# SCAPULAR KİNEMATİCS, SHOULDER MUSCLE ACTİVATİON AND PAİN DURİNG OPEN CAN AND EMPTY CAN SUPRASPİNATUS EXERCİSES İN DYNAMİC CONDİTİONS

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## SUMMARY

Rotator cuff tendinopathy is a condition produces pain and loss of shoulder function. The rehabilitation of rotator cuff injury includes exercises that involve elevation of the arm. These excises are performed with the arm in either internal rotation/empty can (EC) or external rotation/full can (FC). Each of the position has been shown to activate the muscle of the rotator cuff. The EC position might produce scapular positions associated with the extrinsic mechanisms of rotator cuff tendinopathy.

Scapular position and muscle activation were measured with the arm in 90° of abduction in the plane of the scapula, in 22 subjects without shoulder pain. Measurements were taken during a maximal isometric contraction (MVIC) and with the arm supported in the test position.

The scapula was positioned in less external rotation (ER) and posterior tilt (PT) in EC compared to FC. The MVIC produced a decrease in upward rotation (UR) and no change in PT. The MVIC produced an increase in ER in the FC and a decrease in ER in the EC. The deltoid, infraspinatus and middle trapezium showed greater activity in the EC position.

## INTRODUCTION

Tendinopathy of the rotator cuff tendon (RC) is the most common musculoskeletal shoulder disorder. Mechanisms of rotator cuff tendinopathy, specifically subacromial impingement syndrome (SAIS) are not well understood due to the complex nature of the disorder. SAIS is theorized to be caused by extrinsic and intrinsic mechanisms. Extrinsically, the rotator cuff tendons can be compressed beneath the bony acromion of the scapula due to narrowing of the subacromial space (SAS). Intrinsically, the rotator cuff tendons and muscles can breakdown with altered tissue characteristics secondary to overuse.

The full-can and empty-can exercises are commonly used for supraspinatus strengthening in shoulder rehabilitation. Recent systematic literature reviews report that eccentric loading the tendon produce favorable clinical outcomes in the treatment of tendinopathy of the achilles and patellar tendons.

Scaption exercises to strengthen the rotaotor cuff are performed with the arm in either glenohumeral internal rotation (empty can) or external rotation (full can). Both positions have been shown to produce maximal supraspinatus activity.[74] Differences in the actvation of the scapular muscles between the two positions is not known. The empty can position produces scapular positioning that has been associated with SAIS.[1] Arm elevation in the empty can position showed less scapular posterior tilt and external rotation.

Better understanding the effects of these two exercises on scapular kinematics and scapular muscle activation will assist healthcare professionals in recommending favorable strengthening exercises for the rehabilitation of rotator cuff tendinopathy. This investigation explored the scapular position and activation of the shoulder musculature during open can and full can exercises.

## METHODS

Twenty two participants were recruited for this investigation. All participants were free of shoulder pain and did not report a history of shoulder pain or trauma. All subjects provided their informed consent prior participation. The Human Subjects IRB of the Virginia Commonwealth University approved this project. All data for this investigation was collected during a single data collection session. During the session scapular position and muscle activation data was collected during maximal isometric voluntary contraction (MVIC) with the arm at 90° abduction in the plane of the scapula and at rest with the arm supported in the same position. Two MVIC's were performed in the full can and empty can position.

Three dimensional scapular positions was determined using the Polhemus 3Space Fastrak electromagnetic-based motion capture system (Polhemus, Colchester, VT) and Motion Monitor software (Innovative Sports Training, Inc, Chicago, IL) following ISB recommendations. Scapular upward rotation (UR), scapular external rotation (ER), and scapular posterior tilt (PT), clavicular elevation (ELE) and clavicular retraction (RET) positions were calculated during a 3 second window during rest and each MVIC.

Muscle activation was determined using surface electromyography (SEMG), signals were collected with an 8 channel Bagnoli EMG System (Delsys INC, Boston, MA). The SEMG was collected from the upper trapezium (UT), middle trapezium (MT), lower trapezium (LT), serratus anterior (SA). midline deltoid (MD) and infraspinatus (INF). The SEMG was recorded during all arm elevation repetitions. A duel silver bar (inter-electrode distance 2cm) surface

electrode was placed over the muscle belly of each of the muscles. The reference electrode was placed over the olecrenon process of the opposite arm. The SEMG signals were be collected at 1000Hz, bandpass filtered 20-400Hz and full wave rectified. The integrated EMG (IEMG) value for each muscle was calculated during a 3 second window during each MVIC contraction and standardized to the time duration of the contraction. 2x2 repeated measures ANOVA (position x muscle activity) was used to test for statistical differences between the dependent variables, statistical significance was determined at $p \leq 0.05$.

