Fractures of the scapula

Stephen Aldridge
Matthew Gray

Abstract

Scapular fractures are relatively uncommon fractures, which often are a result of high-energy trauma. The majority of fractures of the scapula can be successfully treated without operation and require a short period of immobilization before physiotherapy to regain function. The indications for surgery are based on the general principles of trauma surgery; to reduce significant intra-articular fractures and restore the necessary alignment of extra-articular fractures. There is an absence of compelling studies that define the threshold for surgical intervention, making the treatment of these fractures difficult. This is further complicated by the complexity of the structures which interact with the scapula to allow the shoulder girdle to function. In this article, the anatomy and fracture patterns which affect the scapula and treatment options, will be discussed.

Keywords anatomy; clinical examination; fracture; management; scapula; shoulder

Introduction

Scapular fractures make up 0.7% of all fractures and account for 3–5% of fractures around the shoulder girdle. Traditionally extra-articular fractures have been treated non-operatively with mobilization of the affected limb as pain allows, with physiotherapy to maximize functional outcomes. This has been acceptable because the range of movement that occurs at the shoulder is large and loss of movement is relatively well tolerated. The function of the rotator cuff muscles, which originate from and pass across the scapula, have a clear function to initiate glenohumeral joint movement and are integral to the dynamic stabilization of the glenohumeral joint. There are some studies showing unsatisfactory outcomes following non-operative treatment of displaced scapula fractures, which may relate to disruption of the rotator cuff function. The actual effect on the function of the shoulder following malunion of the scapula is not well understood. This has led to an interest in operative interventions for these injuries, with a view to restoring the alignment of the scapula and maintaining anatomical reduction of the articular surface, with stable internal fixation.

Stephen Aldridge *MA MD FRCS (T&O) MFSEM Consultant Trauma and Orthopaedic Surgeon, Trauma and Orthopaedic Department, Royal Victoria Infirmary, Newcastle Upon Tyne, UK. Conflicts of interest: none declared.*

Matthew Gray *MBBS BSc MRCS Trauma and Orthopaedic Registrar, Trauma and Orthopaedic Department, Royal Victoria Infirmary, Newcastle Upon Tyne, UK. Conflicts of interest: none declared.*

Anatomy

The scapula is made up of the body, neck, glenoid, coracoid and acromion (Figure 1). The flat body allows the origin of the rotator cuff muscles, which insert onto the humeral head. They are integral to the stability of the glenohumeral joint, and their attachment onto the scapula alone allows the scapula to move over the thorax whilst maintaining the control of the glenohumeral joint. The neck connects the body to the glenoid cavity, holding the humeral head out to the appropriate length and alignment for the excursion of the rotator cuff muscles. The glenoid cavity is the articular portion of the scapula, and articulates with the humeral head articular surface. As a 'socket' in the ball and socket joint the glenoid fossa is not well constrained by the bony anatomy. It is like a golf tee, holding the humeral head like a golf ball. This is inherently unstable, and even small fractures can lead to instability. As in other joints, malalignment can risk subluxation, dislocation and in the longer-term arthritis.

The rotator cuff is central to the function of the shoulder. Its function is to maintain the humeral head centred in the glenoid fossa. Its constituent parts act like guy ropes, which can tension and relax to create rotation whilst maintaining the head's position in the fossa.

The scapula and its articulation with the clavicle make up the shoulder girdle, which connects the arm with the axial skeleton. This connection is achieved through the ligamentous connections between the two bones. Goss described the superior shoulder suspensory complex (SSSC), which is made up of the ring of structures comprising: glenoid, coracoid, coraco-acromial ligaments, lateral clavicle, acromioclavicular joint (ACJ), acromion and acromial spine.

The scapula, along with the clavicle, provides the anchor for the upper limb to the thorax, both in static and dynamic positions. Fractures to these two bones may well lead to malunion, which might affect the resting position of the shoulder girdle. It is postulated that a malunion may affect the function of the rotator cuff muscles, by changing their working length, or through impingement on their excursion. Malalignment of the scapular body may also affect the way that the scapula is able to slide over the thorax.

Various classification schemes have been proposed, but the simplest way to consider these fractures is by the anatomical location. Body fractures make up approximately 35%, neck 27%, acromion 12%, spine 11%, glenoid 10%, and coracoid 5%[1] (Figure 2).

