/or after training sessions). The aim of this study was to determine the optimal moment to apply phototherapy irradiation when used in association with strength training. Forty-eight male volunteers (age between 18 to 35 years old) completed all procedures in this study. Volunteers performed the strength training protocol where either a phototherapy and/or placebo before and/or after each training session was performed using cluster probes with four laser diodes of 905 nm, four LEDs of 875 nm, and four LEDs of 640 nm-manufactured by Multi Radiance Medical. The training protocol duration was 12 weeks with assessments of peak torque reached in maximum voluntary contraction test (MVC), load in 1-repetition maximum test (1-RM) and thigh circumference (perimetry) at larger cross-sectional area (CSA) at baseline, 4 weeks, 8 weeks, and 12 weeks. Volunteers from group treated with phototherapy before and placebo after training sessions showed significant ($p < 0.05$) changes in MVC and 1-RM tests for both exercises (leg extension and leg press) when compared to other groups. With an apparent lack of side effects and safety due to no thermal damage to the tissue, we conclude that the application of phototherapy yields enhanced strength gains when it is applied before exercise. The application may have additional beneficial value in post-injury rehabilitation where strength improvements are needed.

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Low level laser therapy associated with a strength training program on muscle performance in elderly women: a randomized double blind control study.

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The aging process leads to a gradual loss of muscle mass and muscle performance, leading to a higher functional dependence. Within this context, many studies have demonstrated the benefits of a combination of physical exercise and low level laser therapy (LLLT) as an intervention that enhances muscle performance in young people and athletes. The aim of this study was to evaluate the effects of combination of LLLT and strength training on muscle performance in elderly women. For this, a hundred elderly women were screened, and 48 met all inclusion criteria to participate in this double-blind placebo-controlled trial. Volunteers were divided in three groups: control (CG = 15), strength training associated with placebo LLLT (TG = 17), and strength training associated with active LLLT (808 nm, 100 mW, 7 J) (TLG = 16). The strength training consisted of knee flexion-extension performed with 80 % of 1-repetition maximum (1-RM) during 8 weeks. Several outcomes related to muscle performance were analyzed through the 6-min walk test (6-MWT), isokinetic dynamometry, surface electromyography (SEMG), lactate concentration, and 1-RM. The results revealed that a higher work ($p = 0.0162$), peak torque ($p = 0.0309$), and power ($p = 0.0223$) were observed in TLG compared to CG. Furthermore, both trained groups increased the 1-RM load (TG vs CG: $p = 0.0067$ and TLG vs CG: $p < 0.0001$) and decreased the lactate concentration in the third minute after isokinetic protocol (CG vs TLG: $p = 0.0289$ and CG vs TG: $p = 0.0085$). No difference in 6-MWT and in fatigue levels were observed among the groups. The present findings suggested that LLLT in combination with strength training was able to improve muscle performance in elderly people.

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Effects of Light-Emitting Diode Therapy on Muscle Hypertrophy, Gene Expression, Performance, Damage, and Delayed-Onset Muscle Soreness: Case-control Study with a Pair of Identical Twins.

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OBJECTIVE: The aim of this study was to verify how a pair of monozygotic twins would respond to light-emitting diode therapy (LEDT) or placebo combined with a strength-training program during 12 weeks. DESIGN: This case-control study enrolled a pair of male monozygotic twins, allocated randomly to LEDT or placebo therapies. Light-emitting diode therapy or placebo was applied from a flexible light-emitting diode array (lambda = 850 nm, total energy = 75 J, t = 15 seconds) to both quadriceps femoris muscles of each twin immediately after each strength training session (3 times/wk for 12 weeks) consisting of leg press and leg extension exercises with load of 80% and 50% of the 1-repetition maximum test, respectively. Muscle biopsies, magnetic resonance imaging, maximal load, and fatigue resistance tests were conducted before and after the training program to assess gene expression, muscle hypertrophy and performance, respectively. Creatine kinase levels in blood and visual analog scale assessed muscle damage and delayed-onset muscle soreness, respectively, during the training program. RESULTS: Compared with placebo, LEDT increased the maximal load in exercise and reduced fatigue, creatine kinase, and visual analog scale. Gene expression analyses showed decreases in markers of inflammation (interleukin 1beta) and muscle atrophy (myostatin) with LEDT. Protein synthesis (mammalian target of rapamycin) and oxidative stress defense (SOD2 [mitochondrial superoxide dismutase]) were up-regulated with LEDT, together with increases in thigh muscle hypertrophy. CONCLUSIONS: Light-emitting diode therapy can be useful to reduce muscle damage, pain, and atrophy, as well as to increase muscle mass, recovery, and athletic performance in rehabilitation programs and sports medicine.

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