



## Quadruple Disruption of the Superior Shoulder Suspensory Complex: Case Report and Review of the Literature

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**DOI:** 10.31080/ASOR.2022.05.0581

**Received:** August 11, 2022

**Published:** September 28, 2022

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### Abstract

The superior shoulder suspensory complex (SSSC) is an extremely important structure composed of a ring of bone and soft tissues at the superior aspect of the shoulder. Double disruption leads to instability of the construct and usually requires operative treatment.

Triple disruption of the SSSC is extremely rare and is encountered in high-energy trauma cases often in association with other injuries. The authors experienced a case of quadruple disruption involving the acromion, glenoid, and segmental clavicle fracture.

This type of SSSC disruption is unlikely to have been caused by a single impact and is rather caused by multiple impacts during one traumatic event.

**Keywords:** Superior Shoulder Suspensory Complex; Quadruple Disruption; Clavicle; Acromion, Coracoid; Acromioclavicular Joint

### Introduction

The Superior Shoulder Suspensory Complex (SSSC) is a bony and soft tissue ring-shaped structure that is located between the scapula and distal clavicle. It consists of the distal clavicle, acromial process, glenoid fossa and process, coracoid process, acromioclavicular (AC) joint, and coracoclavicular (CC) ligaments. All these components are parts of the scapula except the distal clavicle [1,2].

This ring-like complex provides biomechanical functions and stability to the shoulder. It also provides connection of the axial skeleton with the upper extremity through the clavicle [3].

Traumatic Single, double, triple and quadruple disruptions can occur at the SSSC. Single and double disruptions of the SSSC are relatively common, but triple and quadruple injuries are extremely rare. The more structures involved in the SSSC disruption, the more complex and unstable the injury pattern becomes and more likely the surgical intervention required.

Single disruption of the SSSC can be due to clavicle fracture, acromial fracture or AC joint injury with intact coracoclavicular (CC) ligaments. It is commonly treated non-operatively as the SSSC stability is not disrupted. Double disruption of the SSSC occurs due to disruption of two structural components of the SSSC, and therefore treated operatively as it results in SSSC complex instability [4-6].

Triple and quadruple SSSC disruptions involve 3 and 4 components of the SSSC respectively. They occur in high energy trauma cases that can be associated with the ribs, spine, nerves and head injuries [7-12]. These disruptions are rare but there is a growing recognition of these injuries among orthopaedic surgeons.

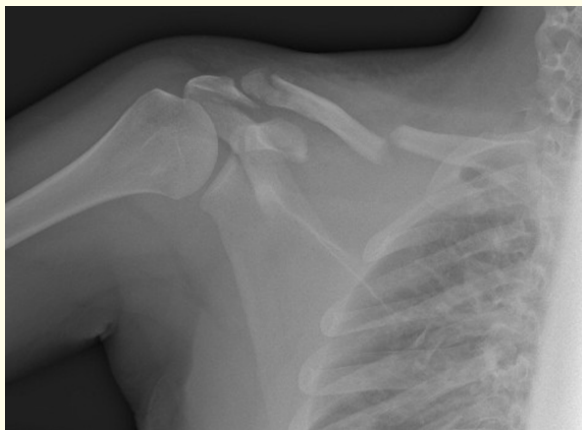
Surgical fixation is required as significant displacement of injured structures can lead to long-term functional difficulties and healing issues like delayed union, malunion and non-union [6].

### Case Report

A 24 years old male sustained a motor vehicle accident when driving on highway at speed of 180 Km/Hr. He lost control over the vehicle and hit a lamppost. He had a transient loss of consciousness. He was taken to the nearest hospital for resuscitation and initial management. He was then transferred to trauma centre for further management. He did not remember the accident details. He has the following injuries: left subdural hematoma, right sided hemothorax, sixth rib fracture, segmental clavicle fracture, acromial fracture, glenoid fracture, scapula fracture and T12 fracture.

Posterior spinal pedicle screws fixation and vertebroplasty were done by neurosurgeons. The patient complained of right shoulder pain that was worse with movement. On physical examination, he had superficial skin abrasions and bruising over the right shoulder. He also had tenderness on palpation of the right clavicle, acromion and acromioclavicular (AC) joint. He had intact neurovascular examination of the right upper extremity. He had limited range of motion (ROM) because of pain, his ROM was forward flexion 70° (Active)/90° (Passive), external rotation 20° (active)/40° (passive) and internal rotation up to the sacrum.

Right shoulder radiographs showed glenoid fracture (Ideberg type III), segmental clavicle fracture and acromial fracture (Figure 1).



**Figure 1:** Right shoulder X-ray.

Computed Tomography (CT) of the right shoulder with three-dimensional bone reconstruction (3D) was done to delineate the fractures pattern and plan for surgical fixation pre-operatively (Figure 2). The CT showed displaced glenoid fracture (Ideberg type III), segmental clavicle fracture (distal clavicle and clavicle shaft fractures), acromial fracture and medial border scapular fracture that do not extend to involve the entire scapular body. There was clear disruption of superior shoulder suspensory complex (SSSC).



