Photobiomodulation

A light therapy that heals and relieves pain.

Photobiomodulation therapy (PBM Therapy) is the application of monochromatic light to improve the speed and quality of tissue repair. It reduces inflammation, reduces edema and can induce analgesia.

Applications of Photobiomodulation

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Wellness

Medical

Photobiomodulation therapy reduces fatigue, accelerates recovery and improves performance.

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Clinical Evidence

Fatigue

Reduce Fatigue

Performance

Improve performance

Recovery

Recover faster

Performance Wellness Medical

PBM vs Cryotherapy

PBM therapy is better than cryotherapy in muscle recovery after a high intensity exercise

Endurance

PBM Therapy increases endurance for repeated elbow extension against resistance and decreased blood lactate, creatine kinase, and C- reactive protein

Performance

PBM Therapy improves the VO2 kinetics in competitive cyclists

Muscle Performance

PBM Therapy increases torque in quadriceps muscle fatigue (Knee Extensor) study

Oxidative Stress

PBM increases performance, decreases oxidative stress and reduces muscle damage after progressive running exercise.

Delayed Onset Muscle Soreness

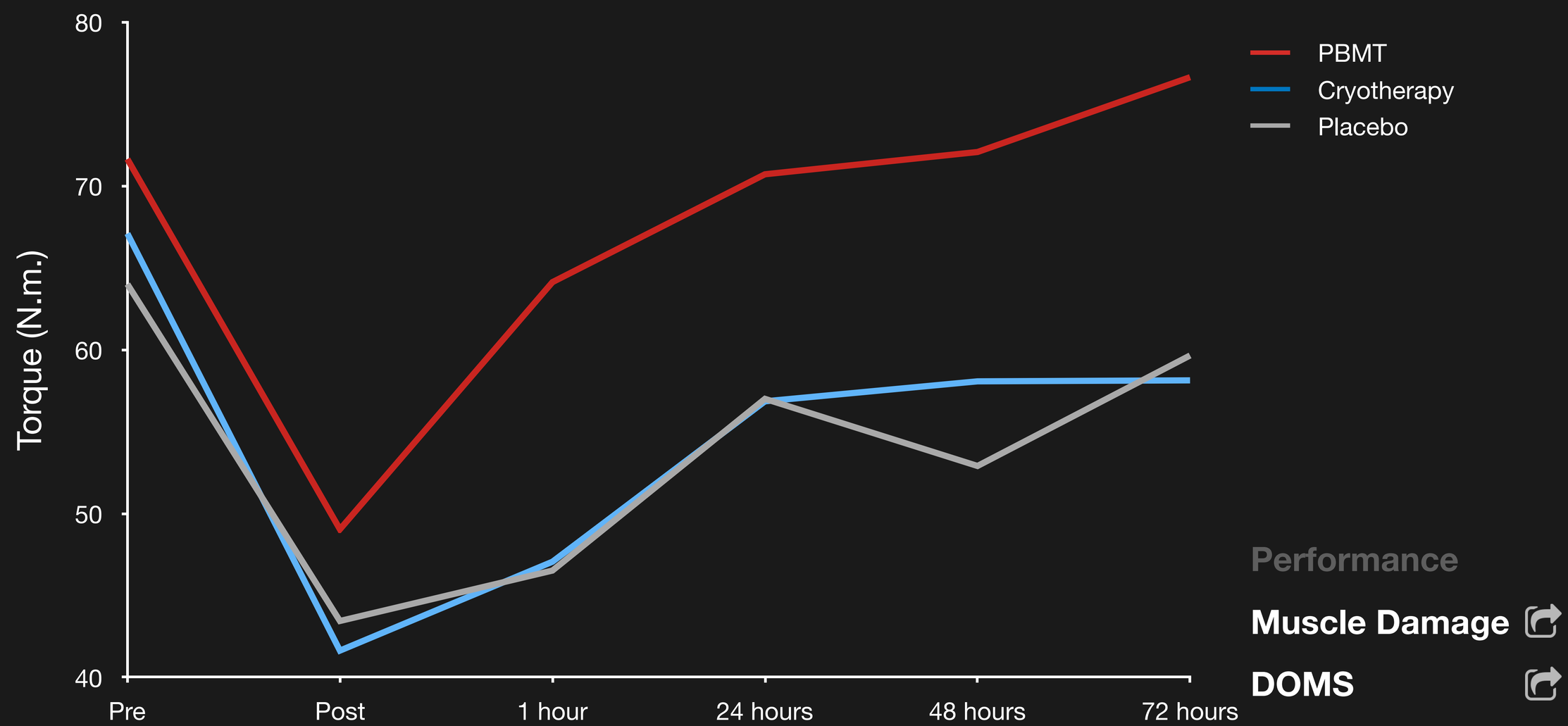
PBM Therapy reduces muscle soreness, increases strength, and reduces R0M impairment up to 96 hours after eccentric exercise

Performance in maximal voluntary contraction

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

De Marchi et al, Lasers Med Sci (2017)

"We obtained significant increases in the [maximal voluintary] capacity and decrease in DOMS of the volunteers who received treatment with PBMT"



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Performance in maximal voluntary contraction

