INTRODUCTION

Fatigue of shoulder muscles has shown to alter scapular kinematics during humeral elevation [1]. Of the shoulder muscles, the infraspinatus is involved in external rotation and stabilization of the humerus. Instability of the humerus, due to fatigued shoulder muscles, could increase the chance of shoulder injury such as impingement.

The central nervous system influences the activation of motor neurons and the contractility of muscles. Signals from the motor cortex cause the response from muscles, but this response is not instantaneous. There is a latency between the stimulation of the motor cortex and activation of muscle contractility. There may be an effect on latency and motor evoked potential (MEP) of a muscle after being fatigued.

The purpose of this study is to examine the change, pre- and post-fatigue, in muscle activation latency and MEP amplitude of the infraspinatus.

METHODS

A total of 18 subjects participated in this experiment. Aged 22 ± 2.1 years old. Average height 175.7 ± 9.1 cm and average mass of 73.3 ± 14.5 kg. All subjects were recruited from the campus of Western Washington University.

The right infraspinatus was monitored with dual surface electrodes with an inter-electrode distance of 1.75 cm apart with a Noraxon TeleMyo desktop direct transmission electromyography (EMG) system. Transcranial magnetic stimulation (TMS) was performed with a figure-of-8-coil using Magstim BiStim system to stimulate the motor cortex. Optimal stimulation was found by mapping of the motor cortex by stimulating multiple points on a 5x5cm grid every 1 cm around C1 to locate the spot that most excites the target muscle. C1 is the position over the motor cortex on the contralateral side of the right infraspinatus when following the international 10 20 electrode placements for electroencephalography [2]. During mapping and recording of data, the subject held their right arm horizontal to the floor at 45° of scapular abduction to cause a 6-10% activation of maximum voluntary contraction in the infraspinatus. Active motor threshold (aMT) is the lowest setting on the TMS device that will elicit an MEP from the target muscle. During data collection, 120% of the aMT was used during recording.

When the optimal spot and active motor threshold for infraspinatus activation was found, twelve pre-fatigue stimulations were recorded, followed by a fatigue protocol, and then twelve post-fatigue stimulations. The fatigue protocol consists of the subject holding their arm at their side, pinching a rolled towel between their right elbow and torso, and having the elbow flexed at 90° while the forearm is in a semi-prone position while holding onto an elastic band in the right hand. Subjects were instructed to externally rotate (ER) their shoulder rapidly with as full range of motion. The experimenter held the other end of the elastic band to provide resistance. After the subjects had failed to move into ER because of fatigue, ER force was measured. When force production was decreased by 25%, measured by a Microfet2 handheld dynamometer, the post-fatigue stimulations began.

RESULTS AND DISCUSSION

Muscle activation latency did not show a difference between pre- and post-fatigue with an average change of -0.2 ms (p=0.77). The MEP amplitude has shown an average decrease of 111.4 µv, (p=0.43) but was not statistically significant. The peak to peak latency within the MEP, measured by the time between the minima and maxima of the MEP, has shown statistically significant (p=0.005) increase from an average of 4.5 ms pre-fatigue to 5.9 ms post-fatigue with an effect size of 0.68 (Figure 1).

CONCLUSIONS

Latency between the stimulation of the motor cortex and activation of muscle contractility has shown no difference after the fatigue protocol. There is a trend to the change in MEP amplitude but did not show statistical significant. The peak to peak latency has shown to have a significant increase. The increase in time to the same stimulus, post-fatigue, might mean that the muscle has a longer activation in a fatigued state. This change in activity could lead to alteration in shoulder kinematics. The infraspinatus might influence a decrease in stabilization depending on its interactions with other shoulder musculature.

REFERENCES