PBM Laser Therapy- Muscles, Sports Injuries

Photobiomodulation, Photomedicine, and Laser Surgery Volume XX, Number XX, 2020 ª Mary Ann Liebert, Inc. Pp. 1–8 DOI: 10.1089 / photob.2020.4820

Dose-response effects of photobiomodulation therapy on muscle performance and fatigue during a multi-stage knee extension exercise:
a randomized, crossed, double-blind placebo-controlled study

Mateus Rossato, PhD, 1,2 Rodolfo Andre 'Dellagrana, PhD, 1,3 Raphael Luiz Sakugawa, MS, 1
Bruno Manfredini Baroni, PhD, 4 and Fernando Diefenthaeler, PhD1

Summary
Objective: The aim of this study was to determine the best absorbed dose of photobiomodulation therapy (PBMT). who are able to improve muscle performance and reduce fatigue during multiple knee extension exercises.

The Methods: Eighteen physically active men participated in this study. Each participant performed an isokinetic exercise protocol (5 sets of 10 knee extension reps, maximum contractions at 60 $ s-1) in 6 sessions, 1 week apart. A control condition (no PBMT / placebo treatment) was used at the first and sixth sessions. Placebo or PBMT with 135, 270, or 540 J / quadriceps were randomly given from the second through the fifth session. Placebo / PBMT treatments were always carried out at two times: 6 hours before and immediately before the exercise.
The peak isometric and isokinetic concentric torques were assessed before and after the exercise protocol.

Results: The knee extension exercise performance (total work during exercise) was not influenced by PBMT (135, 270 and 540 J) compared to placebo treatment. However, all PBMT treatments (135, 270 and 540 J), 540 J) resulted in a smaller percentage decrease compared to placebo and control conditions for peak isometric torque (IPT), peak concentric torque (CPT) and concentric work (W). All PBMT doses resulted in potentially positive or likely positive effects on IPT, CPT, and W compared to placebo.

Conclusions: Our results show that PBMT with 135, 270 and 540 J at two points in time (6 h before and immediately before the exercise) was able to do the same overall work

---

Photomedicine and Laser Surgery Volume 32, Number 2, 2014 ª Mary Ann Liebert, Inc. Pages 106-112 DOI: 10.1089 / pho.2013.3617

Effects of low-level laser therapy (830 nm) before or after exercise on skeletal muscle fatigue and biochemical markers of recovery in humans: double-blind, placebo-controlled study

Filipe Abdalla dos Reis, PT, PhD, 1,2 Baldomero Antonio Kato da Silva, PT, PhD, 3 Erica Martinho Salvador Laraia, PT, MSc, 1 Rhaiza Marques de Melo, PT, 4 Patrı´cia'cia Henrique Silva, PT , 4 Ernesto Cesar Pinto Leal-Junior, PT, PhD, 5 and Paulo de Tarso Camillo de Carvalho, PT, PhD, 5 and Paulo de Tarso Camillo de Carvalho, PT, PhD5

short version

Objectives: The aim of this study was to investigate the effect of low-level laser therapy (LLLT) before and after exercise on the performance of the quadriceps muscle and to evaluate changes in serum lactate and creatine kinase (CK) levels .

The methods: The study was randomized, double-blind and placebo-controlled. The Patients: A sample of 27 healthy volunteers (male soccer players) was divided into three groups: placebo, laser before fatigue and laser after fatigue. The experiment was carried out in two sessions with an interval of 1 week. The subjects performed two stretching sessions, followed by a blood sample (measurement of lactate and CK) at the start of the study and after fatigue of the quadriceps by leg extension. The LLLT was performed with an infrared laser device (830 nm), 0.0028 cm2 beam area, six 60 mW diodes, an energy of 0.6 J per diode (total energy for each limb 25.2 J (50.4 J total), an energy density of 214.28 J / cm2, 21.42 W / cm2 power density, 70 sec. Applied to the quadriceps muscle per leg. We measured the time to fatigue and the number and maximum load (RM) of the repetitions tolerated. Number of repetitions and time to fatigue were primary results, secondary results were serum lactate levels (measured before and 5, 10 and 15 minutes after exercise) and CK levels (measured before and 5 minutes after exercise).