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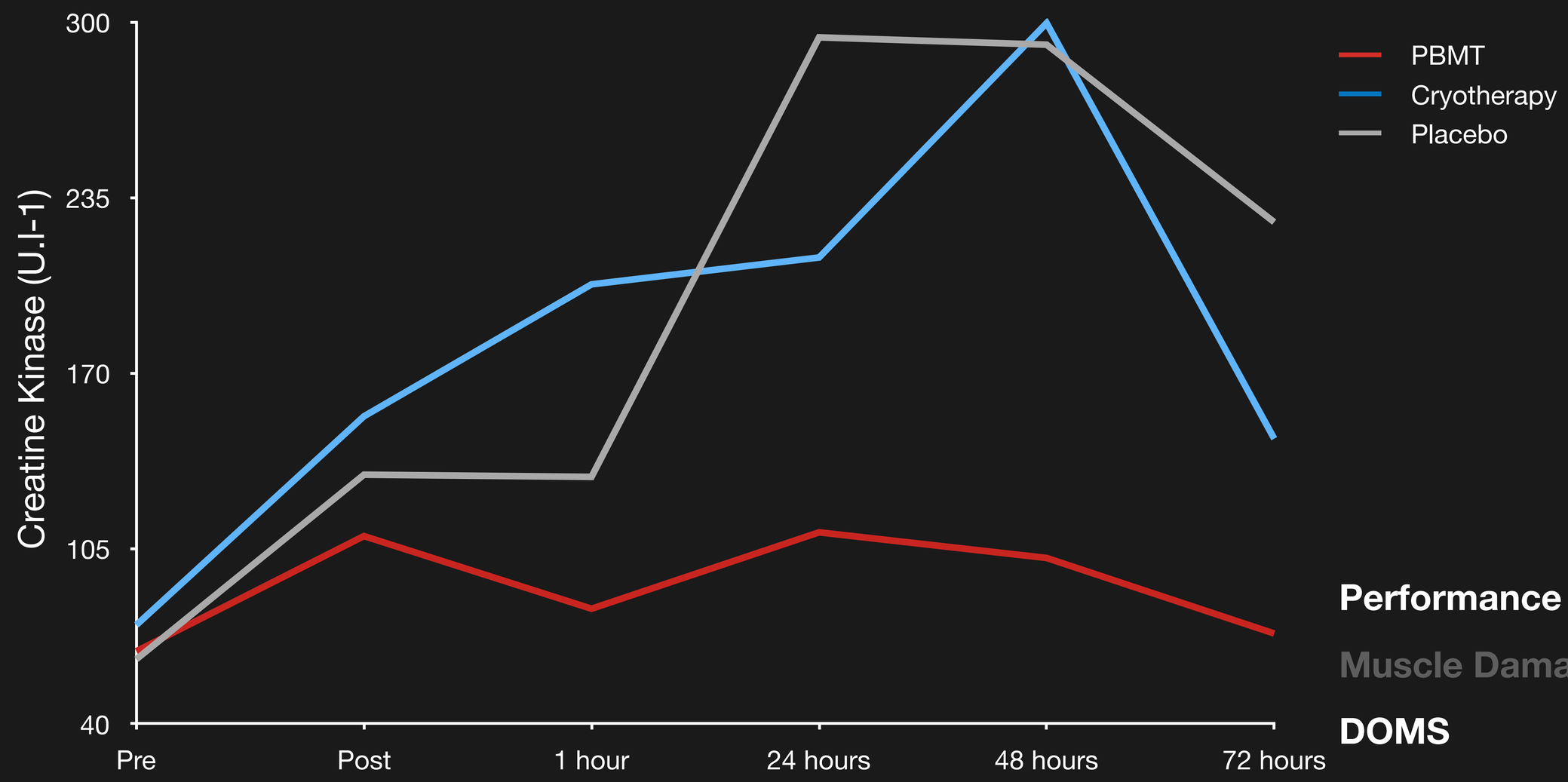

Performance

Muscle Damage

DOMS

Next article

Performance in maximal voluntary contraction

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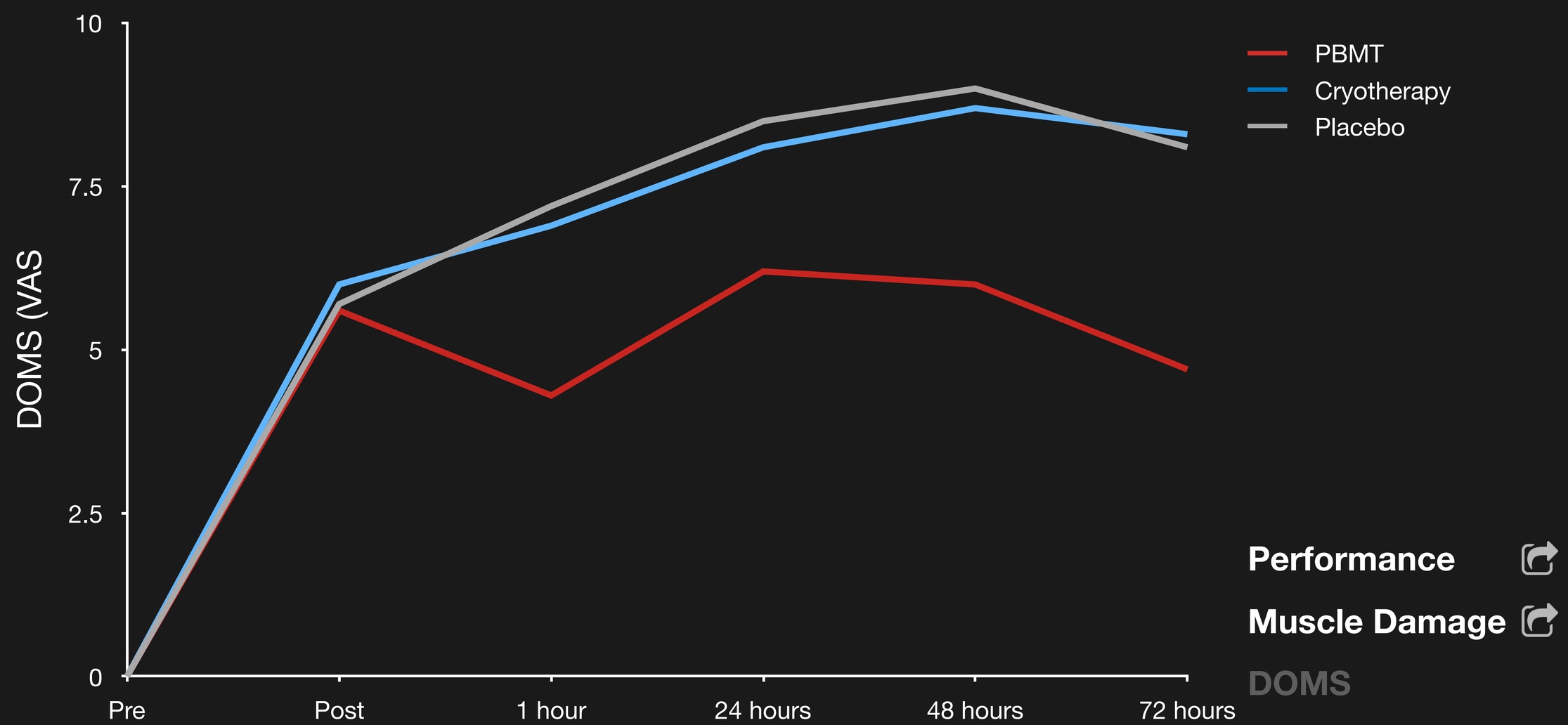

