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# Scapula fractures: functional anatomy, clinical assessment and management

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## Abstract

Fractures of the scapula are rare injuries, accounting for 3–5% of all shoulder girdle fractures. They are frequently the result of high energy trauma and often present with concurrent and life-threatening injuries to adjacent structures, leading to significant morbidity and mortality. Patients presenting with scapula fractures must receive a thorough and systematic clinical assessment as directed by national trauma guidelines. Appropriate imaging is essential in delineating fracture morphology and should at the very least include anteroposterior, anteroposterior oblique (Grashey) and axillary or scapula 'Y' view of the shoulder. Computed tomography imaging with three-dimensional reconstruction allows better delineation of the fracture morphology and helps with surgical planning. A lack of randomised controlled trials comparing the efficacy of conservative and operative management of scapula fractures has resulted in limited consensus for surgical indications. Nevertheless, most extra-articular fractures can be managed conservatively while intra-articular fractures of the glenoid frequently require surgical fixation.

Key words: Diagnosis; Management; Scapula fracture; Trauma

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## Introduction

The scapula serves a vital role in the shoulder girdle, providing the foundation for shoulder motion and stability through the superior shoulder suspensory complex, scapulothoracic, acromioclavicular and glenohumeral joints. This allows for the excellent range of motion needed in this joint. Fractures of the scapula are relatively rare, accounting for 3–5% of all shoulder girdle fractures, with an incidence of 10 in 100 000 (Ideberg et al, 1995). They often result from high-energy trauma with 80–95% of cases associated with potentially life-threatening injuries to the thorax, spine and head (Ideberg et al, 1995). Consequently, diagnosis may be delayed as other critical injuries take precedence. This review provides an overview of the functional anatomy, clinical assessment and management of scapula fractures.

## Anatomy

The scapula has a complex three-dimensional shape consisting of the body, spine, acromion, coracoid process and the glenoid (Figure 1). The body is a large triangular region articulating with the thorax via the scapulothoracic joint. Posteriorly, the scapula spine forms a horizontal projection creating two concavities: the supraspinatus and infraspinatus fossae. Formed as continuation of the scapular spine, the acromion curves anteriorly, articulating with the clavicle at the acromioclavicular joint. The coracoid process is a superior and anterior protrusion tethering the scapula to the clavicle via the coracoclavicular ligament.

The glenoid is attached to the scapula body via the scapula neck and has a shallow, oval-shaped surface that articulates with the humeral head as part of the glenohumeral joint. Its concavity is limited, especially in comparison to other ball-and-socket joints. While this contributes to the shoulder's extensive range of motion, it also makes the joint less stable.

The large surface area of the scapula serves as an origin for a range of muscles allowing it to function as the foundation of the shoulder. The muscles comprise two groups: the axioscapular muscles, anchoring the scapula to the thorax, and the scapulohumeral muscles, which include the rotator cuff muscles that are responsible for glenohumeral movement.



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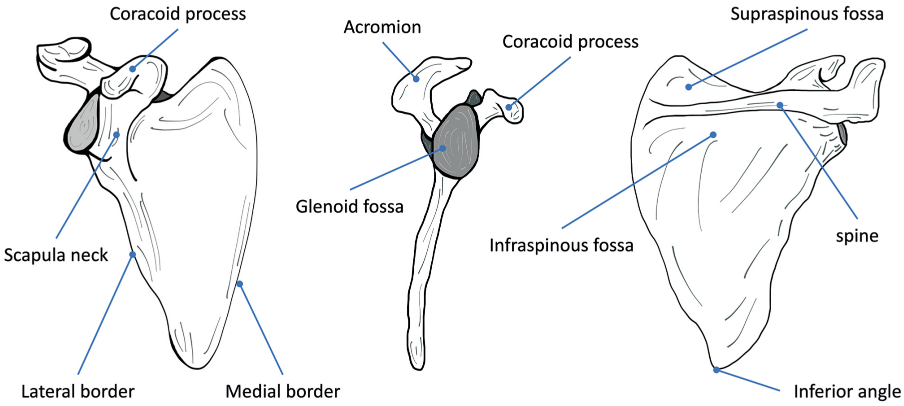


