Case Report

Reconstruction of a Recalcitrant Scapular Neck Nonunion and Literature Review

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Abstract We present the first reported treatment failure of a reconstructed scapula body that proceeded to nonunion. This is a unique case report of an otherwise healthy patient who underwent open reduction and internal fixation of a scapula fracture nonunion, which is very rare. Failure of internal fixation in this application has not been reported, and, to our knowledge, this is only the fifth case report of a scapula body nonunion that was reconstructed. Of 159 reported cases of open reduction and internal fixation for treatment of scapula neck and body fractures (with or without intraarticular glenoid fractures), there is not one reported case of a nonunion. Our case is described in detail, including the method of surgical reconstruction, and a review of the literature regarding surgical treatment of scapula nonunions after nonoperative treatment also is presented.

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Each author certifies that his or her institution has approved the reporting of this case report, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Scapular fractures are rare, comprising less than 1% of all fractures and only 3% to 5% of all osseous injuries to the shoulder girdle [28, 32, 36]. The most common area of the scapula to be fractured is the body [23, 24, 35]. Although nonoperative management of scapular body fractures is recommended routinely and generally results in fracture union with acceptable functional outcomes [15, 23, 24, 35], some authors suggest surgery for highly displaced scapular fractures [1, 2, 14].

Nonunion of any type of scapula fracture is extremely rare. A 2008 English-language search of the medical literature discovered only 15 cases of scapula nonunion after nonoperative management. These reported cases included four body fractures [11, 13, 16, 25], five acromion fractures [8, 9, 26, 27, 29], three scapular spine fractures [1, 4, 31], two coracoid fractures [12, 29], and one report of a nonunion involving the scapular body, spine, and coracoid process [5].

In the asymptomatic or minimally symptomatic patient with a scapula nonunion, observation and/or functional rehabilitation remain the preferred treatment. However, in the patient with pain, deformity, and/or shoulder dysfunction, surgical management may be indicated. Isolated case reports of symptomatic scapular body nonunions treated with open reduction and internal fixation (ORIF) and local bone grafting have consistently described good outcomes, reporting complete radiographic healing with pain-free restoration of function and no loss of power in the muscles of the shoulder girdle [11, 13, 25] (Table 1). There is also one report of partial body excision for ununited segments [16]. Surprisingly, there are no reports of scapula nonunion after operative management.

We present the case report of a patient who had undergone ORIF of the scapula body for a symptomatic

Table 1. Summary of scapular nonunion case reports

Study (year)	Location of scapula nonunion				Treatment	Followup (months)	Outcome
	Scapula body	Acromion	Scapula spine	Coracoid			
Ada and Miller [1] (1991)			1		ORIF	15	—
Bohm [4] (1998)			1		ORIF	12	Pain-free, active
Charlton et al. [5] (2003)	1*		1*	1*	ORIF	60	Pain-free, no instability in shoulder function
Darrach [8] (1914)		1			ORIF	2	Improved shoulder motion
Douchis et al. [9] (1999)		1			ORIF	9	Pain-free, full ROM
Ferraz et al. [11] (2002)	1				ORIF	24	Pain-free, full ROM and strength
Garcia-Elias and Salo [12] (1985)				1	Excision	3	Minimal discomfort, returned to work
Gupta et al. [13] (1998)	1				ORIF	24	Pain-free, symmetric motion
Kaminsky and Pierce [16] (2002)	1				Resection	4.5	Asymptomatic, returned to all activities
Michael et al. [25] (2001)	1				ORIF	—	Pain-free, full ROM and normal strength
Mick et al. [26] (1983)		1			ORIF	12	Pain-free, full function of the shoulder
Naested et al. [27] (1995)		1			ORIF	—	—
Ogawa and Naniwa [29] (1997)		1		1	ORIF	12	Fracture union, but recovery from complete brachial plexus palsy was inadequate
Robinson and Court-Brown [31] (1993)			1		ORIF	—	Successful
Current study (2008)	1				ORIF	36	After revision ORIF: unrestricted function with occasional mild pain

* Single patient with nonunion involving body, spine, and coracoid; ORIF = open reduction and internal fixation; ROM = range of motion.

nonunion after prolonged nonoperative treatment and who then had another nonunion. Postoperatively, despite a return to activities within 3 months, the patient presented again with clinical and radiographic evidence of a persistent pseudarthrosis. We detail our experience of successfully managing this recalcitrant nonunion with revision surgery and present 3-year followup data. We also provide a comprehensive review of the literature pertaining to nonunions of the scapula.