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Muscle Damage

DOMS

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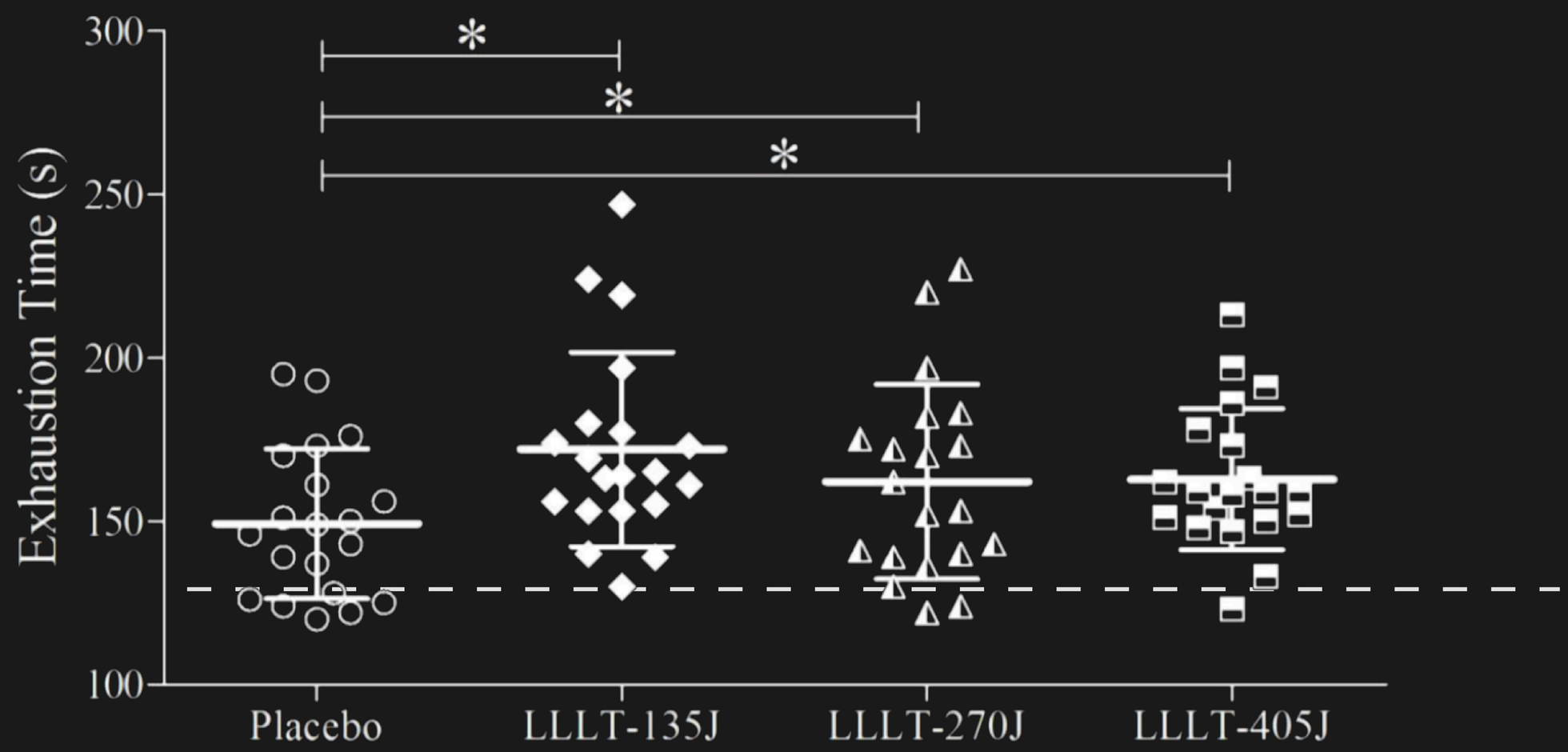
Performance and endurance

Low-Level Laser Therapy Improves Performance and Reduces Fatigue in Competitive Cyclists
Fábio J Lanferdini et al, International Journal of Sports Physiology and Performance (2017)

"Increased cycling performance was observed for all LLLT trials compared to the placebo. LLLT increased time-to-exhaustion by ~15% compared to placebo."



