# Clinical Article

# Open reduction and internal fixation of scapula fractures

HR Hobbs MBChB(UCT)
Registrar, Department of Orthopaedic Surgery, University of Cape Town
BR Garrett MBChB(UCT)
Registrar, Department of Orthopaedic Surgery, University of Cape Town
P Sanchez MBChB(Wits), FCS(SA)Orth
Private Practice, East London
SJL Roche MBChB(UCT), FCS(SA)Orth
Consultant, Shoulder and Elbow Unit, Department of Orthopaedics, University of Cape Town
BC Vrettos MBChB(Zim), FRCS(Eng), FCS(SA)Orth, MMed(Orth)(UCT)
Cape Town Centre for Bone and Joint Surgery, Vincent Pallotti Hospital

**Reprint requests:**
Dr SJL Roche
sroche@iafrica.com
Fax: 027 21 532-2821
Tel: 027 21 404-5108

## Abstract

Scapular fractures requiring surgery are relatively rare injuries. This retrospective review looks at the outcome of open reduction and internal fixation of these fractures and the surgical exposures necessary for their fixation.

All surgically treated scapular fractures from January 2000 to December 2006, with the exception of Ideberg type Ia (anterior rim) fractures of less than 25% with an associated dislocation, had their clinical notes and radiology reviewed. The surgical approach was analysed with regard to the fracture classification and exposure. Reduction, union and failure of fixation were assessed. Outcomes were determined with respect to pain and range of movement.

At an average follow-up of 9 months (range 6 to 72 months), all of the fractures had united. Twenty out of the 25 patients were pain-free (80%) and the rest only had mild pain. Twenty-two patients (88%) had a good or functional range of movement. Adequate reduction was obtained in all but one fracture.

A good outcome can be expected in over 80% of scapular fractures requiring surgical fixation. Union is predictable and the complication rate is low. Most of the fractures can be addressed by employing teres minor/infraspinatus intermuscular planes or subscapularis muscle splits without rotator cuff tenotomies.

## Introduction

Fractures of the scapula are relatively uncommon injuries, making up 3% to 5% of all fractures of the shoulder girdle and <1% of all fractures.[1,2] They are usually the result of high energy trauma, and more than 50% of the patients have associated injuries.[1] The majority of fractures, extra-articular (scapular body 99%, scapular neck 83% and intra-articular glenoid 80%), are treated conservatively.[3] Approximately 10% of scapular fractures involve the glenoid articular surface. Reported series of surgically treated intra-articular fractures are generally small series (Cofield 10 patients,[4] Mayo 27 patients[5] and Schandelmaier 22 patients[6]). These series show good results in greater than 80% of patients. The most widely accepted classification of these fracture is the anatomic classification with the intra-articular glenoid fractures being further sub-classified using the Ideberg[7] classification modified by Goss.[8]

The deltopectoral approach with a subscapularis tenotomy has been the described approach for type Ia fractures.[8] The posterior approach with an infraspinatus tenotomy is the described approach for the rest of the intra-articular glenoid fractures and for the glenoid neck fractures. More recently the teres minor/infraspinatus split has been recommended.[9] Occasionally a superior extension of the posterior approach or an anterior approach is made for type III fractures.

## Patients and methods

All patients who had surgery for their scapular fractures over a 6-year period between 2001 and 2007 were identified from the surgical logbooks of the two senior authors. Anterior rim fractures (Ideberg type I) of less than 25% of the glenoid associated with a dislocation were excluded as with other published series (*Figure 1*). This left 28 patients with 31 scapular fractures. Three patients were lost to follow-up or their clinical notes were missing, leaving 25 patients with 28 scapular fractures. All case notes, X-rays and CT scans (when done) were reviewed.

Fractures were classified using the anatomic classification. The intra-articular glenoid fractures were further sub-classified using the Ideberg[7] classification modified by Goss.[8]

Indications for fixation were based on the literature[1,4,8,9,10] and were as follows:

For the intra-articular glenoid fractures:

- any displaced fracture of the glenoid surface with:
  - >5 mm gap in the articular surface
  - displacement of >1 cm
  - >25% of articular surface involvement
  - subluxation of the humeral head with the fracture fragment.
- For the extra-articular fractures:
  - scapular neck fractures >40° angulated or with medialisation of >1 cm
  - floating shoulder
  - displaced acromial fractures
  - non-unions.

Radiographs were reviewed for accuracy of reduction, union and whether osteophytes or loss of joint space was present. Failure of fixation or loosening was documented. Failure to achieve reduction was if there was a 2 mm or more step or gap, and if there was more than 10° angulation.

Documentation regarding range of motion and pain was noted.

## Results

The average age of the patients was 37 years (range 15 to 63 years). Twenty-one were male. As with other series 45% (12) sustained associated injuries.

