Acromial and Scapular Fractures after Reverse Shoulder Arthroplasty: Comparison of Inlay versus Onlay humeral design

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INTRODUCTION:
Periscapular fractures specifically acromial and scapular spine fractures, have been identified as one of the leading complications of RSA. However, very little is known of the etiology of these post-operative fractures, or how variations in humeral designs correlates with risk of post-operative fracture development. Therefore, the purpose of this study was to analyze the prevalence, timing, and relationship of humeral component design to acromial or scapular spine fractures.

METHODS: A retrospective study of primary reverse total shoulder arthroplasty (RSA) performed for elective and traumatic indications from two tertiary institutions. Exclusions consisted of primary oncologic reconstructions, diagnosis of osteogenesis imperfecta, and less than 1 year of clinical follow-up. A total of 3,018 primary RSA with a mean follow-up of 6.4 ± 3.8 years were included in the study. The implants utilized varied based on surgeon preference and included 9 different types. The humeral component of the RSA were categorized as an inlay design (n = 762; 25.2%) defined as a humeral component where the tray is seated within the metaphysis and an onlay design defined as a humeral component where the humeral tray sits on the metaphysis at the level of the humeral neck cut.
RESULTS: A fracture of the acromion or scapular spine was radiographically identified in 64 of 3018 (2.1%) RSA at an average of 8.5 months ± 12.6 months after surgery. The majority of fractures included the acromion (n = 57; 89.1%) and scapular spine (n = 7; 10.9). Non-operative management (n = 60; 93.8%) was the predominant treatment strategy for fractures, while 4 (6.2%) RSA underwent open reduction and internal fixation. When compared by humeral component design (inlay versus onlay), there was no differences in rates of acromial or scapular spine fractures (2.6% vs. 2.0%; P = .264). Similarly, there were no treatment differences between non-operative (90% vs. 95.5%) or operative management (10% vs. 4.5%) of the fractures based on the type of humeral component (P = .403).

Table I. Demographic and clinical characteristics among patients undergoing RSA stratified by the presence of an acromial or scapular spine fracture.

Variable	**Acromial or Scapular Spine Fracture (n = 64)**	**No Fracture (n = 2,954)**	**Overall Cohort (n = 3,018)**	***P***
Age at SA (yr.)	70.3 ± 9.1	71.3 ± 9.4	71.3 ± 9.4	.381
Sex				**.010**
Male	17 (26.6%)	1262 (42.7%)	1279 (42.4%)	
Female	47 (73.4%)	1692 (57.3%)	1739 (57.6%)	
BMI at SA (kg/m^2)	30.1 ± 5.4	30.6 ± 6.6	30.6 ± 6.6	.559
Previous Surgical Procedures				
Rotator Cuff Repair	17 (27.9%)	478 (17.2%)	495 (17.4%)	**.030**
Acromioplasty	5 (12.8%)	72 (3.2%)	77 (3.4%)	**< .001**
Diagnoses				.267
RCTA	45 (70.3%)	1727 (58.5%)	1772 (58.7%)	
Osteoarthritis	7 (10.9%)	654 (22.1%)	661 (21.9%)	
Acute Fracture	3 (4.7%)	199 (6.7%)	202 (6.7%)	
PTOA including malunion or non-union	4 (6.2%)	219 (7.4%)	223 (7.4%)	
IA	2 (3.1%)	69 (2.3%)	71 (2.4%)	
Other	3 (4.7%)	86 (2.9%)	89 (2.9%)	
Glenosphere sizes				**.012**
32 mm	8 (12.5%)	122 (4.1%)	130 (4.3%)	
36 mm	41 (64.1%)	1795 (60.8%)	1836 (60.8%)	
38 mm	4 (6.2%)	181 (6.1%)	185 (6.1%)	
39 mm	1 (1.6%)	12 (0.4%)	13 (0.4%)	
40 mm	2 (3.1%)	180 (6.1%)	182 (6.0%)	
41 mm	4 (6.2%)	415 (14.0%)	419 (13.9%)	