Case Report

The patient was a 42-year-old, healthy, right hand-dominant man with a medical history noteworthy for left closed scapular neck fracture sustained after a motor vehicle collision. Associated injuries included ipsilateral clavicle and rib fractures. The patient was managed nonoperatively with a brief period of immobilization. Three weeks postinjury, the patient was advised to begin gentle active range-of-motion (ROM) exercises. Six weeks postinjury, the patient was

referred to physical therapy to continue active ROM exercises and begin active, assisted and passive ROM exercises as well. Throughout the initial 6-month followup, the patient continued to report substantial pain, weakness, and a sense of catching with shoulder motion. Followup radiographs revealed scapular nonunion (Fig. 1). The patient was a nonsmoker and nondiabetic who specifically denied non-steroidal antiinflammatory medication or steroid use and described no other medical problems. At the same time, multiple rib nonunions were seen on plain radiographs. This concomitant injury did not cause any long-term morbidity nor impact the course of treatment for the scapula nonunion. The patient was asymptomatic for this condition.

On examination 6 months postinjury, the patient had marked tenderness to palpation of the scapula with palpable mobility and gross crepitation at the nonunion site. The patient had full active and passive ROM of the left shoulder but considerable weakness in all planes according to the first treating surgeon. A CT scan corroborated the suggested findings of a nonunion seen on radiographs. Eight months postinjury, the patient underwent ORIF (Fig. 2)

Fig. 1A–B (A) anteroposterior and (B) scapula Y view radiographs obtained 6 months postinjury reveal a scapular nonunion.

Fig. 2A–B Intraoperative radiographs obtained 8 months after injury of the left shoulder: (A) anteroposterior view and (B) axillary view, demonstrating fixation of the nonunion at the time of the patient's first surgery.

with autologous iliac crest bone graft augmentation. Cultures taken from the nonunion site were negative.

Postoperatively, the patient was compliant with the recommended regimen of brief immobilization followed by gentle exercises at 1 month. After 4 months, he noted resolving symptoms and increased ROM (FF-150, ABD-120, IR-T4, ER-70) with improved subjective strength. Radiographs showed persistent lucency, although the hardware revealed no signs of loosening or failure, and consolidation of the nonunion seemed to have started. As a

result of the marked clinical improvement, the patient's activities were advanced as symptoms would allow with no definitive restriction of activities.

Seven months postsurgery, the patient again presented with a chief complaint of recurrent left shoulder pain after a relatively minor car accident in which he sustained no bodily injuries. Repeat radiographs of the left shoulder (Fig. 3) showed a major angular deformity of the glenoid neck with multiple broken and loose screws. The patient had admitted to persistent symptoms even before the

Fig. 3 Four months after the initial ORIF, an anteroposterior radiograph shows hardware failure and an angular deformity of the scapular neck.

accident. The patient initially was managed nonoperatively. However, during the next several weeks, he noted the persistence of left shoulder pain, weakness, and instability. At this juncture, he was referred to one of the senior authors (MFS).

Nine months postsurgery, an examination showed loss of ROM in all planes (FF-140, ABD-120, IR-T12, ER-60) and major weakness in external rotation relative to the opposite side. Motion was measured specifically with a goniometer. The surgeon concluded the patient had a nonunion rather than a refracture given conditions of the bone and fractured hardware. The decision then was made to render a biologic and mechanical surgical solution to achieve healing at the site and thus 16 months after his original ORIF, the patient underwent reconstruction of the scapula by the senior authors (PAC, MFS).