Clinical examination

The evaluation of patients with scapula fractures should reflect the nature of the mechanism of injury, and likely associated injuries. Many scapula fractures are high energy, and frequently associated with other injuries. Reported rates of head injury (38%), pneumothorax (41%), haemothorax (25%) (dimitroulis). This demonstrates the importance of a full primary and secondary survey of these patients to identify life threatening and other emergent injuries. Specific associated injuries were identified from the US National Trauma Database. These were found to be rib fractures 52%, spine fractures 29%, clavicle fractures 25%, with 47% lung injury and 39% head injury.[2]

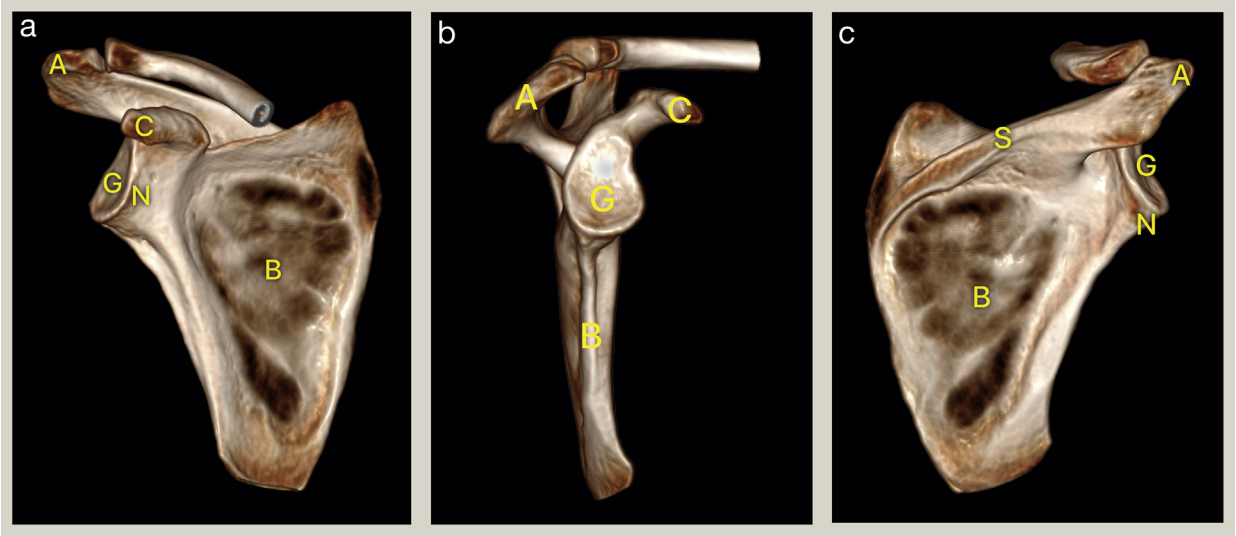

Figure 1 Anatomy of the scapula represented on CT three-dimensional reconstruction imaging. (**a**) Anterior view; (**b**) lateral view; (**c**) posterior view. C = coracoid process; A = acromion; B = body; N = neck; S = spine; G = glenoid.

Local injuries often include skin abrasions; although frankly open injuries are rare, they can occur with direct trauma. This can affect the timing of any surgery, as it may be safer to wait for the abrasion to have healed. Neurovascular injuries are not uncommon, and a clear examination of the distal perfusion and the function of the brachial plexus should be performed. Plexus injuries have been described but the most common injuries affect the suprascapular nerve as it passes through the spinoglenoid notch, and the axillary nerve. Examination of the motor function is often difficult due to pain, but sensation over the deltoid should be examined. These associated injuries may make examination of the injured shoulder difficult. Compliance, pain, and immobility may mean the routine shoulder examination is best undertaken sitting or standing to assess the shoulder position and any deformity in the presence of gravity.

Investigations

Most patients who have major traumatic episode nowadays have a trauma CT scan, which will identify the scapula injury and the associated injuries. Plain films at this stage are still useful, as the follow-up subsequently will be radiographic, but also to help

