Szkoła Główna Gospodarstwa Wiejskiego
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Charakterystyka aktywności mioelektrycznej wybranych mięśni szkieletowych koni

Characteristics of myoelectric activity of selected equine skeletal muscles

Rozprawa doktorska

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1 Summary

Surface electromyography (sEMG) is a non–invasive technique that uses surface electrodes attached to the skin over selected muscles or muscle groups. The non–invasiveness and ease of measurement mean that sEMG can be used to monitor the daily work of horses, orthopedic diagnostics, kinesiology, rehabilitation, and training optimization. sEMG has also been used in neurological diagnostics, including differential diagnosis and monitoring of neurological diseases like shivers, stringalt, and equine grass sickness. In human medicine, cooperation between international research centers has allowed the development of reference guidelines for sEMG examination, including protocols describing the electrode placement method and recommendations for processing and analysis of the obtained signal. In veterinary medicine, such guidelines for electrode placement are lacking and guidelines for signal processing and analysis are under research, which makes it difficult to compare the obtained results.

The study aimed to demonstrate the variability of sEMG signal features dependent on the location of electrodes along the surface of the examined muscles, to determine the optimal location of surface electrodes for recording the sEMG signal of selected horse skeletal muscles, to determine the variability of sEMG signal features dependent on the horses' gait and characteristic for selected skeletal muscles. The study assumed the following research hypotheses: 1) the features of the sEMG signal of individual skeletal muscles of the horse differ depending on the location of surface electrodes along the course of the examined muscle; 2) the analysis of the features of the sEMG signal – representing the absolute value, purity and variability of the signal – and the structural features at the signal recording site – representing the thickness of the examined muscle and the signal conducting medium allows for determining the optimal location of surface electrodes for sEMG recording; 3) the features of the sEMG signal recorded in the optimal location differ depending on the horse's gait.

The study was conducted on 8 Konik Polski horses aged 6 to 12 years. Nineteen selected superficial muscles were examined: subclavius, supraspinatus, infraspinatus, deltoid, triceps brachii, biceps brachii, extensor carpi radialis, extensor digitorum communis, extensor digitorum lateralis, extensor carpi ulnaris, flexor carpi ulnaris, tibialis cranialis, extensor digitorum longus, biceps femoris, quadriceps femoris, tensor fascia latae, glutei muscles, semitendinosus, and semimembranosus. The study included ultrasound examinations of the muscle thickness (MT) and subcutaneous fat plus skin thickness (SF–Skin) at the electrode

location and recording the sEMG signal of selected muscles at the following gaits: walk, trot, and canter. The raw signal was filtered using 40–450 Hz bandpass filtering and ten activity bursts were annotated for each individual signal. From the filtered signal, the following features of the sEMG signal were extracted for each activity bursts: amplitude, root mean square (RMS), duration, integrated electromyography (iEMG), signal to noise ratio (SNR) and median frequency (MF). The obtained data were subjected to statistical analysis.

The sEMG signal recorded along the course of the examined muscles shows variability dependent on the location of the surface electrodes. Based on the analysis of amplitude, RMS and SNR as well as MT and SF–Skin, the optimal location of surface electrodes was determined in the following areas: at the proximal part of the muscle belly for the triceps brachii and biceps brachii, at the middle of the belly for the subclavius muscle, supraspinatus, infraspinatus, extensor carpi radialis, extensor digitorum communis, extensor digitorum lateralis, tibialis cranial, tensor fasciae latae, and semimembranosus, as well as at the proximal part of the muscle belly for the deltoid, extensor carpi ulnaris, flexor carpi ulnaris, extensor digitorum longus, biceps femoris, quadriceps femoris, glutei muscles, and semitendinosus.

Analysis of the amplitude, RMS, duration, iEMG, MF and SNR of the sEMG signal recorded at the optimal electrode location revealed the variability of the signal features associated with the change in the horse's gait. Within the studied muscles, the transition to a higher gait was associated with an increase in the amplitude and variability of the signal, an increase in iEMG and a decrease in the duration of a single burst. The signal of the infraspinatus, deltoid, triceps brachii, biceps brachii, extensor carpi radialis, extensor digitorum communis, extensor digitorum longus, quadriceps femoris, tensor fascia latae, glutei muscles, semitendinosus, and semimembranosus recorded at a walk was characterized by greater purity than the signal recorded at a trot and/or canter.

The presented dissertation is a continuation of the international work of other research teams conducted on the development of guidelines for sEMG examination in horses based on the guidelines compiled in the protocols applicable in human medicine.

Keywords: myoelectric activity, surface electromyography, sEMG, horse