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Subacromial decompression for impingement syndrome following type II acromion fracture nonunion



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Acromion and scapular spine fractures (ASFs) remain common complications following reverse total shoulder arthroplasty (rTSA), with a reported incidence of 3.9%.¹¹ Several prior studies have identified patient-specific risk factors for ASF, including advanced age, female gender, osteoporosis, and cigarette smoking.^{13,16} Implant selection and positioning may also be implicated in augmenting risk for ASF¹⁴ as well as surgical indication and scapular morphology.^{1,12} While the current literature extensively describes factors to identify at-risk patients, the proper management of acute and nonunited fractures remains unclear.

ASFs have historically been treated nonoperatively, given the unpredictable outcomes of patients treated with fixation techniques, which have been associated with high failure rates and complications.^{19,20} However, those patients with medial ASF fractures (Levy type IIB and III) have demonstrated unacceptably low patient-reported outcome measures and high rates of dissatisfaction, suggesting that the nonoperative management of these fractures is inadequate.³ Lateral fractures (Levy type I and IIA) fractures typically demonstrate minimal impact on postoperative outcomes and patient satisfaction as compared with rTSA controls without fractures.³ As the understanding of the nuances of surgical and nonoperative management continues to grow, an algorithm is needed to better direct a surgeon in their clinical decision-making,

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with appropriate operative options for even those lateral type I and IIA fractures that fail nonoperative treatment and progress to nonunion.

Nonunion of the lateral acromion is associated with a tilting of the lateral fragment and can result in symptomatic subacromial impingement by further reducing the space between the greater tuberosity and an inferiorly tilted lateral acromion. While implant design and positioning in rTSA have been tailored to reduce impingement at the scapular pillar and avoid scapular notching, there has been less investigation into maintenance of sufficient subacromial space. The lateralization of the rTSA center of rotation, which has been associated with an increase of impingement-free range of motion, enhanced stability, and decreased scapular notching or adduction impingment.^{57,9} may also be associated with greater abduction (Abd) impingement.¹⁰ Consequential subacromial notching, an erosion by repeated Abd impingement, has been observed radiographically in as high as 12.8% of rTSA patients and may be associated with poor clinical outcomes.⁸

Despite the growing understanding of the impact of Abd impingement, there is a paucity of research describing the incidence and management of subacromial impingement following ASF in the setting of rTSA. The potential role of subacromial decompression (SAD) in treating impingement due to acromion fractures following reverse shoulder arthroplasty has not yet been investigated. This case report describes a patient who underwent bilateral rTSA 8 years apart, using two different implant systems, both complicated by acromion fracture in the same location and persistent symptomatic Abd impingement. Patient consent for research participation was obtained. We describe the treatment of the ASF nonunion utilizing an open acromioplasty, turberoplasty, and implant exchange during revision surgery in an effort to resolve painful acromion impingement.

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All work was performed at the Levy Shoulder to Hand Center at the Paley Orthopedic and Spine Institute (9960 N Central Park Blvd. Suite 150A, Boca Raton, FL 33428).

Institutional review board approval was not applicable for this case report.

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Figure 1 Anterior-posterior (A) and axillary (B) views of the patient's right shoulder at initial presentation, with multiple retained anchors from a prior failed rotator cuff repair visible and superior migration of the humeral head noted.

Case presentation

A 64-year-old right hand-dominant male presented to the clinic with insidious-onset right shoulder pain and loss of motion following a failed right rotator cuff repair over a decade prior. Clinical examination of the right shoulder revealed pseudoparesis and loss of function. The patient could only actively range his shoulder 30 degrees in forward flexion (FF), 60 degrees in Abd, and 40 degrees in external rotation (ER), with dynamic instability and anterosuperior escape. The patient demonstrated weakness in supraspinatus, ER, and internal rotation strength testing.

Radiographs (Fig. 1) revealed mild glenohumeral arthritis with superior migration of the humeral head, consistent with rotator cuff tear arthropathy. Having failed conservative management, including physical therapy and cortisone injections, the patient elected to proceed with a right reverse shoulder arthroplasty.

