EMG ANALYSIS OF ABDUCTOR POLICIS LONGUS, EXTENSOR CARPI ULNARIS AND FLEXOR CARPI ULNARIS DURING FOREARM PRONO-SUPINATION

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INTRODUCTION

Little is known about forearm biomechanics compared to joints such as the knee and hip. In order to develop a model to analyze the biomechanics of the forearm at locations such as the distal radioulnar joint, the function of forearm muscles must be analyzed and understood. Developing an accurate set of data to determine muscle function of various forearm muscles is necessary so that data placed into a biomechanical model is accurate as possible. This initial forearm muscle study examined the muscle function of the abductor policis longus (APL), extensor carpi ulnaris (ECU) and the flexor carpi ulnaris (FCU) during forearm rotation. Data was collected using indwelling electrode electromyography (EMG) and was collected in both the pronating and supinating direction.

METHODS

Data was collected using ten subjects in this IRB approved study. Two indwelling electrodes were placed in the right APL, ECU and FCU of each subject using a 25 Gauge needle. The needles were placed using published guidelines [1]. A grounding surface electrode was placed on the olecranon of the right shoulder. A 5 second baseline test was collected while the subject relaxed their arm. In order to scale the muscle activity between subjects, maximum EMG muscle activity of the muscle of interest was determined using published maximum voluntary isometric contraction exercises (MVIC) [2]. Each exercise was performed 3 times for 5 seconds with a 2 minute rest between each trial. The subject was then asked to hold the handle of an isokinetic dynamometer with the elbow at 90° of flexion (Figure 1). An abduction pillow was also placed under each subjects arm to standardize the testing and allow the subject to comfortably rest between trials. The handle of the dynamometer was placed in one of nine positions of forearm rotation: maximum pronation, 75° of pronation, 50° of pronation, 25° of pronation, neutral, 25° of supination, 50° of supination, 75° of supination and maximum supination. The subject was asked to grip the handle at the specified position and pronate their forearm as hard as they comfortably could for 5 seconds. This was done three times with a 2 minute break between each trial. The same procedure was then carried out at the same position while the subject supinated their forearm.

Figure 1: Instrumented subject holding dynamometer handle in testing position.

Data was collected at a rate of 2000 Hz. Once all data had been collected, the maximum value from the baseline test was subtracted from each muscle. The EMG data were then full wave rectified and low pass filtered. The root-mean-square (RMS) of the resulting linear envelope was then calculated. EMG values were normalized to the maximum RMS value. Ideally the highest value for a specific muscle would be from data collected from the MVIC trials, but this was not always the case. The normalized EMG values were then averaged for each of the three trials in both the pronating and supinating direction at each of the nine positions.

RESULTS AND DISCUSSION

EMG data from the APL (Figure 2) shows that the muscle was more active while supinating than pronating at each of the 9 positions. While pronating, APL muscle activity was greatest at 50° of pronation while supinating it was greatest at 50° of supination. The peak pronating signal was 46% of the largest APL signal observed while the peak supinating signal was 65%.

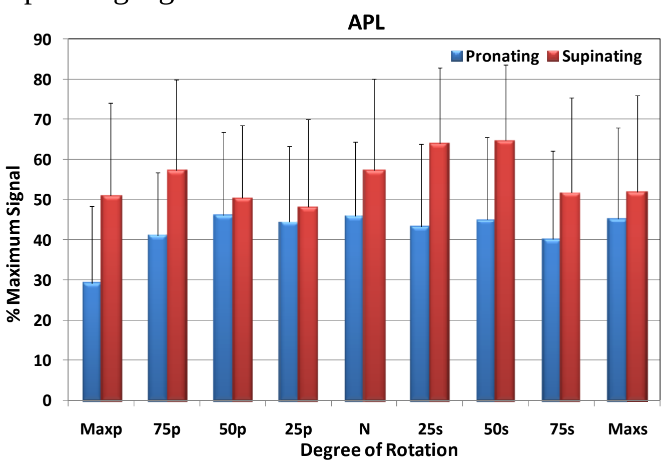

Figure 1: Pronating and supinating EMG activity for the APL for nine positions of forearm rotation.

EMG data from the ECU (Figure 3) shows that in pronated positions, the signal was greatest while the forearm was supinating. In supinated positions, the signal was greatest while the forearm was pronating. The greatest pronating signal occurred at maximum supination while the maximum supinating signal occurred at 50° of pronation. The peak pronating signal was 63% of the largest ECU signal observed while the peak supinating signal was 71%.

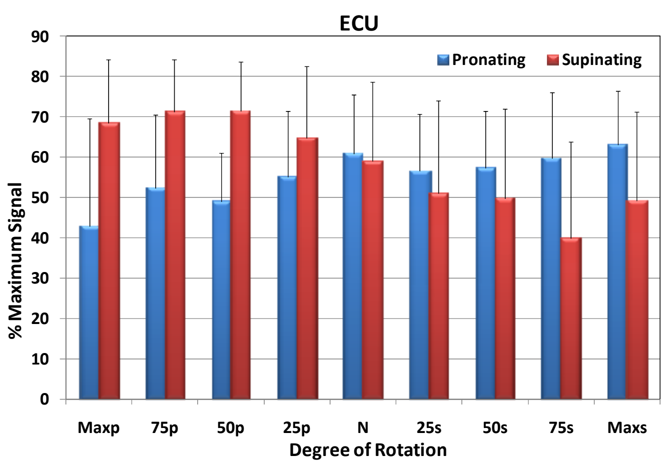

Figure 2: Pronating and supinating EMG activity for the ECU for nine positions of forearm rotation.

EMG data from the FCU (Figure 4) shows that in pronated positions, the signal was greatest while the forearm was supinating. In supinated positions, the signal was greatest while the forearm was pronating. The greatest pronating signal occurred at maximum supination while the maximum supinating signal occurred at maximum pronation. The peak pronating signal was 58% of the largest FCU signal observed while the peak supinating signal was 48%.

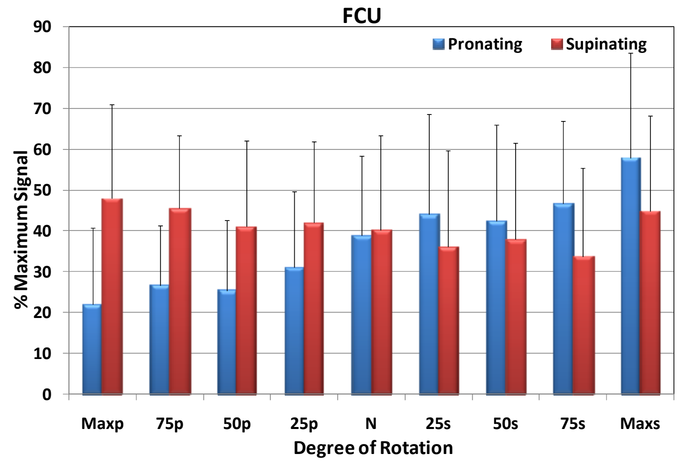

Figure 3: Pronating and supinating EMG activity for the FCU for nine positions of forearm rotation.

CONCLUSIONS

These results show that the APL is more active when the forearm is supinating than when it is pronating. The ECU and FCU are both more active in pronation positions when they are supinating and more active in supinating positions when they are pronating. This may indicate that the ECU and FCU play a role in slowing down forearm rotation as the maximum range of motion is approached in either direction.

REFERENCES

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