Lasers Med Sci
https://doi.org/10.1007/s10103-017-2347-y

ORIGINAL ARTICLE

Low-level laser therapy improves the VO_2 kinetics in competitive cyclists

Fábio J. Lanferdini[1,2] · Renata L. Krüger[1,3] · Bruno M. Baroni[4] · Caetano Lazzari[5] · Pedro Figueiredo[6,7] · Alvaro Reischak-Oliveira[1] · Marco A. Vaz[1]

Abstract Some evidence supports that low-level laser therapy (LLLT) reduces neuromuscular fatigue, so incrementing sports performance. A previous randomized controlled trial of our group showed increased exercise tolerance in male competitive cyclists treated with three different LLLT doses (3, 6, and 9 J/diode; or 135, 270, and 405 J/thigh) before time-to-exhaustion cycling tests. Now, the present study was designed to evaluate the effects of these LLLT doses on the VO_2 kinetics of athletes during cycling tests. Twenty male competitive cyclists (29 years) participated in a crossover, randomized, double-blind, and placebo-controlled trial. On the first day, the participants performed an incremental cycling test to exhaustion to determine maximal oxygen uptake (VO_{2MAX}) and maximal power output (PO_{MAX}), as well as a familiarization with the time-to-exhaustion test. In the following days (2 to 5), all participants performed time-to-exhaustion tests at PO_{MAX}. Before the exhaustion test, different doses of LLLT (3, 6, and 9 J/diode; or 135, 270, and 405 J/thigh, respectively) or placebo were applied bilaterally to the quadriceps muscle. All exhaustion tests were monitored online by an open-circuit spirometry system in order to analyze the VO_2 amplitude, VO_2 delay time, time constant (tau), and O_2 deficit. Tau and O_2 deficit were decreased with LLLT applications compared to the placebo condition ($p < 0.05$). No differences ($p > 0.05$) were found between the experimental conditions for VO_2 amplitude and VO_2 delay time. In conclusion, LLLT decreases tau and O_2 deficit during time-to-exhaustion tests in competitive cyclists, and these changes in VO_2 kinetics response can be one of the possible mechanisms to explain the ergogenic effect induced by LLLT.

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Lasers Med Sci
DOI 10.1007/s10103-011-0955-5

ORIGINAL ARTICLE

Low-level laser therapy (LLLT) in human progressive-intensity running: effects on exercise performance, skeletal muscle status, and oxidative stress

Thiago De Marchi · Ernesto Cesar Pinto Leal Junior · Celiana Bortoli · Shaiane Silva Tomazoni · Rodrigo Álvaro Brandão Lopes-Martins · Mirian Salvador

Abstract The aim of this work was to evaluate the effects of low-level laser therapy (LLLT) on exercise performance, oxidative stress, and muscle status in humans. A randomized double-blind placebo-controlled crossover trial was performed with 22 untrained male volunteers. LLLT (810 nm, 200 mW, 30 J in each site, 30 s of irradiation in each site) using a multi-diode cluster (with five spots - 6 J from each spot) at 12 sites of each lower limb (six in quadriceps, four in hamstrings, and two in gastrocnemius) was performed 5 min before a standardized progressive-intensity running protocol on a motor-drive treadmill until exhaustion. We analyzed exercise performance ($VO_{2\ max}$, time to exhaustion, aerobic threshold and anaerobic threshold), levels of oxidative damage to lipids and proteins, the activities of the antioxidant enzymes superoxide dismutase (SOD) and catalase (CAT), and the markers of muscle damage creatine kinase (CK) and lactate dehydrogenase (LDH). Compared to placebo, active LLLT significantly increased exercise performance ($VO_{2\ max}$ p=0.01; time to exhaustion, p=0.04) without changing the aerobic and anaerobic thresholds. LLLT also decreased post-exercise lipid (p=0.0001) and protein (p=0.0230) damages, as well as the activities of SOD (p=0.0034), CK (p=0.0001) and LDH (p=0.0001) enzymes. LLLT application was not able to modulate CAT activity. The use of LLLT before progressive-intensity running exercise increases exercise performance, decreases exercise-induced oxidative stress and muscle damage, suggesting that the modulation of the redox system by LLLT could be related to the delay in skeletal muscle fatigue observed after the use of LLLT.

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ORIGINAL ARTICLE

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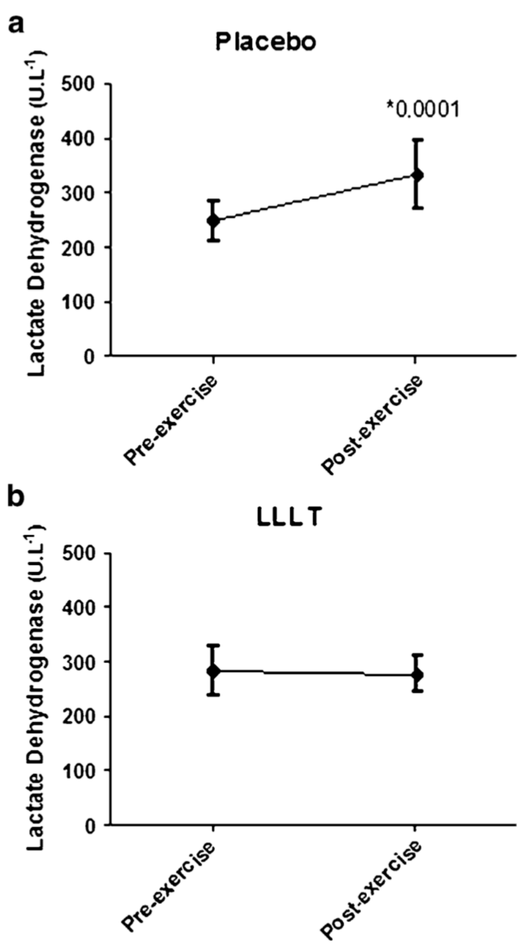