**Figure 1.** Osseous anatomy of the scapula.

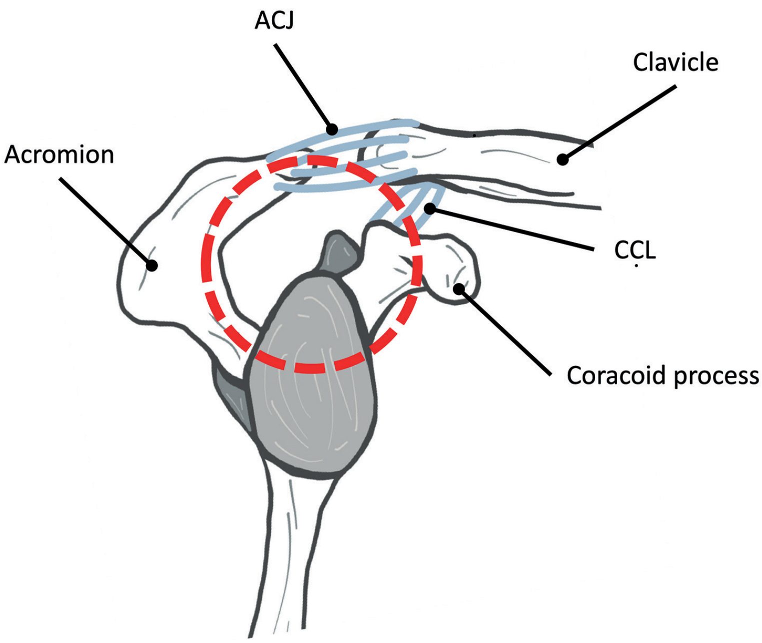


**Figure 2.** Superior shoulder suspensory complex, formed of the distal clavicle, the coracoclavicular ligament (CCL), the acromioclavicular joint (ACJ) and the scapula (glenoid, coracoid process, acromion).

The superior shoulder suspensory complex is a bone and ligamentous ring formed from the distal clavicle, the coracoclavicular ligament, the acromioclavicular joint and the scapula (glenoid, coracoid process, acromion) (Figure 2). The superior shoulder suspensory complex, working together with the axioscapular muscles, functions to suspend the upper limb from the chest, while the scapula (because of its association with the superior shoulder suspensory complex) is suspended from the clavicle via the acromioclavicular joint and coracoclavicular ligament.

## Biomechanics

An inherently unstable joint by design, the glenohumeral joint relies upon the synergistic action of static and dynamic stabilisers to preserve congruency and maintain function.

### Static stabilisation

The morphology of the glenoid is an important static stabiliser and is retroverted on average by 5°, articulating with 33% of the humeral head in any position. The surrounding fibrocartilaginous labrum serves to deepen the glenoid, thereby improving stability of the humeral head within it. Additionally, a negative intra-articular pressure is produced within the joint, secondary to the adhesion–cohesion relationship of the synovial fluid, creating a 'suction-cup' effect. The synovial fluid is kept in place by the joint capsule, the final static stabiliser of the shoulder. This fibrous synovium-lined capsule is lax to allow a wide range of motion but tightens at the extremes of movement and is reinforced by the superior, middle and inferior glenohumeral ligaments.

### Dynamic stabilisation

Dynamic stabilisers are contractile, active structures that provide stability to the shoulder joint especially during movement. These work in a coordinated fashion and consist of the intrinsic rotator cuff muscles and the extrinsic axioscapular muscles.

