

SCAPULAR KINEMATICS DURING ACTIVE AND PASSIVE ARM ELEVATION

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INTRODUCTION

Due to large rotational and translational motions, the scapula plays an important role in the normal kinematics of the shoulder complex (Kibler, 1998). The production and control of these motions are primarily regulated by active muscle contraction (Bagg and Forrest, 1986; Bagg and Forrest, 1988; Pink and Perry, 1996). Understanding the mechanisms behind this regulation would further our understanding of the importance of active muscle contractions in scapular kinematics. The purpose of this study was to examine this controlling mechanism by comparing the three-dimensional (3D) scapular and clavicular kinematics during active and passive arm elevation.

MATERIALS AND METHODS

Kinematics

The Polhemus 3Space Fastrak (Colchester, VT) was used to collect 3D scapular and clavicular kinematics. A thoracic receiver was placed over T3 using double sided tape, a humeral receiver was placed at the level of the deltoid tuberosity using an elastic strap, and a scapular receiver was fixed to a scapular tracker device that was attached to the scapular spine and acromion process using Velcro strips. The scapular tracker device has been shown to be accurate in measuring scapular kinematics (Karduna, 1998). The arbitrary axes defined by the Polhemus were converted to appropriate

anatomical axes using digitized bony landmarks.



Figure 1 Passive Elevation System

Electromyography

Surface electrodes were used to collect electromyographic (EMG) activity from the upper and lower trapezius, lower serratus anterior, anterior deltoid, and infraspinatus muscles. Raw EMG data was band pass filtered (10 – 750 Hz) and collected at 1200 Hz (Instech Laboratories, Exton, PA.). EMG data from the active and passive trials were normalized to a maximum voluntary contraction for each muscle.

Protocol

Thirteen healthy subjects performed three trials of active elevation in the scapular plane. Their wrist was then placed in a splint, which was attached to a rope that ran

over an overhead pulley system (figure 1). The other end of the rope was used to passively elevate their arm (three times) in the scapular plane.

ANALYSIS

Averaged active/passive kinematic differences for scapular posterior tilt, upward rotation, external rotation, and clavicular retraction and elevation were evaluated at the following positions of arm elevation: 35°, 55°, 70°, 85°, 100°, 115°, and 135°. Paired t-tests were used for statistical comparisons. At the aforementioned positions, normalized EMG data was processed using a RMS filter.

RESULTS

Significant differences were found for scapular upward rotation, clavicular retraction, and clavicular elevation. See figure 2 for upward rotation example. During active motion there was a greater amount of scapular upward rotation, clavicular retraction, and clavicular elevation. No differences were found for scapular external rotation or posterior tilt.

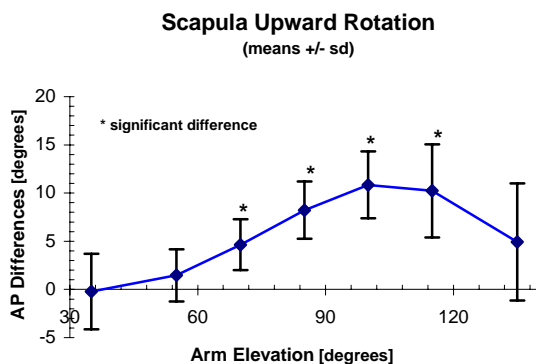


Figure 2 Means and standard deviations for active/passive differences for scapular upward rotation. *Significant difference

EMG activity for all muscles at each position of elevation was lower during

passive elevation, ranging from 1-12% of a MVIC. This demonstrates that our method was indeed passive.

DISCUSSION

Active elevation resulted in greater scapular motion, particularly within the range of 70°-115° of elevation. These findings are consistent with a similar study by McQuade and Smidt (1998). Muscle control of scapular position may be most important in this range. Beyond 115°, active and passive motion became similar which seems to suggest a passive mechanism controlling scapular position such as capsular tension or passive muscle tension. The active/passive kinematic differences reported in this study maybe altered in patients with shoulder pathology who demonstrate impaired muscle performance and/or abnormal tightness of the capsule and surrounding muscles. This type of information would provide clinicians with an understanding of some of the underlying biomechanical impairments associated with shoulder pathologies which in turn could be used in the clinical decision making process for the selection of appropriate treatments.

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