Fractures of the Scapula: Diagnosis, Indications, and Operative Technique

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Introduction

Scapular fractures account for 3% to 5% of all fractures of the shoulder girdle and compose 0.4% to 1% of all fractures.[1] The annual incidence of these injuries is estimated at 10 per 100,000 persons.[2] The scapula plays an integral role in the association between the upper extremity and the axial skeleton. Scapular fractures have the potential to cause significant pain and to alter normal function of the shoulder girdle as a result of malunion, nonunion, rotator cuff dysfunction, scapulothoracic dyskinesis, or impingement.

Presentation and Diagnosis

Fractures of the scapula typically result from a high-energy, blunt-force mechanism.[3-7] Direct force may cause fractures in all regions of the scapula, while indirect force via impaction of the humeral head into the glenoid fossa can cause both glenoid and scapular neck fractures. Motor vehicle collisions account for the majority of scapular fractures with 50% occurring in occupants of motor vehicles and 20% in pedestrians struck by motor vehicles.[5,8]

Because of the high-energy nature of scapular fractures, 80% to 95% are associated with additional traumatic injuries.[2-5,9,10] On average, patients with fractures of the scapula have four additional injuries.[6] Potentially life-threatening injuries may include pneumothorax, pulmonary contusion, arterial injury, closed head injury, and splenic or liver lacerations,[5,6] with the associated mortality rate reaching nearly 15%.[3,6] Brachial plexus injury occurs in 5% to 13% of cases and serves as an important prognostic indicator of ultimate clinical outcome.[3-5]

Patients with scapular fractures present with the ipsilateral upper extremity adducted against the body and protected from movement. Typical physical examination findings include swelling, ecchymosis, crepitus, and tenderness about the shoulder. Range of motion of the shoulder is limited, particularly with abduction. A meticulous neurovascular examination is necessary in order to evaluate for injury to the ipsilateral brachial plexus and/or vascular structures.

The earliest opportunity to diagnose a scapular fracture may be on the initial supine anteroposterior chest radiograph taken in most trauma patients; however, one study found that 43% of trauma patients with scapular fractures did not have this injury recognized

Figure 1. Anteroposterior and lateral radiographs of the left shoulder demonstrating a comminuted fracture of the lateral aspect of the left scapula with glenoid involvement.

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Figure 2. Three-dimensional reconstructions of the left shoulder CT scandemonstrating a displaced, comminuted scapular fracture that originates at the base of the coronoid process and extends into the posterior glenoid and into the midbody of the scapula.

on their initial chest radiograph.[11] Therefore, all patients at risk for scapular fractures should have a dedicated series of shoulder radiographs (Figure 1), including anteroposterior, lateral, and axillary views. A computed tomography (CT) scan is recommended for complex or displaced fractures, as it allows for assessment of the size, location, and degree of displacement of fracture fragments, as well as confirmation of the position of the humeral head in relation to the glenoid fossa.[12] Furthermore, three-dimensional CT reconstructions may be helpful in visualizing complex fracture patterns and planning for operative treatment (Figure 2).

Indications

Historically, scapular fractures have been treated non-operatively. In 1805, Desault provided an early description of closed treatment of scapular fractures in his treatise on fractures. More recent research has shown that over 90% of scapular fractures are non-displaced or minimally displaced and can be effectively managed with conservative treatment.[4,5,7] However, advanced imaging techniques have allowed for the identification of certain subtypes of scapula fractures that may portend a poor prognosis without surgical intervention.

For glenoid fossa fractures, some surgeons advocate open reduction and internal fixation for patterns that result in articular displacement greater than 5 mm,[13] as this is the approximate maximum thickness of the glenoid articular cartilage.[14] Surgical treatment is also indicated if the glenoid fracture is associated with persistent or recurrent instability of the glenohumeral joint. Surgical intervention may also be beneficial in severe cases of shoulder suspensory complex disruption or scapulothoracic dissociation.[15]

While most extra-articular scapular fractures can be treated non-operatively, surgical intervention should be considered for significantly displaced fractures.[8,13,16] Nordqvist and Peterson evaluated 37 displaced glenoid neck fractures that were treated nonoperatively and found that functional results were only fair or poor in 32% of cases at 10- to 20-year follow-up.[17] Similarly, Ada and Millar reported that, of

Figure 3. The patient is positioned in lateral decubitus on a beanbag with the operative arm in the prone position.