The four rotator cuff muscles (the supraspinatus, subscapularis, infraspinatus and teres minor) play a crucial role in centring the humeral head on the glenoid, particularly in the mid-range of movement when the capsule and associated ligaments are lax. Force couples are generated in both the coronal and transverse planes, ensuring the humeral head is not translated relative to the glenoid in abduction, internal and external rotation. At the extremes of movement, to avoid complete glenohumeral dislocation, a rotator cuff reflex arc is believed to take place. Here, impending dislocation results in stretch of one or more rotator cuff muscles, with activation of proprioceptors within the muscle and joint capsule. In turn, this results in preferential and unequal contraction in the affected muscle thereby restoring joint congruency (Cole et al, 2013).

The axioscapular muscles (serratus anterior, pectoralis minor, trapezius, rhomboids and levator scapulae) anchor the scapula to the thorax that is otherwise only connected to the axial skeleton via the acromioclavicular joint and coracoclavicular ligament. Their actions contribute significantly to glenohumeral stability by ensuring the glenoid is positioned precisely over the humeral head and that the rotator cuff muscles remain within an optimum working window (Cole et al, 2013). Anterior humeral translation during overhead activities is limited by the long head of biceps inserting superiorly on the glenoid labrum.

## Clinical presentation and assessment

Scapula fractures typically result from high-energy blunt trauma to the shoulder and are frequently associated with significant, life-threatening injuries including haemothorax or pneumothorax (>30%), pulmonary contusion (>40%), head injury (35–50%), rib fractures (53%), spinal fractures (26–30%), and ipsilateral extremity injuries (50%) (Baldwin et al, 2008). Scapula fractures are therefore associated with significant morbidity and mortality and may be diagnosed late as other injuries take precedence (Kozanlı and Güler, 2023). Consequently, all patients presenting with high energy trauma should undergo a thorough systematic clinical assessment as outlined by Adult Trauma Life Support guidance.

High-energy trauma can result in fractures anywhere in the scapula, while low-energy events, such as a fall on an outstretched hand or glenohumeral dislocations, typically result in glenoid rim fractures.

Following the secondary survey, a focused shoulder examination should be performed, ideally with the patient in the sitting position if other injuries allow. A visibly abnormal shoulder contour may point to fractures of the acromion or scapular spine, and while swelling is common, the degree of bruising may be less than expected because there is significant overlying tissue posteriorly. Abrasions or open wounds should be identified and are most frequently found overlying the acromion. Tenderness rarely provides useful information regarding the location of scapula fractures. The arm is typically held in an adducted position, but active assessment of range of motion is discouraged as this will likely cause significant pain and provide limited information. Gentle passive assessment of range of motion may identify any apprehension or blocks to motion. Finally, a detailed neurovascular examination of the ipsilateral limb is essential as brachial plexus injuries occur in 13% of cases and can significantly affect the overall outcome (Mayo et al, 1998). Pulse symmetricity with the contralateral arm should be documented.

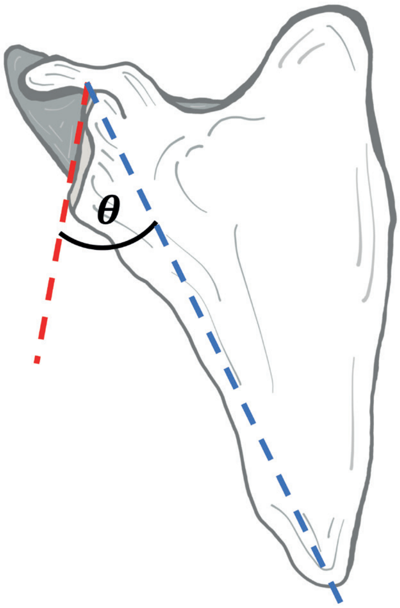


**Figure 3.** Glenopolar angle (θ) subtended by a line connecting the superior and inferior borders of the glenoid fossa (red line) and another connecting the most superior border of the glenoid fossa and the inferior angle of the scapula (blue line) (Pace et al, 2005).

