Muscle Activation Patterns and Torque Output during External Rotation (ER) After a Reverse Total Shoulder Arthroplasty comparing Coper and Non-Coper ER Patient Populations

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INTRODUCTION: Reverse total shoulder arthroplasty (RTSA) is a reliable treatment for restoring shoulder function. RTSA patient outcomes to return to functional external rotation (ER) is less predictable and needed for activities of daily living. ER muscle activation patterns with RTSA are not well understood in teres minor deficient patients. Therefore, the purpose of this study was to examine the timing of upper extremity muscle activation patterns and torque output during shoulder ER and internal rotation (IR) in teres minor deficient patients who have a well-coping and non-well-coping RTSA during external rotation.

METHODS: Preliminary data of fourteen teres minor deficient patients were recruited and split into two groups based on their external rotation function, coper (n=9) or non-coper (n=5) group. Groups were defined using the American Shoulder and Elbow Surgeons (ASES) for Activities of Daily Living questionnaire for question 5 where copers indicated a score of 2 or 3 and non-copers indicated a score of 0 or 1. Seven surface electromyography (EMG) leads and 2 needle EMGs were placed prior to participation. Patients performed two movement positions of moderate neutral (MN) and abduction (AB) with their post-surgical shoulder. MN and AB are described as follows: MN position; arm at side with 90 degrees of elbow flexion and AB; abduction of shoulder to 90 degrees with 90 degrees of elbow flexion. At the respected positions, the patients were informed to externally rotate as far as they could without pain. Patients performed 5 movement trials in both AB and MN conditions on the dynamometer. The dynamometer recorded torque and position (100 Hz) and electromyography (2000 Hz; EMG), simultaneously. Visual 3D was used to identify external rotation time series. Custom software (MATLAB, 2021a) was utilized to perform Teager-Kaiser energy operator on EMG signals to determine EMG onset and offset from which integrated RMS EMG was calculated. An independent sample t-test was used to compare normalized iEMG, and torque output for both movement positions during external rotation. Alpha was set at 0.05.

RESULTS: In the patient groups, the sequence of iEMG (microvolts*msec) muscle activation timing from maximal IR to maximal ER began with the pectoralis major and scapular stabilizers (upper trapezius (15.7), middle trapezius (21.6), and latissimus dorsi (19.9)), followed to external rotation the anterior deltoid (18.6) and serratus anterior (28.2) activated past neutral into ER. The non-Coper muscle activation patterns were similar compared to the Coper group, however the teres major assisted from neutral through ER and altered similarly in the AB position (39.7) (Figure 2A and 2B). No differences were found for peak ER torque output in the Coper compared to the non-Coper group for either MN or AB position (Figure 1A and 1B).

DISCUSSION: After RTSA, individually mapped muscle activation patterns and peak ER torque output were similar in the coper compared to non-coper groups during external rotation. Our findings show the important role of the anterior deltoid, pectoralis major, trapezius group, and serratus anterior to help perform ER. A limitation to the study was power was not sufficient to reach significance, further enrollment is required to analyze differences between patient groups, however, this study provides potential trends to follow once data collections are completed. Future studies should analyze EMG intensity in addition to muscle activation timings during external rotation time series to better understand individual muscle efforts towards the task.

CLINICAL RELEVANCE**:** The preliminary data elaborates the complexity of the upper extremity post RTSA operations for rehabilitation. Potentially, this study specifies the importance of implementing a rehabilitation protocol to strengthen perivascular musculature to better patient outcomes for activities of daily living that include external rotation of the shoulder.

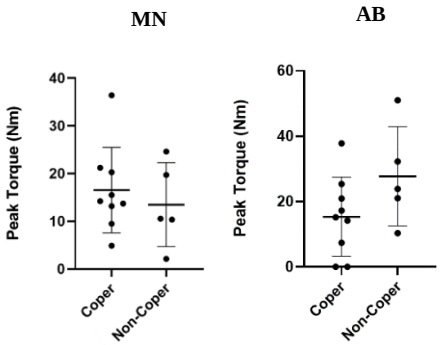

Figure 1A.

Figure 1B.

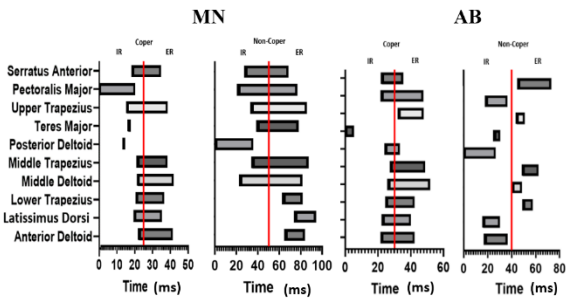

Figure 2A. **Figure 2B.**