the 16 patients treated conservatively for displaced scapular neck fractures in their series, 50% complained of pain at night, 40% had weakness with abduction, and 20% had decreased range of motion.[8] Hardegger noted that displaced glenoid neck fractures altered the relationship of the glenohumeral joint with the acromion and nearby muscle origins, thereby resulting in functional imbalance.[16] As a result, some surgeons recommend operative treatment for all glenoid neck fractures with at least 1 cm of translation or 40 degrees of angulation in the AP plane of the scapula.[8,17,18]

Approximately 50% of scapular fractures involve the scapular body and spine.[15] These fractures generally heal with conservative treatment and do not require operative intervention.[3-5,7,9,19] In their systematic review, Zlowodzki *et al* found that 99% of scapula body fractures were being treated non-operatively with excellent or good results in 86% of cases.[20] These favorable results are likely due to the fact that the scapular body is associated with an extensive muscular envelope, which assists with fracture healing and minimizes displacement.

Operative Technique

For the patient with scapular fractures that do not involve the anterior glenoid, the following procedure can be performed in the lateral decubitus position (Figure 3). We prefer to use a radiolucent table that is reversed to allow additional room for fluoroscopic imaging intraoperatively. It is critical to offload all bony prominences and areas of possible nerve compression, including the use of an axillary roll. The operative arm is draped free as it is often necessary to manipulate the limb in order to facilitate reduction, and the arm supported on a padded, freely movable stand. The non-operative arm is positioned on a padded, radiolucent arm board. The primary surgeon stands posterior to the patient and fluoroscopy should be positioned to enter the operative field anteriorly. Appropriate pharmacologic relaxation is necessary to manipulate the fracture fragments. In addition, suspending the arm in gentle traction will facilitate visualization of the articular surface of the glenoid. Positioning of the patient should account for the potential need to manipulate the arm.

