

# Cuff Arthropathy, Scapular Spine Fracture Non-union, and Instability: Open Reduction, Internal Fixation & Simultaneous Reversed Shoulder Arthroplasty – A Case Report

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## Learning Point of the Article:

Double plating with locking fixation and spanning of the entire scapular spine and acromion when fixing fractures and non-unions related to reverse shoulder arthroplasty are essential to achieve durable results.

## Abstract

**Introduction:** This article presents a simultaneous operative technique, which allowed to successfully treat a Cuff Tear Arthropathy (CTA), instability and Levy-type III scapular spine fracture non-union with 90°-double plating, humerus-to-scapula grafting and simultaneous reverse shoulder arthroplasty.

**Case Report:** We present a 64-year-old woman with previously known cuff arthropathy (2012/53yo). She fell in 2017 (58 years old with minor shoulder disability) before dislocating the shoulder in 2020 (60 years old) with evidence of a medial Levy-type III scapular spine fracture non-union and severe apprehension, unable to anteriorly elevate her arm more than 90°. She underwent ORIF of a flexed scapular spine with locked 90°-double plating and bone grafting as well as simultaneous lateralized reverse shoulder arthroplasty (RSA) with an excellent outcome at 3.5 years of follow-up (Constant score of 84 points and a subjective shoulder value of 99%).

**Conclusion:** The radiographic sequence suggests an abduction fracture mechanism due to an axial force. RSA with simultaneous locked 90°-double plating with grafting from the humeral head achieved correction and union with an outstanding result despite tensioning the deltoid with a lateralized RSA. To deal with excessive forces, five important practical recommendations are essential: (1) assess the bone stock with a CT-scan, (2) span the scapular spine and acromion with a long superior plate and its screws, (3) use at least two locking screws on either side of the fracture on each plate, (4) avoid stress risers from erroneous drilling, and (5) protection with an abduction sling for 6–8 weeks.

**Keywords:** Scapular Spine fracture, fracture Non-union, open reduction and internal fixation, 90°-double plating, reverse shoulder arthroplasty.

## Introduction

Scapula fractures make up 1% of all fractures, and only 10% of all scapula fractures involve the scapular spine (SS) and/or acromion [1].

The acromion and scapular spine origin of the deltoid muscle often apply flexion forces leading to a downward tilt of the distal acromion fragment exposing the patient to sub-acromial impingement. Open reduction and internal fixation (ORIF) in

Levy type II-III fractures should thus be considered [2, 3].

Non-union is a complex orthopedic problem and may be defined as the absence of bone-healing after a period of nine months without any sign of bone-healing for a period of at least three months [4]. Biological and mechanical aspects impact bone healing [5] and the presence of adequate blood supply and tissue oxygenation as well as mechanical stability of the fracture site are essential for healing [6].