## Investigations

Initial radiographic assessment of scapula fractures should include anteroposterior, anteroposterior oblique (Grashey) and axillary or scapula 'Y' views (Ropp and Davis, 2015). Anteroposterior imaging allows identification of glenohumeral joint dislocation, fractures of the scapula body and angulation of the glenoid neck. Anteroposterior oblique and axillary views are particularly useful in visualising the glenoid fossa and therefore intra-articular fractures, as well as the status of the acromion and coracoid process. Anteroposterior oblique views also allow measurement of the glenopolar angle (**Figure 3**), a radiographic measure that allows scapular deformity to be quantified and can serve as an indicator for surgical fixation. The scapula 'Y' view may help identify angular or rotational displacement of the scapula or glenoid.

For significantly displaced (>1 cm) or intra-articular fractures, computed tomography imaging with three-dimensional reconstruction allows better delineation of the fracture morphology and helps with surgical planning. Patients must be carefully assessed for the presence of clavicle fractures and/or acromioclavicular joint separation as these contribute significantly to scapular stability. Given the high-energy cause of most scapula fractures, many patients warrant a whole-body trauma computed tomography, to rapidly identify life-threatening injuries – this is often how scapula fractures are first identified. Patients with neurological deficit of the ipsilateral arm need C-spine imaging for concomitant spinal fractures. Transverse process fractures suggest a nerve root avulsion and magnetic resonance imaging should be performed to evaluate for brachial plexus injury (Gilcrease-Garcia et al, 2020).

## Classification

Extra-articular fractures include fractures to the acromion, coracoid process, scapular body and neck. Kuhn et al (1994) described a classification system for acromion fractures, discriminating between the displacement of fractures and whether the subacromial space is compromised (**Table 1**). Coracoid fractures are described by the Ogawa system (Ogawa et al, 1997), assessing the fracture location relative to the coracoclavicular ligament (**Table 2**).

Extra-articular scapula fractures are also described by the wider AO classification published in 2018, including scapula body fractures discriminating by the degree of

| Table 1. Kuhn classification of acromion fractures | |
|---|---|
| **Type of fracture** | **Description** |
| Type I | Minimally displaced |
| Type II | Displaced but does not reduce the subacromial space |
| Type III | Displaced with narrowing of the subacromial space |

*From Kuhn et al (1994)*

| Table 2. Ogawa classification of coracoid process fractures | |
|---|---|
| **Type of fracture** | **Description** |
| Type I | Fracture occurs proximal to the coracoclavicular ligament |
| Type II | Fracture occurs towards the tip of the coracoid |

*From Ogawa et al (1997)*

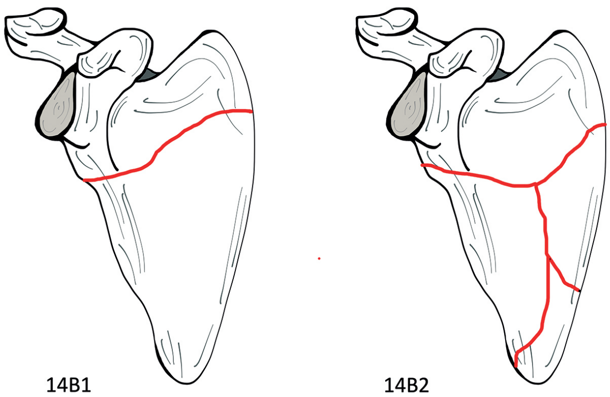


**Figure 4.** AO classification for scapula body fractures. 14B1: fracture exits the body at two or less points. 14B2: fracture exits the body at three or more points. The number 14 specifies the scapula and B denotes scapula body fractures.

comminution (Meinberg et al, 2018) (Figures 4 and 5). Extra care is needed when assessing injuries to any component of the superior shoulder suspensory complex. A single disruption to the superior shoulder suspensory complex does not affect its integrity, but the presence of two or more disruptions creates an unstable shoulder complex, commonly described as a floating shoulder. Multiple extra-articular fractures must therefore be assessed in conjunction with each other, appreciating their synergistic contribution to shoulder dysfunction and instability.