The primary surgery consisted of a routine, cementless reverse shoulder arthroplasty through a standard deltopectoral incision using an inlay humeral component (AltiVate RSP; DJO Global, Lewisville, TX, USA) and a lateralized glenosphere (32 Neutral, 10 mm lateralized center of rotation). The humeral osteotomy was made in 30° of retroversion. The subscapularis was repaired to the lesser tuberosity after the final implants were placed. There were no surgical complications. The radiographs taken immediately postoperatively are presented in Figure 2, *A*.

The patient was followed up on routine intervals of 6 weeks, 3 months, and 6 months. At the three-month follow-up, the patient presented with superior shoulder pain and limited function following an initial improvement in his motion and pain. Routine interval radiographs demonstrated a Levy type IIA acromion fracture (Fig. 2), with correlating tenderness over the acromion on examination. The expectation was for improvement in function and pain over time, and the fracture was treated nonsurgically with a 6-week period of protected immobilization and table-slide exercises. At 6 months postoperatively, the patient complained of persistent lateral shoulder pain with Abd with limited range of motion (100 FF and 55 Abd) and painful crepitus with Abd on examination, despite there no longer being tenderness over the acromion. A computed tomography scan confirmed the type IIA acromion fracture nonunion (Fig. 3).

The patient expressed their dissatisfaction with their complicated postoperative course and elected for revision surgery. The revision surgery consisted of an open acromioplasty, using a 4 mm round burr to resect the majority of the lateral acromion fragment, leaving a thin shell of superior cortical bone to preserve the deltoid origin. In addition, the glenosphere was exchanged from a 32 Neutral (10 mm lateralized center of rotation) to a 36 Neutral (6 mm lateralized center of rotation) in an effort to distalize the humerus away from the acromion. A 360° periglenoid release was performed. The humeral polyethylene was exchanged for a +4 to optimize soft tissue balance following the glenosphere exchange. The original humeral polyethylene was removed using a 6.5 mm screw. A tuberoplasty was also performed by burring down any possible impingement points on the greater tuberosity around the well-fixed humeral component. The procedure was performed through the same deltopectoral incision. There were no surgical complications. The radiographs taken immediately postoperative are presented in Figure 4.

The patient had an uncomplicated postoperative rehabilitation course for the right shoulder after the revision surgery was satisfied with their pain relief and restored function. The patient was seen for his two-year follow-up appointment (Fig. 5) and endorsed continued satisfaction.

Almost five years later (8 years following his right reverse shoulder replacement), the patient presented for a new complaint of left shoulder pain. He continued to be pleased with the pain-free function of his right shoulder at this time and was hoping that his left shoulder could achieve a similar outcome as that of his right shoulder. The patient had recently been treated with a reverse shoulder arthroplasty at another institution using a different implant system (Comprehensive; Zimmer Biomet, Warsaw, IN, USA) after a failed prior rotator cuff repairs from years prior. His postoperative course was complicated by an early Levy type IIA acromion fracture sustained 4 weeks postoperatively, which was treated with open reduction and internal fixation using a tension band construct with K-wires (Fig. 6). A wire had shifted and required surgical removal. He presented to the clinic with significant left shoulder pain and loss of function with 80 degrees of painful active FF, 60 degrees of Abd, and zero degrees of ER. The patient demonstrated weakness in supraspinatus, ER, and internal rotation strength testing. There was no clinical suspicion of infection.

Given the success he experienced with his right shoulder, the patient again elected to proceed with a similar revision surgery for

A.D. Mousad, B. Lack and J.C. Levy



Figure 2 Anterior-posterior views of the patient's right shoulder immediately postoperatively (**A**), 6 weeks postoperatively (**B**), and 3 months postoperatively (**C**&**D**). Radiographs at 3 months postoperatively revealed a Levy type IIA acromion fracture. Of note, the blue line indicates a reduced subacromial space between (**B**) and (**C**).