## Author's Photo Gallery



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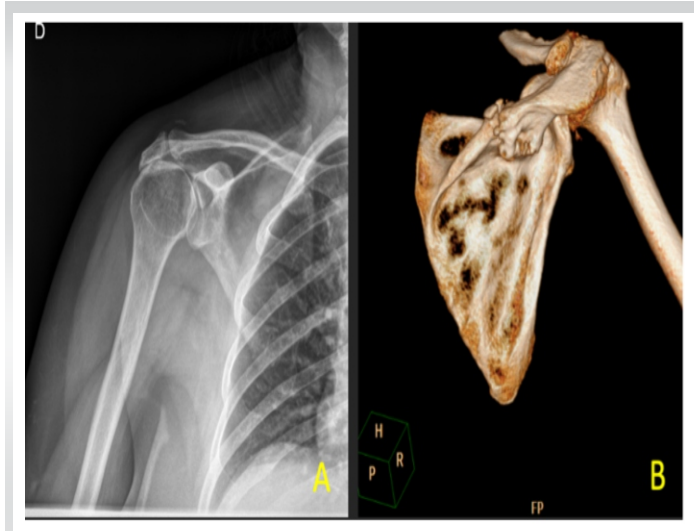
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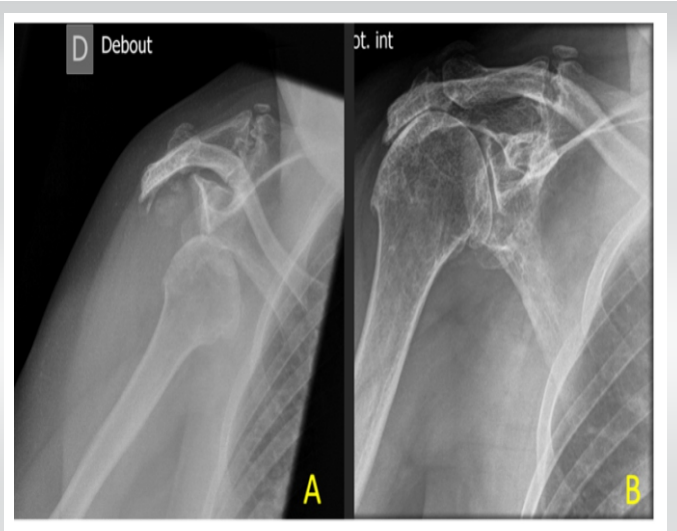
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**Figure 1:** Shoulder radiograph from 2012 (A) and CT-scan from 2020 (B).



**Figure 2:** Shoulder radiographs after dislocation (A) and reduction (B).

In 1995, Bauer et al. recommended ORIF (open reduction and internal fixation) for displaced fractures of the SS and the acromion to allow for reduction, fixation, and stability of the fracture site [7].

Acromial and SS fractures also occur as a complication of reverse shoulder arthroplasty (RSA) with an estimated occurrence varying from 2.2% to 4.4% [8-11]. Whether fractures should be reduced and internally fixed or treated nonoperatively is currently still controversial [11]. At present, it has been reported in the literature that the non-operative approach should rather be chosen, which has been documented to lead to similar reduced functional outcomes as the operative approach [12,13] when compared with the results of RSA without this complication. However, the operative techniques used in the past were inhomogeneous including single plates, non-locking plates, screws, tension band wiring, and bone strut

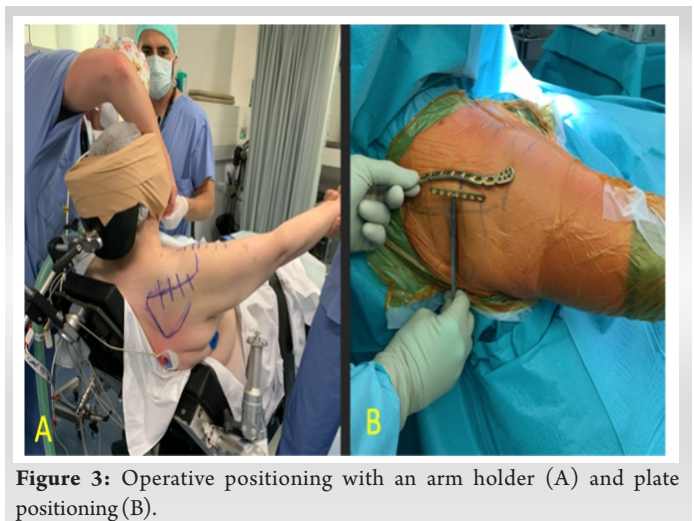
plates.

As we witnessed an excellent outcome and bony union in the treatment of an acute SS fracture after RSA with locked 90° double plating of the scapular spine [14], we aimed to apply the same technique for this case of a hypertrophic non-union with additional humerus-to-scapula bone grafting, and a simultaneous RSA for the cuff tear arthropathy and shoulder.

