Electromyographic Biofeedback Immediately Increases Quadriceps Corticospinal Excitability

David Florea MS, ATC,† Michelle McLeod MA, ATC,‡ Phillip Gribble PhD, ATC, FNATA,† Michael Tevald, PhD, PT,‡ Brian Pietrosimone, PhD, ATC‡

*United States Naval Academy, Annapolis, MD, †The University of Toledo, Toledo, OH, ‡University of North Carolina at Chapel Hill, Chapel Hill, NC

Introduction

• Quadriceps corticospinal excitability (CSE) pathways are altered following knee injury.1

• Altered CSE may contribute to chronic neuromuscular dysfunction, such as quadriceps weakness and decreased voluntary activation which may lead to disability2 or the development of osteoarthritis.3

• Previous reviews4 have identified modalities that influence spinal reflexive pathways; however, there is no accepted modality that specifically targets impaired CSE.

• Electromyographic biofeedback (EMG-BF) is theorized to enhance the quality of muscle contraction by incorporating externally focused visual and/or auditory feedback to improve motor unit recruitment or optimizing motor unit firing rates.4,5

• The ability of EMG-BF to alter CSE remains unknown.

Purpose

• Determine the immediate effects of EMG-BF during a maximal voluntary isometric contraction (MVIC) on vastus lateralis (VL) CSE and peak torque, compared to a MVIC without EMG-BF (control) in healthy individuals.

Methods-Participants

All volunteers reviewed and signed an informed consent form and were screened for inclusion/exclusion criteria prior to participation. (Table 1)

| Table 1. Means ± SD for Participant Demographics (n=15) |
|-----------------|----------------|----------------|
| Sex             | Age  (yrs)     | Height (cm)    | Mass (kg)     |
| Males = 6       | 21.47 ± 3.78   | 171.45 ± 10.55 | 70.80 ± 14.77 |
| Females = 9     |                |                |               |

Methods-Study Design

Order of testing session was randomly allocated

Methods-Intervention

• Practice trials were performed to obtain maximal right mean square EMG.

• A visual target line was set on the EMG-BF unit 5% above peak EMG.

• Participants were encouraged to exceed the target line during each MVIC.

Methods-Outcome Measures

• Five peak-to-peak motor evoked potentials (MEP) at baseline, collected at 100% AMT during contractions at 5% of MVIC at the beginning of each session.7 (Figure 4) Five peak-to-peak MEPs collected at 100% AMT during MVICs prior to TMS during the control or EMG-BF conditions. Peak torque was recorded during each MVIC at 150 ms prior to TMS during the control or EMG-BF conditions.

• Percent change scores [(post-pre)/pre]*100] were calculated for changes in peak-to-peak MEP amplitudes, that occurred during EMG-BF and control MVICs compared to baseline. Dependent t-tests were utilized to determine differences in MEP change scores and peak torque between conditions. Alpha level was set a priori at P ≤ 0.05.

Results

EMG-BF produced statistically significant increases (*) in MEP change scores (t_14=2.926, Figure 5a) and increased torque (t_14=2.186, Figure 5b) compared to the control condition.

Discussion

• Increases in VL MEP amplitude during an MVIC when using EMG-BF indicates a gross overall increase CSE.

• External focus of attention, such as that provided by EMG-BF, has been found to produce greater improvements in acquisition and retention of motor skills.6

• Increased CSE may be the mechanism responsible for improved strength found following EMG-BF in the past.7

• CLINICAL IMPACT: EMG-BF used in conjunction with therapeutic exercise may improve outcomes related to muscle strengthening for patients with impaired CSE.

Conclusion

There was increased VL CSE and knee extension torque during MVICs performed with EMG-BF compared to knee extension MVICs performed without EMG-BF in healthy individuals.

References