Differential Patterns of Muscle Activation in Patients with Symptomatic and Asymptomatic Rotator Cuff Tears

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Introduction: Some patients with two tendon, full thickness tears of the supraspinatus and infraspinatus can present with symptoms of pain and limited motion, whereas, others with the same diagnosis can have near normal, pain-free motion. [5,6]. The purpose of this study was to evaluate the differential firing patterns of rotator cuff, peri-scapular, and extrinsic shoulder muscles in normal controls, and in patients with symptomatic and asymptomatic large cuff tears. The primary hypothesis was that there were differences in muscle firing patterns between patients with rotator cuff tears and normal, healthy controls with no rotator cuff tear during functional shoulder movements. The secondary hypothesis was that there were additional differences in firing patterns between patients with symptomatic rotator cuff tears and patients with asymptomatic rotator cuff tears of approximately the same size.

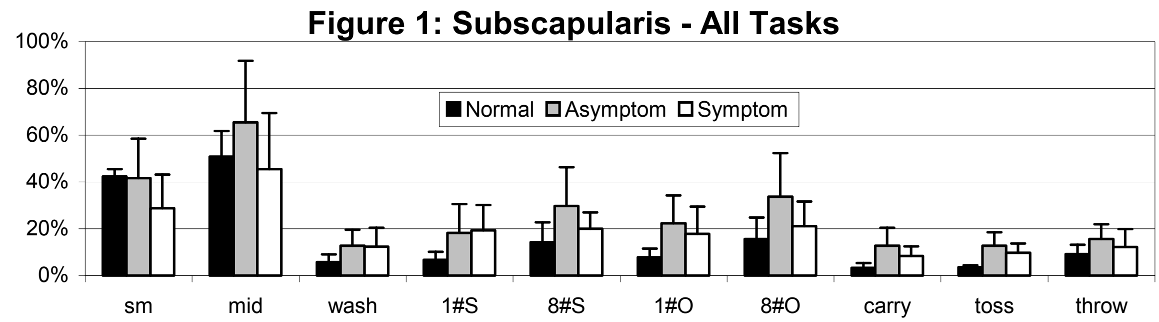
Statement Of Clinical Significance: Delineating the functional differences between these two groups and how they differ from normal will aid the development of rehabilitation protocols that restore the function of symptomatic patients to the level of asymptomatic patients, as well as maintaining function or, potentially, restore full function in asymptomatic patients. Ultimately this may help utilizing the motion analysis facility to determine those patients who are likely to improve with conservative treatment.

Methods: Eighteen subjects were evaluated: 6 controls, 6 with asymptomatic rotator cuff tears, and 6 with symptomatic rotator cuff tears. IRB approval was obtained and informed consent was obtained from all participants. Each subject underwent a shoulder examination and completed three shoulder outcomes questionnaires (Simple Shoulder Test, L'Insalata Questionnaire [3], ASES Shoulder Score Index [4]). Subjects were divided into groups based upon physical exam findings and questionnaire scoring. Inclusion criteria for controls required them to have subjectively and objectively normal shoulders as well as an ultrasound confirming the absence of rotator cuff tendon tears. The asymptomatic group had minimal pain (< 3 on the visual analog scale (VAS)); near complete active ROM (within 5° of the opposite side). The symptomatic group had pain > 3 on the VAS; decreased active or passive ROM (> 5° difference compared to the opposite side); functional weakness on clinical examination. All rotator cuff tears were verified on MRI that showed comparable tear patterns in both groups involving both the supraspinatus and infraspinatus tendons.

Surface adhesive electrodes were used for the deltoid (anterior, middle, posterior); trapezius (upper, middle, lower); pectoralis major; latissimus dorsi; and serratus anterior. Indwelling wire electrodes were used for the supraspinatus, infraspinatus, and subscapularis muscles. Electromyography (EMG) at 1000 Hz was collected simultaneously with 3-D kinematics (60 Hz, 6 camera Motion Analysis Corp system). Maximal voluntary isometric contractions (MVC) were performed for each of the 12 muscles [1,2]. All subsequent data was normalized to the MVC (%MVC). Subjects were then asked to perform 10 functional tasks: 2 internal rotation tasks (reaching to small of back (sm) and reaching to middle of back (mid)); 5 shoulder elevation tasks (wash back of opposite shoulder (wash), lift 1 lb to shoulder level (1#S), lift 8 lbs to shoulder level (8#S), lift 1 lb overhead (1#O), lift 8 lbs overhead (8#O)); a carrying task (carry 20 pounds at your side (walk)); and 2 throwing tasks (throw a softball underhand (toss), throw a softball overhand 10 yds (throw)). During all tasks, simultaneous

EMG and kinematic data were collected. Each task was performed 3 times. Kinematic data delineated the initiation and the completion of the task.
ANOVA and post-hoc testing was used to determine differences in scores and %MVC when all three groups were included. Appropriate two-sample t-tests were used when only two groups were examined (i.e. symptomatics v. asymptomatics) and corrected for multiple measures (alpha = 0.05).

Results: Subjective shoulder scoring questionnaires demonstrated significant differences between all three groups for the L'Insalata and Shoulder Score Index ($p < 0.05$). For the Simple Shoulder Test symptomatic patients scored significantly lower than the other two groups ($p < 0.05$). There was no difference between asymptomatics and normals.



EMG data demonstrated a trend toward increased muscle activation of all muscles in both asymptomatic and symptomatic patients compared to controls. During the internal rotation tasks, asymptomatics had greater ($p < 0.05$) subscapularis activity than symptomatics (65 vs 42% MVC) – Fig. 1. During the carrying task, asymptomatic demonstrated less ($p < 0.03$) upper trapezius muscle activation than the symptomatic patients (16 vs 50% MVC). During shoulder elevation tasks, symptomatics had greater supraspinatus ($p < 0.03$), infraspinatus ($p < 0.05$), and upper trapezius ($p < 0.04$) activation compared to asymptomatics. During 8lb elevation, asymptomatics showed a trend toward increased activation ($p < 0.06$) of the subscapularis compared to symptomatics (34 versus 21% MVC).

Discussion: The subjective questionnaires used accurately reflect differences between symptomatic and asymptomatic patients with large rotator cuff tears. Patients with rotator cuff tears have a trend toward increased muscle activation compared to normal controls. When compared to asymptomatics, symptomatics have a paradoxical increased firing of their torn rotator cuff muscles; a lack of adaptive firing of their intact subscapularis; and exaggerated firing of their upper trapezius muscle when countering downward loads and during elevation maneuvers which results in compromised function. Our data suggest that patients with large cuff tears may benefit from a program with increased focus on subscapularis rather than supraspinatus and infraspinatus strengthening.

References

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