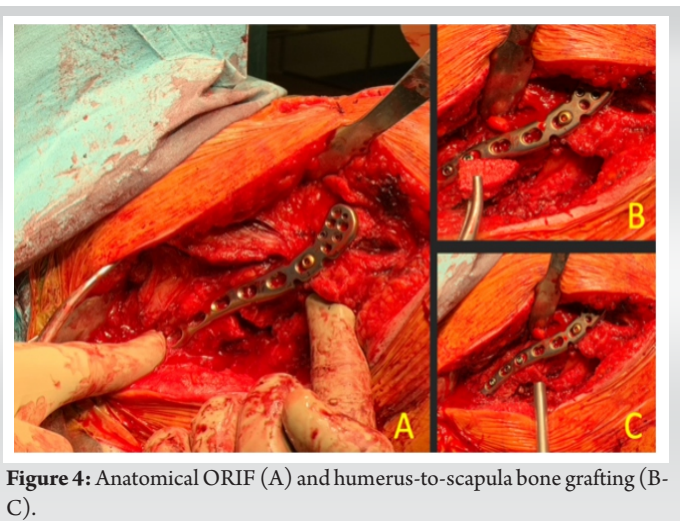
### Case Presentation

We present a 60-year-old female who suffered from a cuff tear arthropathy, documented at first on radiographs in 2012 after a fall (Fig. 1).

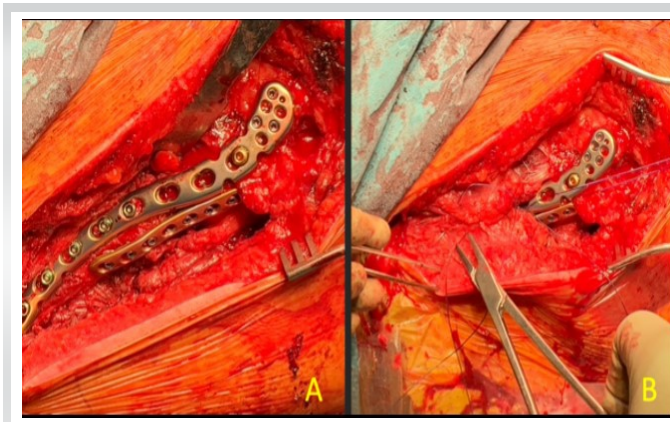
She dislocated her right shoulder after a fall in 2020, which she reduced herself. Two more episodes of shoulder luxation occurred, the last requiring reduction under sedation in the