### Anatomic classification

The distribution of our fractures was as follows:

- scapular neck — 3 (2 of which were floating shoulders)
- scapular body — 1 (non-union)
- scapular spine — 3
- acromion — 6 (2 non-unions)
- glenoid — 15

Permission to use the Ideberg/Goss Classification type I to VI was granted by Prof Goss (*Figure 2*).

The following shows the distribution of the glenoid fractures (No 15):

- Ia — 2
- II — 3
- III — 5
- Vb — 3
- VI — 2

Three patients had two fractures of the scapula with both fractures requiring fixation.

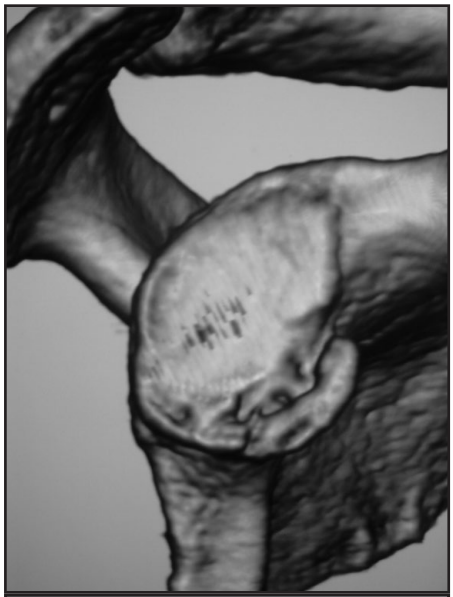

**Figure 1: Ideberg type Ia less than 25% glenoid fractured**

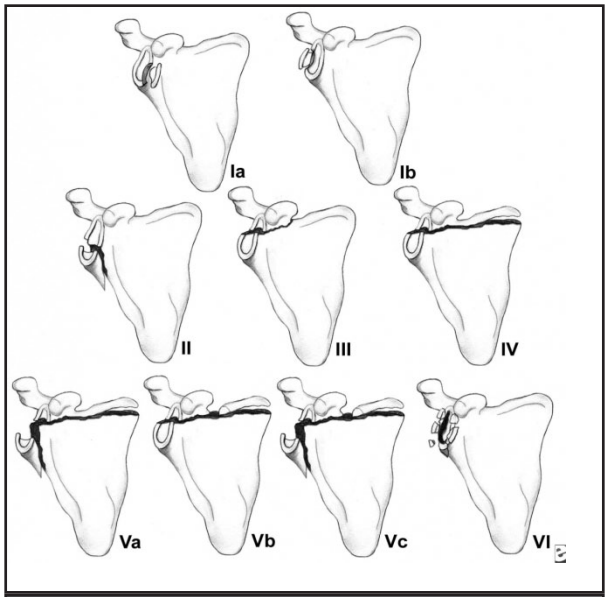


**Figure 2: Classification of Ideberg as modified by Goss: type I to VI**

## Surgery

The average time to surgery was 12 days (3 to 42 days) with non-unions excluded. The anterior approach was used in five patients and the posterior in 19. They were fixed with lag screws, plates or combinations. One case was managed arthroscopically using cannulated screws.

## Anterior approach

The patient was placed in the beach chair position and the deltopectoral approach was performed. This approach was utilised for two Ideberg Ia fractures and two type III fractures. One type VI fracture was approached from anteriorly as the extent of the comminution made only limited fixation possible. We initially did a subscapularis tenotomy (two patients), as suggested in the literature. We subsequently progressed to a subscapularis split (three patients) with a transverse capsulotomy.

The posterior approach was utilised for the remaining intra-articular glenoid, glenoid neck and acromial fractures. The patients were placed in the lateral position with their arms over a bolster (*Figure 3*). The isolated acromial fractures were treated through a direct incision over the acromion/spine. The full Judet (*Figure 4*) exposure was performed in the one patient with the scapula body fracture non-union. The remaining intra-articular and glenoid neck fractures were approached through the modified Judet (*Figure 4*). This can be extended superiorly over the shoulder when further exposure is required to address an additional acromial fracture, explore the suprascapular nerve or when the superior approach is necessary for the type III fracture. The posterior deltoid is partially taken down off the scapula spine to reveal the shoulder external rotators. An infraspinatus tenotomy, as recommended by the literature, was done in the first four patients. The other nine patients were addressed by splitting the infraspinatus and teres minor muscles in the neuromuscular plane. A variety of fixations were used ranging from cannulated screws to locked plate systems. The acromion/spine fractures were fixed with a direct approach if isolated, otherwise with superior extension of the modified Judet approach. They were fixed with either lag screws or plates, including a locked lateral end of clavicle plate (*Figure 5*).

The patients were placed in a shoulder immobiliser for 6 weeks. The minimum rehabilitation was an active assisted range of motion exercise programme. If good fracture stability was obtained, an active range of motion below shoulder height was allowed. At 6 weeks all progressed to a full range of motion and strengthening regimen.