Figure 3 Axial cuts (A and B) of the computed tomography scan of the patient's right shoulder at 6 months postoperatively, confirming a Levy type IIA acromion fracture.

his left shoulder. A computed tomography scan of the left shoulder was taken before the reoperation (Fig. 7). The revision surgery consisted of removing the tension band and K-wires as well as performing an open acromioplasty, tuberoplasty, and glenosphere exchange to maximize impingement-free Abd in the setting of the inferiorly tilted lateral acromion. The prior deltopectoral incision was utilized. The previous humeral polyethylene tray and 36+3 glenosphere were removed. A tuberoplasty and acromioplasty were performed using the identical technique used on the contralateral shoulder 8 years prior. A 40+3 glenosphere was dialed with the eccentricity inferiorly with a 3+ offset standard tray placed with the goal of maximizing impingement-free motion. Intraoperative assessment of range of motion demonstrated forward elevation to 160 degrees and Abd to 90 degrees with no crepitus or Abd impingement. The final implants were placed and the incisions were closed. There were no surgical complications.

The radiographs taken immediately postoperatively are presented in Figure 8.

The patient again had an uncomplicated postoperative rehabilitation course for the left shoulder after the revision surgery and was satisfied with their pain relief and restored function. The patient was last seen for his 6-month follow-up appointment (Fig. 9) and endorsed continued satisfaction. Table 1 summarizes the patient's patient-reported outcome measures and examination findings over the nine-year clinical course, which included bilateral revision reverse shoulder arthroplasties with open SAD that yielded significant pain relief and restored shoulder function.

Discussion

This case demonstrates an often overlooked etiology of pain after ASF nonunion. By both increasing humeral distalization with



Figure 4 Axillary (A), anterior-posterior (B), and scapular Y (C) radiographs of the patient's right shoulder immediately after revision surgery.



Figure 5 Axillary (A) and anterior-posterior (B) radiographs of the patient's right shoulder, 2 years following revision surgery, demonstrating good positioning of the implants and no evidence of loosening, new fracture, or subluxation.



Figure 6 External rotation (A), scapular Y (B), and anterior-posterior (C) radiographs of the patient's left shoulder at initial presentation to clinic, demonstrating hardware consistent with a prior reverse shoulder arthroplasty and open reduction and internal fixation of a Levy type IIA acromion fracture with a tension band construct and Kirschner-wires.



Figure 7 Sagittal (A) and axial (B) computed tomogrpahy scan of the patient's left shoulder at 9 months postoperatively from open reduction and internal fixation of a Levy type IIA acromion fracture.

an implant exchange and concurrently performing a tuberoplasty and acromioplasty, the resolution of painful Abd impingement was achieved. Both revision surgeries achieved optimal improvement in pain relief and function without complication. While nonoperative treatment of lateral acromion fractures (Levy type I and IIA) have been shown to have equivalent outcomes when compared to control rTSA patients who did not sustain ASF despite high nonunion rates,³ there may be patients who remain symptomatic. The described surgical technique in this case report provides an alternative surgical option for the patient with persistent pain.

Proper management of ASFs after rTSA remains controversial, with up to a 61% nonunion rate after nonoperative management of acromion fractures and variable results after historical open reduction and internal fixation efforts.³ This is the first case report demonstrating a favorable outcome in a patient who underwent open revision surgery to address impingement-related pain due to the inferior tilted acromion in the setting of a nonunion. The resolution of pain and preservation of function following identical procedures 8 years apart provides hope that this surgical technique

may provide a salvage option for those patients with persistent impingement-related pain with a lateral ASF nonunion.

The potential risk of deltoid dysfunction with acromion resection, especially considering the intimate origin of the intermediate deltoid muscle fibers along the lateral acromial border, has historically demonstrated poor outcomes.¹⁵ However, these outcomes are often exclusively in the context of complete acromionectomies and were later attributed to failure of adequate deltoid repair rather than acromion resection itself.⁴ Excellent, near-normal shoulder function has been reported following complete acromionectomy when an intact deltoid is present,¹⁸ as it was in this case with well-maintained deltoid function before and after the bilateral procedures (Table I). This is why special care is taken to not disrupt the shell of superior cortical bone to preserve the deltoid origin while performing the acromioplasty portion of the revision surgery.

