Original Paper

DE GRUYTER OPEN

Biomedical Human Kinetics, 6, 142–145, 2014
DOI: 10.2478/bhk-2014-0023

The H-reflex modulation in lying and standing positions in young canoeists

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Summary

Study aim: to evaluate the differences in H-reflex parameters in lying and standing positions in canoeists.
Material and methods: twenty seven male canoeists (age 17.2 ± 1.6 year, body mass 73.7 ± 7.6 kg, height 180.9 ± 6.1 cm, training experience 6.5 ± 3.6 years) participated in the study. None of the subjects had any history of neuromuscular disorders. The soleus H-reflex was examined in each subject twice: in lying and standing position. H-reflex was elicited by one-millisecond electrical stimulation of a posterior tibial nerve in the popliteal fossa. A recruitment curve for each subject was obtained by gradually increasing the stimulus intensity.
Results: the results obtained in the present study showed statistically significant differences of the variables characterising effects of stimulations performed in lying and standing positions ($F_{4,23} = 8.063$; $p < 0.001$). H/M ratio was 0.50 ± 0.25 and 0.64 ± 0.27 for lying and standing positions, respectively. Our results support previous findings.
Conclusions: the lying position is recommended for measurements as more comfortable for subjects and providing a greater level of the elicited H-reflex.

Keywords: H-reflex – Posture – Soleus muscle

Introduction

The position of the subject is likely to affect the amplitude of the Hoffmann reflex. The angle in the hip joint, knee joint, ankle joint, head position, and sound and visual stimuli must be standardized during measurements of the Hoffmann reflex. Testing of the H-reflex is usually performed in sitting or lying positions [1, 5, 10], although some studies have tested subjects in standing position [6]. Kimura [7] reports that the position which helps maintain muscles relaxed is the lying position (0° flexion in the hip joint, 30° flexion in the knee joint, 30° in the plantar flexion). It was also demonstrated that plantar flexion of the ankle joint increases stimulation of the motor neuron pool for the soleus muscles, whereas dorsal flexion of this joint has an inhibitory effect on the motor neuron pool [3]. The amplitude of the H-reflex can also be affected by tonic neck reflex [4]. It is claimed that the sitting position is less comfortable than the lying position, especially for older people with respiratory problems, and allows for carrying out longer sessions of examinations with small discomfort perceived by both patients and examiners [1, 5]. On the other hand, the lying position allows for easier access to locations of stimulation in the popliteal fossa. Al-Jaweyed et al. [1], who compared the H-reflex amplitude in sitting and lying positions, did not find significant differences between the positions studied. Alrowayeh et al. [2] measured Hoffmann reflex amplitude in the soleus muscle at different angles of the knee joint (0°, 30°, 45°, 60°) and observed no significant differences in H-reflex amplitude and Hmax/Mmax ratio between standing and lying positions in all angular positions of the knee joint. As this study represents an introduction for further research, the authors attempted to verify which position is the most comfortable for both subjects and researchers. Regarding the above results, we decided to adopt two positions (standing and lying) in the study, with an angular position in the knee joint of 0°.

The purpose of this study was to evaluate the differences in H-reflex parameters in lying and standing positions in canoeists.

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Material and methods

Participants

Twenty five young male canoeists (age 17.3 ± 1.6 year, body mass 74.0 ± 7.8 kg, body height 181.0 ± 6.3 cm) served as subjects in the study. None of the participants had any history of neuromuscular disorders. The study was approved by the Ethics Committee at the Institute of Sport in Warsaw, Poland. All participants were informed about the study aim and methodology as well as about the possibility of immediate resignation at any time during the experiment. Subjects gave their written consent to the above conditions.