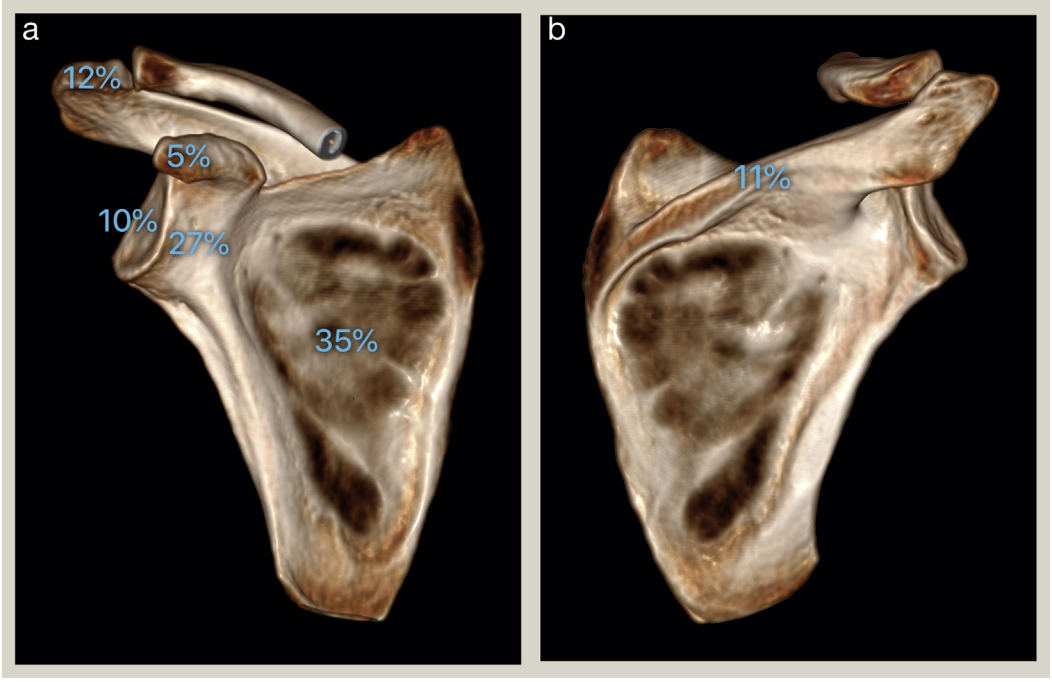

Figure 2 Frequency of scapula fractures by anatomical location based on analysis in reference 1. (**a**) Anterior view (three-dimensional (3D) CT); (**b**) posterior view (3D CT).

decision-making for surgery. For those with lower energy injury, plain radiographs make the diagnosis. In this situation, chest X-ray should be performed to identify rib fractures and there should be a low threshold for either C-spine X-ray or CT.

The series of radiograph views required are anteroposterior (AP) scapula, axillary, and scapula-Y view, which allow assessment. The AP view allows assessment of the gleno-polar angle. This is the angle subtended by a line drawn from the superior glenoid to the inferior glenoid and the line drawn from the superior glenoid to the inferior angle. The normal gleno-polar angle is about 40°. This view also allows measurement of the medial displacement of the lateral fragment relative to the medial fragment. The scapula −Y view allows assessment of the angulation of superior fragment relative to the inferior fragment. The axillary view allows assessment of the glenoid fossa, acromion and coracoid, and associated subluxation/dislocation of the glenohumeral joint (Figure 3).

It has been shown that CT assessment allows more accurate assessment of the radiographic parameters above, and so if surgery is considered, CT scanning should be used to confirm the displacement and allow planning of the intervention. Reconstructions with 3D rendering centred on the scapula should be performed to get the most information available. The trauma CT scan often shows all the scapula fracture, but some protocols may not capture the entire scapula, often missing the superior part. If it is inadequate then, repeating may be required.

Treatment options

The vast majority of scapula fractures heal with good outcomes following non-operative treatment. Zlowodzki undertook a systematic review of scapula fractures, which identified 520 patients in 22 retrospective case series:[3]

- 80% of cases with glenoid involvement were treated operatively, with 82% good or excellent results
- 90% of isolated scapula body fractures were treated non-operatively, achieving good or excellent results in 86% of cases
- 83% of neck fractures were treated non-operatively, with excellent or good results in 77% of cases.

It was not possible to comment on surgically managed neck or body fractures, or on non-surgically treated glenoid fractures as the numbers were too low.

