Electromyographic Biofeedback Immediately Increases Quadriceps Corticospinal Excitability

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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 disability[2] or the development of osteoarthritis.[3]
- Previous reviews[4] 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 real-time feedback to improve motor unit recruitment or optimizing motor unit firing rates.[5,6]
- The ability of EMG-BF to alter CSE remains unknown. Identifying modalities to enhance excitability is important to optimize rehabilitative efforts to decrease disability and preserve long-term joint health.

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 Females = 9	21.47 ± 3.78	171.45 ± 10.55	70.80 ± 14.77

Methods-Study Design

Order of testing session was randomly allocated

Control Session | **Sessions Separated by 1 Week** | EMG-BF Session

Positioned on Dynamometer and Performed Practice MVICs	**Step 1**	Positioned on Dynamometer and Performed Practice MVICs
Located TMS "Hot Spot" and collected AMT at 5% of MVIC	**Step 2**	Located TMS "Hot Spot" and collected AMT at 5% of MVIC
Baseline Corticospinal Excitability Collected 5 MEPs at 5%MVIC	**Step 3**	**Baseline Corticospinal Excitability** Collected 5 MEPs at 5%MVIC
Dummy MVIC Performed an MVIC with encouragement from investigator	**Step 4**	**Setting Threshold on EMG-BF Unit** Performed an MVIC with encouragement from investigator while becoming familiar with the EMG-BF unit
Corticospinal Excitability Assessed During MVIC (Collection of MEPs and Torque) TMS applied at 100% AMT intensity without any feedback	**Step 5**	**Corticospinal Excitability Assessed During MVIC (Collection of MEPs and Torque)** TMS applied at 100% AMT intensity with EMG-BF

Methods-Set Up

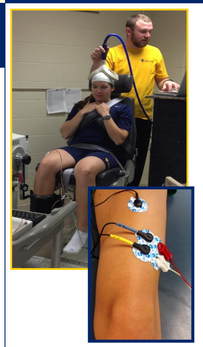


Figure 2. Participant set-up for MVIC and AMT/MEP assessments.

- Participants were seated in an isokinetic dynamometer with hips and knees flexed to 90 degrees.
- Ag/Ag-Cl EMG electrodes were affixed over the VL, 10-cm superior to the superior lateral border of the patella.
- A double-coned coil was placed on the scalp over the area corresponding with the motor cortex.

Methods-Intervention

Figure 3. MVIC with EMG-Biofeedback

MyoTrac Infiniti (Thought Technology, Ltd., Montreal, QC, Canada)

- Practice trials were performed to obtain maximal root 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 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.

Figure 4. Peak-to-Peak Motor Evoked Potential

- 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 $P \leq 0.05$.

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.

Figure 5a. Differences in MEP Amplitude Change Scores Between Conditions

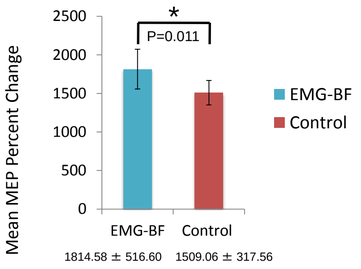
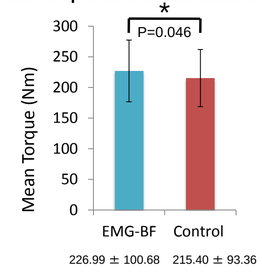


Figure 5b. Differences in Mean Peak Torque Between Conditions



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.[8]
- Increased CSE may be the mechanism responsible for improved strength found following EMG-BF in the past.[9]
- **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

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