Methods

EMG data was continuously recorded from the right soleus muscle (DS7A, Digitimer Ltd., Hertfordshire, England) with bipolar surface electrodes (Blue Sensor N, Ambu, Ballerup, Denmark) that had an inter-electrode distance of 20 mm. To keep the inter-electrode impedance low (<5 kΩ), the skin area was dry shaved, abraded with scrub, and cleaned with alcohol. Hoffmann reflexes were evoked by stimulating the tibial nerve in the popliteal fossa. A small circular cathode (Unilect , Ag/AgCl, Unomedical Ltd., Redditch, England) with a pick-up area of 77 mm^2 was placed over the common tibial nerve on the popliteal fossa and a bigger self-adhesive anode (V-trodes, Mettler Electronics corp., Anaheim, USA) above the patella. Stimulation intensity increased stepwise until the H-reflex had disappeared and Mmax was reached. The electrical stimulus used for the H-reflex and M-wave recording was a rectangular and single mode signal with pulse duration of 1 ms. The recruitment curve was measured for each subject twice: in lying and standing position. For measurements in lying position, subjects were placed in a comfortable prone position on a couch with a facial opening to keep the head in a neutral midline position (knee angle 0°). At the second measurement, subjects were standing naturally on both feet symmetrically. In both cases the upper extremities were aligned symmetrically along the body.

MANOVA for repeated measures (Tukey post-hoc test) was used to compare mean values of the tested variables in both measurement positions. The p-values less than 0.05 were considered significant.

Results

Figures 1 and 2 present the recruitment curves of the H-reflex and M responses recorded for a representative subject in lying and standing positions, respectively.

Means and standard deviations of the maximum amplitude of H-reflex, M-wave (Hmax and Mmax, respectively), Hmax/Mmax, and the ratio of the amplitude of the H-reflex at 20% of maximal M-wave for both lying and standing positions are shown in Table 1.

The results obtained in the present study showed statistically significant differences of the variables characterising effects of stimulations performed in lying and standing position ($F_{4,23} = 8.063$; $p < 0.001$).

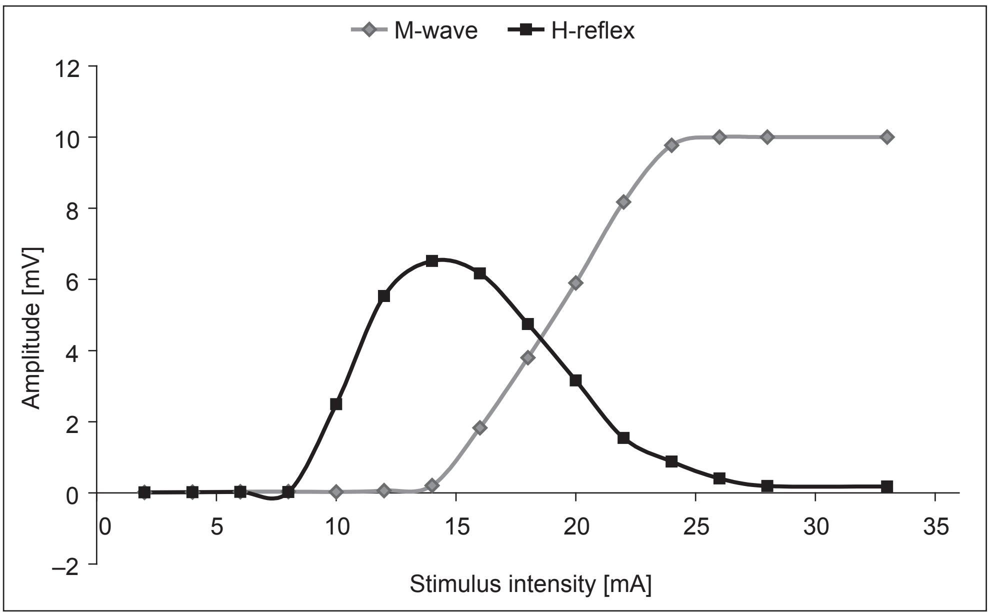

Fig 1. Recruitment curves of the H-reflex and M responses recorded for a representative subject in lying position