Intra-articular fracture treatment

The rationale for surgical treatment of glenoid fossa fractures is based on the AO group's principles for the treatment of intra-articular fractures.[4] This is to reduce the risk of acute instability, which for the glenohumeral joint manifests as dislocation, and also to reduce the incidence of posttraumatic degenerative changes in the joint leading to arthrosis in the long term. Any evidence of instability with either dislocation or subluxation should warrant surgical intervention. For those with a centred head the indication for surgery relates to articular step-off, with proposals between 2

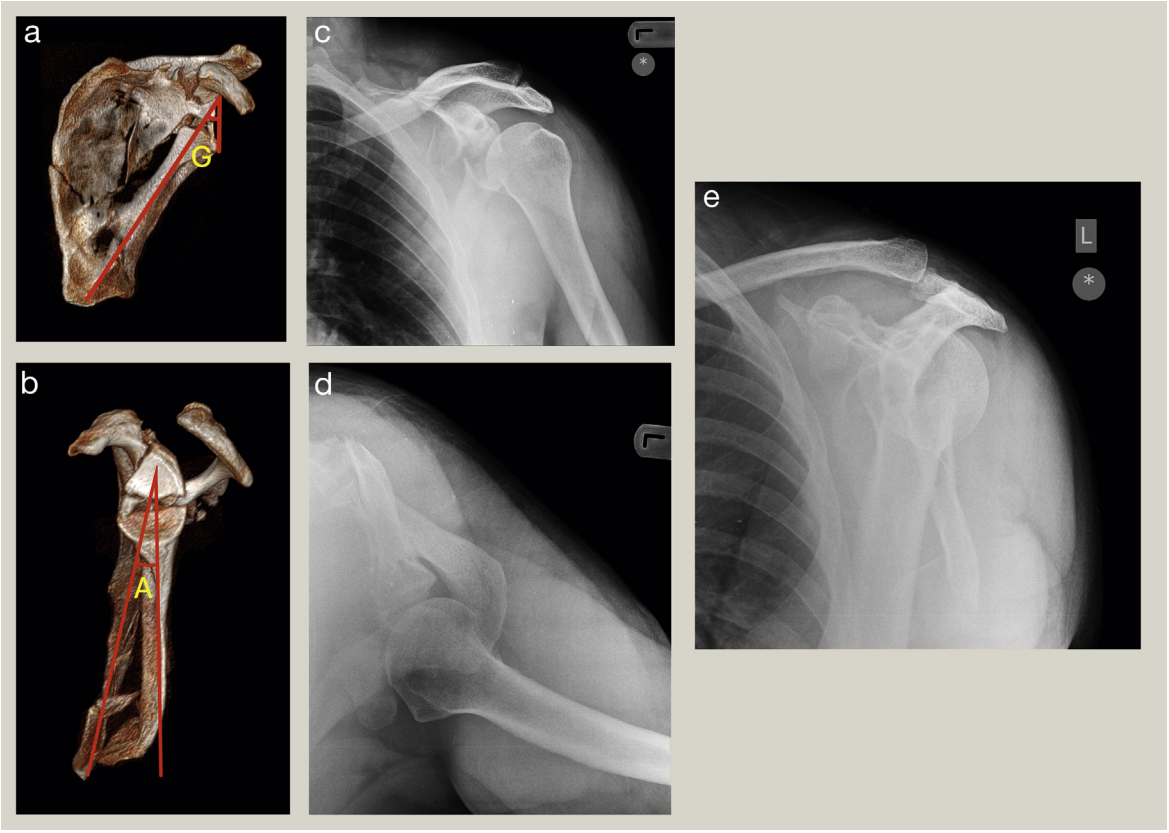

Figure 3 Glenopolar angle (GPA) measurement, angulation measurement and radiographic series for scapula fractures. (**a**) GPA measurement (three-dimensional (3D) CT); (**b**) angulation measurement (3D CT); (**c**) Anteroposterior scapula view radiograph; (**d**) axillary view radiograph; (**e**) scapula Y-view radiograph. G = GPA; A = angulation of fracture.

and 10 mm while most agree with that proposed by Ideberg of 4 mm. A joint involvement of greater than 25% anteriorly or 30% posteriorly, have been considered unstable. However, the decision should take into account all these factors along with patient expectations and functional requirements.

Surgical fixation of the glenoid is performed through a delto-pectoral approach for anterior glenoid fractures, using compression screws fixation, although some fractures such as isolated glenoid rim or transverse glenoid fractures may be amenable to arthroscopic fixation.

For posterior fractures, the glenoid is approached from posteriorly. This can be undertaken through a direct posterior approach elevating deltoid superiorly and developing the interval between infraspinatus and teres minor, to expose the glenoid neck and into the joint. The modified Judet approach allows exposure of associated neck and body fractures, which may also need to be addressed. Fixation may be with compression screws or stable plate fixation (Figure 4).