42 mm	4 (6.2%)	249 (8.4%)	253 (8.4%)	
Glenosphere size thresholds				**.019**
≤ 38 mm	54 (84.4%)	2098 (71.0%)	2152 (71.3%)	
> 38 mm	10 (15.6%)	856 (29.0%)	866 (28.7%)	
Humeral bearing configuration				
Inlay	20 (31.2%)	742 (25.1%)	762 (25.2%)	
Onlay	44 (68.8%)	2212 (74.9%)	2256 (74.8%)	
Follow-up (yr.)	5.6 ± 3.5	6.4 ± 3.8	6.4 ± 3.8	.080

BMI, body mass index; *RCTA*, Rotator Cuff Tear Arthropathy; *PTOA*, Post-traumatic osteoarthritis; *IA*, Inflammatory osteoarthritis
Data are presented as mean (standard deviation) or n (%)
Bold values represent statistical significance ($p < 0.05$)

Table II. Demographic and clinical characteristics among patients based on the humeral component design

Variable	**Inlay humeral component (n = 762)**	**Onlay humeral component (n = 2,256)**	***P***
Age at SA (yr.)	71.1 ± 9.8	71.4 ± 9.3	.454
Sex			.111
Male	304 (39.9%)	975 (43.2%)	
Female	458 (60.1%)	1281 (56.8%)	
BMI at SA (kg/m^2)	30.4 ± 6.5	30.6 ± 6.6	.528
Previous Surgical Procedures			
Rotator Cuff Repair	140 (20.3%)	355 (16.5%)	**.021**
Acromioplasty	13 (2.3%)	64 (3.7%)	.097
Diagnoses			**< .001**
RCTA	442 (58.0%)	1330 (59.0%)	
Osteoarthritis	151 (19.8%)	510 (22.6%)	
Acute Fracture	79 (10.4%)	123 (5.5%)	
PTOA including malunion or non union	49 (6.4%)	174 (7.7%)	
IA	12 (1.6%)	59 (2.6%)	
Other	29 (3.8%)	60 (2.7%)	
Glenosphere sizes			**< .001**
32 mm	122 (16.0%)	8 (0.4%)	
36 mm	181 (23.8%)	1655 (73.4%)	
38 mm	168 (22.0%)	17 (0.8%)	
39 mm	11 (1.4%)	2 (0.1%)	
40 mm	30 (3.9%)	152 (6.7%)	
41 mm	0 (0%)	419 (18.6%)	
42 mm	250 (32.8%)	3 (0.1%)	
Glenosphere size thresholds			**< .001**
≤ 38 mm	472 (61.9%)	1680 (74.5%)	
> 38 mm	290 (38.1%)	576 (25.5%)	
Acromial or Scapular Spine Fracture	20 (2.6%)	44 (2.0%)	.264
Fracture classification			.344
Levy Type 1	15 (75.0%)	25 (56.8%)	
Levy Type 2	4 (20.0%)	13 (29.5%)	
Levy Type 3	1 (5.0%)	6 (13.6%)	
Time to fracture	5.5 ± 8.4	10.1 ± 14.2	.188
Fracture management			.403
Non-operative treatment	18 (90.0%)	42 (95.5%)	
Open reduction internal fixation	2 (10.0%)	2 (4.5%)	
Follow-up (yr.)	6.6 ± 4.4	6.3 ± 3.6	.090

BMI, body mass index; *RCTA*, Rotator Cuff Tear Arthropathy; *PTOA*, Post-traumatic osteoarthritis; *IA*, Inflammatory osteoarthritis
Data are presented as mean (standard deviation) or n (%)
Bold values represent statistical significance ($p < 0.05$)

DISCUSSION AND CONCLUSION: Acromial and scapular spine fractures complicated the postoperative course of 2.1% of primary RSA when performed across two high volume shoulder arthroplasty centers with multiple surgeons including all implant types. Most of the fractures involve the acromion, with less frequent involvement of the spine of the scapula. When compared by inlay versus onlay humeral component design, the rates of post-operative acromial or scapular spine fractures were statistically similar.