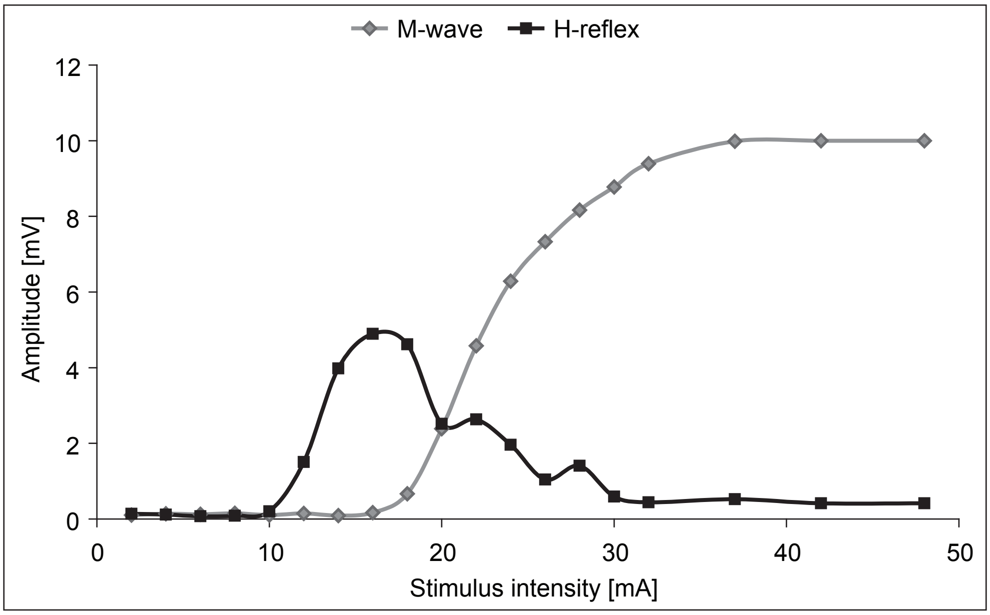

Fig 2. Recruitment curves of the H-reflex and M responses recorded for a representative subject in standing position

Table 1. Mean (±SD) of the maximum amplitude of H-reflex and M-wave, Hmax/Mmax ratio, and the ratio of H-reflex amplitude at 20% of maximum M wave.

	Lying (n = 27)	Standing (n = 27)
Hmax [mV]	5.10 ± 2.68	3.58 ± 2.27***
Mmax [mV]	7.98 ± 2.16	7.21 ± 2.23*
Hmax/Mmax ratio	0.64 ± 0.27	0.50 ± 0.25**
H/Mmax20%	3.16 ± 1.58	2.61 ± 1.46*

Significant differences, * – $p < 0.05$, ** – $p < 0.01$, *** – $p < 0.001$

Discussion

It has been documented that the soleus Hmax/Mmax ratio is significantly lower in standing than lying position [2, 8]. Kim et al. also [6] demonstrated that the Hmax/Mmax ratio for soleus muscle was (right leg) significantly higher in prone than standing (bipedal) position (0.53 ± 0.23 and 0.39 ± 0.14, respectively). The same results were observed in the present study. This difference is mainly caused by substantial depression of H-reflex in standing position. The position-dependent variability of M-wave has been reported as respectively small. It has been attributed to changes in the angle of the underlying muscle fibres [9]. Our results support previous findings. Changes in M-wave amplitude were also observed in the study, which was an unexpected effect. It is expected that the study was not carried out until reaching the maximum M-wave, which could be attributable to high current intensity in the last phase of examination, causing discomfort in the subjects. Despite this, the lying position is recommended for measurements as more comfortable for subjects and as providing greater level of the elicited H-reflex. The position of the 0° angle in the knee joint does not require the use of goniometers to adjust angles, which makes the test easier. In addition, access to the point of stimulation in the popliteal fossa is easier in the lying position. Further research will concern changes in the parameters of Hoffmann reflex (immediately post-exercise) for which time is critical. The need for adjustment of angles of the joints would unnecessarily elongate the measurement time.

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Received 24.10.2014
Accepted 04.12.2014

Acknowledgments

The study was supported by the Ministry of Science and Higher Education No. R RSA1 001051.