**Figure 3:** Operative positioning with an arm holder (A) and plate positioning (B).



**Figure 4:** Anatomical ORIF (A) and humerus-to-scapula bone grafting (B-C).

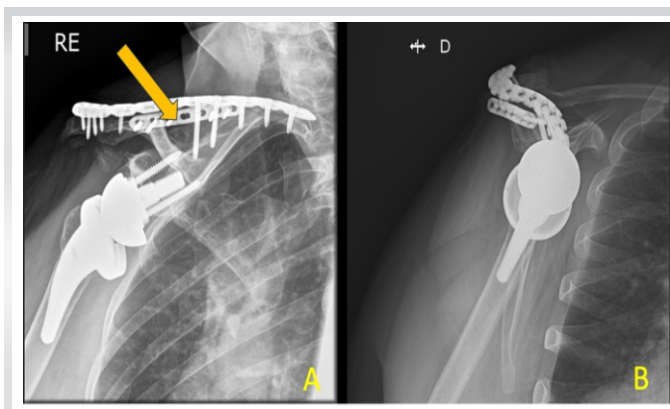


**Figure 5:** Final plate positioning (A) and muscular repair and closure (B).

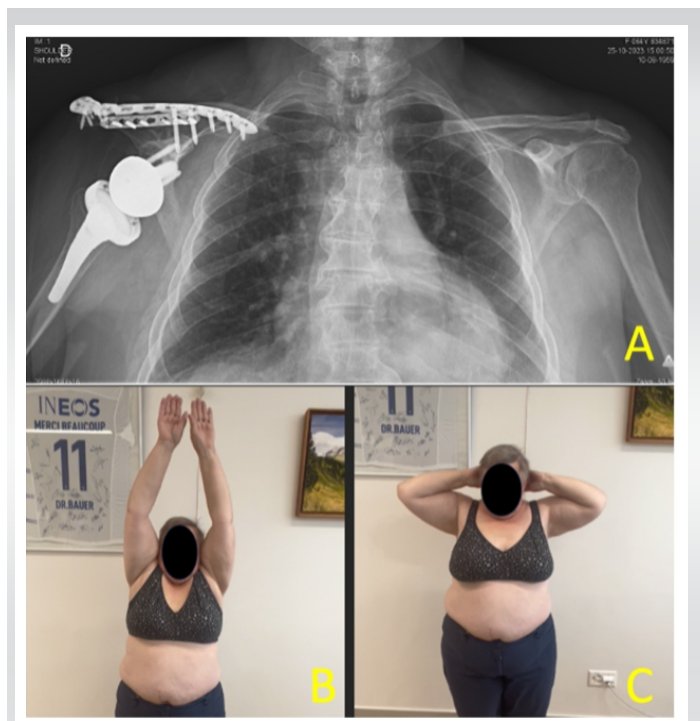
emergency department. Her fear about to dislocate again prompted her to seek consultation with a shoulder surgeon. During the clinical examination, she presented with apprehension, slight pain – which occurred only during movement (2/15 VAS), as well as reduced range of motion (ROM) (Table 1). The radiographs and CT-scan confirmed the diagnosis of hypertrophic scapular spine non-union and rotator cuff arthropathy of the right shoulder (Fig. 2). The patient had attended the emergency department twice before, once in 2012 at age 53 and again in 2016 at age 57, each time due to falls. No fractures were detected on radiographs. She was treated with simple analgesia, and her shoulder was mobilized as tolerated. She had not received any other treatment for her shoulder.

### Indication and treatment

Recurrent dislocations associated with a flexed scapular spine non-union and a radiographically severe CTA required simultaneous correction of the flexed acromion with ORIF and RSA. A two-staged approach, with primary ORIF and grafting before RSA as most recently reported [15], was not considered, as it would not have adequately addressed the instability and would have required an additional site for autologous grafting,



**Figure 7:** Follow-up radiographs with bony union (A–arrow).



**Figure 6:** Follow-up radiograph (A) and clinical ROM (B-C).

such as the iliac crest.

The patient was positioned in beach chair position (80°) with an adjustable arm holder in abduction (Fig. 3).

A double approach was used: First a direct posterior approach to the scapular spine, revealing a hypertrophic L-shaped non-union with posterolateral flexion of the acromion. It was debrided and freshened up with an awl and small 2.0 drill bit. The ORIF was planned with a long superolateral titanium clavicle plate (Depuy Synthes) contoured for optimal fit. A second posterior 2.4-mm LCP (Depuy Synthes compact foot set) was used (Fig. 4).

The RSA was performed with a deltopectoral approach. In situ, the humeral head osteotomy (20° retroversion) was incompletely performed before decorticating the head segment proximal to the osteotomy with a saw for autologous humerus-to-scapula grafting. After decortication of the humeral head, the osteotomy was completed and the graft stored on the back table. The humeral rasp (Ascend flex, Stryker, Kalamazoo, MI, USA) was inserted and the wound packed with a sponge and temporarily closed.

Several graft wedges from the head were impacted between bleeding bony surfaces and the spine of scapula extended up and reduced to an anatomical position. The ORIF was completed with clusters of angular stable screws angled 90° to each other on both sides of the fracture. Erroneous attempts of drilling must be avoided not to create stress risers. The deltoid