The patients were followed up for an average of 9 months (range 6 to 72 months). All fractures united and none to date shows loss of the joint space. There was no loss of reduction. Twenty out of the 25 patients were pain-free (80%) and 22 patients had a good or functional range of movement (88%).

**Figure 3: Patient positioning for posterior approach**

**Figure 4: Judet approach – dashed line, modified Judet – skin incision**

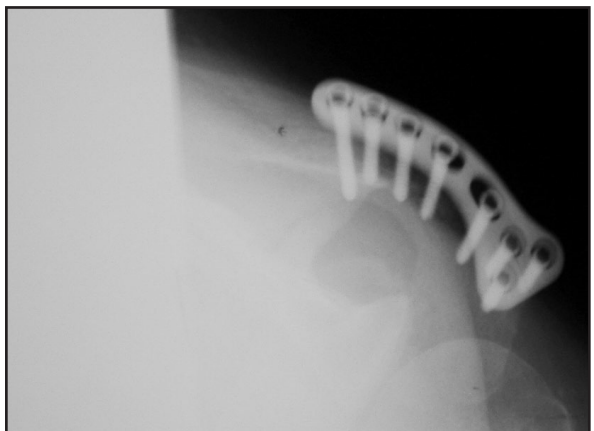

**Figure 5: Lateral end clavicle plate for scapular spine fracture**

## Complications

Three patients developed shoulder impingement. Not surprisingly it occurred in the two patients with acromial fractures and one with a scapula neck fracture where the shoulder outlet had been altered. They all had subsequent acromioplasties with resolution of their pain. One patient with a gunshot acromion developed low grade sepsis following surgery which was treated with debridement and antibiotics. He eventually had the hardware removed and has been sepsis-free for five years. A single screw (in a plate) fractured in the patient with a non-union of an acromion. The non-union went on to unite without further intervention.

There were three suprascapular nerve palsies, all of which were documented pre-operatively. One was due to a gunshot scapular spine and one due to a scapular neck and body fracture, neither of which recovered (*Figure 6*). The third was due to an Ideberg III fracture, where the suprascapular nerve was explored at operation. It was found to be intact and recovered postoperatively.

*Table I* summarises the methods of fixation used.

## Discussion

Ideberg type Ia (anterior rim) fractures of less than 25% with an associated dislocation were excluded, as in other series, as they are commonly addressed using the dislocation treatment protocols.

We used the widely accepted criteria for fixation of displaced scapula fractures (*Figure 7*). Our results of surgical fixation compare with the literature, where Cofield[4] achieved good results in eight out of 10 patients (80%), Mayo[5] had good results in 22 out of 27 patients (81%) in one of the largest series and Schandelmaier[6] achieved good results in 18 out of 22 patients (82%). However these studies only looked at intra-articular glenoid fractures. Unfortunately we have no formal scoring at the follow-up as this was a retrospective study and we were unable to recall all the patients.

Not surprisingly there is a delay in getting to surgery and we believe this is probably due to three reasons. The first is many of these patients are polytraumatised and are in ICU or have injuries which take priority over fixation of the scapula. Secondly, some patients have a delay as they are referred from other hospitals and thirdly our access to surgical time is limited to one day a week and the patients need to wait for this day.

Our surgical approach has changed as we have gained experience with these fractures. As mentioned above we believe the anterior exposure can be adequately done through a subscapularis split. This came about with the experience of using the split in recurrent dislocation surgery (Bankart repair and modified Latarjet Procedure). The literature has favoured the tenotomy for exposure. The advantage of the split is earlier mobilisation without fear of rupture of the repair, and possible prevention of the reported fatty changes and atrophy associated with tenotomy.

**Table I: Methods of fixation in the individual fracture types :Ssc = subscapularis, IS/TM = Infraspinatus/Teres minor**

| Approach | Type of fracture | Muscle approach |
|---|---|---|
| **ANTERIOR (DELTOPECTORAL)** | | |
| | Ia | Ssc split |
| | Ia | Ssc tenotomy |
| | III | Ssc tenotomy |
| | III | Ssc split |
| | VI | Ssc split |
| **POSTERIOR** | | |
| | II | IS/TM split |
| | II | IS/TM split |
| | II | IS/TM split |
| | III | IS tenotomy |
| | III | IS/TM split |
| | Vb | IS/TM split |
| | Vb | IS/TM split |
| | Vb | IS tenotomy |
| | VI | IS/TM split |
| | Body (non-union) | Judet |
| | Neck | IS tenotomy |
| | Neck | IS tenotomy |
| | Neck | IS/TM split |
| | Spine | Direct |
| | Spine | Direct |
| | Spine & acromion | Direct |
| | Acromion | Direct |
| | Acromion | Direct |
| | Acromion | Direct |
| **ARTHROSCOPICALLY** | | |
| | III | Nil |

We also approached other fracture types via the anterior approach which is controversial with respect to the literature. There were two patients with type III fractures where we felt they were best visualised from anterior. The fixation for these fractures is still difficult as the direction of screw is awkward. Cannulated screws definitely help. We chose this approach as those fractures which exit high on the posterior border of the glenoid are difficult to see, and it is difficult to place a screw across the fracture line because it is hidden by the posterior acromion. If the fracture line is below the acromial spine it is easier from posterior. However if the fracture line is more superior it may be more easily dealt with from an anterior approach.

