

QUADRICEPS FEMORIS MUSCLE FORCE PRODUCTION USING A PORTABLE NEUROMUSCULAR ELECTRICAL STIMULATION DEVICE

Khuzeykin I*, Coppinger S**, Varnell M***, Silva KJ***, Gallo JA***
North Reading High School*, Lahey Hospital**, Salem State University***

Introduction

Previous literature indicates that neuromuscular electrical stimulation (NMES) devices, capable of producing quadriceps femoris force $\geq 50\%$ of maximal volitional isometric contraction (MVIC), play an important adjunctive role in optimizing quadriceps strength during rehabilitation. The current evidence supporting force generating capabilities of portable battery-powered NMES devices has been inconsistent. A secondary goal of the study was to compare maximum torque production versus MVIC differences between males and females.

Purpose

The purpose of this study was to test the force generating capacity of a portable battery-powered NMES device and determine if the device would be effective in enhancing quadriceps strength during rehabilitation.



Figure 1. InTENSity Select Combo II NMES Device.



Figure 2. Example of a participant set-up for a NMES trial using a handle held manual muscle testing dynamometer secured with a seatbelt strap.

Methods

Setting:

Athletic Training Research Laboratory

Participants:

Twenty-four healthy subjects (13 female, 11 male), 24.5 \pm 4.78 years old

Design:

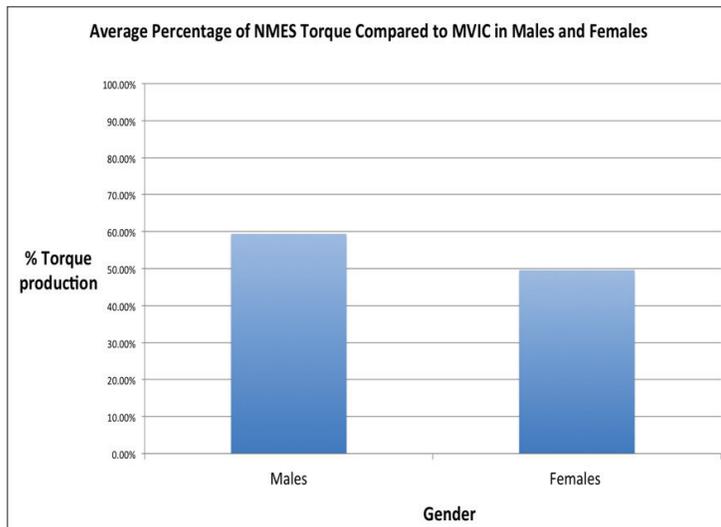
Experimental laboratory study using repeated measures

Measures:

An InTENSity Select Combo II Model DI2195 (Compass Health, Middleburg Heights, OH) (Figure 1) was used to deliver NMES to the quadriceps femoris at maximum tolerable intensity. The device was set to a symmetrical biphasic waveform with a phase duration = 200 μ sec, frequency = 50 pps, ramp = 2 sec, on-time = 10 sec, and off-time = 60 sec. A 2.75 x 5.0 inch Dura-Stick Plus self-adhesive electrode (DJO, Vista, CA) was placed over the vastus lateralis and vastus medialis oblique. A handheld manual muscle testing dynamometer (Lafayette Instrument, Lafayette, IN) was used to measure peak isometric force (kg) and average isometric force (kg) (Figure 2). The peak isometric force (kg) produced over three trials was used to calculate % MVIC.

Results

The InTENSity Select Combo II produced an average peak isometric force of 54.1% +/- 19.5% of the MVIC in 24 subjects. This was higher than the peak isometric force of 50% MVIC that was found to be effective in previous studies.



Discussion

Based on the findings of this study, the InTENSity Select Combo II has the capacity to produce the necessary level of force to effectively deliver high intensity NMES to the quadriceps femoris. When comparing NMES torque production, both males and females were able to effectively produce the predicted 50% of MVIC. Some factors that could have resulted in a varying torque production among the participants were unfamiliarity, discomfort, caffeine intake prior to testing, large amounts of adipose, subjects voluntarily contracting during NMES, and general body composition. Future studies should pay close attention to these factors. Further investigation is needed to determine the effectiveness of using the InTENSity Select Combo II in subjects with impaired quadriceps femoris strength.

References

1. Lyons CL, Robb JB, Irrgang JJ, Fitzgerald GK. Difference in quadriceps femoris muscle torque when using a clinical electrical stimulator versus a portable electrical stimulator. *Phys Ther.* 2005; 85:44-51
2. Maffiuletti NA, Herrero AJ, Jubeau M, Impellizzeri FM, Bizzini M. Assessment of comfort during NMES-induced quadriceps contractions at two knee joint angles: Differences in electrical stimulation thresholds between men and women. *Annals of Neurology.* 2008; 63(4):507-512
3. Selkowitz DM. Improvement in isometric strength of the quadriceps femoris muscle after training with electrical stimulation. *Phys Ther.* 1985;65:186-196
4. Snyder-Mackler L, Garrett M, Roberts M. A comparison of torque generating capabilities of three different electrical stimulating currents. *Journal of Orthopaedic & Sports Physical Therapy.* 1989;10(8):297-301

Presented January 6th, 2018 at The Eastern Athletic Trainers' Association 70th Conference, Boston, MA