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Assessment of Change in EMG-based Muscular Activity and Kinematics of the Shoulder Joint after Reverse and Anatomic Total Shoulder Arthroplasty

Abstract

Background:

Muscular activity and joint kinematics play a crucial role in the success of shoulder arthroplasty due to the difference in presence of an intact versus deficient cuff in glenhumeral osteoarthritis (GHOA) and rotator cuff arthropathy (RCA), two highly common indications of reverse shoulder arthroplasty (RSA). Differences in muscle activity and joint kinematics could provide valuable insight into predicting surgical outcomes of RSA. Electromyography (EMG) sensors can record electrical activity in precise locations in muscles and offer a non-invasive quantitative method for assessing muscle function. This study aimed to assess postoperative muscular activity using EMG sensors in patients undergoing RSA for GHOA and RCA, as well as in patients undergoing anatomic total shoulder arthroplasty (TSA) for GHOA, alongside healthy controls.

Methods:

In a single-center, observational prospective cohort study, 20 subjects were divided into 4 sub-cohorts, RSA for GHOA (n=5), RSA for RCA (n=5), TSA for OA (n=5) and age-matched healthy controls without any shoulder pathologies (n=5). Patients were selected base on the following criteria: ASES score > 90 at 2 year minimum follow up, Age < 85 and BMI, < 35 in order to reduce confounding factors. Each patient performed four movements, forward elevation, abduction, external rotation and internal rotation to assess shoulder function and range of motion. EMG signals were recorded for the deltoid, pectoralis major, infraspinatus, upper trapezius, and latissimus dorsi muscles during all four movements. The EMG data from the patient groups was normalized against the control patient data to ensure comparisons were made against a standard physiological baseline. Mann-Whitney U tests were conducted between the RSA for GHOA and RSA for CTA sub-cohorts as well as between the TSA for GHOA and RSA for GHOA sub-cohorts. Fischer exact tests were run on the patient demographics and range of motion measurements between all three sub-cohorts.

Results

The final cohort included 15 patients with a mean follow-up of 43.7 ± 23.5 months. Each sub cohort (n = 5) contained 60% females (n = 3) and the average age was 72.2 ± 8.7. Average BMI of the entire cohort was 28.5 ± 3.9. The Mann-Whitney U tests did not reveal any significant differences in muscle activation across all muscles measured between the RSA for GHOA sub-cohort and the RSA for CTA sub-cohort as well as between the TSA for GHOA and RSA for GHOA sub-cohort. A higher muscle activation of the latissimus dorsi in the RSA for OA (RMS = 3.209) compared to RSA for CTA (RMS = 0.552) did appear to be trending towards significance with a P value = 0.116. To a lesser degree but also nearing significance was a higher activation of the pectoralis major in the RSA for CTA sub-cohort (RMS = 1.033) compared to the RSA for GHOA sub-cohort (RMS = 0.174) with a P value = 0.222.

Conclusion

The initial findings of this study suggest a potential variance in muscle activation between different implant types in RSA compared to total shoulder arthroplasty TSA, as well as between differing indications such as OA and RCA. However, conclusive determinations require larger sample sizes. Furthermore, this study highlights the significant potential of EMG sensors in advancing the field of shoulder arthroplasty, offering critical insights that could profoundly impact patient rehabilitation strategies.

Table II: Comparison of Mean Normalized RMS Values of Muscle Activity in RSA vs. TSA			
Muscle *Movement*	RSA n = 5	TSA n = 5	P Value
Deltoid			
Abduction	1.237	1.448	0.841
Forward elevation	2.325	2.351	> 0.999
Pectoralis major			
Forward elevation	0.174	1.012	0.548
Trapezius			
Abduction	1.126	1.341	0.841
Infraspinatus			
External rotation	1.21	2.001	> 0.999
Latissimus Dorsi			
Internal rotation	3.209	2.627	> 0.999

Table III: Comparison of Mean Normalized RMS Values of Muscle Activity in Diagnosis of OA vs CTA			
Muscle *Movement*	OA n = 5	CTA n = 5	P Value
Deltoid			
Abduction	1.237	1.023	0.690
Forward elevation	2.325	1.988	0.841
Pectoralis major			
Forward elevation	0.174	1.033	0.222
Trapezius			
Abduction	1.126	0.940	0.690
Infraspinatus			
External rotation	1.210	2.536	0.548
Latissimus Dorsi			
Internal rotation	3.209	0.552	0.116