We also treated a type VI fracture from anterior as we felt only partial fixation was possible as this was so comminuted.

Figure 6: Suprascapular nerve palsy wasting


Figure 7: Displaced scapular fracture type V with post reduction X-ray

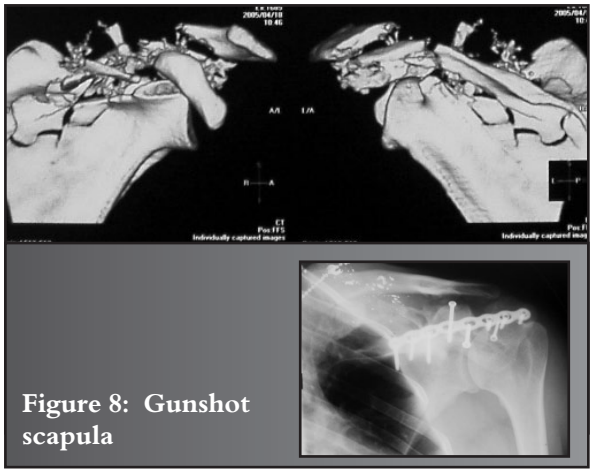

Figure 8: Gunshot scapula

Figure 9: Incomplete reduction of type III fracture

The arthroscopic case was done in a lateral position with radiographic imaging control. This makes the theatre crowded with the arthroscopic equipment and the image intensifier present. The difficulties encountered were with the K-wire insertion for the cannulated screw. Unfortunately they bend too easily and we have not attempted this again. We do however use this technique in type Ia fractures which were excluded from this series.

The rest of the fracture types were approached from posterior. We did one Judet approach, which was for a non-union of the scapular body. We felt this was too extensive to use again as the entire infraspinatus has to be elevated off the body. Initially we did four infraspinatus tenotomies for exposure. As with the anterior approach we found we had enough exposure by taking the split between infraspinatus and teres minor further laterally. The infraspinatus and the teres minor can be elevated with a Cobb to give further exposure while protecting the suprascapular nerve.

The approach to the type III fracture from superiorly or when exploring the suprascapular nerve we found to be surgically challenging.

The isolated acromial fractures were approached through an incision over the acromion. The combination of a spine fracture with a neck/glenoid fracture is approached through a routine modified Judet with superior extension.

The one concern with the posterior approach is taking down the posterior deltoid off the spine of the scapula. We did not however encounter any disruptions post-surgery. We did protect it by avoiding active extension for two weeks.

The three suprascapular nerve palsies were identified preoperatively. The diagnosis was made by testing infraspinatus. This was done by examining for active external rotation. They all had a lag sign where there was no active external rotation while passive external was maintained. It is too difficult to assess supraspinatus in the earlier stages as the pain and deltoid confound the examination. They have an intact subscapularis and can therefore actively internally rotate.

The other patients maintained active external rotation despite the pain and therefore may have a partial injury to the nerve. We may have missed injuries of the nerve where there was enough strength of teres minor to prevent the loss of active external rotation.

Two have not recovered clinically with resultant residual weakness and wasting of infraspinatus; one of them is the patient with an extensive gunshot injury with intra-operative confirmation of the nerve injury (*Figure 8*). Despite this, both have active external rotation and active elevation above 90°, with well-developed teres minor muscles which may be compensating for the loss of infra-spinatus.

Reduction was acceptable in all but one of the intra-articular fractures (*Figure 9*) and all went on to union without loss of fixation.

We have included the other scapular fractures and the non-unions in our series as we felt these were also uncommon and they contributed to our surgical understanding of scapular fractures and the surgical approach.

## Conclusion

Scapular fractures are relatively uncommon and therefore there is limited surgical experience with the approaches. The anterior approach is commonly used for other shoulder surgery and the reduction through a subscapularis split can be used successfully to achieve reduction. The posterior approach however is much less common. The majority of fractures can be adequately exposed, reduced and fixed through a teres minor / infraspinatus split. A good outcome can be expected in more than 80% of patients with minimal complications.

*This article was submitted to an ethical committee for approval. The content of this article is the sole work of the authors. No benefits of any form have been derived from any commercial party related directly or indirectly to the subject of this article.*

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