**Figure 2:** Right shoulder three-dimensional bone reconstruction (3D).

### Surgical technique

Patient was taken to the operative room on 10<sup>th</sup> day post-injury for open reduction and internal fixation (ORIF) of glenoid, segmental clavicle and acromion fractures.

Patient underwent general anaesthesia and positioned on beach-chair. Intravenous Cefazolin (2g) was given prior to skin incision.

A standard deltopectoral approach to the right shoulder was utilized through 10 cm incision. Cephalic vein was identified and retracted laterally. The clavipectoral fascia was incised. The lateral side of the conjoint tendon was incised and a space under the conjoint tendon was developed as well as underneath the deltoid.

The superior 50% of the subscapularis tendon was tenotomised (1 cm medial to the insertion of the subscapularis tendon), leaving the inferior fibres of the subscapularis tendon and vessel intact. The tenotomised part of the subscapularis was retracted medially and dissected off the underlying anterior glenohumeral joint capsule and glenoid neck periosteum. Longitudinal capsulotomy was performed. Fukuda ring retractor used to retract the humeral head. This allowed a clear visualization of the intra-articular and extra-articular components of the glenoid fracture. The fracture reduced anatomically and fixed with cannulated screw and washer (Synthes 4.0 mm x 50 mm) from superior pole to the inferior pole of the glenoid.

The skin incision was extended proximally along the AC joint and the superior aspect of the acromion. The distal clavicle fracture was exposed, reduced and fixed with anatomical distal clavicle plate (Synthes). The acromial fracture was reduced and fixed with tension band wiring. The mid-shaft clavicle fracture approached through a separate incision and fixed with 2 straight plates. Post-operative X-rays and CT scan are shown in figures 3 and 4.

Fourteen months post-operatively, the patient was brought back to the OT for removal of hardware and X-rays post-removal of hardware is shown in figure 5. Range of motion is almost identical to the contralateral side (Figure 6).



Figure 3: Post-operative X-ray.

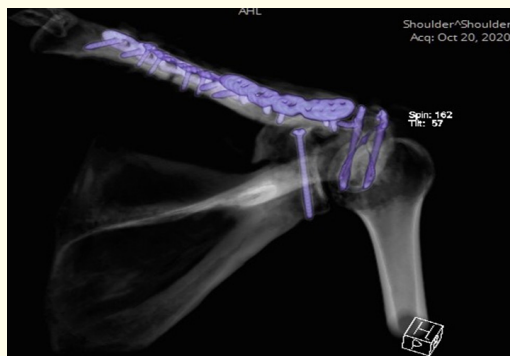


Figure 4: Post-operative CT scan.

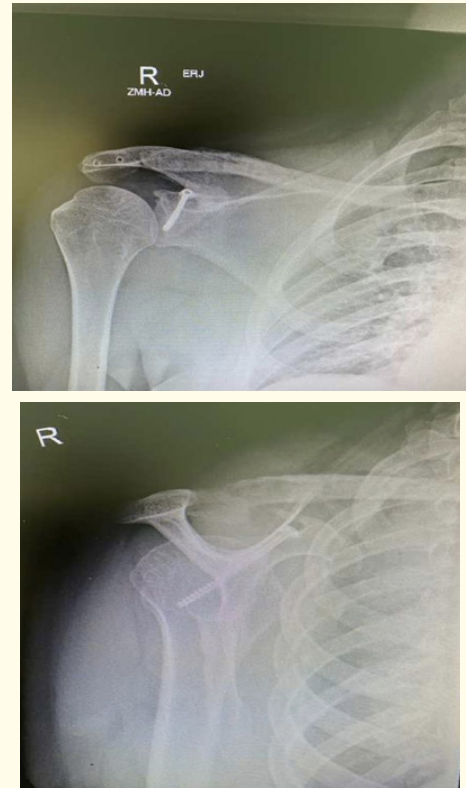


Figure 5: X-rays post removal of hardware.





**Figure 6:** Range of motion.

**Discussion**

This case report describes a quadruple disruption of the SSSC that is a very rare injury and successfully treated surgically. Quadruple disruption of this case consisted of 4 disruptions at the SSSC: Superior glenoid fracture and base of coracoid fracture (Ideberg Type III fracture), clavicle fracture (distal clavicle and clavicle shaft) and acromial fracture. The complexity of these fractures required careful pre-operative planning and intraoperative surgical decision-making to provide an optimum fracture fixation that will lead to fracture healing and excellent functional outcome.

Many possible combinations of the SSSC disruptions can occur. The common combinations include the distal third of the clavicle fracture, acromial fracture, coracoid process fracture and the AC joint separation [13].

The multiple disruptions of the SSSC are likely to have been caused by multiple impacts during the traumatic event rather than single impact. Many mechanisms of injury resulting in fractures around the shoulder girdle have been described in the literature.

