Assessing changes in deltoid and trapezius muscle coordination of patients after reverse total shoulder arthroplasty

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Introduction/ Background

Reverse total shoulder arthroplasty (RTSA) is the preferred surgical option for patients with inoperable rotator cuff tears or shoulder arthritis[1]. The RTSA is designed to maximize deltoid and trapezius muscle coordination and restore shoulder function while improving pain. Despite general success and satisfaction, up to 25% of patients exhibit persistent functional deficits with overhead reaching tasks[2]. These ongoing deficits may indicate functional differences that could be related to poor muscular coordination following surgery. It is critical to understand not just the range of motion changes and improvements in these patients, but also the relative improvements in their muscular coordination and excitation.

Clinical Significance

Identifying changes in shoulder muscle coordination of patients following RTSA will reveal potential targets for therapy and rehabilitation to improve outcomes.

Methods

Patients undergoing planned RTSA (n = 14) consented to participate in this IRB-approved study. Participants were recruited up to 16 days prior to undergoing RTSA and returned at least six months following surgery. All participants presented with rotator cuff insufficiency, glenohumeral arthritis, and/or poor active elevation that had failed conservative management. At post-op timepoints, participants underwent biomechanical analysis during an arm abduction task in the neutral plane (3 repetitions). Optical motion capture reflective markers were used to track body segment motions of the thorax, humerus, and scapula (Optitrack, Corvallis, OR, USA). Muscle excitations were measured using surface electromyography (EMG; 3000Hz, Noraxon, AZ, USA) for the following seven muscles: anterior/middle/posterior deltoid, upper/middle/lower trapezius, and pectoralis major. Upper extremity segment reference systems, joint angles, and angular displacements were defined following ISB recommendations[3] (Visual 3D). EMG data were filtered with a 4th order zero-phase butterworth bandpass filter (10-500 Hz) and underwent RMS averaging 20ms bins[4]. All EMG data was normalized to each subject's maximal voluntary isometric contraction (MVIC) for each muscle group[4]. Outcomes included range of motion and mean EMG activation for the concentric phase of the tasks. Statistical analysis included normality tests and independent t-tests to compare high-functioning and low-functioning patients, which were determined by having these subjects perform a complex task either successfully or not successfully.

Results We found a significant decrease (mean difference = 22.2°) in glenohumeral range of motion (ROM) in the low-functioning patients as compared to high-functioning patients (**F = 9.206, P = 0.010**). No other significant changes in scapulothoracic or humerothoracic joint angles were found (**Figure 1**). We found a significant decrease in mean anterior deltoid activation in the low-functioning patients (**F = 5.466, P = 0.039**) as compared to high-functioning patients (**Figure 2**). Conversely, the low-functioning patients exhibited greater posterior deltoid activation during the abduction task (F = 4.955, P=0.048). No other significant changes in mean muscle activation were observed in our cohort.

Discussion

Post-operatively, RTSA patients exhibit significantly increased levels of anterior and posterior deltoid excitation, but non-significant changes in middle deltoid excitation. Increased levels of activity in the anterior deltoid and posterior deltoid may be a product of improved range of motion in patients that are high functioning vs low functioning. and rehabilitation treatment strategies should be aimed at improving low functioning patients in the middle deltoid and middle and lower trapezius across the range of motion to enhance shoulder function. Future work will be used to identify associations of both pre-operative kinematics and muscle excitation parameters that could predict functional patients following RTSA.

Acknowledgements

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References

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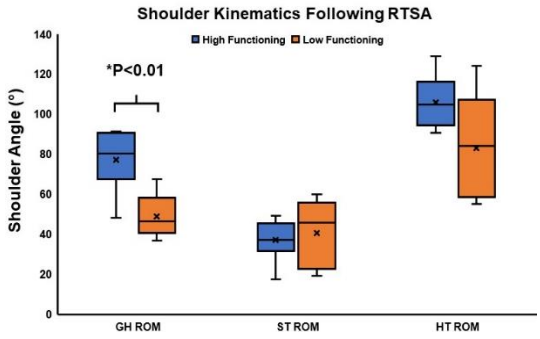

Figure 1. Differences in glenohumeral (GH), scapulothoracic (ST), and humerothoracic (HT) range of motion (ROM) between high and low functioning patients following RTSA.

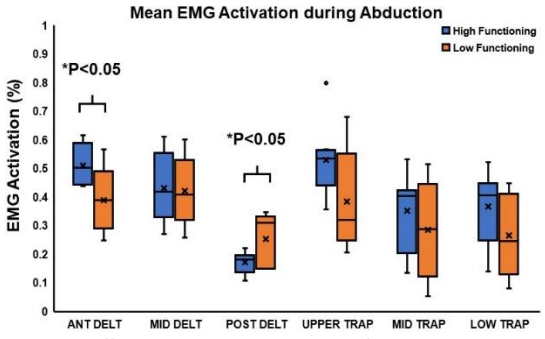

Figure 1. Differences in mean EMG excitation for the anterior, middle, posterior deltoid and upper, middle and lower trapezius of high and low functioning patients following RTSA.