In Reverse Shoulder Arthroplasty, Glenoid Lateralization Significantly Increases the Risk of Acromial Stress Fracture, and Selectively Medializing Higher-Risk Patients Significantly Reduces It

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INTRODUCTION: Reverse shoulder arthroplasty (RSA) has roughly a 2-10% risk of acromial stress fracture (ASF), which may be associated with poor functional outcomes and carry a low union rate, operatively or nonoperatively. Previous finite element analyses indicated that glenoid center of rotation (COR) lateralization significantly increased acromial strain, however, clinical studies have reported conflicting data with regards to implant position parameters on the incidence of ASFs. Therefore, the purpose of this study was to delineate the risk factors for ASF in a single-surgeon series. We hypothesized that lateralizing the COR would increase the rate of ASFs. The senior author began medializing patients perceived to be at higher risk of ASF during the study period, and we hypothesized that doing so would decrease the rate of ASFs.

METHODS: We retrospectively evaluated primary RSAs performed by a single shoulder surgeon between October 2018 and September 2023, with minimum 3-month follow up. We excluded revision RSA and patients whose central fixation was placed in the base of the scapular spine. We evaluated patient factors, including age, gender, BMI, indication, and Deltoid Tuberosity Index (DTI), and implant factors, including glenoid COR lateralization, humeral lateralization, humeral distalization, and Levy classification. We compared continuous data with t-tests, and fisher exact tests. We also performed univariate and multivariate analyses to identify risk factors for ASF. During the 4th quarter of 2020, the senior author began selectively medializing patients at higher risk of ASF, so we compared the rate of and risk factors for ASF before (PRE group) and after (POST group) this time. P values less than 0.05 were considered significant.

RESULTS: We included 259 patients with mean follow-up of 13.8 months (+/-9.8), and a 4.6% incidence of ASF. On univariate analysis patient's with ASF were older (78.4 vs 73.6, p=0.04) and had more lateralized glenoids (11 of 12 ASFs were lateralized, p = 0.01), despite less humeral distalization. On multivariate analysis, glenoid lateralization was the only significant factor associated with ASF, with a 9.1 OR for ASF, p = 0.04. In the PRE group (n=72), 86% had lateralized glenoids, resulting in a 9.7% rate of ASF, while in the POST group after the senior author began selectively medializing glenoids in higher risk patients (n=156), only 48% had lateralized glenoids, resulting in a 1.9% rate of ASF (p = 0.02) (Table 1). The ASF rate decreased in the POST group despite 4 mm more distalization (p < 0.001) (Figure 1C). In the POST group, 2 of the 3 ASFs still occurred in lateralized glenoids. The largest change in the PRE and POST groups was medializing glenoids in woman with diagnoses other than osteoarthritis (Figure 1A and 1B).

DISCUSSION AND CONCLUSION: Glenoid lateralization was the most significant patient- or implant-related risk factor for the development of ASF. Specifically, 92% of ASFs occurred in lateralized glenoids, despite the ASF patients having less distalization. In addition, selectively medializing the glenoid in higher-risk patients, specifically women and those with massive rotator cuff tears, cuff tear arthropathy, inflammatory arthritis, and proximal humerus fractures, reduced the ASF rate from 9.7% to 1.9%, despite more humeral distalization in those patients.

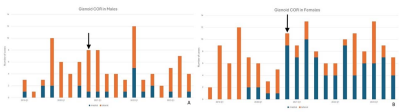

Figure 1. Selectively Medializing the Glenoid Center of Rotation (COR) in Higher-Risk Patients Significantly Reduces the Rate of Acromial Stress Fractures (ASF)
This histogram shows the number of lateralized (orange) and medialized (blue) glenoids during each quarter in males (A) and females (B). During the 4th quarter of 2020 (black arrow), the senior surgeon began selectively medializing the glenoid COR in patients at higher-risk for ASF, specifically women with diagnoses other than osteoarthritis, including massive rotator cuff tears, cuff tear arthropathy, inflammatory arthritis, and proximal humerus fractures.

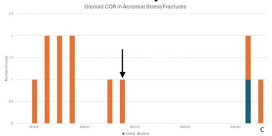

Figure 2. Selectively Medializing the Glenoid Center of Rotation (COR) in Higher-Risk Patients Significantly Reduces the Rate of Acromial Stress Fractures (ASF)
This histogram shows the number of ASFs in lateralized (orange) and medialized (blue) glenoids during each quarter. During the 4th quarter of 2020 (black arrow), the senior surgeon began selectively medializing the glenoid COR in patients at higher-risk for ASF, specifically women with diagnoses other than osteoarthritis, including massive rotator cuff tears, cuff tear arthropathy, inflammatory arthritis, and proximal humerus fractures. The rate of ASF decreased from 9.7% before this to 1.9% after (C), and 2 of the 3 ASFs after were still in lateralized glenoids.

Table 1. Patient and Implant Factors Before and After the Senior Surgeon Began Selectively Medializing the Glenoid Center of Rotation (COR) in Patients at Higher Risk of Acromial Stress Fracture (ASF)
The medial and lateral columns represent medialized and lateralized glenoid CORs. In Q4 2020, the senior surgeon began medializing the COR in patients at higher risk of ASF, specifically women with massive rotator cuff tears, cuff tear arthropathy, inflammatory arthritis, and proximal humerus fractures. The ASF rate decreased significantly in the Post Q4 2020 group despite more humeral distalization in that time period.

	Pre Q4 2020		Post Q4 2020		
Variable	medial	lateral	medial	lateral	p
n (%)	10 (13.9%)	62 (86.1%)	81 (51.9%)	75 (48.1%)	**0.02**
ASFs, n (%)	0 (0%)	7 (9.7%)	1 (0.6%)	2 (1.3%)	**0.04**
Female gender, n (%)	5 (8.9%)	40 (55.6%)	66 (43.6%)	32 (20.5%)	**0.01**
Age	76.3	78.3	73.9	70.6	**<0.01**
DTI	1.45	1.41	1.52	1.50	**0.01**
Diagnoses, n (%)					
Osteoarthritis	4 (5.6%)	10 (13.9%)	20 (12.8%)	11 (7.1%)	0.81
Cuff tear arthropathy	1 (1.4%)	26 (36.1%)	24 (15.4%)	40 (25.6%)	0.18
Massive rotator cuff tear	1 (1.4%)	16 (22.2%)	12 (7.7%)	17 (10.9%)	0.67
Inflammatory Arthritis	0 (0%)	5 (6.9%)	12 (7.7%)	9 (5.8%)	0.45
Trauma	5 (8.9%)	18 (25%)	28 (17.9%)	6 (3.8%)	**0.01**
Humeral lateralization, mm	47.77	47.71	49.26	51.32	**<0.01**
Humeral distalization, mm	23.38	20.86	26.72	26.4	**<0.01**