Neuromuscular Electrical Stimulation Effects on Skeletal Muscle Fatigue in Older Adults

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ABSTRACT

Neuromuscular electrical stimulation (NMES) is often used as a rehabilitative modality and evidence has suggested that high frequencies of NMES may elicit increases in muscle strength. However, little is known regarding the effects of a high-frequency NMES intervention on voluntary skeletal muscle fatigue. **PURPOSE**: The aim of this study was to determine the effect of a 4-week high-frequency NMES intervention on voluntary muscular fatigue and changes in neuromuscular activation patterns of the quadriceps during voluntary fatiguing muscle contractions in older adults. **METHODS**: Seventeen healthy, older adults (68.8 ± 1.8 years old) participated in the study (NMES: n = 12; SHAM: n = 5). Each participant was seated on an isokinetic dynamometer, and a 40-min NMES treatment was applied to the quadriceps muscles of each leg 3x/week for 4 weeks with the stimulation frequency set at 60 Hz. Stimulation intensity was set to achieve 15% of knee extension maximal voluntary contraction (MVC). Those in the SHAM group underwent the same treatment procedures but did not receive the NMES treatment. All subjects performed maximal voluntary contractions (MVC) and an intermittent knee extension isometric submaximal voluntary fatigue task at 50% MVC until the fatigue criteria were met for pre-post testing. Surface electromyography (sEMG) of the vastus lateralis (VL) and vastus medialis (VM) muscles were recorded during the fatigue task to examine changes in muscle activation. EMG data were quantified for root mean square (RMS) EMG and reported as a percent rate of change over the duration of the fatigue task and median frequency (MF) is reported as the average MF during the fatigue task. Repeated measures ANOVAs were used to determine differences pre-post NMES for muscular endurance time, MVC and EMG measures. Statistical significance was set at $p < 0.05$. **RESULTS**: MVC increased pre-post NMES in the NMES group (117.1 ± 8.7 Nm vs 127.6 ± 11.1 Nm, $p = 0.049$; pre- and post-training, respectively) with no change in SHAM ($p = 0.96$). Muscular endurance time did not change pre-post NMES (NMES: 159.3 ± 20.1s vs 141.9 ± 21.2s, $p = 0.29$; SHAM: 242.2 ± 43.3s vs 202.9 ± 23.3s, $p = 0.13$; pre- and post-training, respectively). RMS EMG rate of change did not change following NMES treatment (NMES: VL: 16.6 ± 3.6% vs 18.8 ± 10.4%, $p = 0.84$; VM: 11.4 ± 2.1% vs 19.6 ± 5.5%, $p = 0.15$; SHAM: VL: 7.8 ± 1.6% vs 7.1 ± 3.0%, $p = 0.81$; VM: 7.1 ± 3.3% vs 5.9 ± 2.2%, $p = 0.55$; pre- and post-training, respectively). Also, there was no difference in MF EMG with NMES training (NMES: VL: 77.6 ± 4.1 Hz vs 74.9 ± 3.6 Hz, $p = 0.13$; VM: 72.5 ± 2.4 Hz vs 72.6 ± 2.2 Hz, $p = 0.97$; SHAM: VL: 79.3 ± 3.4 Hz vs 80.2 ± 4.9 Hz, $p = 0.85$; VM: 76.9 ± 3.7 Hz vs 83.9 ± 5.1 Hz, $p = 0.12$; pre- and post-training, respectively). **CONCLUSION**: Treatment with high-frequency NMES did not improve muscle endurance or related EMG parameters. It is possible that NMES induced adaptations may be frequency-specific and that high-frequency NMES may not be efficacious when the goal is to improve skeletal muscle endurance.