Clinical Variables	Patient Data
Date of birth	10/8/1959
Sex	Female
Height (cm)	146
Weight (kg)	84
BMI	39.41
Comorbidities	Hypertension, gout, obesity class 2, polyarthritis, gastroesophageal reflux disease
ASA score	II
Levy classification	Type III
Walch classification	Type D equivalent with anterior instability
Hamada classification	Grade 4
Diagnosis	Flexed scapular spine non-union, cuff arthropathy and shoulder instability
Range of motion pre-intervention (right shoulder - standing)	Anterior flexion: 90°
4/3/2020	Abduction: 80°
	Int. rotation: buttock
	Ext. rotation: 25°
Pre-intervention clinical score	4/3/2020
	SSV - 50%
	Constant score - 54P
Date of intervention	2/6/2020
Fracture union	Visualized with CT-scan on the 02.02.2021
Clinical follow -up	02.02.2021:
	SSV - 99%
	Constant score - 84P
	15.06.2022:
	SSV - 99%
	Constant score - 87P
15/10/2023	SSV - 99%
	Constant score - 84P
Range of motion post-intervention (right shoulder - standing)	Anterior flexion: 154°
25/10/2023	Abduction: 136°
	Int. rotation: T12
	Ext. rotation: 25°
Shoulder testing - dynamometer (right shoulder - standing)	Abduction at 45°: 11.1 lb
25/10/2023	Ant. Flexion at 90°: 8.5 lb
	Ext. rotation at 0° abd.: 11.6 lb
	Int. rotation (belly-press): 4.2 lb
Shoulder testing - dynamometer (left shoulder - standing)	Abduction at 45°: 7.8 lb
25/10/2023	Ant. Flexion at 90°: 5.3 lb
	Ext. rotation at 0° abd.: 10.3 lb
	Int. rotation (belly-press): 8.5 lb

**Table 1: Clinical patient data.**

and trapezius muscles were meticulously repaired to the scapular spine and plate (Fig. 5,6).

The deltopectoral approach was resumed, and the lateralized platform RSA (Aequalis Ascend Flex stem and Perform glenoid implants, Stryker, Kalamazoo, MI, USA) was implanted like in a primary setting (Fig. 7: MIO-RSA, 25 mm long post baseplate +3+2 mm lateralized, size 1B stem, +6 mm insert B, 1.5 mm offset tray in position 6, 36 mm + 2 mm eccentric glenosphere).

Based on our previous experience of ORIF of a Levy type IIa fracture associated with an RSA with the complication of plate adjacent secondary fracture [14], we recommend paying attention to eight recommendations for a successful ORIF of Levy-type II-III fractures associated with RSA, some of which we have applied progressively to our cases.

1. CT evaluation of the bone stock. Is double plating possible? A 3D reconstruction and model are helpful to make this decision.
2. Use of an adjustable arm holder to reduce and off-load the fracture during ORIF (Fig. 3A) in a maintained position of abduction.
3. Use of a posterior subacromial incision for finger palpation of the undersurface of the acromion and posterior-anterior drilling to prevent any erroneous drilling creating stress risers.
4. Use of autologous bone graft in non-unions and if considered necessary.
5. Filling of every drilled hole with a screw to prevent stress risers (avoid erroneous drilling).
6. Preferred use of 90° locking plates with a minimum of five screws on either side of the fracture and a minimum of two locking screws per plate on either side of the fracture.
7. Spanning of the acromion and spine of scapula with long plates and screws to avoid stress risers.
8. Use of an abduction orthosis and only passive ROM from the abducted position for 8 weeks after the ORIF to let the fracture heal.

**Outcome and follow-up**

The patient did not suffer from post-operative complications (Fig. 6).

A 30° abduction orthosis was used for 6-weeks and passive mobilization of the shoulder as tolerated above 90° was allowed for 4 weeks followed by active-assisted mobilization after the 4th week.

During the 1st year of follow-up, we noted a significant improvement in ROM and clinical outcomes. There was a notable increase of 30 points in the Constant score and a remarkable 49% improvement in the subjective shoulder value (SSV) (Table 1).

This positive outcome is particularly noteworthy for a younger patient who had previously experienced substantial shoulder-related disability in both, work and activities of daily living. Bony union was observed on radiographs and a CT-scan on the 02.02.2021.

Excellent clinical results persisted at the follow-up of more than 3 years after surgery (Fig. 7).