While adduction impingement and scapular notching are wellestablished complications following rTSA, Abd impingement and subacromial notching have been less thoroughly investigated.² The rates of subacromial notching have been reported to be from 2.9% to



Figure 8 Axillary (A), anterior-posterior (B), and scapular Y (C) radiographs of the patient's left shoulder immediately after revision surgery.



Figure 9 Axillary (A) and anterior-posterior (B) radiographs of the patient's left shoulder 6 months following revision surgery demonstrating good positioning of the implants and no evidence of loosening, new fracture, or subluxation.

Table I

Timeline of patient outcomes.

	Active range of motion (FF/ABD/ER/IR)	Strength (Delt/SS/ER/IR)	ASES	SANE	SST	VAS function	VAS pain	Satisfaction	Same surgery again?
Right shoulder									
Preoperation (primary rTSA)	30/60/40/T12	5/3/4/4	30	15	2	1	7	N/A	N/A
Type 2A acromion fracture nonunion diagnosed by radiographs (3 mo following primary rTSA)									
3-mo follow-up	60/45/50/GT	5/4/5/5	22	15	2	4	7	Satisfactory	Yes
6-mo follow-up	100/55/55/GT	4/4/5/5	27	30	2	2	8	Unsatisfactory	No
Preoperation (revision rTSA, SAD)	75/50/50/sacrum	5/4/5/5	23	23	3	0	7	Unsatisfactory	No
6-mo follow-up (from revision)	40/40/40/sacrum	5/4/5/5	22	14	3	1	8	Unsatisfactory	No
2-y follow-up (from revision)	120/50/50/T10	5/4/4/5	35	47	5	5	8	Unsatisfactory	No
7-y follow-up (from revision)	145/100/55/T6	5/5/5/5	80	72	11	8	3	Good	Yes
Left shoulder									
Representation or preoperation (Revision rTSA, SAD)	80/30/0/sacrum	5/4/4/4	38	28	3	2	7	N/A	N/A
3-mo follow-up	110/70/40/sacrum	5/5/5/5	78	56	7	5	0	Excellent	Yes
6-mo follow-up	120/90/50/L5	5/4/4/4+	63	41	5	6	0	Satisfactory	Yes

rTSA, reverse total shoulder arthroplasty; *SAD*, subacromial decompression; *FF*, forward flexion; *ABD*, abduction; *ER*, external rotation; *IR*, internal rotation; *GT*, greater trochanter; *Delt*, deltoid; *SS*, supraspinatus; *ASES*, american shoulder and elbow surgeons; *SANE*, single assessment numeric evaluation; *SST*, simple shoulder test; *VAS*, visual analog scale.

12.8%, likely influenced by several implant-specific factors.^{8,17} Pak et al found a low rate of subacromial notching (2.9%) utilizing a 135 degree inlay system and found that subacromial notching was not associated with poor patient-reported outcomes or range of motion.¹⁷ A number of additional factors have also been demonstrated to increase subacromial space in biomechanical studies, including glenosphere distalization, glenosphere inferior tilt, and utilizing humeral components with a more valgus neck shaft angle – all of which can also be considered when planning for implant exchange in revision surgery.²

In this case, the subacromial space was dramatically reduced by the lateral nonunion segment. A more extensile open approach for the tuberoplasty and acromioplasty was performed, and given the optimal outcome on the first side, the identical approach was used again when the same indication presented on the contralateral shoulder. One might extrapolate that the tuberoplasty and SAD could be done in an arthroscopic fashion. A technique to treat Levy type I acromial fracture nonunion by arthroscopic excision has been described but lacks clinical outcome data.⁶ While this may be explored in the future, the ability to add additional modular implant changes makes the open surgical approach more attractive. Obviously, open surgical revision is associated with a higher complication rate than arthroscopic approaches. Future studies and efforts at exploring arthroscopic management of impingement-related pain from acromion nonunion are justified.

Conclusion

This case report highlights open SAD as an effective means of treating postoperative impingement syndrome secondary to the inferior tilt of a lateral acromion fracture nonunion. This technique presents a novel surgical option for those faced with difficult clinical decisions associated with managing acromion fracture nonunion following rTSA.

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