Infographic

A practical guide to the evaluation of the functional integrity of the corticospinal tract by transcranial magnetic stimulation in post-stroke patients

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ABSTRACT | INTRODUCTION: Transcranial magnetic stimulation (TMS) can be a particularly useful tool to assess the integrity of corticospinal tract (CST) in post-stroke patients, based on the motor evoked potential (MEP) of which we can determine the extent of brain damage and predict motor recovery after brain injuries. **OBJECTIVE:** To provide a practical guide to assess the functional integrity of the CST in the hand area of primary motor cortex (Hand-M1) using single-pulse TMS. **RESULTS:** A step by step procedure should be initiated with markings to find C3 or C4 from the 10-20 system, depending on which hemisphere is damaged, with the proper coil positioning at a 45° angle for we to properly find the MEP navigating from the original point. If no potentials are evoked at rest condition, MEP should be searched during a slight tonic contraction of the target muscle. If no voluntary movement can be produced in the affected muscles, facilitated MEPs should be searched with an isometric recruitment of the contralateral homologous target muscles. MEP will be considered absent if no visible muscle contraction is identified after the pulse. In addition, we can perform MEP search with electromyographic recordings for a peak-to-peak signal analysis. **CONCLUSION:** We can use this practical guide to assess the functional integrity of CST in Hand-M1 with single pulse TMS to consider a present or absent MEP and determine the extent of brain damage and predict a possible motor recovery after stroke.

KEYWORDS: Stroke. Stroke Rehabilitation. Corticospinal Tract. Transcranial Magnetic Stimulation. Single Pulse. Prognostic Factor.

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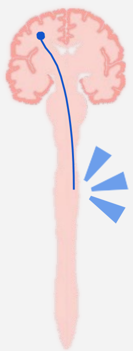
A practical guide to the evaluation of the functional integrity of the corticospinal tract by transcranial magnetic stimulation in post-stroke patients

Transcranial Magnetic stimulation (TMS) is a neurophysiological tool capable of assessing the functional integrity of corticomotor pathways in several diseases associated with motor dysfunction, such as stroke[1]. Here, we provide a practical guide to assess the functional integrity of the corticospinal tract (CST) in the hand area of primary motor cortex (Hand-M1) using single-pulse TMS.

C3 and C4 are the points equivalent to the HAND-M1, according to the international 10/20 system for electroencephalography[2].

Functional integrity of the corticospinal tract and MEP



Motor evoked potential (MEP) has been studied to determine the extent of brain damage and predict motor recovery after brain injuries[1], since the presence of MEP depends on the functional integrity of the corticospinal tract.

Therefore, TMS can be a particularly useful tool to assess the integrity of corticospinal pathways in post-stroke patients, based on MEP.

MEP can be observed on an electromyogram (EMG) of peripheral muscles (more precise method) or by a visual feedback of muscle contraction.

Ipsi- and contralateral voluntary muscle action changes the excitability of homotopic muscle representations increasing the MEP amplitude[4,5]. Furthermore, we can alternatively facilitate MEPs, e.g., through motor imagery of the target muscle[6] and other cognitive maneuvers[7].

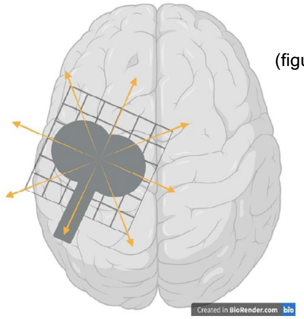
1. Marking C3 or C4

Mark the halfway point between inion and nasion site. Do the same with the midpoint between the bilateral tragus sites (preauricular). The vertex (CZ) is where both lines cross each other. Calculate 20% of the preauricular distance and then measure this distance from CZ laterally to the left (C3) or right (C4) side, depending on which hemisphere is damaged.

2. Coil positioning

MEP search is performed with the coil held tangentially to the scalp with the handle pointing backward and laterally 45º away from the mid-sagittal line over C3 or C4 (figure 1).

The orientation at 45º posterior and lateral is due to the current direction, which, with a figure-of-8 coil is posteroanterior and orthogonal to the central sulcus[3].



(figure 1)