Fig. 2 Pre and post-exercise activity of lactate dehydrogenase (**a**) in placebo (**b**) and in active LLLT group. * Statistical significance from pre to post-exercise levels using the software SPSS 18.0 for Windows

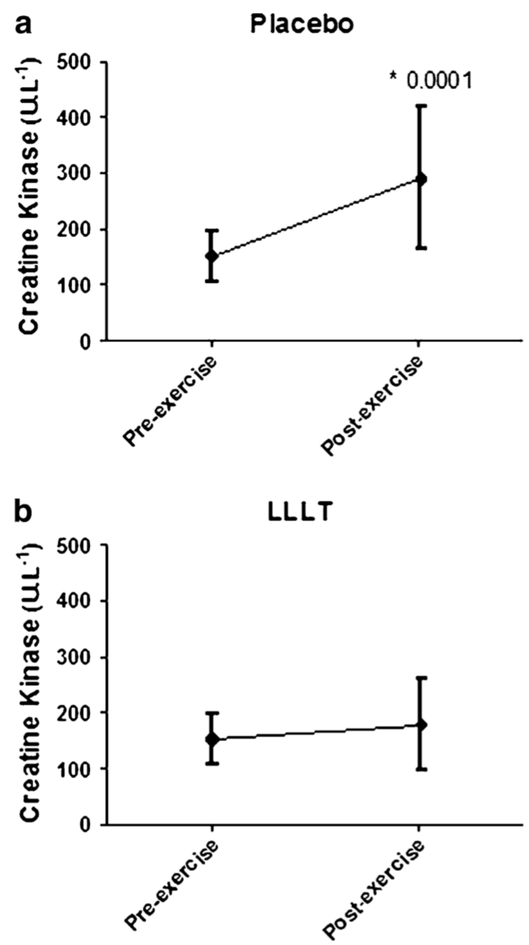

Fig. 3 Pre and post-exercise activity of creatine kinase (**a**) in placebo (**b**) and in active LLLT group. * Statistical significance from pre to post-exercise levels using the software SPSS 18.0 for Windows

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Effects of Low-Level Laser Therapy (LLLT) in the Development of Exercise-Induced Skeletal Muscle Fatigue and Changes in Biochemical Markers Related to Postexercise Recovery

ERNESTO CESAR PINTO LEAL JUNIOR, PT, PhD[1] • **RODRIGO ÁLVARO BRANDÃO LOPES-MARTINS,** PhD[2] • **LUCIO FRIGO,** PhD[3]
THIAGO DE MARCHI, PT[4] • **RAFAEL PAOLO ROSSI,** PT[5] • **VANESSA DE GODOI,** PT[5] • **SHAIANE SILVA TOMAZONI,** PT[6] • **DANIELA PERIN SILVA**[7]
MAIRA BASSO, PT[7] • **PEDRO LOTTI FILHO**[8] • **FRANCISCO DE VALLS CORSETTI**[8] • **VEGARD V. IVERSEN,** PhD[9] • **JAN MAGNUS BJORDAL,** PT, PhD[10]

STUDY DESIGN: Randomized crossover double-blinded placebo-controlled trial.

OBJECTIVE: To investigate if low-level laser therapy (LLLT) can affect biceps muscle performance, fatigue development, and biochemical markers of postexercise recovery.

BACKGROUND: Cell and animal studies have suggested that LLLT can reduce oxidative stress and inflammatory responses in muscle tissue. But it remains uncertain whether these findings can translate into humans in sport and exercise situations.

METHODS: Nine healthy male volleyball players participated in the study. They received either active LLLT (cluster probe with 5 laser diodes; λ = 810 nm; 200 mW power output; 30 seconds of irradiation, applied in 2 locations over the biceps of the nondominant arm; 60 J of total energy) or placebo LLLT using an identical cluster probe. The intervention or placebo were applied 3 minutes before the performance of exercise. All subjects performed voluntary elbow flexion repetitions with a workload of 75% of their maximal voluntary contraction force until exhaustion.

RESULTS: Active LLLT increased the number of repetitions by 14.5% (mean ± SD, 39.6 ± 4.3 versus 34.6 ± 5.6; P = .037) and the elapsed time before exhaustion by 8.0% (P = .034), when compared to the placebo treatment. The biochemical markers also indicated that recovery may be positively affected by LLLT, as indicated by postexercise blood lactate levels (P<.01), creatine kinase activity (P = .017), and C-reactive protein levels (P = .047), showing a faster recovery with LLLT application prior to the exercise.

CONCLUSION: We conclude that pre-exercise irradiation of the biceps with an LLLT dose of 6 J per application location, applied in 2 locations, increased endurance for repeated elbow flexion against resistance and decreased postexercise levels of blood lactate, creatine kinase, and C-reactive protein.

