Consideration for Injury Prevention and Pain Management using Wearable Pulsed Blue-Red Photobiomodulation

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Keywords: muscle fatigue, athletic injury, printed LEDs

Background

Youth, adolescent, and collegiate sports in the United States have led to 0.95 - 23.0 injuries per 1,000 athletic exposures [1, 2] and cost approximately $935 million per year. Muscle strains are one of the leading causes of sports-related injuries, with the majority of muscle strains occurring late in competition or practice.[2]

Methods

A series of studies were conducted to determine effectiveness of a novel flexible LED printed blue 450 nm and red 630 nm light patch on muscle fatigue in order to potentially limit sport-related injury and pain. First, we enrolled 34 strength trained individuals and determined their 1 repetition maximum (RM) for a controlled elbow flexion task using their non-dominate arm. After at least 4 days rest the participants completed a fatigue task using a weight of 50% of their 1 RM. During the fatigue task a marker was set to 90° of elbow flexion. The participant complete elbow flexion repetitions at 25 rep/min. The task was stopped when the participant was unable to move the weight back to the marker or they were in the wrong position at the metronome beat. After the fatigue task a 30-minute active red-blue or sham treatment, determined by random assignment, was applied. The active treatment had a peak irradiance of 9 mW/cm^2, 33% duty cycle, and fluence of 5.4 J/cm^2. After the treatment, participants repeated the fatigue protocol with the same working weight (50% of 1 RM). The number of repetitions were counted during the pre- and post-treatment fatigue tasks. Second, we enrolled 42 strength trained participants to determine the treatment application timing effects on an isometric fatigue task. Participants were randomly assigned to a 0 h pre-, 5 h pre-, 24 h pre-, or sham-treatment group. On the first visit, participants completed an extensive orientation of the Biodex isometric dynamometer procedures. On the second visit, the participants isometric maximum voluntary contraction (MVC) was determined. A 30-minute active or sham treatment was applied using the same treatment parameters as above. At their designated exercise time, participants isometrically contracted 50% of their MVC for 20 s repetitions and 2 seconds rest between reps. A guide line was provided for visual encouragement. The fatigue task was stopped once the participant's isometric force dropped below 45% of their MVC for ≥ 2 s. Immediately after the fatigue task participant's post-fatigue MVC was measured.

Results

First, 29.4% of active treatment participants improved the number of fatigue repetitions while no participants in the sham treatment improved during the post-treatment fatigue task ($P = 0.045$). Second, less isometric fatigue occurred during the 0 h (8.2±15.5%) and 5 h (8.9±11.8%) treatment groups over the 24 h (18.6±9.8%) and sham (-14.6±17.8%) groups.

Conclusions

The use of a blue 450 nm and red 630 nm flexible light patch applied with a hydrogel light guide over a muscle group can reduce muscle fatigue during intense exercises. This is of high importance to the current state of muscle injury and pain, where high rates of injuries occur when the muscle is in a fatigued state.

References

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Funding: Study funded through research agreement from Carewear Corp. and Texas State University.