Results: The number of repetitions ($p = 0.8965$), RM ($p = 0.9915$) and the duration of fatigue ($p = 0.8424$) were similar in the groups. Laser treatment after fatigue reduced the serum lactate concentration compared to placebo treatment ($p <0.01$) and also within the group significantly over time (after 5 min vs. after 10 and 15 min, $p <0.05$ both). The CK level was lower in the laser group after fatigue ($p <0.01$).

Conclusions: Laser application either before or after fatigue reduced the levels of serum lactate and CK after fatigue. The results were more pronounced in the laser group after fatigue.

Photomedicine and Laser Surgery Volume 31, Number 10, 2013

Protective effect of laser phototherapy on acetylcholine receptors and creatine kinase activity in denervated muscles

Shimon Rochkind, MD, 1,2 and Asher Shainberg, PhD1

Objective: This study was designed to assess the condition of skeletal muscles after laser treatment during long-term denervation processes by examining changes in the activity level of acetylcholine receptors (AChR) and creatine kinase (CK) in denervated gastrocnemius muscle of the rat.

Background data: Progressive muscular atrophy is common in patients with severe peripheral nerve injury. Denervated muscles can be responsible for significant differences in the level of AChR and CK activity during the denervation period.

The Methods: The study was carried out on 96 rats: 48 that received laser treatment and 48 untreated controls. The gastrocnemius muscle was denerved by removing a 10 mm segment of the

sciatic nerve. The right gastrocnemius muscle was transcutaneously irradiated for 14 consecutive days (HeNe laser with continuous wave [CW], 632.8 nm, 35 mW, 30 min). Under general anesthesia, the rats were euthanized at seven times: day 7 (n = 10), day 14 (n = 10), day 21 (n = 10), day 30 (n = 5), day 60 (n = 4), Day 120 (n = 5) and day 210 (n = 4), each with and without laser treatment. The AChR was quantified with the 125I-a-bungarotoxin. The CK activity was measured using a specific spectrophotometric method.

Results: The laser treatment had a significant therapeutic effect on the denervated muscle during the first 21 days for the AChR and during the first 30 days for the CK activity.

Conclusion: In the early stages of muscular atrophy, laser phototherapy can preserve the denervated muscle by maintaining CK activity and the amount of AChR.

Photomedicine and Laser Surgery Volume 31, Number 10, 2013

Effect of low-level laser therapy (808 nm) on skeletal muscles after resistance training in rats

Tatiane Patrocinio, PhD, 1 Andre Cabral Sardim, 2 Livia Assis, PhD, 2 Kelly Rossetti Fernandes, MS, 2 Natalia Rodrigues, PhD, 1 and Ana Claudia Muniz Renno, PhD1

Objective: The aim of this study was to investigate the effects of an 808 nm laser applied following a resistance training protocol on biochemical markers and the morphology of skeletal muscles in rats.

Background data: Excessive physical activity leads to fatigue and decreased muscle strength, impaired motor control and muscle pain. Many biochemical and biophysical interventions have been studied in an attempt to speed up the recovery process from muscle fatigue. Among these, low level laser therapy (LLLT) has been shown to be effective in increasing skeletal muscle performance in in vivo studies and in clinical studies. However, little is known about the effects of LLLT on muscle performance after resistance training.

The methods: Thirty Wistar rats were randomly divided into three groups: control group (CG), trained group (TG) and trained and laser irradiated group (TGL).

The resistance training program was carried out three times a week for 5 weeks and consisted of a climbing exercise in which weights were attached to the tail of the animal. In addition, according to the exercise protocol, laser irradiation was carried out in the middle region of the tibialis anterior (TA) muscle of both legs.

Results: The analysis showed that the TGL had a significantly reduced resting lactate level and a reduced muscle glycogen depletion compared to the animals that were only trained and that the cross-sectional area of the TA muscle fibers was significantly increased compared to those in the other groups .

Conclusion: These results suggest that LLLT could be an effective therapeutic approach to increasing muscle performance during a resistance exercise protocol.