LEVEL OF EVIDENCE: Performance enhancement, level 1b. *J Orthop Sports Phys Ther 2010;40(8):524-532. doi:10.2519/jospt.2010.3294*

KEY WORDS: *biceps, skeletal muscle damage, skeletal muscle performance*

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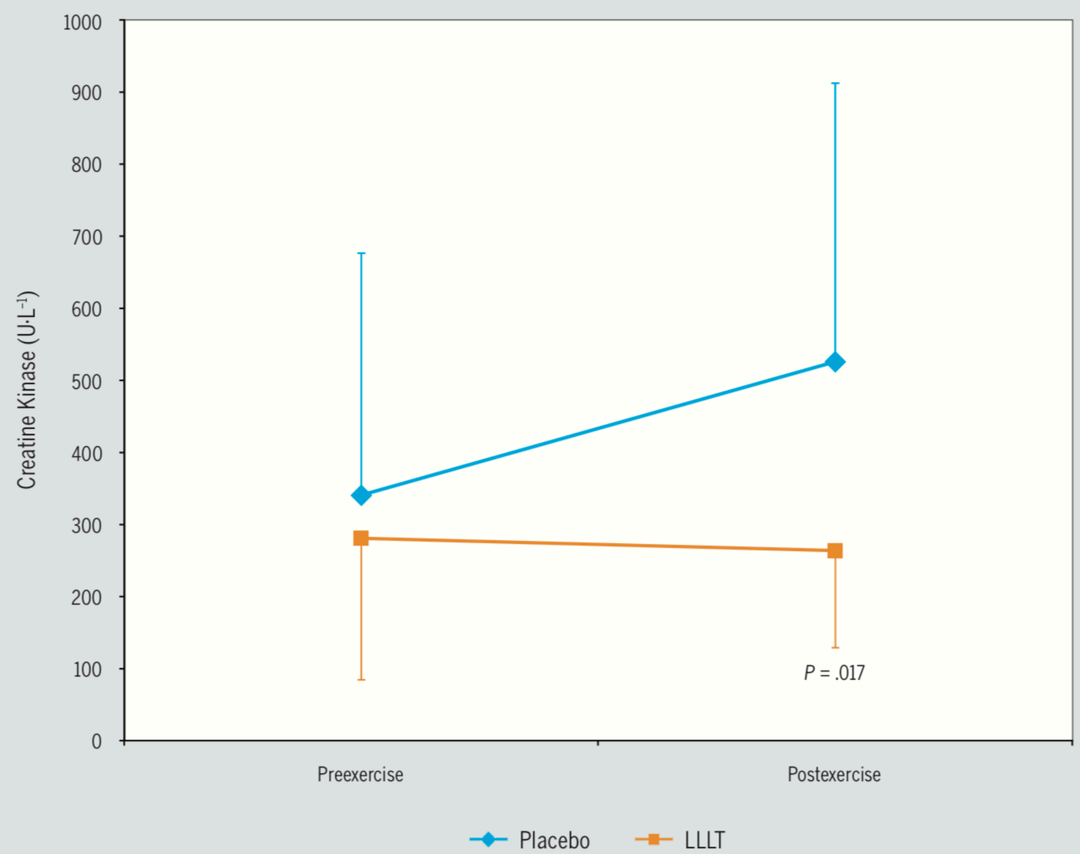

FIGURE 7. Creatine kinase activity prior to treatment with LLLT or placebo and after exercises to fatigue. A significant difference between groups (P = .017) was found postexercise. Error bars indicate standard deviations.

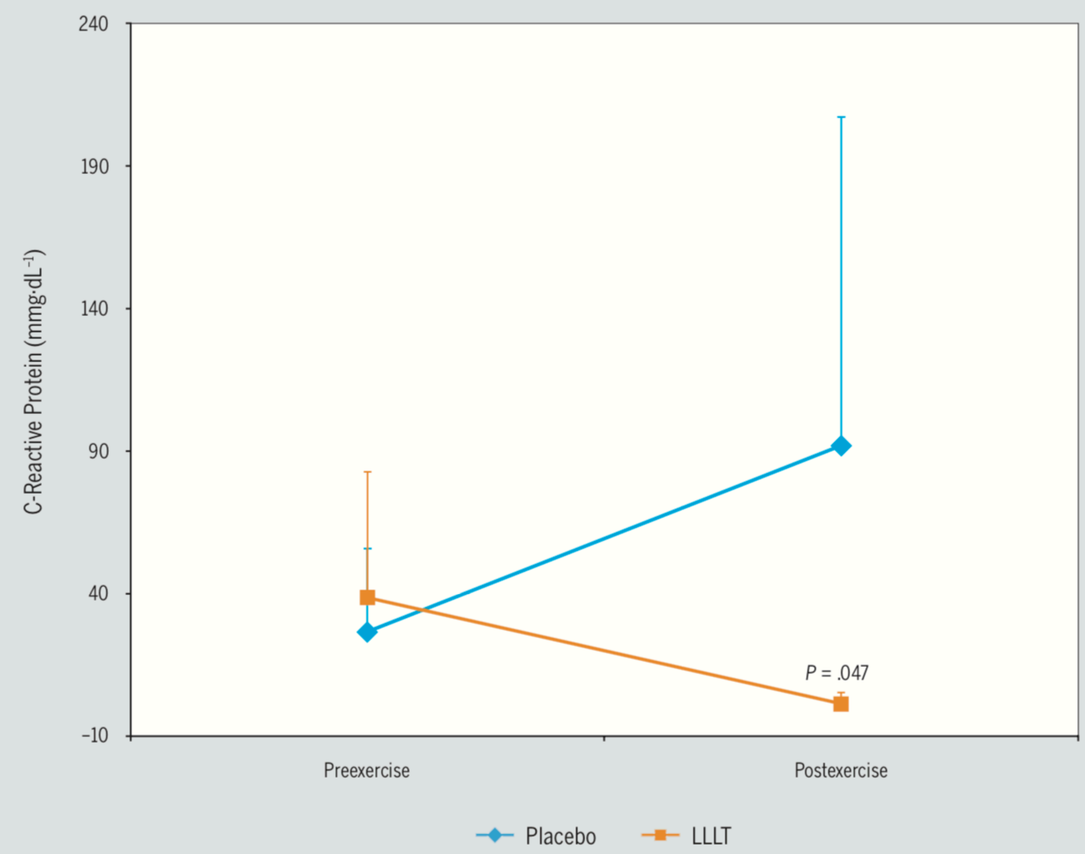

FIGURE 8. C-reactive protein levels prior to treatment with LLLT or placebo and after exercises to fatigue. A significant difference between groups (P = .047) was found postexercise. Error bars indicate standard deviations.

