BME 504/BKN 504: Neuromuscular Systems Fall 2011

EMG Lab

Timing of muscle activity

The lab will take place during class time in the Bice Center, CHP 159 at the USC Health Sciences Campus on Monday, Nov 7th 2011.

Goal: To determine whether and how muscle activity in three arm muscles changes with different tasks. You will write the report individually.

EMG recordings

We will record surface EMG from the biceps, triceps and medial deltoid muscles of a dominant arm. Raw EMG will be sampled in three channels at 1000 samples/s per channel, high-pass filtered at 10 Hz and stored to ASCII files. A hand-held switch will be pressed at the start of each cycle to mark the onset of the task. Each ASCII file will contain five columns: time, switch, biceps, triceps, and deltoid.

Experimental tasks

Subjects will use a 500 g weight to perform two tasks:
Task #1: Repeatedly lift the weight from being on a table to above your head and back, as will be demonstrated in the lab. The hand-held switch will be pressed at the start of each cycle.
Task #2: Repeatedly move the weight along a horizontal line at the level of the table. The hand-held switch will be pressed at the start of each cycle.

Each task will be performed for 10 complete cycles. The subject will undergo a short training session to practice the task. A volunteer will be selected from those wearing a comfortable t-shirt or tank top.

At the end of these 20 cycles the following reference data will be collected:
1) 10 seconds of baseline will be collected from all channels with all muscles relaxed.
2) Maximal contraction of biceps.
3) Maximal contraction of triceps.
4) Maximal contraction of medial deltoid.

EMG processing

Process the EMG data files as follows:
1) Full wave rectify all data files
2) Low pass filter of all data files. For example, you with a symmetrical moving average of width N=10.
3) Calculate the baseline mean and standard deviation of the filtered EMG for each muscle over the middle 3 seconds of the filtered baseline trial. Subtract the mean baseline plus 3 standard deviations from all maximal contraction and experimental trials for each muscle. (i.e., subtract biceps baseline plus 3 standard deviations from all filtered biceps data).
4) For each muscle, normalize all experimental trials obtained in step 3 by dividing by the peak filtered EMG level seen in the maximal contraction trials obtained in step 3 (e.g., normalize biceps data by dividing by the peak EMG activity seen in biceps during its maximal contraction).

EMG Analysis

1) In each of the 20 files for each muscle, find the time when the filtered and normalized EMG goes above or below 0.15 (i.e., 15% of maximal contraction value for each muscle). These are the on/off times for each muscle.

3) For each muscle, identify these on/off times as a percent of task cycle. The start of each trial is 0% of task cycle; the end is 100% of task cycle.

4) For each task and muscle, find the mean and standard deviation of these on/off times from the ten trials.

5) Represent the activity of each muscle for each task as bars on a horizontal scale.

6) Represent the EMG signals as vectors in 3D muscle activation space and trace the changes in magnitude and direction. Find the average changes in magnitude and direction and interpret them in light of the task.

Lab report (about 5 double spaced pages long)

Write the lab report in the form of a scientific report with the following sections:

Title
Abstract
Introduction
Methods
Results
Conclusions
References (if any)
Appendix – your code

All the above sections gravitate around the hypothesis of the study. Namely, whether or not the timing of these muscles changes across tasks. Chose one hypothesis (i.e., muscle timing should or should not change), explain your rationale for the hypothesis in the introduction, present your methods and results, and discuss why the muscle activities you see do or don't make anatomical and functional sense.