Examination and Quantification of Motor Evoked Potentials in a Non-Target Resting Leg

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Background

Transcranial Magnetic Stimulation (TMS) is a noninvasive neurostimulation technique used in both clinical and research settings. TMS of the lower limbs is challenging due to the motor cortex representation residing deep within the interhemispheric fissure, necessitating performance of TMS during active contractions. Concerningly, this may not be feasible for individuals with compromised limbs due to injury. However, there is a significant gap in understanding how off-target responses present in the resting non-target leg. Differences in quantifying motor evoked potentials (MEPs) further exacerbate this issue.

Purpose

This study examined MEPs in off target, resting lower limb muscles during TMS of the dominant rectus femoris (RF). Secondarily, we aimed to provide methodological insight on how to quantify MEPs in the resting leg.

Methods

Participants:

Twenty-seven healthy adults participated (13 males: mean ± SD age=23±4 years; height=179.2±8.8cm; mass=80.0±9.0kg; 14 females: age=23±2 years; height=166.2±6.2cm; mass=64.8±15.4 kg).

Protocol:

Single-pulse TMS was performed to the vertex of the scalp while participants performed submaximal isometric contractions at 10% peak torque with the dominant leg. Active motor threshold (AMT) was determined as the lowest stimulator output that elicited an MEP from the active RF with a peak-to-peak amplitude of ≥double baseline surface electromyography (EMG) for 5 of 10 pulses. Following AMT determination, 20 pulses were delivered at both 120% and 130% AMT while participants maintained submaximal contractions with the dominant leg. The nondominant leg remained at rest. MEP peak-to-peak amplitude from the RF, vastus lateralis (VL), biceps femoris (BF), medial gastrocnemius (MG), and tibialis anterior (TA) of the resting leg was measured. MEPs were quantified as having reached a threshold of ≥ 50μV, ≥ double baseline EMG, and ≥ triple baseline EMG. For each muscle, the mean ± SD percentage of MEPs breaking the target threshold was calculated.

Methods

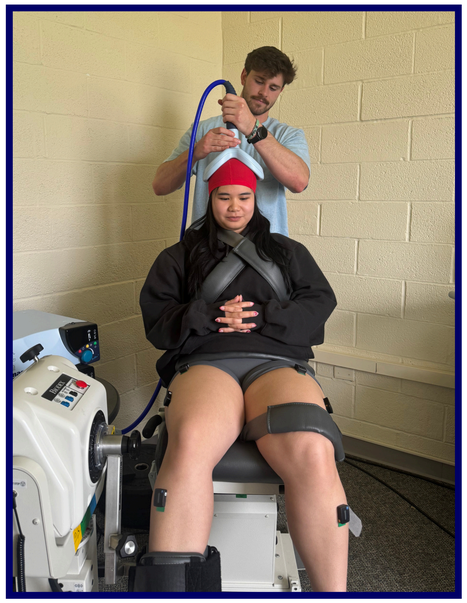

Figure 1: Demonstration of TMS, EMG and Biodex set up.

Results

MEPs were present in all off-target muscles at both stimulation intensities and all quantification criteria, but standard deviations were large. In general, 130% AMT resulted in a higher percentage of quantifiable MEPs. Table 1 lists the mean ± SD percent of MEPs breaking each specific threshold.

		RF	VL	BF	TA	MG
120% AMT	≥ 50μV	62 ± 40%	49 ± 43%	30 ± 38%	87 ± 27%	65 ± 39%
	≥ 2x EMG	83 ± 33%	56 ± 44%	61 ± 40%	84 ± 29%	70 ± 41%
	≥ 3x EMG	60 ± 40%	50 ± 43%	48 ± 44%	82 ± 34%	60 ± 41%
130% AMT	≥ 50μV	77 ± 35%	63 ± 40%	35 ± 41%	96 ± 13%	76 ± 32%
	≥ 2x EMG	90 ± 28%	69 ± 39%	77 ± 33%	93 ± 21%	78 ± 33%
	≥ 3x EMG	82 ± 31%	63 ± 42%	57 ± 42%	91 ± 23%	67 ± 40%

Table 1: Percent (mean ± SD) of MEPs with peak-to-peak amplitudes of ≥50μV, ≥ twice the baseline EMG, ≥three times the baseline EMG at both 120% and 130% AMT.

Conclusions

The study revealed two important findings. First, when the vertex is stimulated, MEPs are evident in the resting leg, regardless of the MEP quantification approach. Second, while MEPs are apparent at multiple stimulation intensities and thresholds, both should be considered when determining how to approach MEP identification

Practical Applications

Patients whose dominant leg may be inaccessible due to stroke, amputation, or immobilization can still utilize TMS as MEPs are apparent in the resting leg. Investigators should carefully consider their methodological approach and selection criteria for MEP identification based on their target population.

References

Barker, A. T., Jalinous, R., & Freeston, I. L. (1985). Non-invasive magnetic stimulation of human motor cortex. Lancet (London, England), 1(8437), 1106–1107. https://doi.org/10.1016/S0140-6736(85)92413-4

Kesar, T. M., Stinear, J. W., & Wolf, S. L. (2018). The use of transcranial magnetic stimulation to evaluate cortical excitability of lower limb musculature: Challenges and opportunities. Restorative neurology and neuroscience, 36(3), 333–348. https://doi.org/10.3233/RNN-170801

Pagan, J. I., Harmon, K. K., Girts, R. M., MacLennan, R. J., Beausejour, J. P., Hernandez-Sarabia, J. A., Coker, N. A., Carr, J. C., Ye, X., DeFreitas, J. M., & Stock, M. S. (2023). Sex-Specific Reliability of Lower-Limb Corticospinal Excitability and Silent Periods. Journal of strength and conditioning research, 37(9), 1882–1887. https://doi.org/10.1519/JSC.0000000000004525

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