Extra-articular neck and body fracture treatment

For the extra-articular group of injuries, the decision-making is less clear. Due to the relative rarity of these injuries and the good outcomes of these in most instances with non-operative treatment, trying to identify those patients that will have improved outcomes through surgery is difficult. Despite this, there has been a growing enthusiasm for surgical treatment for some specific fracture patterns. Cole[5] has suggested a surgical threshold of:

- gleno-polar angle (GPA) $<22^\circ$
- scapula angulation $>45^\circ$
- medial displacement >25 mm.

Surgery for patients using these criteria delivered good radiographic outcomes but eight out of 84 needed removal of metal, and three manipulation. Unfortunately, there were no patient-related functional outcomes reported for this study but a later study reported excellent for all surgically treated scapula fractures in the same department.[6] The importance of the GPA was highlighted in a retrospective review of 19 patients, where five out of six of the patients with GPA$<20^\circ$ had pain and three out of 13 with GPA$>20^\circ$ had pain at 8 years.[7] The rationale for scapula angulation is based on an analysis of 113 cases of which 24 were reviewed as having the most significant injuries. Of these there were two patients with malunion of the body who had crepitus on scapulothoracic movement, but had little in the way of pain.[1] The rationale for 20 mm medialization was based on historical accepted practice of other experts, and the theoretical suggestion that shortening of the rotator cuff muscle working length, would lead to poor function. However, undertaking any surgery to mitigate these theoretical problems must take into account the risks to these structures and their nerve supply in doing the surgery.

These criteria have been studied to compare to practice at two level-1 trauma centres in the USA.[8] About 9% had >20 mm medialization, 0% had $>45^\circ$ angulation, 4.2%, had $<22^\circ$ GPA. About 14% had one indication, 4.2% had two indications, and 1% had three indications. They showed there is a divide between what is performed and what the advocates for surgery recommend. Unfortunately, there were no outcome data for these patients. There is one prospective study of 32 consecutively non-operatively treated displaced scapula body fractures (glenoid fractures were excluded), at a Level 1 Trauma Centre in the USA, which revealed that they all healed.[9] There was no correlation of outcome with GPA, body comminution, angulation, or medialization. The only significant factors affecting the outcome were the Injury Severity Score and the presence of rib fractures.

This shows that the evidence is sparse for the decision-making about treating extra-articular fractures of the scapula. Patients should, where possible, be involved in any decision to operate and should understand what is hoped to be achieved with surgery and the level of evidence to support this.

Symptomatic malunion has been successfully treated with corrective osteotomy for debilitating pain and weakness.[10] The five patients treated had significant improvement in DASH score, and four were able to return to work where they were unable preoperatively. When measured on 3D CT scan, the mean pre-operative fracture deformity was 3 cm (range, 1.7–4.2 cm) of medial/lateral displacement, 25° (range, 10°–40°) of angular deformity, and a 25° (range, 19°–29°) GPA.

Double disruption of superior shoulder suspensory complex (SSSC) (floating shoulder) treatment

Goss[11] described the SSSC, which is made up of the ring of structures comprising: glenoid, coracoid, coraco-acromial ligaments, lateral clavicle, ACJ, acromion and acromial spine. It

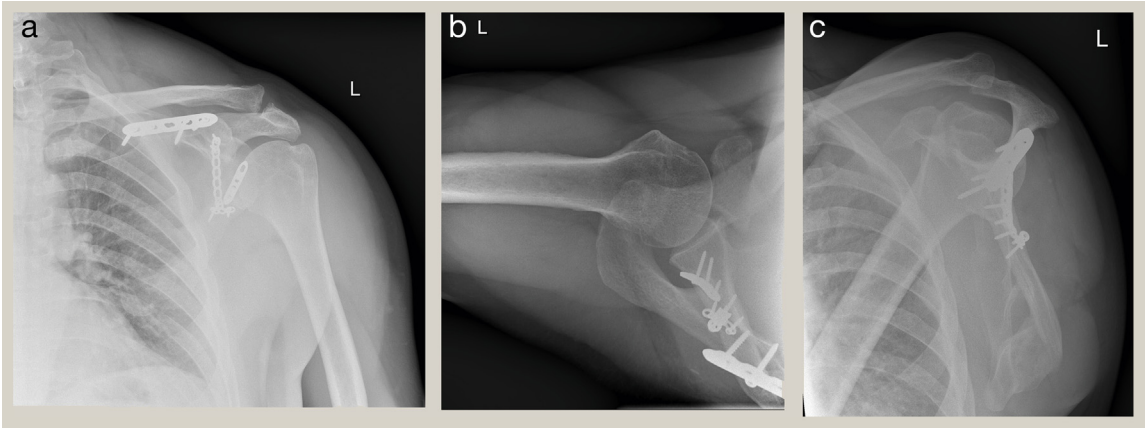

Figure 4 Postoperative radiographs for scapula fracture plate fixation.