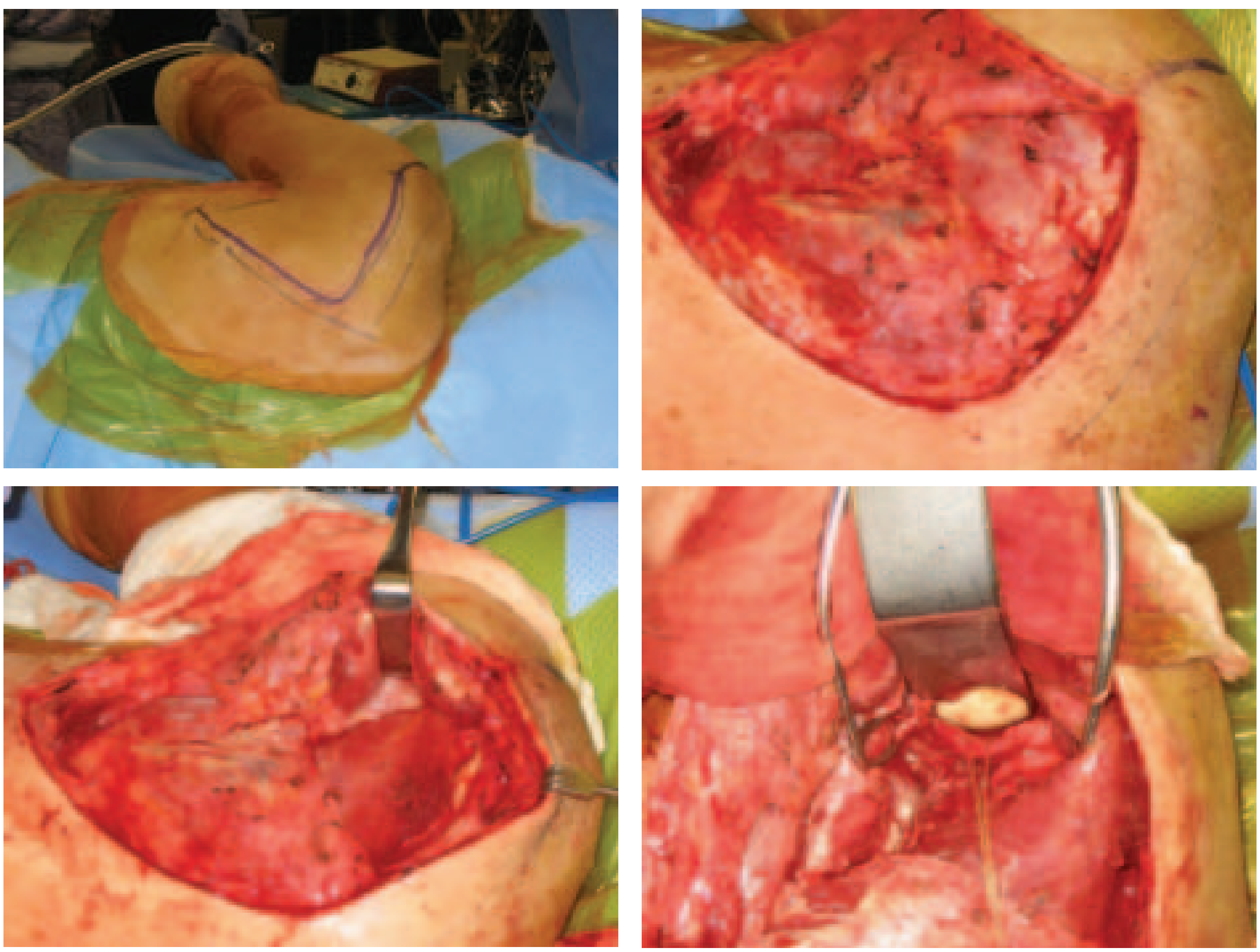

Figure 4. Intraoperative photographs demonstrating a curvilinear incision along the medial border of the scapula and the scapular spine. Subsequently, a full-thickness flap overlying the deltoid fascia is created, exposing the posterior deltoid. The deltoid origin is sharply released from the scapular spine, and the deltoid is retracted laterally. The interval between the infraspinatus and teres minor is developed with meticulous care taken to avoid the axillary nerve and the innervation to the infraspinatus. The scapular fracture is exposed within this interval.