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Photomedicine and Laser Surgery
Volume 28, Number 5, 2010

Pp. 653–658
DOI: 10.1089/pho.2009.2688

Effect of Light-Emitting Diodes Therapy (LEDT) on Knee Extensor Muscle Fatigue

Bruno Manfredini Baroni, B.Sc.,[1] Ernesto Cesar Pinto Leal Junior, Ph.D.,[2] Jeam Marcel Geremia, B.Sc.,[1] Fernando Diefenthaeler, Ph.D.,[3] and Marco Aurélio Vaz, Ph.D.[1]

Objective: The purpose of this study was to evaluate the effects of light-emitting diodes therapy (LEDT) on quadriceps muscle fatigue by using torque values from the isokinetic dynamometer as an outcome measure. ***Background Data:*** Light therapy is considered an innovative way to prevent muscle fatigue. Although positive results have been obtained in animal models and in clinical experiments, no results are available on the effects of this therapeutic modality on human performance studies with isokinetic dynamometry. ***Materials and Methods:*** Seventeen healthy and physically active male volunteers were included in a crossover randomized double-blinded placebo-controlled trial. They performed two sessions of an isokinetic fatigue test (30 maximal concentric knee flexion–extension contractions; range of motion, 90 degrees; angular velocity, 180 degrees per second) after LEDT or placebo treatment. Maximal knee extensor muscle isokinetic voluntary contractions were performed before (PRE-MVC) and after (POST-MVC) the fatigue test. LEDT treatment was performed with a multidiode cluster probe (34 red diodes of 660 nm, 10 mW; 35 infrared diodes of 850 nm, 30 mW) at three points of the quadriceps muscle, with a total irradiating dose of 125.1 J. ***Results:*** No differences were observed in the PRE-MVC between LEDT (284.81 ± 4.52 Nm) and placebo (282.65 ± 52.64 Nm) treatments. However, for the POST-MVC, higher torques ($p = 0.034$) were observed for LEDT (237.68 ± 48.82 Nm) compared with placebo (225.68 ± 44.14 Nm) treatment. ***Conclusion:*** LEDT treatment produced a smaller maximal isometric torque decrease after high-intensity concentric isokinetic exercise, which is consistent with an increase in performance.

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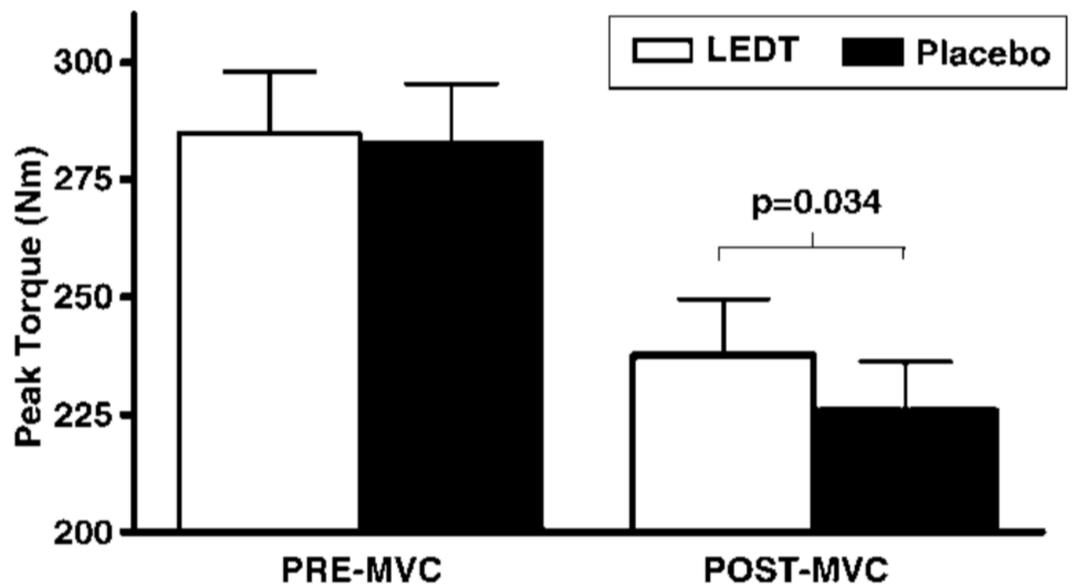

FIG. 3. PRE-MVC and POST-MVC knee-extensor maximal isometric torques for LEDT and placebo treatments (mean ± SEM). The bracket indicates differences in POST-MVC between LEDT and placebo (p value above the bracket).

