# EFFECTS OF TASK INTENSITY ON CHANGES IN SCAPULAR KINEMATICS

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## INTRODUCTION

Muscle fatigue and shoulder pain are commonly reported in manual laborers whose job requires repetitive hand use at or above shoulder level. Fatigue of the shoulder girdle musculature may result in altered kinematics of the shoulder complex (McQuade, 1998), which could lead to the development of abnormal forces and stresses being placed upon the tissues associated with the shoulder girdle. The purpose of this study was to investigate the effects of two protocols for shoulder girdle muscle fatigue on three-dimensional scapular kinematics.

## METHODS

*Kinematics* The 3Space Fastrak (Polhemus, Colchester, VT) was used to collect kinematic data. A thoracic receiver was placed over T3 with double sided tape, a humeral receiver was placed at the deltoid tuberosity using an elastic strap, and a scapular receiver was fixed to a scapular tracking device attached to the scapular spine and acromion using Velcro strips (Karduna et al., 2001). Data were collected during three trials of elevation in the scapular plane, with data averaged over the three trials. Data for 3 scapular rotations were analyzed: posterior tilting, upward rotation, and external rotation.

*EMG* The MyoSystem 1200 (Noraxon, Scottsdale, AZ) was used to collect surface EMG data. Passive electrodes were applied to the upper and lower trapezius, lower serratus anterior, anterior deltoid, and infraspinatus muscles. Data were collected during a 30 second isometric contraction and the mean power frequency (MPF) of each muscle was determined.

*Protocol* Sixteen subjects (10 male, 6 female; mean age = 22 years) without a history of shoulder injury volunteered to participate in the study. The first step was to collect baseline measurement of EMG and kinematics during scapular plane elevation. Subjects then went through a fatigue protocol, classified as either "high" or "low" intensity. Immediately afterwards, EMG and kinematic data collection was repeated. After a one-hour rest period, each subject repeated the protocol (baseline testing and post-fatigue testing) at the other intensity level. Order of performance of the high or low intensity protocol was determined randomly.

*Fatigue Tasks* The first task required subjects to stand and manipulate a puzzle with their arms in an elevated position for a defined period (high = 1 min at $115^{o}$, low = 2 min at $45^{o}$). The second task required them to elevate their arm in the scapular plane against resistance (high = 10 reps at 40% MVC, low = 20 reps at 20% MVC). The third task required them to raise their arm in a diagonal pattern against resistance (high = 10 reps at 40% MVC, low =20 reps at 20% MVC). Subjects cycled through the three tasks until they were unable to complete two tasks in a row.

## RESULTS

The MPF decreased across all muscles for both the low (2 - 22%) and high (7 - 25%) intensity protocols. Significant increases in scapular rotations were noted following both fatigue protocols for all three rotations. For upward and external rotation (figure 1 A and B), the low load protocol resulted in greater changes, approaching 10° at some elevation angles. For posterior tilting (figure 1C), the effects of fatigue were greater for the high load protocol, however, for both protocols, the changes were small.

## DISCUSSION

Scapular rotations were found to be affected by fatigue regardless of the intensity level of the fatiguing protocol. The low load, high repetition protocol resulted in greater changes than the high load, low repetition protocol. This finding is particularly interesting, since a NIOSH report concluded that although there is evidence of a link between high repetition and shoulder injuries, there is insufficient evidence to link force and shoulder disorders (Bernard, 1997). Particularly important are the increases in upward rotation, since we recently demonstrated in a cadaver model that an increase in upward rotation may resulted in a decrease in subacromial clearance (Karduna et al., 2002). Consequently, shoulder fatigue may be associated with increased compressive forces on tissues within the subacromial space due to changes in scapular kinematics.

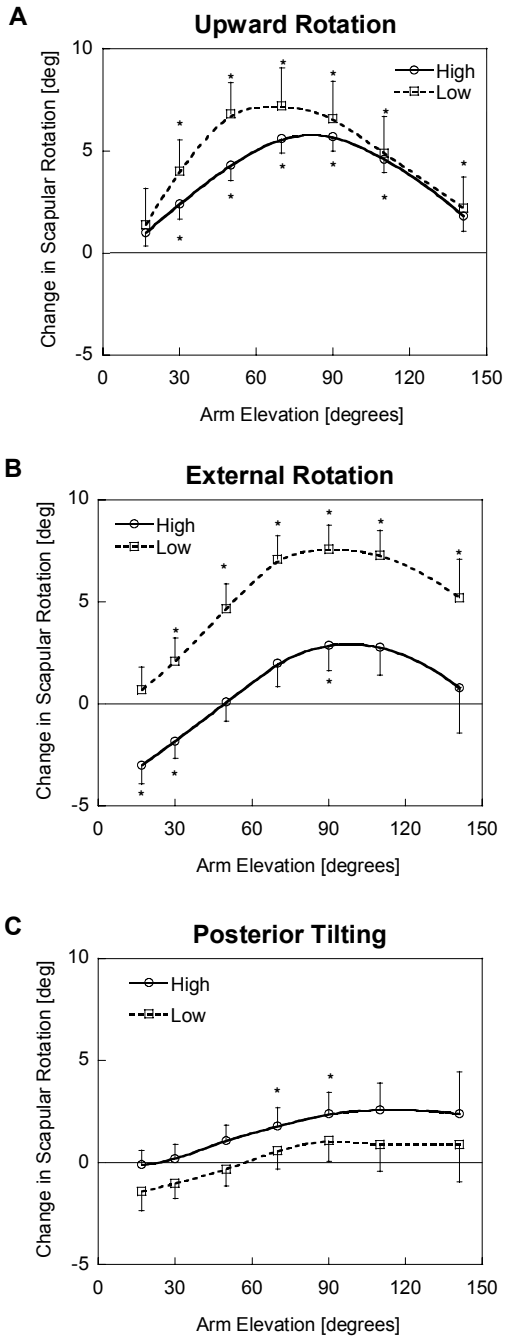


**Figure 1** Changes in scapular rotations after the fatigue protocols (means ± sem).
* $p < 0.05$ comparing pre to post fatigue

## REFERENCES


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