Multiple classification systems have been described for intra-articular glenoid fractures including the Ideberg–Goss, Mayo and AO. The Ideberg–Goss classification (Ideberg et al, 1995) is the most well established and includes six fracture types of the glenoid rim and fossa. Type Ia and Ib are commonly a result of instability events, whereas type II–VI are more commonly a result of high-energy trauma (Figure 6).

## Treatment

A lack of randomised controlled trials comparing the efficacy of conservative and operative management of scapula fractures has resulted in limited consensus for surgical indications. Nevertheless, a systematic review by Zlowodzki et al (2006) demonstrated that most extra-articular fractures are managed conservatively including 99% of scapula body and 83% of scapula neck fractures, achieving excellent or good results in 86% and 77% of cases respectively. Some of the rationale for conservative treatment stems from the fact that the range of motion for the shoulder exceeds what is needed for activities of daily living. Moreover, the extensive muscular envelope surrounding the scapula provides excellent

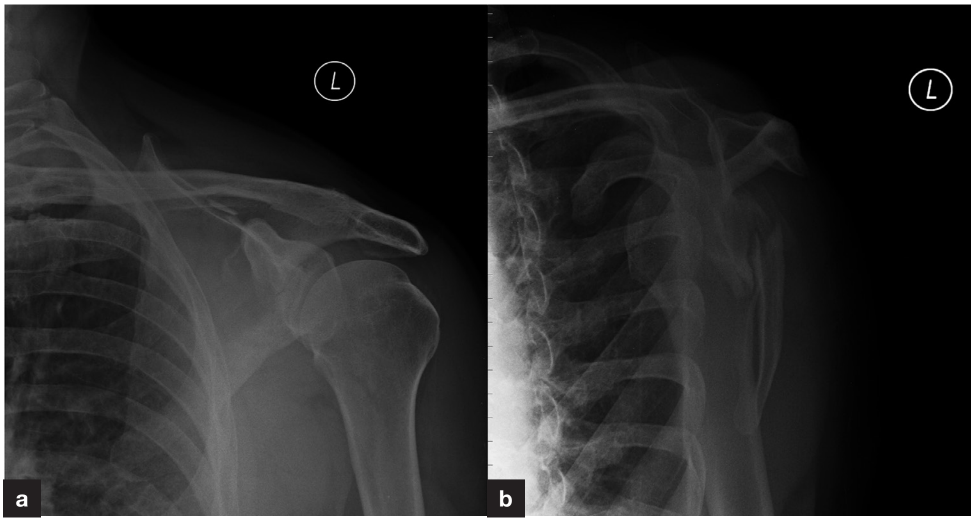


**Figure 5.** Anteroposterior (a) oblique radiograph and (b) scapular 'Y' view demonstrating an extra-articular displaced fracture though the scapula body and neck.