**RESULTS AND DISCUSSION**

Scapular position during the rest phase and MVIC are presented in Table 1. During static elevation of the arm at 90° abduction in the plane of the scapula there was not a statistical difference in UR ($p=0.38$) between EC and FC. There was less UR ($p=0.001$) during the MVIC than during the rest phase. The position by activity interaction was significant ($p=0.009$), less UR was seen in the FC position during the MVIC than at rest; the decrease in UR during the MVIC in the EC position was not statistically significant. Less ER ($p \leq 0.001$) was seen in the FC position than the EC position. The ER activity main effect was not significant ($p=0.69$). The position by activity interaction was significant ($p \leq 0.001$), in the FC position ER increased during the MVIC while in the EC position ER decreased during the MVIC. Greater PT ($p \leq 0.001$) was seen in the FC position than the EC position. The PT main effect ($p=0.98$) and position by activity interaction ($p=0.26$) were not significant. The IEMG values measured during the MVIC are presented in Table 2. Statistically significant greater IEMG during the MVIC in the EC position in the DEL ($p \leq 0.001$), INF ($p=0.003$) and MT ($p=0.001$) muscles. The differences in IEMG during the MVIC of the UT ($p=0.93$), SA ($p=0.64$) and LT ($p=0.36$) were not statistically significant. The differences in the activation of the MT might explain the differences in the ER during the MVIC. With the arm at rest in the EC the less in UR and PT are consistent with the scapular position seen with SAIS. However during the MVIC the differences in these scapular positions in the EC and FC were reduced. The differences in PT between the EC and FC were not affected by the MVIC.

**CONCLUSIONS**

In subjects without shoulder pain, the activation of the scapular musculature may prevent the scapula from being positioned in the associated with rotator cuff tendinopathy. The activation of the scapular muscles in subjects with SAIS needs to be investigated.

**REFERNCES**

1. Thigpen et al , *AM J Sports Med*, 34(4):644-652, 2006

**Table 1:** The scapular position during the rest phase and maximal voluntary isometric contraction, scapular position is reported with respect to the thorax.

| Scapular Position | Arm Position | Rest | MVIC | mean |
|---|---|---|---|---|
| **Upward Rotation** | Full Can | 33.5°±2.9° | 26.7°±3.3° | 30.1°±3.1° |
| | Empty Can | 31.9°±3.2° | 30.5°±3.6° | 31.2°±3.3° |
| | mean | 32.8°±3.0° | 28.6°±3.4° | |
| **External Rotation** | Full Can | -29.6°±2.0° | -32.3°±1.8° | -30.1°±1.9° |
| | Empty Can | -36.3°±1.8° | -32.8°±1.9° | -34.5°±1.8° |
| | mean | -32.9°±1.8° | -32.5°±1.9° | |
| **Posterior Tilt** | Full Can | -4.0°±1.7° | -5.3°±1.6° | -4.7°±1.6° |
| | Empty Can | -10.2°±2.1° | -9.0°±1.6° | -9.6°±1.5° |
| | mean | -7.1°±1.7° | -7.2°±1.5° | |

**Table 2**. Surface electromyography, the mean of the IEGM of 2 MVIC's standardized to contraction time and presented in millivolts (mV).

| Muscle | Full Can | Empty Can |
|---|---|---|
| **Midline Deltoid** | 0.2164±0.02 | 0.3545±0.03 |
| **Upper Trapezium** | 0.2488±0.035 | 0.2480±0.034 |
| **Infraspinatus** | 0.0673±0.005 | 0.0853±0.006 |
| **Serratus Anterior** | 0.0781±0.011 | 0.0764±0.013 |
| **Middle Trapezium** | 0.1656±0.014 | 0.2079±0.019 |
| **Lower Trapezium** | 0.1666±0.021 | 0.1729±0.023 |