The Correlation of Muscle Volume Imbalance with the Development of Walch B Type Glenoids

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INTRODUCTION: Walch B-type glenohumeral osteoarthritis (OA) has been linked to total shoulder (TSA) and reverse total shoulder (RSA) arthroplasty implant survival. Although the etiology of this eccentric glenoid deformity is likely multifactorial, it is felt that posterior humeral head subluxation may precede eccentric glenoid wear and function as the primary driver in the development of glenoid biconcavity and retroversion. The central aim of this study is to (1) identify muscle imbalances as they pertain to the rotator cuff (supraspinatus, infraspinatus + teres minor, and subscapularis) and deltoid (anterior vs. posterior deltoid) in patients undergoing TSA and RSA in B-type versus A-type glenoids and (2) correlate these potential muscle imbalances with the development of glenohumeral bony deformity and posterior glenoid wear (type B glenoid), using patients with type A glenoids as a control.

METHODS: All patients with primary glenohumeral OA and/or rotator cuff arthropathy who underwent computed tomography (CT) scans of the affected shoulder within one year prior to TSA or RSA between 8/1/2020-12/31/2021 were identified from our institution's shoulder arthroplasty registry. Patients were included if they were older than 18 years of age with type A or B glenoids, had preoperative CT scans performed within a year of the date of surgery and had minimum two years follow up. Pre-operative CT imaging sequences were used to quantitatively measure fatty infiltration per Goutallier grading as well as to quantify rotator cuff and deltoid muscle volume based on previously published methodologies. The ratio of anterior to posterior muscle volumes was calculated for (1) rotator cuff muscle groups 'RCR' (subscapularis vs. infraspinatus+teres minor), (2) deltoid 'DMR', and (3) combined RCR and deltoid muscle volume 'CMR'. Glenoid retroversion, inclination and humeral head subluxation were also recorded. Univariate and multivariable regression analyses as well as independent welch's t-test were performed to compare muscle volume ratios between the different glenoid types, as well as to characterize associations between muscle area and glenoid morphology.

RESULTS: Among the 147 included patients, there were 50 type A1, 29 type A2, 26 type B1 and 42 type B2. No significant differences were found between the RCR ratios amongst groups; however, patients with B2 glenoids had mean DMR and CMR ratios that were smaller compared to the remaining A and B type glenoids ($p<0.01$ for all pairwise comparisons). There was a significant association found between increased ratio of the posterior rotator cuff muscle volume and posterior deltoid to subscapularis cross-sectional volumes ($p<.01$) amongst groups but this did not correlate with degree of glenoid retroversion ($p=0.534$). Both B type glenoids had larger supraspinatus volumes compared to A type glenoids ($p=0.015$), but this difference did not correlate with increased glenoid retroversion or humeral subluxation. Posterior humeral subluxation in B2 glenoids was also not significantly correlated with any of the muscle volume ratios ($p=0.635$).

DISCUSSION AND CONCLUSION: Patients with eccentric and biconcave glenoid wear (Walch type B2) in the setting of primary glenohumeral OA and an intact rotator cuff appear to have larger combined posterior musculature, with the posterior deltoid having significantly larger volume. Although the development of eccentric wear is likely a multifactorial event, the increased muscle volume may indicate an abnormal pulling action that unbalances the glenohumeral forces and drives posterior humeral subluxation.