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Influence of visual feedback gain and contraction intensity on the discharge properties of motor units recruited in a force-matching task

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Abstract
Decomposition of intramuscular electromyogram (iEMG) into its constituent motor unit spike trains is a useful tool for understanding the neurophysiological control of muscle force. Some experimental results have shown that the performance in a force-matching motor task is influenced by the gain of the visual feedback provided to the subject. In this project, the purpose was to decompose iEMG signals from the Soleus muscle recorded in a force-matching task (plantarflexion contractions with different intensities). The motor unit spike trains were analyzed in six different conditions of visual feedback.

Key words:
Intramuscular electromyography, Motor units, Force control.

Introduction

Decomposition of intramuscular electromyogram (iEMG) is of paramount importance when one is interested in evaluating the neurophysiological mechanisms underlying force control[1]. Previous studies have shown that the gain of visual feedback influences force variability[2]. However, there is no information on whether visual feedback gain exerts any influence on the discharge properties of motor units (MUs) recruited in a force-matching motor task. In the present study, a semi-automated decomposition algorithm[3] was used to extract the spike trains of Soleus motor units recruited during plantarflexion contractions.

Results and Discussion

Five subjects (29.6±5yrs) participated of the experimental study[2]. Plantarflexion contractions were performed at 10% and 25% of the maximum voluntary contractions (MVCs). Analysis of interspike-interval (ISI) variability was performed for the motor unit spike trains recorded in six different conditions of visual feedback: high visual gain (HVG), medium visual gain (MVG), low visual gain (LVG), high initial gain (HIG), medium initial gain (MIG), and low initial gain (LIG). Different metrics were calculated from the MU spike trains: number of MUs (#MU), mean ISI (ISI_M), ISI standard deviation (ISI_{STD}), ISI coefficient of variation (ISI_{CV}), and mean firing rate (FR).

A total of 2,122 MUs were decomposed from iEMG signals in all visual feedback conditions. Tables 1 and 2 show the metrics (mean±standard deviation) obtained for the MUs recruited at 10%MVC and 25%MVC, respectively. From these results, visual feedback did not influence ISI variability and MU FR. The average number of MUs extracted in each condition increased when the contraction intensity increased from 10%MVC to 25%MVC. Also, the MU FR was slightly higher at 25%MVC, but contraction intensity did not influence ISI variability.

Conclusions

The visual feedback gain do not to influence the discharge properties of MUs recruited in a force-matching task. Force intensity only influenced the number of recruited MUs and the MU FR, which is expected from the recruitment and rate coding mechanisms of force control[4].

Table 1. Analysis of MU spike trains at 10%MVC.

	HVG	HIG	MVG	MIG	LVG	LIG
#MU	10.5 ±4.4	10.5 ±4.5	10.1 ±4.0	10.7 ±4.4	10.6 ±4.5	10.6 ±4.4
ISI_M [ms]	145.7 ±18.3	147.1 ±18.1	141.9 ±16.1	144.3 ±15.8	143.9 ±17.9	142.6 ±15.7
ISI_{STD} [ms]	15.9 ±9.1	16.3 ±8.0	14.3 ±7.3	14.1 ±7.1	15.3 ±9.3	14.2 ±6.7
ISI_{CV} [%]	10.4 ±4.0	10.7 ±3.7	9.7 ±3.3	9.5 ±3.5	10.2 ±4.3	9.7 ±3.2
FR [Hz]	7.1 ±1.4	7.1 ±1.4	7.3 ±1.4	7.1 ±1.3	7.2 ±1.3	7.2 ±1.3

Table 2. Analysis of MU spike trains at 25%MVC.

	HVG	HIG	MVG	MIG	LVG	LIG
#MU	14.0 ±6.6	12.9 ±5.8	14.3 ±5.6	13.3 ±5.2	13.1 ±5.4	14.3 ±4.6
ISI_M [ms]	132.5 ±16.9	129.5 ±15.5	130.3 ±16.8	129.0 ±18.3	128.5 ±16.4	127.3 ±16.3
ISI_{STD} [ms]	14.6 ±8.5	13.6 ±7.5	15.0 ±7.6	15.7 ±9.4	14.5 ±7.8	14.1 ±8.3
ISI_{CV} [%]	10.6 ±4.1	10.3 ±4.2	11.2 ±4.1	11.8 ±5.6	11.0 ±4.2	10.7 ±4.6
FR [Hz]	7.9 ±1.5	8.0 ±1.5	8.0 ±1.5	8.0 ±1.4	8.1 ±1.5	8.1 ±1.5

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