In scapula fractures, the most common mechanism of injury is direct trauma to the lateral or posterosuperior aspect of the fore-quarter [14].

Coracoid fractures can occur due to direct trauma to anterolateral shoulder, sudden contraction of the conjoint tendon or acromioclavicular dislocation [15,16]. It can be associated with AC joint separation or distal clavicle fractures [17].

Acromion fractures can be due to direct force, deltoid muscle contraction resulting in avulsion fracture, force transmitted through humeral head causing traumatic superior displacement, or superior migration as a sequelae of rotator cuff arthropathy [18,19].

It is imperative to distinguish between the SSSC injuries and floating shoulder, as management can be different. Table 1 illustrates the components of the SSSC injuries and floating shoulder. The inability to distinguish between these two injuries can create confusion and lead to misdiagnosis and mismanagement. The SSSC injuries have a combination of bony and soft tissue injuries but the floating shoulder by definition has bony injuries only consisting of ipsilateral mid-shaft clavicle fracture and the neck of the glenoid fracture. In floating shoulder, the SSSC is not disrupted as it only involves the mid-shaft clavicle and glenoid neck fractures. Mid-shaft clavicle fractures are not part of the SSSC and confusion occurs when these fractures are considered as part of the SSSC and therefore misdiagnosis occurs.

	SSSC Injuries	Floating Shoulder
Clavicle	Distal Clavicle	Mid-Shaft Clavicle
Scapula	Glenoid Fossa	Glenoid Neck
	Acromion	
	Coracoid Process	
Soft Tissue	Acromioclavicular (AC) joint	
	Coracoclavicular (CC) ligaments	

**Table 1:** Components of the SSSC Injuries and Floating Shoulder.

A comprehensive literature review has shown that very limited studies have discussed quadruple disruption of the SSSC. There are 3 publications in the literature that described the SSSC quadruple disruption (Table 2) [20-22]. Some of the published case reports on quadruple injuries are not true quadruple injuries.

Oshima, *et al.* [20] classified quadruple injuries into 4 locations: (1) Injury around the AC ligament (2) Injury around the CC ligament (3) Scapular neck fracture (4) Mid-clavicular fracture. They had 2 cases with quadruple disruption, however, mid-clavicle is not part of the SSSC complex, and therefore, the two cases described in their article cannot be considered as a true quadruple

Authors	Year	Country	QD Cases	Sites of QD	True QD?	Comments
Oshima, <i>et al.</i>	2003	Japan	2	Mid-Clavicle	No	Mid-Clavicle Fracture not part of the SSSC
				Scapular Neck		
				AC Joint		
				CC Ligaments		
Mulawka, <i>et al.</i>	2015	United States	3	Case 1. Mid-Clavicle/Scapular Body/Neck/Acromion/AC Joint	No	Mid-Clavicle Fracture not part of the SSSC
				Case 2. Mid-Clavicle/ScapularBody/Coracoid/Acromion	No	Mid-Clavicle Fracture not part of the SSSC
				Case 3. Scapular Body/Neck/Coracoid/Acromion/AC Joint	Yes	All disrupted parts are part of the SSSC
Toft., <i>et al.</i>	2016	Switzerland	1	Glenoid Neck/Rim	Yes	All disrupted parts are part of the SSSC
				Coracoid		
				Acromion		
				AC Joint		

**Table 2:** Summary of Publications on Quadruple Disruptions (QD)of the SSSC.

disruption but rather a triple disruption. They performed surgical fixation of at least two injury sites in cases with triple disruption and questionable quadruple disruption. They recommended surgical fixation of each fracture in cases where ligament reconstruction is needed.

Mulawka, *et al.* [21] published a prospective observational study and identified 3 cases with quadruple disruption. Out of these 3 cases, there is only one case can be classified as a true quadruple disruption. The true quadruple case consisted of the SSSC disruption at 4 locations: scapular neck/body, acromion, coracoid and AC joint. The other 2 cases, however, had disruptions at 3 locations of the SSSC: one case at the scapular neck/body, acromion, mid-shaft of clavicle and AC joint and the other case at the scapular body, acromion, coracoid and mid-shaft of clavicle. As mentioned earlier, mid-clavicle is not part of the SSSC complex and these two cases cannot be classified as a true quadruple disruption.

Toft., *et al.* [22] described a quadruple disruption case at 4 SSSC locations: glenoid Neck/Rim, coracoid, acromion and AC Joint. This case was treated conservatively and was the first quadruple dis-

ruption case to be treated non-operatively. The patient had excellent shoulder function and shoulder outcome scores.

**Conclusion**

The quadruple disruption of the SSSC is an extremely rare injury. Our case report is the third true quadruple disruption of the SSSC that has been published.

The clinical evidence is scarce with regards to the most appropriate management of these injuries. There are limited numbers of case reports on these injuries and authors described their experience, surgical techniques and clinical.

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