3. MEP search

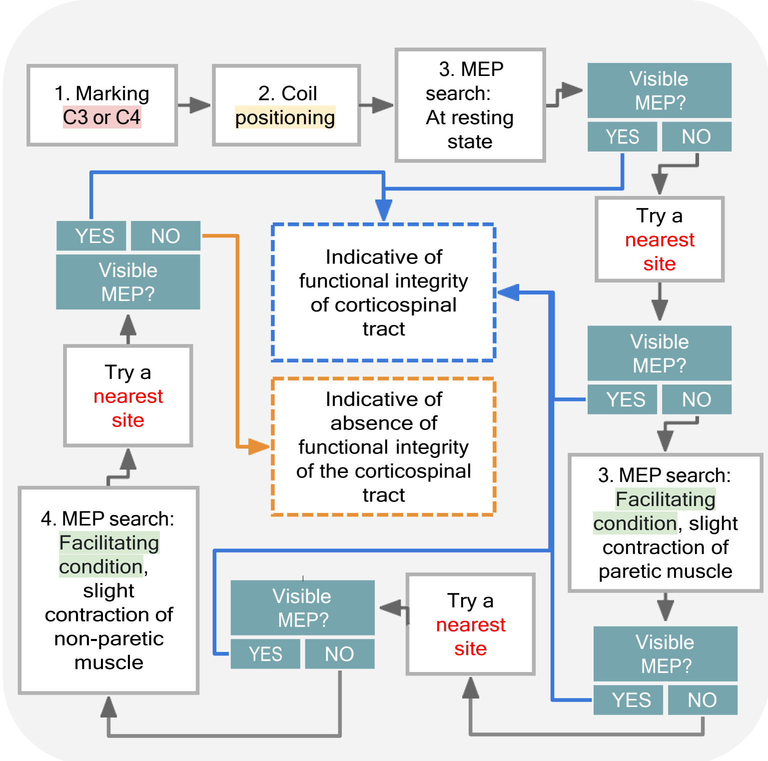
With the coil properly positioned, the MEP search begins with a single-pulse TMS at the machine maximal output stimulation (100%) at rest. After three consecutive pulses, if no MEP were found, try a nearest site (1-2 cm above, below, or laterally to the original point) (figure 1).

It is also possible to perform the MEP search at lower intensities (for example, starting with 140% of resting motor threshold intensity of the HAND-M1 of the non-lesioned hemisphere and increase 10% for each failed attempt, up to 100%). This way, the possible discomforts caused by the intensity of the stimulation are minimized.

If no potentials are evoked at rest condition, MEP should be searched during a slight tonic contraction of the target muscle. If no voluntary movement can be produced in the affected muscles, facilitated MEPs should be searched with an isometric recruitment of the contralateral homologous target muscles.

MEP will be considered absent if no visible muscle contraction is identified after the pulse. In addition, in case of EMG recordings, MEP will be considered absent if no peak-to-peak amplitude ≥50 µV in a relaxed target muscle or ≥ 200 µV in a contracted muscle was elicited when a TMS pulse is applied to [1].

Step by step



Authors' contributions

Brito RM, Barreto G, Monte-Silva KK, Lima BSN, Nascimento ACR, Lima FA, Melo DG, Araújo CS, Guerra SV and Albuquerque RM contributed to the conception of the work. Brito RM, Barreto G, Monte-Silva KK and Albuquerque RM contributed to the embasement. Barreto G, Lima BSN, Nascimento ACR, Lima FA, Melo DG, Araújo CS, Guerra SV and Albuquerque RM contributed to drafting and writing. Monte-Silva KK, Brito RM, Barreto G critically reviewed the work for important intellectual content. All authors contributed to the final approval of the version to be published and agreed to be accountable for all aspects of the work to ensure that the issues related to the coherence and integrity of any part of the work are investigated and resolved properly.

Conflicts of interest

No financial, legal or political conflicts involving third parties (government, companies and private foundations, etc.) were declared for any aspect of the submitted work (including, but not limited to grants and funding, participation in an advisory board, study design, preparation manuscript, statistical analysis, etc.).

References

1. Groppa S, Oliviero A, Eisen A, Quartarone A, Cohen LG, Mall V et al. A practical guide to diagnostic transcranial magnetic stimulation: report of an IFCN committee. Clin Neurophysiol. 2012;123(5):858-82. https://doi.org/10.1016/j.clinph.2012.01.010.

2. Acharya JN, Acharya VJ. Overview of EEG Montages and Principles of Localization. J Clin Neurophysiol. 2019;36(5):325-329. https://doi.org/10.1097/WNP.0000000000000538.

3. Di Lazzaro V, Ziemann U, Lemon RN. State of the art: Physiology of transcranial motor cortex stimulation. Brain Stimul. 2008;1(4):345-62. https://doi.org/10.1016/j.brs.2008.07.004.

4. Di Lazzaro V, Restuccia D, Oliviero A, Profice P, Ferrara L, Insola A et al. Effects of voluntary contraction on descending volleys evoked by transcranial stimulation in conscious humans. J Physiol. 1998;508(2):625-33. https://doi.org/10.1111/j.1469-7793.1998.625bq.x.

5. Muellbacher W, Facchini S, Boroojerdi B, Hallett M. Changes in motor cortex excitability during ipsilateral hand muscle activation in humans. Clin Neurophysiol. 2000;111(2):344-9. https://doi.org/10.1016/s1388-2457(99)00243-6.

6. Kiers L, Fernando B, Tomkins D. Facilitatory effect of thinking about movement on magnetic motor-evoked potentials. Electroencephalogr Clin Neurophysiol. 1997;105(4):262-8. https://doi.org/10.1016/s0921-884x(97)00027-1.

7. Pascual-Leone A, Brasil-Neto JP, Valls-Solé J, Cohen LG, Hallett M. Simple reaction time to focal transcranial magnetic stimulation. Comparison with reaction time to acoustic, visual and somatosensory stimuli. Brain. 1992;115(1):109-22. https://doi.org/10.1093/brain/115.1.109.