With the patient in the right lateral decubitus position, the scapula was approached using the previous incision extending from the posterior edge of the acromion along the spine, curving along the medial scapular border to the inferior angle distally. Periosteocutaneous flaps along the inferior edge of the spine, the acromion, and vertebral border were raised. The infraspinatus, teres minor, and deltoid muscles were elevated off the posterior scapula body

exposing the nonunion. A periosteal elevator was used to mobilize the musculature from the fossa and reflect it laterally taking great care not to generate excessive traction on the suprascapular nerve and artery. Once the infraspinatus and teres minor were elevated, the plate along the posterior aspect of the glenoid was viewed and found to be intact. This plate and the plate along the medial border of the scapula were removed. The lateral plate was grossly loose with three screws broken along the lateral border where the nonunion was easily appreciated extending into the body medially. With the plate removed, the nonunion site was exposed further using a lamina spreader. Fibrous tissue was curetted and discarded to mobilize the glenoid (proximal) segment and the deformity was corrected by aligning the lateral borders. A Schanz pin in the glenoid neck allowed for this reduction maneuver. Autologous iliac crest bone graft was harvested and mixed with 10 cc of an autologous platelet aggregate substance (SYMPHONY; DePuy Spine, Inc, Raynham, MA) and this was applied to the defect. A 3.5-mm locking reconstruction plate was contoured to fit the posterior aspect of the glenoid neck and extend down along the lateral scapular border. This nine-hole plate had all its holes filled with 3.5-mm screws achieving balanced fixation. To obtain greater rigid fixation, another six-hole, 2.7-mm reconstruction plate was placed along the glenoid neck across the nonunion site. A suction drain was placed below the muscle flap and the infraspinatus and teres musculature were reattached with braided Number 2, nonabsorbable sutures through multiple drill holes along the scapula border. The rest of the fascial margin was repaired with absorbable, braided Size 0 sutures.

Rehabilitation included postoperative pendulum exercises during the first week followed at 3 weeks by passive flexion to 90° and full passive external rotation. At 6 weeks, active ROM exercises were initiated followed by a program of scapular strengthening 3 months after surgery. The patient's recovery was unremarkable, and he returned to work and all preoperative physical activities.

At the 1-year followup, the patient reported minimal shoulder discomfort. On examination, he had full active left shoulder motion, nearly symmetric to the opposite extremity, specifically FF-170, ABD-140, IR-T7, and ER-75. Subtle infraspinatus atrophy and weakness (graded as 4 +/5) with external rotation relative to the contralateral extremity were noted.

At 3-year followup, the patient reported occasional mild pain over the posterolateral aspect of the scapula (in the region of the latissimus dorsi) but was able to use his left arm in an unrestricted manner. On examination, he had improved ROM in all planes and minimal weakness was detected in the rotator cuff, deltoid, biceps, and triceps muscles compared with the contralateral side. Radiographs (Fig. 4) showed osseous union of the scapula.

Fig. 4A–B (A) Anteroposterior and (B) scapula Y view radiographs of the left shoulder taken 3 years after revision ORIF of the scapular nonunion are shown. The retained broken screw fragments are from the original surgery.

Discussion

Nonunion after closed management of scapula fractures is extremely rare with only 15 reported cases in the English literature and, although the body is the most commonly reported region of the scapula to be fractured [23, 24, 35], nonunions in this area have not been frequently reported. Of the 15 reported nonunions, 13 have been treated successfully by ORIF. The remaining two of 15 cases were treated with resection or excision (Table 1).

This is the first report of failed treatment using ORIF after a scapula fracture nonunion. In addition to this, we specifically reviewed the literature for all operatively treated scapula neck and body fractures using ORIF. To our knowledge, of the 159 reported operatively treated scapula neck and body fractures, nonunion was not once cited as a complication [1–3, 5, 10, 11, 13, 14, 17–22, 25, 30, 33–35]. Remarkably, the collective nonunion rate of these reported 159 operative cases is 0%.

