



Effects of photobiomodulation on pain, lactate and muscle performance (ROM, torque, and EMG parameters) of paretic upper limb in patients with post-stroke spastic hemiparesis—a randomized controlled clinical trial

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Abstract

The objective of the study was to investigate the impact of photobiomodulation (PBM) on the paretic upper limb in post-stroke patients with spastic hemiparesis and to understand the potential of PBM as a long-term non-invasive therapy for reducing the side effects caused by spasticity in the hemiparetic upper limb after a stroke. This is a double-blind randomized clinical trial constituted of 27 participants, being Control group (CG = 12 healthy individuals) and PBM group (PBMG = 15 post-stroke individuals). In the CG, the baseline blood lactate (BL) was evaluated, followed by the evaluation of the IC torque of the biceps and triceps muscles, with the isokinetic dynamometer associated with surface electromyography (EMG) and, subsequently, a new measurement of BL. The PBMG received 10 sessions of treatment with PBM (780 nm, Power: 100 mV, Power Density: 3.18 W/cm², Energy: 4 J, Fluency: 127.4 J/cm², Time: 40 s per point and 1.280 s total, Spot: 0.0314 cm², 32 Points: 16 points (brachial biceps) and 16 points (brachial triceps) applied with contact at 90°, Total Energy: 64 J), which in the pre-treatment evaluation measured BL, the visual analogue scale (VAS) of pain; torque and EMG of the same muscles in the IC, subsequently, a new measurement of VAS and BL, and measurement of range of motion (ROM) during the reaching movement. At the conclusion of the ten sessions, all participants underwent a reassessment, wherein all tests originally administered during the initial evaluation were repeated. Subsequently, the data were analyzed using the Shapiro–Wilk normality test. For related data, the paired t-test was used for normal distributions and the Wilcoxon test for non-normal data. For unrelated data, the t test was used for normal distributions and the Mann–Whitney test for non-normal data. Muscle torque was higher for the CG, with a significant difference (CGxPBMG = $p < 0.0001$). There was no significant difference between the EMG values of the CG in relation to the Pre-PBM phase and with the Post-PBM phase of the PBMG ($p > 0.05$). On the other hand, there was a 38% reduction in pain reported by hemiparetic patients ($p = 0.0127$) and a decrease in BL in the PBMG. Post-PBM ROM increased by 46.1% in the elbow extension of the paretic limb. In conclusion, Photobiomodulation (PBM) demonstrated significant improvements in muscle performance, reducing fatigue and pain levels, and enhancing range of motion in post-stroke patients with spastic hemiparesis. These findings support the potential integration of PBM into rehabilitation protocols, but further research and clinical trials are needed to validate and expand upon these promising outcomes.

Keywords Stroke · Photobiomodulation · Spastic muscle · Fatigue · Isokinetic dynamometer · Surface electromyography

Introduction

Spasticity is defined as a disorder of the upper motoneuron of the corticospinal tract, caused by a neuronal hyperexcitability associated with impairment of the descending

inhibitory pathway, resulting in a marked response of muscle contraction with consequent hypertonia and hyperreflexia in the chronic phase after stroke [1]. It is characterized by increased resistance to passive-dependent muscle stretching and compromising the upper limbs more frequently than the lower limbs [2]. It affects the antigravity muscles, generating pathological sensorimotor patterns that lead to decreased

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