A Bimodal Relationship: Traumatic and Atraumatic Acromial and Scapular Spine Fractures after Reverse Total Shoulder Arthroplasty

Todd W. Phillips, Benjamin Garrett Fiedler, Albert D. Mousad, Casey Michelle Beleckas , Jonathan Chad Levy

INTRODUCTION:

Acromial and scapular spine fractures (ASF) are recognized complications following reverse total shoulder arthroplasty (RSA). Currently classifications of these fractures have been delineated into traumatic and atraumatic; however, the purpose of this paper was to characterizes the distinct temporal risk profiles of traumatic and atraumatic ASFs following RSA. The authors hypothesize that atraumatic fractures occur closer in time to the date of surgery while traumatic fractures occur farther from the surgical date, creating a bimodal distribution of ASFs.

METHODS: Using the methods published by Wan et al. in 2014 to estimate sample mean and standard deviation from the sample size, median, range, or interquartile range, the data available in the recently published “Risk factors of acromial and scapular spine stress fractures differ by indication: a study by the ASES Complications of Reverse Shoulder Arthroplasty Multicenter Research Group“ (ASES Complications of RSA Research Group, 2023) was utilized to run analysis on the temporal relationship of ASFs after RSA. Collected variables from the paper included nature of ASF (traumatic versus atraumatic), time to ASF, Pre-operative diagnosis (glenohumeral osteoarthritis (GHOA) or cuff tear arthropathy/massive cuff tear (CTA/MCT)), and patient risk factors for ASF including age, self-reported diagnosis of osteoporosis, female gender, and inflammatory arthritis. Analysis was performed following the formulas set in Equation 1. Estimates of mean and standard deviation for ‘time to ASF’ were calculated and stratified into traumatic and atraumatic cohorts. Subanalysis included stratification via pathologic indication for surgery (GHOA versus CTA/MCT). Descriptive statistics were utilized to analyzes significant differences in the time to ASF for each cohort.

RESULTS:

Of the 4764 included patients, there were 196 included ASFs – 44 traumatic and 52 atraumatic. From the analysis estimations, the mean time to traumatic ASF was significantly longer than atraumatic ASF, 41.8 months to 17.9 months respectively (p<.001). When stratified by surgical indication, there was a significant difference in temporal relationship between traumatic and atraumatic ASF in the CTA/MCT cohort, 39.9 and 17.7 months respectively (p<.001). The GHOA cohort did not show a significant difference between the timing of traumatic and atraumatic ASFs, 41.2 and 21.8 months respectively (p=.123).

DISCUSSION AND CONCLUSION:

The evidence suggests that there is a strong bimodal distribution of ASFs after RSA, especially in the CTA/MCT cohort. The authors posit that atraumatic fractures are found within the first two years of surgery from stress reaction whereas traumatic fractures typically present later from a traumatic event. Interestingly while the bimodal distribution held for the GHOA cohort, it was not found to be significant, which may be due to the protective nature of an intact rotator cuff on ASFs, delaying the appearance of atraumatic ASFs as seen in the data.

$$\bar{X} \approx \frac{q_1 + m + q_3}{3}$$

$$S \approx \frac{q_3 - q_1}{1.35}$$

or, if you have the sample size :

$$S \approx \frac{q_3 - q_1}{2\Phi^{-1}\left(\frac{0.75n+0.125}{n+0.25}\right)}$$

where q_1 is the first quartile, m the median, q_3 is the 3rd quartile and $\Phi^{-1}(z)$ the upper z^{th} percentile of the standard normal distribution.

Equation 1 – The equations described by Wan et al (2014) to estimate mean and standard deviation based upon sample size, median, range, or interquartile range.

Demographics			**Stratified Cohorts**					
Nature of ASF	196			GHOA			CTA/MCT	
Traumatic	44		N	1637		N	3127	
Atraumatic	152							
			ASF	34	2.10%	ASF	162	5.20%
Time to ASF	18.6	10.1, 40.9						
Traumatic	33.6	16.5, 75.4	Risk Factor			Risk Factor		
Atraumatic	14.4	9.5, 29.9	Female	927	57.20%	Female	1855	59.30%
			Osteoporosis	156	9.50%	Osteoporosis	441	14.10%
Pre-Operative Diagnosis	4764		Inflammatory Arthritis	89	5.40%	Inflammatory Arthritis	347	11.10%
GHOA	1637	34.40%	Age	71.7	7.7	Age	71.5	8.3
CTA/MCT	3127	65.50%						
			Traumatic	6	17.60%	Traumatic	38	23.50%
Risk Factor			Atraumatic	28	82.40%	Atraumatic	124	76.50%
Age	71.6	8.1						
Female	2792	58.60%	Time to ASF	16.9	10.9, 42.3	Time to ASF	18.6	10.1, 40.0
Osteoporosis	597	12.50%	Traumatic	34	19.4, 70.3	Traumatic	33.6	17.3, 68.7
Inflammatory Arthritis	437	9.20%	Atraumatic	13.1	10.7, 41.6	Atraumatic	14.9	9.3, 29.0

Table 1 – Demographic and Stratified Cohort Data collected from ASES Multicenter Study. Time to ASF is listed as median and interquartile range. ASF = Acromial and Scapular Fracture. GHOA = Glenohumeral Osteoarthritis. CTA/MCT = Cuff Tear Arthropathy/Massive Rotator Cuff Tear.

All Patients				p-value
Traumatic (n)	44	Atraumatic (n)	152	
Mean	41.83	Mean	17.93	**<.001**
STDev	43.63	STDev	15.11	

GHOA				
Traumatic (n)	6	Atraumatic (n)	28	
Mean	41.23	Mean	21.80	0.123
STDev	44.00	STDev	22.89	

MCTA/MCT				
Traumatic (n)	38	Atraumatic (n)	124	
Mean	39.87	Mean	17.73	**<.001**
STDev	38.07	STDev	14.59	

Table 2 - Time to acromial and scapular fracture (ASF) for all patients, glenohumeral osteoarthritis (GHOA), and Cuff Tear Arthropathy/Massive Cuff Tear (CTA/MCT) stratified by traumatic and atraumatic. STDev = Standard Deviation.