VARIABILITY OF SUPERPOSITION OF ACTION POTENTIALS, THEORETICAL MODEL

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Elektromyogram (EMG) usually represents a complex electrical biosignal, the result of superposition of action potential trains recorded from muscle fibers. The assumption of linearity of this summation is crucial for an evaluation of intensity of muscle activation, for decomposition of multiunit EMG, for computer simulations and mathematical models. Linearity of values of rectified and integrated EMG signals with frequency of incidence of action potentials in muscle fiber and the effect of moving average window width on the range where the values of rectified signals fall was tested on theoretical model. The model consisted of five waveforms, four waveforms simulated single unit EMG signals and one waveform represented algebraic summation of these four single units. A three phase shapes of action potentials (single units) corresponded to the in vivo recordings and lasted 5 ms (the 1st and the 3rd waveform) and 7 ms (the 2nd and the 4th waveform). The frequency of their incidence was 5 - 75 Hz (the 1st and the 3rd one) and 9 - 135 Hz (the 2nd and the 4th one). Integrated waveform represented rectified (absolute values) and averaged signal using 3 windows widths - 1 s, 200 ms and 40 ms. Theoretical model was built and simulations were performed in PC environment MATLAB. Our simulations demonstrated that integrated EMG signals are approximately linearly proportional to the frequency of action potentials. The width of moving average window influences the range (dispersion) of integrated values. Approximately three fold higher variability was found with the moving average window of 40 ms compared to that with the 200 ms window. Quality of EMG recordings, the frequency of action potentials as well as the width of moving average window affect an accuracy of the determination of integrated EMG signal.