Effect of low-level laser therapy at 655 nm on exercise-induced skeletal muscle fatigue in humans

Ernesto Cesar Pinto Leal Junior, M.Sc., 1,2,3 Rodrigo Ã lvaro BrandÃ £ o Lopes-Martins, Ph.D., 4, Dalan, PT, 5 MaurÃcio Ferrari, PT, 5 Fernando Montanari Sbabo, PT , 5, Rafael Abeche Generosi, PE, 6 Bruno Manfredini Baroni, PT, 5, SÃ³crates Calvoso Penna, Ph.D., 4 Vegard V. Iversen, Ph.D., 8 and Jan Magnus Bjordal, Ph.D.3, 7th

Objective: To investigate whether the development of skeletal muscle fatigue during repeated voluntary biceps contractions could be mitigated by low-level laser therapy (LLLT).

Background data: Previous animal studies have shown that LLLT can reduce oxidative stress and delay the onset of skeletal muscle fatigue.

The Methods: Twelve male volleyball professional players were enrolled in a randomized, placebo-controlled, double-blind study with two sessions (on the 1st and 8th day) 1 week apart, with both groups doing as many voluntary biceps contractions as possible with a load of 75% of the maximum volunteer contractile force (MVC) performed. At the second session on day 8, the groups received either an LLLT (655 nm) of 5 J at an energy density of 500 J / cm2 administered at each of four points along the center of the biceps belly or a placebo LLLT the same way immediately before the practice session. The number of muscle contractions with 75% of the MVC was counted by a blinded observer and the lactate concentration in the blood was measured.

The results: Compared to the first session (on the first day), the mean number of repetitions in the active LLLT group increased significantly by 8.5 repetitions (1.9) during the second session (on the 8th day), while in in the placebo LLLT group the increase was only 2.7 repetitions (2.9) (p 0.0001). At the second session, blood lactate levels rose from a pre-exercise mean of 2.4 mmol / L (0.5 mmol / L) to 3.6 mmol / L (0.5 mmol / L) in the placebo group and up 3.8 mmol / L (0.4 mmol / L) in the active LLLT group after exercise, but this difference between groups was not statistically significant.

Conclusion: We conclude that LLLT appears to delay the onset of muscle fatigue and exhaustion by a local mechanism despite elevated blood lactate levels.

Photomedicine and Laser Surgery Volume 32, Number 12, 2014 ª Mary Ann Liebert, Inc. Pages 678-685 DOI: 10.1089 / pho.2014.3812

Use of Low-Level Laser Therapy **(808 nm) for**

Muscle Fatigue Resistance **: A Randomized Double-** Blind **Crossover Trial** Wouber He'rickson de Brito Vieira, PhD, 1 Raphael Machado Bezerra, 1 Renata Alencar Saldanha Queiroz, 1 He'rickson'cia Farias Braga Maciel, 1 Nivaldo Antonio Parizotto, PhD, 2,3 and Cleber Ferraresi, PhD2,3

Abstract
Objectives: The aim of this study was to investigate whether low-level laser (light) therapy (LLLT) over maximum repetitions (RM) with an isokinetic dynamometer could provide fatigue resistance and lower the electromyography fatigue index (EFI).

Background data: The LLLT has been used to increase muscle performance when used before or after intense exercise.

Materials and Methods: This study was a randomized, double-blind, crossover study with placebo. Seven young men (21-3 years old) who were clinically healthy were divided into two groups: active laser (LLLT) and placebo laser (placebo). Both groups were examined at the start of the study, in a training session and at the end of this study. At the beginning and at the end of the

study, the number of RM of squat extensions was measured with an isokinetic dynamometer at 60 degrees / sec. in conjunction with the EFI, recorded according to median frequency. The training sessions consisted of three sets of 20 RM squat extensions using an isokinetic dynamometer at 60 degrees / sec. plus LLLT (808 nm, 100 mW, 4 J) or placebo, that were applied to the muscles of the quadriceps femoris between sets and after the last series of this exercise. After 1 week (rinsing phase), all subjects were exchanged between the groups and then all assessments were repeated.

The results: The LLLT group increased the RM (52%; $p = 0.002$) with a small EFI for the vastus medialis ($p = 0.004$) and rectus femoris muscles ($p = 0.004$).

Conclusions: These results suggest increased muscle fatigue resistance when the LLLT is used during rest intervals and after the last series of vigorous exercises.
