

Musculoskeletal Mechanisms of Stimulation

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III. RESULTS

A. Muscle Twitches Evoked by Electrical Stimulation

An increase in stimulation amplitude resulted in progressively strong finger twitches in response to activation of the motor point on the Flexor Digitorum Superficialis (FDS), associated with the middle finger. At minimum stimulation amplitude, finger movement was minimal, generating little to no force. As amplitude increased, both the magnitude of movement and force production increased accordingly, as illustrated in Fig. 1. Additionally, the subject reported that the twitches became increasingly forceful and violent with higher stimulation amplitudes.

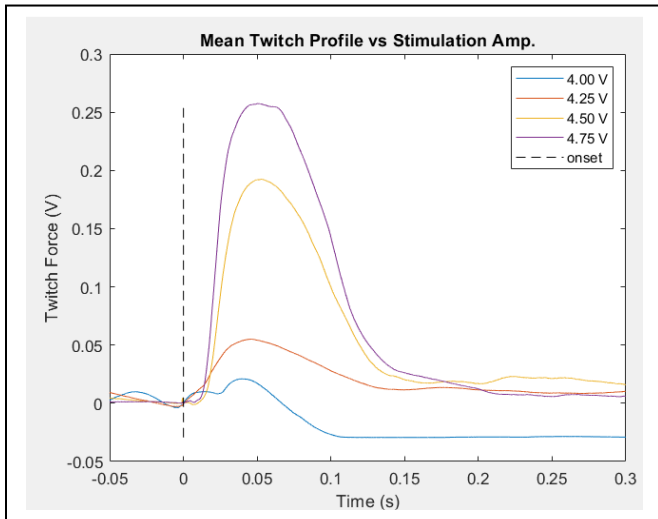


Figure 1. The mean twitch force generated over time, for four different stimulation amplitude profiles.

B. Quantifying the Effects of Stimulation Summation

An increase in stimulation frequency resulted in progressively faster finger twitches due to tendon activation. At minimum frequency, both twitch frequency and force generation were comparable to those observed at minimum stimulation amplitude. As illustrated in Fig. 2, as frequency increased, twitch amplitude fluctuated, with the second-lowest frequency producing the highest force output, while the second-highest frequency generated the lowest force. At maximum frequency, force output was comparable to that observed at minimum frequency.

Additionally, the rate of finger twitches increased with frequency. However, at the highest stimulation frequency, the finger no longer exhibited discrete twitches but instead entered a fused tetanus state, characterized by the observed sustained contraction without relaxation between twitches.

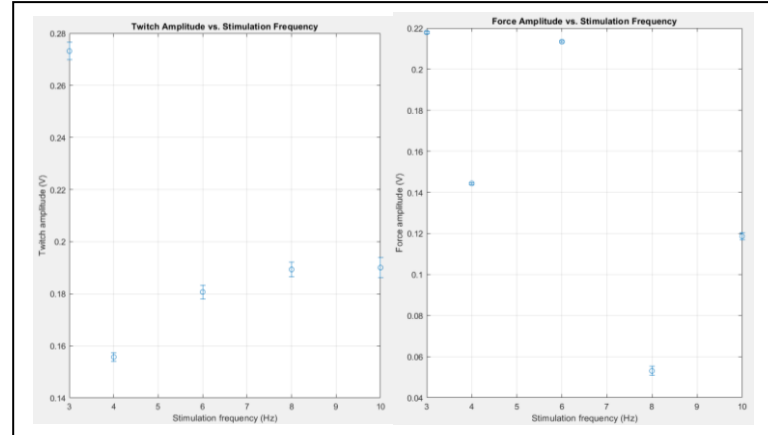


Figure 2. The twitch amplitude of the affected muscle as a function of stimulation frequency (left). The force amplitude generated by the finger twitch as a function of stimulation frequency (right).

C. EMG as a Measure of Muscle Force Generated

The EMG amplitude of the Flexor Carpi Ulnaris (FCU) tendon increased proportionally with grip force. At minimum grip force, EMG signals exhibited low amplitudes and short durations. As grip force increased, EMG amplitudes progressively increased and signal duration slightly extended. At maximum grip force, EMG amplitudes were significantly larger and lasted noticeably longer compared to the minimum force condition, as illustrated in Fig. 3 (left).

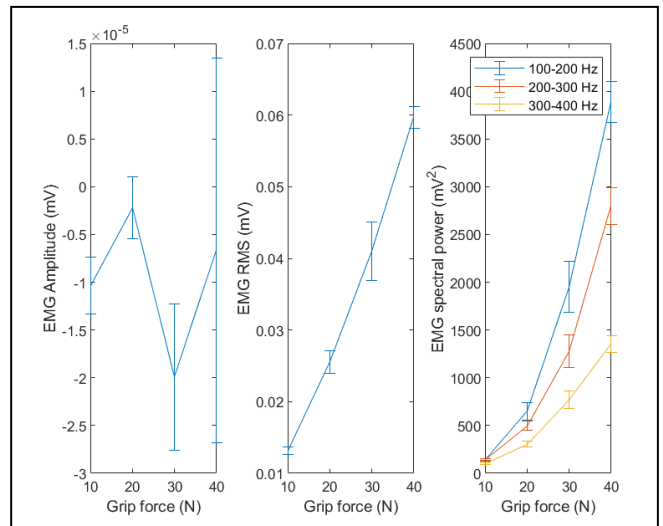


Figure 3. The mean EMG amplitude of the FCU (left), root-mean-squared EMG amplitude (middle), and different frequency bands of EMG spectral power (right) as a function of grip force.