Appreciation of the rare but possible occurrence of nonunion after ORIF of a scapula fracture is important for all surgeons who would attempt surgery on scapula fractures. In addition to counseling the patient about this risk, the surgeon should make an effort to discover any preexisting patient risk factors for nonunion and intervene as necessary. In the operating room, attention must be paid to the biologic matters such as soft tissue injury and bony stripping, and optimal fixation must be rigid and have sufficient biomechanical strength to withstand early rehabilitation. Fixation must be balanced and maximized, particularly in the proximal segment where there may be a short working length of the plate.

As with primary surgical treatment of fractures, there are several key principles and technical considerations recommended to ensure adequate fixation and stabilization of displaced scapula body nonunions. Plate lengths should

be chosen to span the longest length possible, yet only enough of the fractured border to yield balanced fixation, thus reconnecting the perimeter of the scapula and rendering stability by offloading the rotational forces at each fracture site [6]. Also, longer plates (particularly when they are nonlocking) are used to increase the working length of the plate. This is particularly true for the lateral border of the scapula, which transmits the greater stresses given its lateral-most position (and moment arm) and the weight of the extremity. The plate can be contoured in a way to gain length proximally by sweeping up proximal to the neck to the base of the acromion [7]. Alternatively, in cases in which there is lateral border comminution, double plating can be performed if necessary as demonstrated in our patient's reconstruction to further enhance stability. Finally, locked plates can be a consideration to increase holding strength over the working length of plates that are at times necessarily short (such as a high scapula neck fracture) and when screw lengths are short as a result of the narrow and thin corridors for bony fixation seen in the scapula.

The nonunion in our patient may have been caused in part by several factors. It is possible that the original fixation did not provide the stability necessary given that only two screws were used for fixation on the proximal side of the main lateral border fracture line. This was not balanced fixation in that the moment arm on such a small proximal working length of the plate was large. Given that the patient was overly aggressive with postoperative extremity use, if not noncompliant, the race between the fracture healing (or healing inadequately) and implant breaking was lost. Also, the patient may have had an incomplete period of relative immobilization and rest after his index surgical fixation. He rehabilitated very aggressively early in the first postoperative period and admitted to have prematurely resumed his regimen as a weightlifter. In addition, given

the patient's avid weightlifting and very muscular body habitus, although he denied it, there was suspicion of steroid use. If this had been true, it would offer partial explanation for the scapular nonunion and the rib nonunions, which were noted even at the 3-year followup (Fig. 4). However, the patient did seem well nourished by his description and appearance, and his hematocrits were normal around the time of surgeries. Workups for other rare systemic diseases were not done. Finally, it is possible a blow to the shoulder during the motor vehicle accident sustained early after his first surgery caused early partial failure of fixation. Ultimately, for whatever reason, the primary fixation construct could not tolerate the forces that came to bear on the shoulder in the early postoperative period.

Successful reconstruction of any nonunion demands attention to biomechanical and biologic factors. For any patient who has such a rare lesion such as a scapula nonunion, attention should be paid to risk factors for nonunion; thus, surgical fixation perhaps should be more stable than that used for more usual circumstances such as with most fractures. For the same reason, postoperative physical therapy should be gradual and measured. We believe in this case the biologic solution mandated the gold standard of autologous bone grafting, and enhancement was sought with platelet-rich plasma. Additionally, decortication of local bone and maximization of bony contact (particularly the lateral scapular border) was done. For fixation, our biomechanical solution involved multiple carefully contoured plates (including a 3.5-mm locking plate and a 2.7-mm reconstruction plate) positioned to achieve maximum compression and rigid fixation of the bone. Finally, our patient's postoperative rehabilitation protocol included immediate but strict passive ROM exercises for 1 month followed by 1 month of active ROM. By the third month, the patient was allowed to gradually lift weights starting with 3 to 5 pounds and work toward elimination of restrictions as symptoms allowed. Large forces on the shoulder girdle, such as during weightlifting, were disallowed for the first 3 months postoperatively.

This case report illustrates achieving successful union and excellent function after reconstruction of a previously operated scapula with appropriately supervised rehabilitation is possible.

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