was postulated that if the ring is disrupted in two places, the loss of integrity creates a 'floating shoulder'. This discontinuity between the axial skelton and the arm, would lead to poor outcomes and it was suggested that surgery should be indicated in all cases of double disruption. This has been challenged with a number of studies showing acceptable outcomes with non-operatively treated cases and now, advocates for surgery recommend that only displaced or unstable double disruptions of the SSSC should be treated. There was recently a systematic review of the treatment of floating shoulders.[12] A total of 13 studies were identified with 244 subjects treated. These were treated either with non-operatively, clavicle fixation only or scapula neck and clavicle fixation. There was no difference in the outcomes, although there was a positive correlation between constant score and the final GPA. The suggestion is that each component of the double disruption of the SSSC should be separately evaluated and treated on its own merits, but the combination itself does not mandate surgery.

Acromion fracture treatment

The treatment of acromial fractures has been studied with a systematic review of the literature.[13] A total of 14 publications were found but most current recommendations are often based on a limited number of cases. No gold standard to treat these fractures exists. Most authors recommend anatomic reconstruction, especially for dislocated fractures, persistent symptomatic non-unions or additional injuries to the SSSC. The authors also described their own experience in five patients that were all initially treated conservatively. Two were successful and three eventually required reconstruction with open reduction internal fixation. They suggested a treatment algorithm, based on Kuhn classification. They suggest that avulsion fractures can be treated non-operatively, and for low-demand patients undisplaced and displaced fractures with no impingement on the subacromial space can be treated with non-operative treatment. If symptomatic non-union occurs, then reassess and consider for surgery. For high-demand patients and fractures impinging on the subacromial space they recommend operative treatment. There was no consensus about the best way to fix these fractures. Ogawa[14] treated 31 patients with acromial fractures, 13 with surgery, 18 non-operatively. A total of 28 were excellent or satisfactory, and there was one failure when assessed with Neers criteria. The indication for surgery was unclear, although many had associated shoulder injuries.

Coracoid fracture treatment

Isolated coracoid fractures are rare, but are frequently associated with acromioclavicular injuries. On that basis, when a diagnosis of ACJ disruption is made, the base of the coracoid should be clearly assessed. The merit or otherwise of surgery is unclear. Non-operative treatment has been successful, with a risk of non-union of 10% reported,[15] but there are several case reports of symptomatic non-union reported particularly in patients with high functional demands. Ogawa et al.[16] suggest the surgical treatment for those fractures proximal to the insertion of the coraco-acromial ligaments, and non-operative treatment for those with more distal fractures, as they invariably represent double disruption of the SSSC. There are no comparative studies to give other guidance.

Non-operative managent

As most fractures being treated non-operatively are stable, and the risk of non-union is low for scapula fractures, the aim of non-operative treatment should be to get the shoulder moving quickly. These injuries are often very painful, so should have adequate analgesia, and initial rest in a broad arm sling. Once the initial pain has settled, the shoulder should move with both passive and active movements supervised by physiotherapists. The aim is to avoid stiffness of the shoulder and to regain strength. They should have weekly follow-up for 2 weeks, with radiographs, to make sure that any potential glenohumeral joint instability, which was not obvious initially, is excluded and any borderline displaced fractures have not deteriorated. Following that, the follow-up should be until union, and any residual symptoms have been addressed.

Surgical management

The approach to surgery is defined by the surgeon's assessment of the injury, with a detailed review of the imaging. For anterior glenoid fractures and coracoid fractures fixation is undertaken through a deltopectoral approach. Posterior glenoid, neck, and body fractures are best approached from posteriorly. For all surgery to the scapula, it is best to have the head in the centre of the theatre, and discussing with the anaesthetic team prior to surgery about positioning should allow setting the patient up with longer tubes, and the appropriate airway, and perioperative analgesia.

