Improved Glucose Tolerance and Glucose Utilization with Neuromuscular Electrical Stimulation

MICHAEL J. SANCHEZ, MICHELLE J. GALVAN, DANTE NACIM, and SUDIP BAJPEYI

MiNER Laboratory; Kinesiology; University of Texas at El Paso; El Paso; TX.

Category: Masters

Advisor / Mentor: Bajpeyi, Sudip (sbajpeyi@utep.edu)

Abstract

Sedentariness and increased body fat are leading risk factors for developing insulin resistance, obesity, and type 2 diabetes. We have shown that muscle contraction induced by electrical pulse stimulation increases 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; 300 µs 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 137.20 ± 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.

This project was funded by the Student Research Development Award by Texas chapter of American College of Sports Medicine.