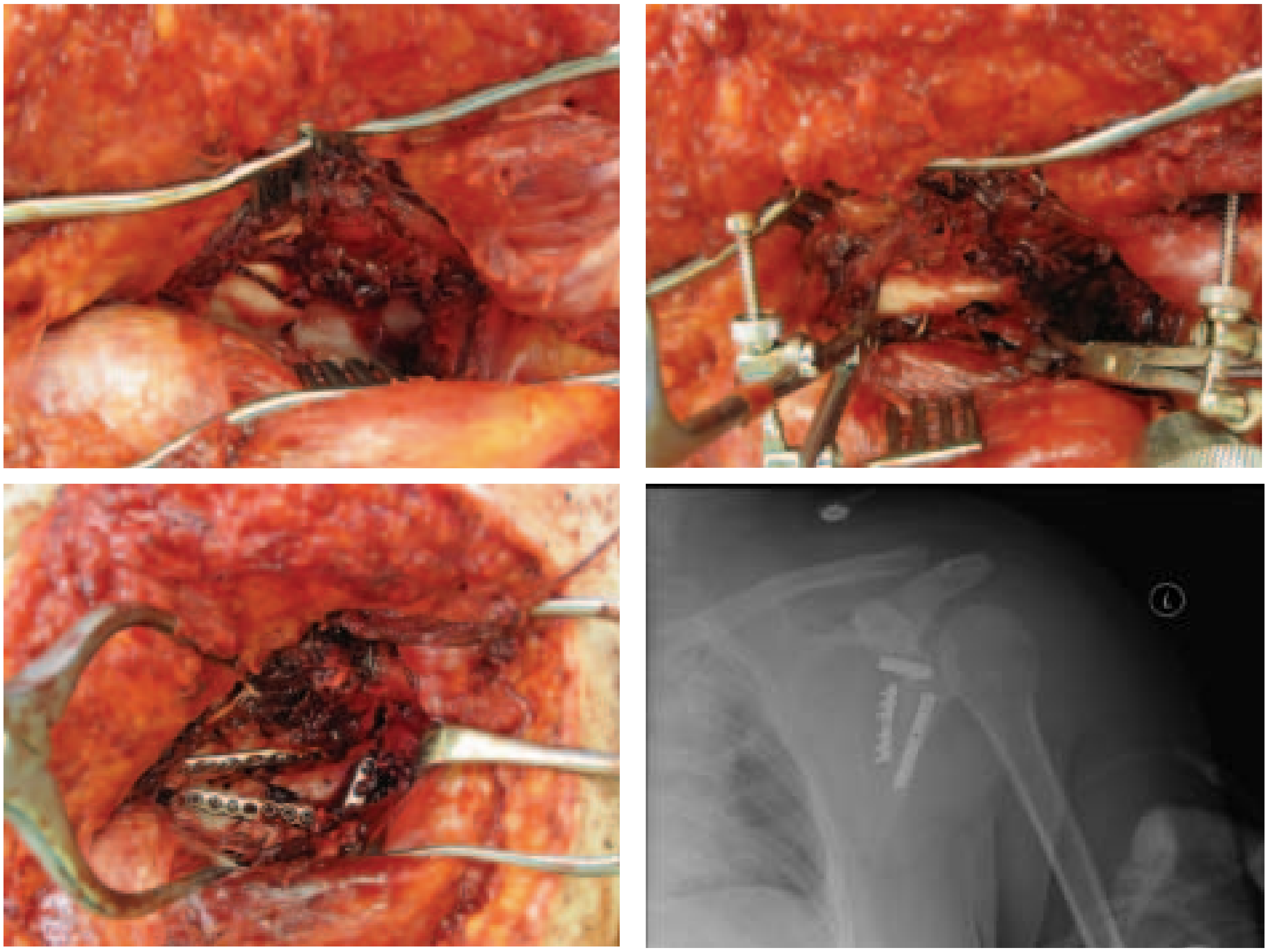

Figure 5. Intraoperative photographs demonstrating the scapular fracture before andafter reduction using a 4-mm Shantz pin and two point-to-point clamps. Three small fragment plates were then placed to maintain reduction of the scapular fracture. The postoperative anteroposterior radiograph of the left shoulder demonstrates an anatomic reduction of the scapular fracture with good positioning of the implants.

Exposure is obtained via a modified Judet approach. A curvilinear incision is positioned along the medial border of the scapula and the scapular spine (Figure 4). Sharp dissection is carried down to the level of the deltoid fascia with maintenance of a full-thickness skin flap. Hemostasis is achieved, and a full-thickness flap overlying the deltoid fascia is created, thereby exposing the posterior deltoid. It is vital not to violate the fascia of the deltoid. The inferior deltoid is then gently dissected off of the infraspinatus, and the deltoid origin is sharply released from the scapular spine. A stitch is placed in the superomedial corner of the deltoid origin in order to allow for anatomic repair back to the scapular spine at the conclusion of the procedure. Using the tagging stitch to pull gentle traction, the deltoid is reflected from medial to lateral. In general, bony exposure is obtained through two separate windows: 1) the interval between infraspinatus and teres minor (exposes the lateral border of the scapula and the inferior glenoid neck), and 2) via elevation of the medial origin of the infraspinatus (exposes the superomedial scapula). The interval between infraspinatus and teres minor is developed with meticulous care taken to avoid the axillary nerve and the innervation to the infraspinatus. It is important to note that a formal Judet exposure would involve reflecting the infraspinatus on its neurovascular pedicle for more complete visualization and may be necessary for more complex or chronic injuries.

Once the fracture site is identified, it is gently debrided. Fracture reduction and fixation is dependent on the fracture pattern and the bone quality. The fracture is reduced using a 4 mm Shantz pin placed proximally in the more lateral fragment for mobilization and reduction and using point-to-point clamps for provisional fixation (Figure 5). Reduction and fixation is conducted from medial to lateral as reduction of the medial scapular body can provide a framework to which one can accurately reduce the lateral border and glenoid neck. It is important to note that draping the arm free is helpful at this stage as manipulation of the limb can further assist in achieving an anatomic reduction. Our preference is to utilize small fragment or mini fragment plates across the fracture using compression technique if the fracture pattern allows. Once reduction and implant position are confirmed with fluoroscopy, the deltoid is repaired either with heavy non-absorbable suture if a cuff of tissue is left attached to the scapular spine or through 2 mm bone tunnels. Our preference is to use bone tunnels, as deltoid detachment is a potentially-devastating complication. The wound is thoroughly irrigated and a deep drain is placed prior to closure of the posterior myocutaneous flap. Patients are placed in a sling, and radiographs are obtained prior to extubation. The deltoid repair is protected for six weeks by limiting the patient to gentle passive motion exercises. After six weeks, active and active-assisted range of motion is initiated, and strengthening generally commences at approximately 3 to 4 months postoperatively.

Disclosure

The contents of this article were previously published in the open-access journal *Advances in Orthopedics*.[21] The authors retain the copyright for this work.

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