

Alternating Muscle Activation Patterns Across the Deltoid Muscles During Sustained Fatiguing Contractions

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ABSTRACT

Alternating muscle activation (AMA) across synergists has been identified in lower-extremity muscles that may function to prolong force output during sustained contractions; however, this has not yet been identified in upper extremity muscles. AMA consists of two periods: co-activation (Co-A), in which a pair of synergists are simultaneously increasing or decreasing EMG amplitude, and trade-off (TO), in which the EMG amplitude of one muscle is increasing while the EMG amplitude of a synergist is decreasing. We hypothesized that TO duration would increase and Co-A duration would decrease during fatigue.

PURPOSE: To investigate AMA patterns during sustained submaximal isometric fatiguing scaption contractions in healthy adults. **METHODS:** Surface electromyographic (EMG) data was collected from 10 healthy individuals (5 males and 5 females, 21.5 ± 2.0 years) from the anterior deltoid (AD), middle deltoid (MD), and posterior deltoid (PD) during an isometric fatiguing contraction of 25% MVC in the scapular plane. Synergistic muscle pairs (AD-PD, AD-MD, PD-MD) were analyzed for Co-A duration (time difference between the zero-crossing points occurring at the onset and offset of a positive correlation phase), TO duration (time difference between the zero-crossing points occurring at the onset and offset of a negative correlation phase), and the frequency of AMA cycles (number of zero-crossing events/15s). We selected 15s from the beginning of the stable force level period as the pre-fatigue phase, and 15s at the end of the stable force level period as the fatigue phase. A two-way repeated measures ANOVA (factors: muscle pair and time) with Tukey's post-hoc analysis was used to compare Co-A duration, TO duration, and the frequency of AMA. **RESULTS:** There was a significant increase in TO duration (pre-fatigue: 3.2 ± 0.5 s; post-fatigue: 5.3 ± 0.6 s, $p=0.006$) and a decrease in Co-A duration (pre-fatigue: 11.8 ± 0.5 s, post-fatigue: 9.7 ± 0.6 s, $p=0.006$). The frequency of AMA cycles did not change over time (pre-fatigue: 4.7 ± 0.5 cycles/s, post-fatigue: 4.9 ± 0.6 cycles/s, $p=0.6$). There were no significant correlations between endurance time and the AMA patterns. **CONCLUSION:** This finding demonstrates that there is rotation of muscle activation levels across the deltoid muscles during sustained isometric fatiguing contractions.