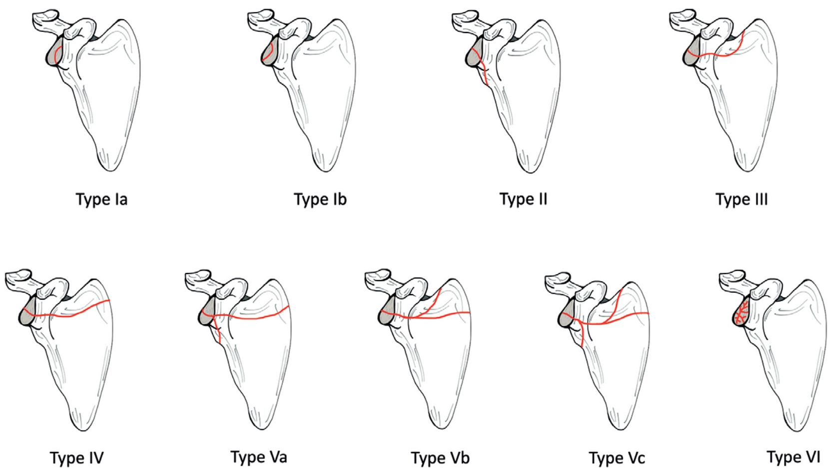


**Figure 6.** Ideberg classification (type I–V) with Goss modification (type VI).

healing opportunities and reduces rates of non-union. However, malunion can occur as a result of excessive angulation and displacement, causing instability, impingement, pain and scapulothoracic dyskinesis (Cole et al, 2011).

Conservative treatment should include immobilisation with a sling for 2–3 weeks followed by early mobilisation under the guidance of a physiotherapist. In general, a fracture displacement of <1 cm, an angulation of <45° and a glenopolar angle of ≥22° is considered amenable to conservative management for scapula body and neck fractures (Cole et al, 2013). Kuhn type I and II acromion fractures with <1 cm of displacement are also amenable to conservative management, as are Ogawa type II fractures of the coracoid with <1 cm displacement (Pires et al, 2021; Van Doesburg et al, 2021). All such fractures are at risk of progressive deformity leading to malunion and therefore weekly serial radiographs are mandated for the first 3 weeks. Additional injuries to the superior shoulder suspensory complex render this unstable and necessitates surgical fixation.

In contrast to extra-articular fractures, most intra-articular glenoid fractures are managed surgically. In these fractures a tolerance of <4 mm of displacement is acceptable for conservative management because of the increased risk of post-traumatic arthritis and dysfunction (Cole et al, 2013). Moreover, fractures with >20% involvement of the glenoid have unacceptable joint instability necessitating surgical fixation (Cole et al, 2013; Nacca et al, 2018). Treatment decisions in all cases must respect patient factors including age, activity level and expectation.

## Key points

- The scapula serves a vital role in the shoulder girdle, providing the foundation for shoulder motion and stability.
- The glenohumeral joint is an inherently unstable joint that relies upon the synergistic action of static and dynamic stabilisers to preserve congruency and maintain function.
- Scapula fractures account for 3–5% of all shoulder girdle fractures, typically resulting from high-energy blunt trauma to the shoulder and are frequently associated with other life-threatening injuries.
- Initial radiographic assessment should include anteroposterior, anteroposterior oblique (Grashey) and axillary or scapula 'Y' view.
- Most extra-articular fractures can be managed conservatively while intra-articular fractures of glenoid often require surgical fixation.

## Conclusions

While rare, scapula fractures are frequently the result of high energy trauma and are associated with significant and life-threatening injuries to adjacent structures. A thorough history, physical examination and appropriate imaging are crucial in identifying these injuries, and minimising patient morbidity and mortality. Although many scapula fractures can be managed conservatively, malunion, non-union, rotator cuff dysfunction and scapulothoracic dyskinesis can all result in chronic pain and long-term shoulder dysfunction. Moreover, developments in understanding of the biomechanical properties of the scapula continue to shape treatment protocols, despite limited consensus in many aspects of treatment.

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**Conflicts of interest**

The authors declare that there are no conflicts of interest.

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## Curriculum checklist

This article addresses the following requirements from the general internal medicine training curriculum:

- Managing an acute specialty-related take
- Managing medical problems in patients in other specialties and special cases
- Managing a multidisciplinary team including effective discharge planning

Kozanlı F, Güler Ö. The relationship between the presence of scapula fracture and mortality and morbidity in cases with blunt thoracic trauma. Ulus Travma Acil Cerrahi Derg. 2023;29(2):218–223. https://doi.org/10.14744/tjtes.2022.02362

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