For the deltopectoral approach, patient can be positioned supine or in a beach chair position. It is essential to ensure intra-operative fluoroscopy to assess the glenoid both AP, and also with an axillary view obtainable before standard preparation and draping. This is best done with the image intensifier accessing the patient from the head end of the patient. The skin incision starts at the coracoid, in interval over deltopectoral region, for glenoid fractures, but may need to extend proximally for the coracoid base. Once the clavipectoral fascia is incised lateral to the conjoint tendon, the subscapularis is identified. To access the glenoid it is possible to undertake a subscapularis tenotomy, carefully dissecting subscapularis off the underlying joint capsule. A separate vertical capsulotomy, allows visualization of the anterior glenoid region for reduction and fixation. Separating the subscapularis from the capsule allows the fracture fragment to be mobilized and fixed extra-articularly, whereas if the capsule and subscapularis are divided as one layer the reduction and fixation must be made within the joint, which might lead to difficulty positioning screws. Alternatively, the subscapularis muscle can be split medial to the tendon at the junction between the upper two-thirds and lower one-third. The muscle is elevated off the glenoid neck with a swab, and the tendon incised laterally if the glenoid rim is not visible. This gives a direct view onto the fracture, and a capsulotomy is made in line of the fibres at the level of the fracture to allow visualization of the joint surface for anatomical fixation. This is a useful approach if there are concerns about tenotomizing the subscapularis (e.g. in the presence of associated proximal humeral fracture).

For posterior approach the patient is positioned in the lateral decubitus position, with the affected arm in abduction over a foam block, which is radiolucent. The arm should be free to

move during the operation, as the surgery requires the arm to be put into different positions during reduction and fixation. Fluoroscopy can be challenging and arranging the image intensifier to get the necessary AP and axillary views needs good communication with the radiographer. The image intensifier is best approaching from the side with the ability to rotate 90° to give a vertical and horizontal view and movement of the patient's arm, to get the required views. There are a number of options for the approach. Judet described the approach to the scapula body, which allows good access to the body and neck fractures particularly if there has been a delay to surgery and callous is starting to develop. It is, however, as good for intra-articular viewing as the suprascapular nerve limits the extent of lateral extension. The skin incision is made along the scapula spine and curved inferiorly along the medial border. The medial aspect of deltoid elevated off the scapula spine and reflect laterally as necessary. At this point Judet described mobilization of infraspinatus from the medial scapula border and reflection on its neurovascular bundle passing from the spinoglenoid notch. This gives access to the infraspinatous fossa and posterior aspect of the glenoid neck. Care and attention are required when handling the neurovascular pedicle and muscle mass. Obremsky[17] described a modification where having reflected deltoid, the scapula is approached through the window between infraspinatus and teres minor. This reduces the trauma to the muscles, but still allows access to lateral border, acromion, neck, and glenoid surface. As the infraspinatus and teres are not mobilized en block, the interval can be extended along the tendon to get better access to the glenoid fossa with a capsulotomy in line with the interval. This also has the benefit that if reduction is difficult due to callous formation, the infraspinatus can subsequently reflected to give the original Judet access.

There is also the option of a direct posterior approach to the neck and glenoid, with an incision in line with the lateral border. The deltoid can be elevated from its inferior border, to expose the window between infraspinatus and teres minor, to give a more limited access to the neck, and glenoid. This is suitable for fresh neck and glenoid fractures giving less soft tissue injury, but is more difficult to extend to for more access.

For fixation of these fractures, each individual fracture should be assessed on its merits and decision-making guided by AO principles. Generally the intra-articular component of glenoid fractures should be fixed with anatomical reduction and compression with interfragmentary screws. The extra-articular components of the neck need restoring the anatomical parameters described, and are best fixed with plates to maintain the alignment. Often 2.7 mm plates are suitable and contoured to the shape required. For acromial fractures the fixation is best achieved with plate fixation, and although there are manufacturers that make anatomical plates, often clavicle or wrist plates are suitable to achieve the fixation required. Corocoid fractures can usually be fixed with screws along the neck across the base into the glenoid neck.

Postoperatively the patient should start mobilization as soon as possible, to avoid stiffness. The risk of non-union is low, and implant failure is rare. Communication with physiotherapists is crucial. They should not worry about harming the fixation and be reassured to start passive and active movements from the outset. Strengthening can start after a few weeks once pain has settled and range of movement regained.

