

Improved Glucose Tolerance and Glucose Utilization with Neuromuscular Electrical Stimulation

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ABSTRACT

Sedentariness and increased body fat are the leading risk factors for developing insulin resistance, obesity, and type 2 diabetes. We have shown that muscle contraction induced by electrical pulse stimulation increase GLUT4 content in an *in vitro* primary cell culture model. Neuromuscular electrical stimulation (NMES) is a novel alternative strategy to induce muscle contraction in humans. Although widely used in rehabilitation settings to prevent muscle atrophy, effectiveness of NMES-induced muscle contractions in improving metabolic health is not clear. **PURPOSE:** To investigate the effects of four weeks of NMES on glucose tolerance, substrate utilization, and muscle mass in a sedentary overweight/obese population. **METHODS:** Sedentary overweight/obese participants were randomized into either a control (n=5; age: 42.2 ± 5.0 years; BMI= 32.8 ± 1.5 kg/m²) or NMES (n=5; age: 30.3 ± 4.5 years; BMI= 32.7 ± 2.3 kg/m²) group. All participants received bilateral quadriceps stimulation (12 sessions; 30 minutes/session; 3 times/week) either using low intensity sensory level (control) or at high intensity neuromuscular level (NMES) for four weeks (50Hz; 300µs pulse width). Insulin sensitivity was assessed by three-hour oral glucose tolerance test (OGTT), substrate utilization was assessed by measuring blood lactate (acute effects) and indirect calorimetry (respiratory quotient, RQ) and body composition was measured by dual X-ray absorptiometry. **RESULTS:** Control and NMES groups had comparable fasting blood glucose (Control 110.2 ± 21.1; NMES 96 ± 3.9 mg/dL; p=0.53), glucose tolerance (Control 430.73 ± 20.23; NMES 455.55 ± 26.07; AU; p=0.49), substrate utilization measured by RQ (Control 0.78 ± 0.02; NMES 0.78 ± 0.02; p=0.99), and muscle mass (Control 48.6 ± 5.5; NMES 47.3 ± 4.3; kg; p=0.86) at baseline. Four weeks of NMES resulted in a significant improvement in blood glucose measured after 2 hours of glucose drink consumption during OGTT (150.90 ± 7.59 to 138.20 ± 7.61 mg/dL, p=0.03) whereas no change was observed in control group (151.75 ± 6.14 to 173.20 ± 34.17 mg/dL, p=0.12). Insulin sensitivity measured by glucose area under the curve (AUC), trended to improve with NMES (455.55 ± 26.07 to 415.36 ± 25.89 AU; p=0.07), whereas no change was observed in control (430.73 ± 20.23 to 494.68 ± 77.21 AU; p=0.32). Lactate accumulation (AUC) assessed during 30 min of NMES was significantly greater compared to that of control group (Control 0.87 ± 0.07; NMES 1.22 ± 0.14 AU; p<0.04). **CONCLUSION:** NMES is a novel and effective strategy to improve glucose utilization and insulin sensitivity in an at-risk overweight/obese sedentary population in the absence of substrate utilization and muscle mass improvement.

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