## Discussion

Isolated traumatic fractures of the scapular spine are infrequent and are often associated with a notable delay in both, diagnosis and definitive treatment. Notably, our review of the literature reveals a higher incidence of Levy type II and type III fractures resulting from falls. In a study by Nyffeler et al. (2020), seven scapular spine fractures were attributed to falls, with 6 of those leading to Levy type II or III fractures, while only one resulted in a Levy type I fracture [16].

Studies measuring the impact of forces from falls on the hand reported values ranging from approximately 1000 N for a fall from a shoulder height of 1 meter on a padded surface to 2800 N for a fall from a height of only 0.75 m [17,18]. Furthermore, cadaveric studies have observed fibula fractures, a bone which has a similar thickness compared to the acromion, already occurring at torque values of around 45 Nm during forced external rotation of the foot [19]. Considering the acromion, with an average length of 41 mm [20], as a potential lever arm for a cranial-directed force during a fall on an abducted arm, we postulate that sufficient torque could be generated to induce a fracture at the base of the acromion from an abduction-type mechanism. This hypothesis may be a plausible explanation for medially sited Levy type II and III fractures associated with falls and an upward directed force in axial direction occurring during abduction in native shoulders and after RSA. This mechanism has been termed “early arc impingement” associated with medial scapular spine fracture after RSA.

Levy type I fractures often do not impose an important functional deficit after a phase of acute pain [12,21]. This can be elucidated through an examination of the anatomy of the deltoid muscle. Its posterior portion attaches to the scapular spine, the middle portion to the acromion, and the anterior portion to the clavicle [22]. Consequently, a fracture on the lateral side of the acromion would primarily affect the function of the middle portion of the deltoid enabling compensatory actions by the anterior and posterior portions for the overall function of the deltoid to be maintained.

Non-operative treatment of medially sited SS fractures is associated with severely impaired ROM of the shoulder, loss of strength, and persistent pain [21,23]. The existing literature offers evidence supporting operative management of these fractures. However, there is inconsistency in both, reported outcomes and surgical techniques [24-27]. Following ORIF,

**Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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the scapular spine becomes subjected to multidirectional forces, encompassing cranial forces of the trapezius, caudal pull of the deltoid, and various muscle insertions of the scapula. Given this complex biomechanical environment, we contend that the operative fixation technique and device configuration need to be sufficient to withstand these forces to achieve sustainable fixation over a sufficient time to allow for bony union and locked 90°-double plating has biomechanically been proven to be superior compared to a single locking plate [28].

In this case, we demonstrate durable mechanical stability and an excellent clinical outcome after correction, grafting and ORIF of a SS non-union with a previously described locked 90°-double plating technique with simultaneous lateralized RSA.

Our aim is to contribute supplementary data to reinforce the evidence that operative intervention for Levy Type II and III scapular spine fractures can result in excellent clinical outcomes despite adverse forces generated from a lateralized RSA design.

## Conclusion

If bone stock is sufficient to apply multiple screws of a locked 90°-double plate construct providing sufficient mechanical stability in the context of adverse forces of a lateralized RSA, excellent function and shoulder comfort can be expected. If the ORIF is successful in achieving union, the outcome may be far beyond results of non-operative management of these fractures associated with RSA, without a difference to primary RSA outcomes. This case illustrates the possible value of the plating technique for medial Levy-3 type SS fractures which may occur after forceful abduction from falls in patients with an RSA.

## Clinical Message

Scapular spine fractures present both diagnostic and surgical challenges. Clinicians should prioritize CT scans when evaluating scapular pain, tenderness and shoulder disability following falls with axial impact to the upper limb.

For planning and performing locked 90°-double plating in RSA associated with Levy-type II-III fractures, the following five clinical recommendations are essential: (1) Assess the bone stock with a CT scan, (2) use a long superior plate and screws that span the scapular spine and acromion, (3) employ at least two locking screws on either side of each plate, (4) avoid stress risers from incorrect drilling, and (5) protect the fracture with an abduction sling for 6–8 weeks.

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