

Effects of photobiomodulation therapy on muscle function in individuals with multiple sclerosis

Background: In people with multiple sclerosis (pwMS), muscle fatigue and weakness are common issues that can interfere with daily activities. Photobiomodulation therapy (PBMT), comprising light in a 600-1100 nm bandwidth, is a low-level laser therapy thought to improve muscle performance in non-disease populations, in part, by improving mitochondrial function and thus, might be beneficial in pwMS. Given this potential, we aimed to investigate the effects of PBMT on muscle performance in pwMS, both in the short-term and over an extended period.

Methods: This study consisted of two parts with a randomized double-blind crossover design. In study I, muscle function was assessed in four sessions before and after PBMT in ambulatory pwMS (N = 17, F = 14) as follows: maximal voluntary contraction (MVC) and muscle fatigue of the right tibialis anterior (TA) muscle was compared at baseline and following a two-min submaximal fatiguing

contraction. Then, PBMT was administered to the belly of TA muscle at different doses of energy of an active device (40 J, 80 J, 120 J) or placebo. The muscle function assessment was then repeated.

Outcome variables: muscle force recovery (%), muscle fatigue (%). Statistical tests included McNemar's exact test, Wilcoxon signed-rank test, and the Friedman test. In study II, a subgroup from study I (N = 12, F = 11) received individualized doses (i.e., best dose-effect observed in study I) of active, or placebo PBMT, which was administered on the TA muscle for two weeks. Muscle function assessments were performed pre- and post-PBMT in four sessions similar to study I.

Outcome variables: Baseline strength (N), endurance time (s), and muscle fatigue (%). The Wilcoxon signed-rank test was used for statistical analysis. Values are reported as mean (SD).

Results: In study I, participants who received a high dose of PBMT showed significant improvement in force recovery (101.89 % (13.55 %)) compared to the placebo group (96.3 % (18.48 %); $p = 0.03$). Muscle fatigue did not significantly improve with either active PBMT or placebo. In study II, active PBMT resulted in a significant improvement in muscle strength compared to both the baseline (pre-PBMT = 162.70 N (37.52 N); post-PBMT = 185.56 N (33.95 N); $p = 0.01$) and

the placebo group (active PBMT: mean-change = 22.87 N (23.67 N); placebo: mean-change = -4.12 N (31.95 N); $p = 0.02$). Endurance time and muscle fatigue did not show significant improvement with either active PBMT or placebo.

Conclusion: Our findings suggest that an individualized dose of PBMT might improve muscle performance, including force recovery and strength in individuals with mild-moderate MS. Therefore, PBMT might be a novel therapeutic modality, either as a standalone treatment or in combination with other interventions, to improve muscle performance in pwMS.

Keywords: Endurance; Low-level laser therapy; Multiple sclerosis; Muscle fatigue; Strength.