Conclusion

Scapula fractures are relatively rare. The surgical technique to reliably fix these fractures is now well described, with good and excellent results. Unfortunately, the evidence defining clear indications for surgery is still not available. Most would agree with the indication for intra-articular surgery, on the basis of principles of treatment of intra-articular fractures of other joints. However, even here, the literature has a paucity of evidence about outcomes following non-operative surgery. For extra-articular fractures the outcome following non-operative treatment is good or excellent for the majority. Advocates of surgery have suggested a number of parameters to guide treatment options on the basis of theoretical risk, small case series and a small number of patients with symptomatic malunion. They have achieved good and excellent results with surgery, as have others who have treated similar groups of patients non-operatively. There is no comparison study available to show that surgical intervention improves outcome. Surgery is likely to improve the outcomes of certain patients, and assessing all the available information concerning the fracture pattern, and the patient factors will guide surgeons in their decision-making. Using deformity of the GPA, medialization, and scapula angulation as a guide for decision-making gives a good basis for decision-making, but cannot be used as an absolute indication for surgery.

However, undertaking any surgery to mitigate these theoretical problems must take into account the risks to these structures and their nerve supply in doing the surgery. ◆

REFERENCES

1 Ada JR, Miller ME. Scapular fractures: analysis of 113 cases. *Clin Orthop Relat Res* 1991; **269:** 174–80.

2 Baldwin KD, Ohman-Strickland P, Mehta S, Hume E. Scapula fractures: a marker for concomitant injury? A retrospective review of data in the National Trauma Database. *J Trauma* 2008; **65:** 430–5.

3 Zlowodzki M, Bhandari M, Zelle BA, Kregor PJ, Cole PA. Treatment of scapula fractures: systematic review of 520 fractures in 22 case series. *J Orthop Trauma* 2006; **20:** 230–3.

4 AO Surgery Reference (online resource), accessible at: https://www2.aofoundation.org/wps/portal/surgery.

5 Cole PA, Gauger EM, Herrera DA, Anavian J, Tarkin IS. Radiographic follow-up of 84 operatively treated scapula neck and body fractures. *Injury* 2012; **43:** 327–33.

6 Tatro JM, Gilbertson JA, Schroder LK, Cole PA. Five to ten-year outcomes of operatively treated scapular fractures. *J Bone Joint Surg Am* 2018; **100:** 871–8.

7 Romero J, Schai P, Imhoff AB. Scapular neck fracture–the influence of permanent malalignment of the glenoid neck on clinical outcome. *Arch Orthop Trauma Surg* 2001; **121:** 313–6.

8 Brandsema B, Neuhaus V, Gradl G, Ring DC. Extra-articular scapular fractures: comparison of theoretical and actual treatment. *Shoulder Elbow* 2016; **8:** 3–8.

9 Dimitroulias A, Molinero KG, Krenk DE, Muffly MT, Altman DT, Altman GT. Outcomes of nonoperatively treated displaced scapular body fractures. *Clin Orthop Relat Res* 2011; **469:** 1459–65.

10 Cole PA, Talbot M, Schroder LK, Anavian J. Extra-articular malunions of the scapula: a comparison of functional outcome before and after reconstruction. *J Orthop Trauma* 2011; **25:** 649–56.

11 Goss TP. Double disruptions of the superior shoulder suspensory complex. *J Orthop Trauma* 1993; **7:** 99–106.

12 Morey VM, Chua KHZ, Ng ZD, Tan HMB, Kumar VP. Management of the floating shoulder: does the glenopolar angle influence outcomes? A systematic review. *Orthop Traumatol Surg Res* 2018; **104:** 53–8.

13 Hess F, Zettl R, Welter J, Smolen D, Knoth C. The traumatic acromion fracture: review of the literature, clinical examples and proposal of a treatment algorithm. *Arch Orthop Trauma Surg* 2019; **139:** 651–8.

14 Ogawa K, Naniwa T. Fractures of the acromion and the lateral scapular spine. *J Shoulder Elb Surg* 1997; **6:** 544–8.

15 Wilber MC, Evans EB. Fractures of the scapula. An analysis of forty cases and a review of the literature. *J Bone Joint Surg Am* 1977; **59:** 358–62.

16 Ogawa K, Yoshida A, Takahashi M, Ui M. Fractures of the coracoid process. *J Bone Joint Surg Br* 1997; **79:** 17–9.

17 Obremskey WT, Lyman JR. A modified Judet approach to the scapula. *J Orthop Trauma* 2004; **18:** 696–9.