Evaluation of Upper Extremity EMG Signal Processing Methods in Individuals with Spinal Cord Injury

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Introduction

- Understanding the musculoskeletal system is important in biomechanics research [1]
- Electromyography (EMG) is a commonly used method to investigate muscle activity [2]
- Signal processing methods for maximum voluntary isometric contraction (MVIC) EMG data remain highly variable [3]
- A large component of MVIC EMG data processing is the root mean square (RMS) filter length

Objective: To investigate the most appropriate methods of signal processing and data analysis of MVIC EMG data in individuals with spinal cord injury (SCI)

Hypothesis: It is hypothesized that a moving window in the range of 15ms-100ms will be most appropriate for MVIC EMG data.

Methods

Data Collection

- One individual with SCI
- Wireless EMG (Delsys Inc., Natick, MA) was collected (1926 Hz)

Experimental Protocol

- Upper extremity manual muscle tests were performed on a multi-joint dynamometer (BTE Technologies, LLC, Hanover, MD)

Data Processing

- Custom MATLAB (The Mathworks, Inc., Natick, MA) code was used to determine 1) the peak MVIC EMG and 2) differences in peak MVIC EMG at different RMS lengths
  - Peak MVIC EMG was calculated using the average peak data for three manual muscle test trials for each muscle
  - RMS filter lengths of 1-1000 ms were evaluated

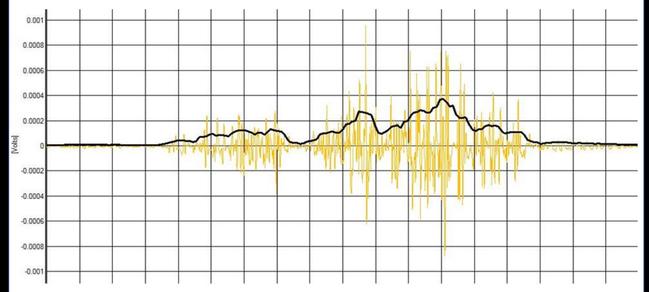

Figure 1. Raw EMG data (yellow) overlaid with data filtered with an RMS window length of 30 ms (black).

Results

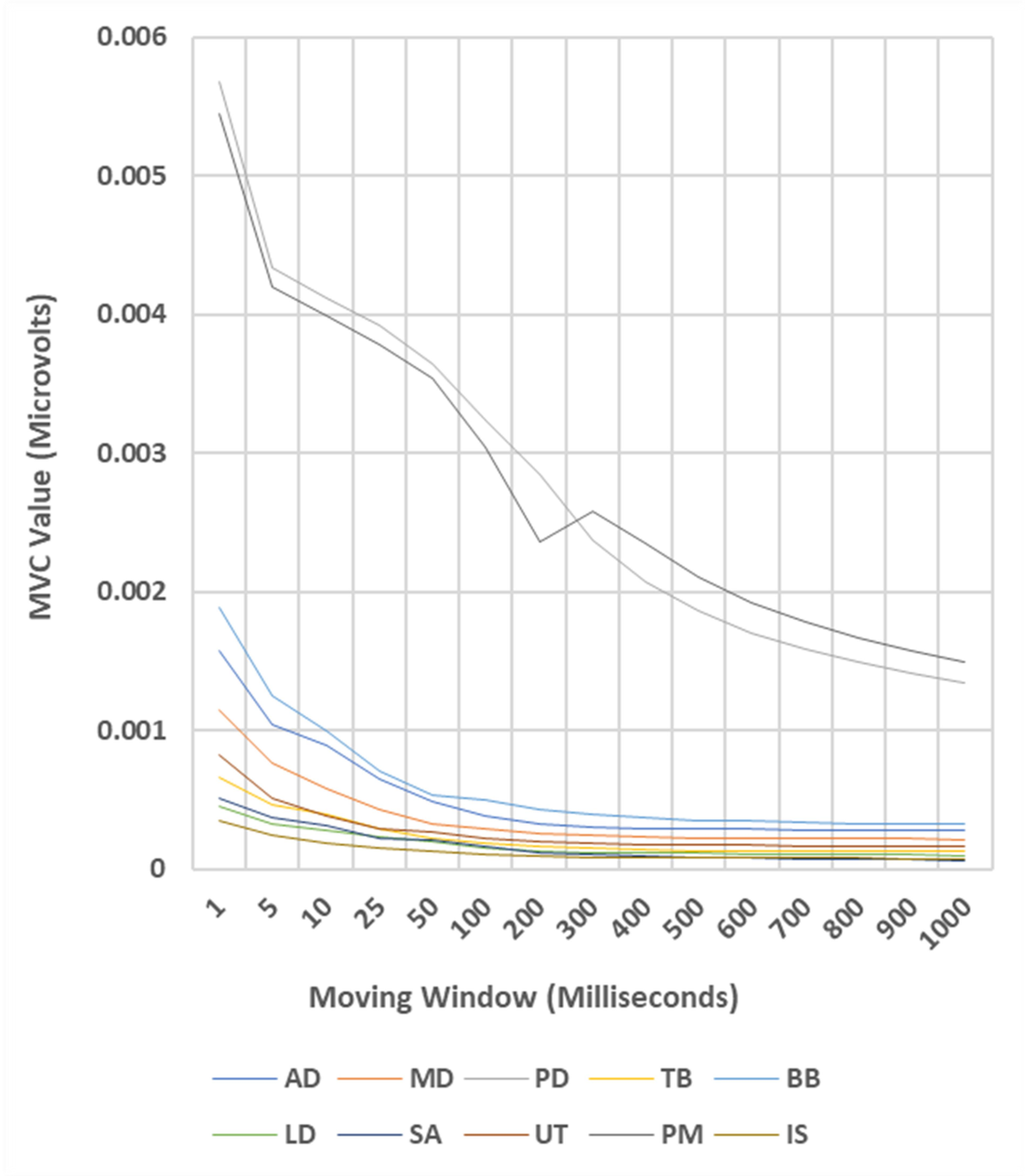

Figure 2. The effect that window size has on the MVIC EMG value for Anterior Deltoid (AD), Middle Deltoid (MD), Posterior Deltoid (PD), Trapezius Brachii (TB), Biceps Brachii (BB), Latissimus Dorsi (LD), Serratus Anterior (SA), Upper Trapezius (UT), Pectoral Majors (PM), Infraspinatus (IS).

Discussion

- All muscles follow a similar pattern
  - RMS Window Length Inversely related to Peak MVIC EMG Value
  - Small amount of instances where peak MVIC EMG value increases with an increase in filter length
- Pectoral Majors and Posterior Deltoids consistently have much larger peak MVIC EMG values relative to the other muscles
- Using an RMS filter of 500 ms was most appropriate (Yellow line) [3,4]
  - Using RMS filter lengths shorter than 500 ms included outlying data points within the MVIC EMG signal
  - Using filter lengths longer than 500 ms were shown to excessively filter datapoint and dilute the signal

Conclusions

- Employing valid and reliable MVIC EMG signal processing strategies can imporve the interpretation of musculoskeletal data in biomechanics research
- Findings could be the basis for MVIC EMG signal processing in research investigating upper extremity biomechanics in individuals with SCI
- Future reserch should investigate a wider spectrum of RMS filters in other upper extremity musculature

References

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