

A study on the influence of contraction intensity on the H-reflex of a hand muscle.

Maria Fernanda C. Correia*, Carina M. Germer, Luciana S. Moreira, Leonardo A. Elias.

Abstract

The H (Hoffman) reflex is a noninvasive technique used to evaluate the synaptic organization of the spinal cord, as well as the excitability of the reflex arc. In this procedure, percutaneous electrical stimuli are applied to the peripheral nerve to evoke reflex responses that can be measured by the electromyogram of the target muscle. Different factors can modulate the H-reflex amplitude. Nonetheless, few studies have investigated how contraction intensity influence the excitability of spinal cord circuits controlling upper limb muscle. Therefore, the present project is aimed at investigating the effect of contraction intensity on the excitability of spinal cord circuits of a hand muscle.

Key words:

Force control; H reflex; Spinal cord neurophysiology

Introduction

The H reflex is a noninvasive technique used to evaluate the synaptic organization of the spinal cord, as well as the excitability of the reflex arc¹. Different factors can modulate the H-reflex amplitude (e.g., contraction intensity and the type of the motor task being performed). Additionally, disorders affecting the nervous system significantly alter the magnitude of the H reflex, thereby reinforcing the importance of the spinal cord circuits for movement control in both normal and pathological conditions². Studies previously reported in the literature have focused on experiments in lower limb muscles due to the reduced experimental complexity³. Therefore, new experiments are needed to investigate the reflex excitability of upper limb muscles. Specifically, little is known about the influence of contraction intensity⁴ on the reflex excitability of the first dorsal interosseous (FDI) muscle, which is an essential muscle for object manipulation. In the present study, the aim was to investigate the H reflex of the FDI muscle in healthy subjects during different contraction intensities.

Results and Discussion

Experiments were carried out in the right (dominant) hand of 9 healthy subjects (5 women; 27±5 yrs; 23,95±3,7 BMI). The experimental procedures were approved by the Ethics Committee of the University of Campinas (CAAE: 71197517.0.0000.5404). H reflexes of the FDI muscle were evoked by electrical stimuli (pulses with 1ms duration) applied to the median nerve (heteronymous reflex) at the wrist level. Surface EMG of the FDI was recorded using bipolar electrodes. Participants performed force-matching tasks at 5% and 10% of the maximum voluntary contractions (MVC) for 30s. Electrical pulses were delivered at low (0.2Hz) and high (4Hz) frequencies. Low-frequency stimulation was used to measure the maximum motor (M) wave, and the high-frequency stimulation was used to measure submaximal M waves and H reflexes in both contractions. Synchronous averaging (N=98) was performed to estimate peak-to-peak amplitudes of M waves and H reflexes.

The magnitude of the maximum M wave (M_{MAX}) did not significantly change with contraction intensity (6.11±2.06mV vs. 5.68±1.77mV; $p=0.28$). During submaximal stimulation, the M wave was maintained at a similar level between both contraction intensities

(12.90±3.46% M_{MAX} vs. 15.17±4.76% M_{MAX} ; $p=0.34$), so that the same afferent inflow was maintained in both conditions⁵. Figure 1 shows the individual and grouped data for the H-reflex amplitude. The peak-to-peak amplitude significantly increased ($p=0.0023$) when the contraction intensity increased (5%MVC to 10%MVC).

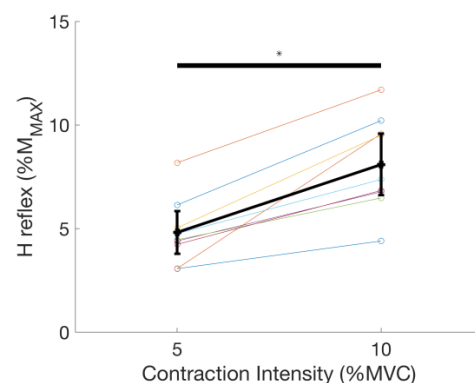


Figure 1. H-reflex amplitude for two contraction intensities.

Conclusions

The excitability of the reflex arc as measured by the H-reflex amplitude significantly increased when the contraction intensity of the FDI muscle increased. This would be explained by the increased excitability of the spinal motor neuron pool caused by cortical activation. These results are consistent with data from other limb muscles (e.g., tibialis anterior and abductor pollicis brevis) of healthy humans⁴.

Acknowledgments

MFCC is funded by a scientific initiation scholarship from FAPESP (#17/13064-8). LSM and CMG are funded by Ph.D. scholarships from CAPES. LAE was funded by FAEPEX (#1483/14) and is currently funded by CNPq (#312442/2017-3).

¹Pierrot-Deseilligny, E.; Burke, D. The circuitry of the human spinal cord: spinal and corticospinal mechanisms of movement. Cambridge U. Press, 2012.

²Nielsen, J.B. Human spinal motor control. Annual Review of Neuroscience. 39(1):81-101, 2016.

³Tucker, K.J.; Tuncer, M.; Türker, K.S. A review of the H-reflex and M-wave in the human triceps surae. Human Movement Science. 24(5-6):667-688, 2005.

⁴Burke, D.; Adams, R.W.; Skuse, N.F. The effects of voluntary contraction on the H reflex of human limb muscles. Brain. 112(2): 417-433, 1989.

⁵Knikou, M. The H-reflex as a probe: pathways and pitfalls. Journal of Neuroscience Methods. 171(1): 1-12, 2008.