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Lasers Med Sci
DOI 10.1007/s10103-013-1486-z

ORIGINAL ARTICLE

Light-emitting diode phototherapy improves muscle recovery after a damaging exercise

Lucio Santos Borges · Mikhail Santos Cerqueira · José Alberto dos Santos Rocha · Luis Augusto Lupato Conrado · Marco Machado · Rafael Pereira · Osmar Pinto Neto

Abstract The goal of the present study was to determine the effect of light-emitting diode phototherapy (LEDT) at 630 nm on muscle recovery after a damaging eccentric exercise bout. Seventeen healthy young male volunteers, without previous experience with eccentric exercise, were included in a randomized double-blinded placebo-controlled trial. They were divided into a LEDT ($n=8$) and a PLACEBO group ($n=9$). To induce muscle damage, subjects performed 30 eccentric contractions with a load of 100 % of maximal voluntary isometric contraction strength of the elbow flexors of the non-dominant arm. LEDT group subjects received biceps brachii phototherapy (λ 630 nm; total energy density, 20.4 J/cm2) immediately after the exercise bout. The LEDT in the placebo group was aimed at the muscle, but it remained turned off. Isometric muscle strength, muscle soreness, and elbow range of motion (ROM) were measured before and at 24, 48, 72, and 96 h the after eccentric exercise bout and compared between groups. Our results showed that the muscle soreness, muscle strength loss, and ROM impairments were significantly reduced up to 96 h after a damaging eccentric exercise bout for the LEDT group compared with the PLACEBO group. A single LEDT (630 nm) intervention immediately after a damaging eccentric exercise bout was effective in terms of attenuating the muscle soreness and muscle strength loss and ROM impairments.

Keywords Phototherapy · Exercise-induced muscle damage · Muscle strength · Delayed onset muscle soreness · Elbow flexors

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ORIGINAL ARTICLE

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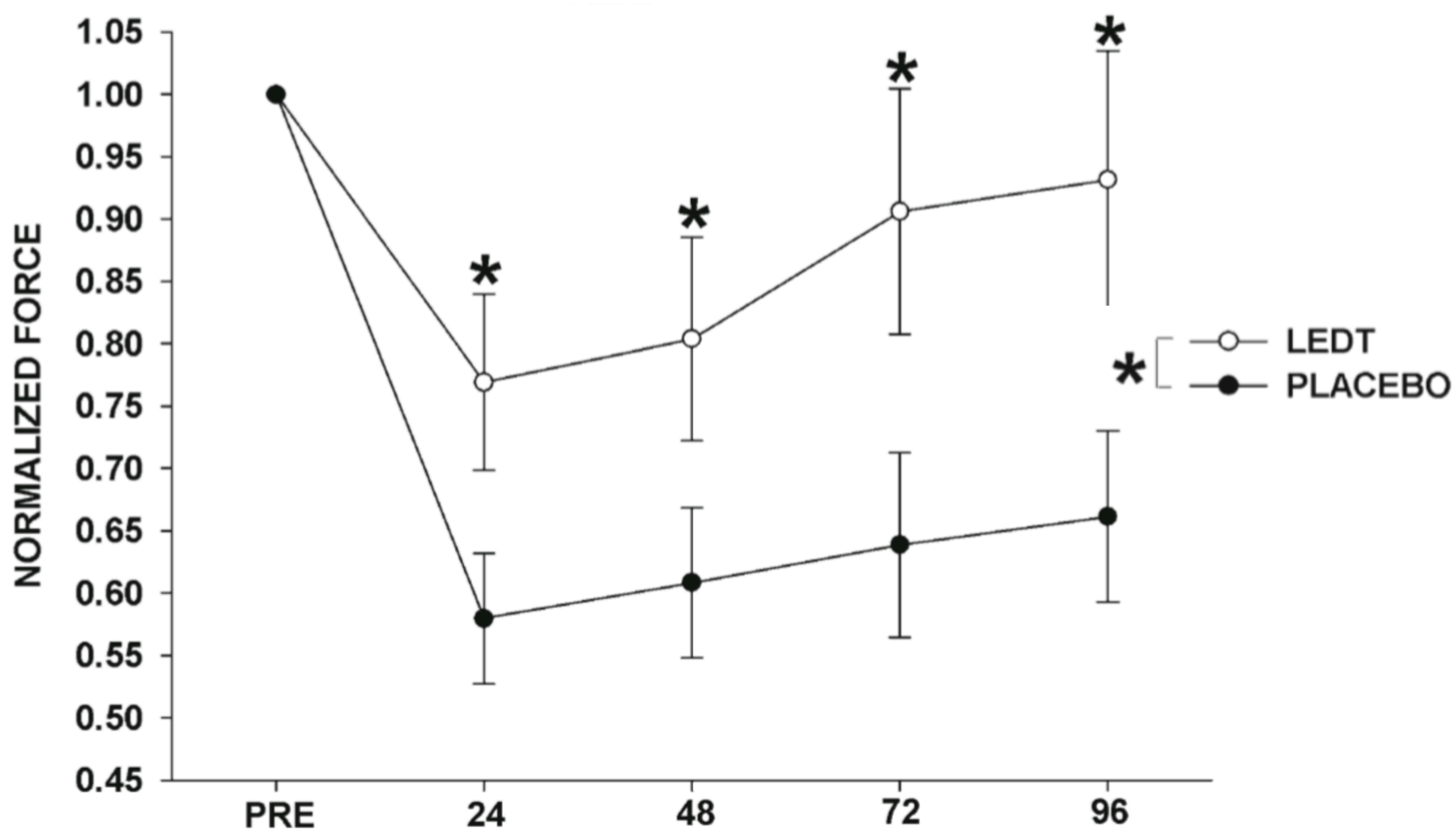

Fig. 1 Normalized force (mean ± SE) from LEDT and PLACEBO groups before (PRE), and 24, 48, 72, and 96 h after an eccentric exercise bout. (*) Significant difference between groups ($p<0.05$)

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