Extra-articular scapular fractures: comparison of theoretical and actual treatment

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Abstract

Background: Discrete radiographic thresholds of scapular fracture deformity proposed as a guide for when to utilize operative treatment are a matter of debate. The purpose of the present study was to determine how many patients would have received operative treatment according to these criteria and how many actually received operative treatment.

Methods: Three hundred and thirty patients with an extra-articular fracture of the scapula at two level I trauma centers were retrospectively analyzed. Glenopolar angle, translation, angulation and medial/lateral displacement were measured on computed tomography scans or radiographs to determine the theoretical operative treatment recommendation according to Cole's criteria.

Results: Sixty-two patients (19%) had one or more radiographic indications for operative treatment, half of them had more than 20 mm of lateral displacement, and one fourth of them had substantial translation. No patients had operative treatment of the scapular body. Two patients had operative treatment of an acromion fracture, neither of which met radiographic criteria for surgery.

Conclusions: At least in our centres, there is a striking discrepancy between theoretical and actual recommendations for surgery. There is clearly a need for more research to determine whether patients are being undertreated or whether the guidelines are too stringent.

Keywords

3D computed tomography, Cole's criteria, extra-articular scapular fracture, operative treatment, radiographs

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Introduction

Scapula fractures are relatively uncommon, most are minimally displaced, and they are usually managed non-operatively.^{1–4} Based on good blood supply and thick muscular coverage, scapular body fractures generally heal with non-operative treatment with good functional outcome. Even malunions usually produce few symptoms.^{4–6} The most important adverse outcomes of extra-articular fractures after non-operative treatment are fair or poor functional outcome in up to 20%, residual scapula deformity on radiographs in 25%, and pain, especially with residual scapula deformity, in 12%.^{4,7} Reported adverse events after operative treatment of the scapula were infections in up to 4%, secondary surgical procedures (i.e. manipulations

under anaesthesia, wound revisions as a result of infections or haematoma, hardware removal, re-osteosynthesis and arthrodesis) in up to 17%, and fair

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or poor functional outcome in up to 12%.^{4,8} Non-unions of scapular body fractures are rare.^{9–11}

Cole and colleagues have developed radiographic criteria for scapular fracture deformity that merits operative treatment. The relevant measurements for extra-articular fractures include the glenopolar angle, translation, angulation and medial/lateral displacement.^{1,2,12–14} There is debate about these recommendations, with some surgeons pointing out that even displaced fractures heal with good functional outcome, and the potential for improvement with surgery is limited.^{15,16}

We reviewed the treatment of extra-articular fractures of the scapula at two level 1 trauma centres aiming to address the primary null hypothesis that there is no difference between the treatment that the patient would receive according to Cole's criteria and the treatment they actually received.

Materials and methods

With Institutional Review Board approval and using a prospectively collected trauma database, we retrospectively identified 457 adult patients at two level 1 trauma centres diagnosed with a scapular fracture between September 2002 and August 2011. We excluded 29 patients younger than 18 years and 98 patients with an intra-articular scapula fracture, leaving a cohort of 330 patients with an extra-articular fracture of the scapula for analysis (Table 1).

Seventy-six percent of patients with an extra-articular scapular fracture were men (Table 1). The most common mechanisms were a motor vehicle collision as a passenger or pedestrian in 52% or a fall in 25%. Eighty-nine percent of the patients with an extra-articular scapular fracture had concomitant injuries: 66% chest trauma, 25% abdominal injury and 55% at least one extremity fracture. Ninety-two percent had an X-ray of the shoulder and 85% had a computed tomography (CT) of the thorax/scapula. Twenty-four patients (7.3%) had a CT scan for an isolated scapular fracture. The mean injury severity score (ISS) in patients with a CT was 17 in comparison to 9.5 without a CT ($p < 0.001$). In 48%, the fracture was an AO subtype A3.1 (Body, not comminuted) fracture; in 42%, an A3.2 (Body, comminuted) fracture; in 6%, a coracoid fracture; and, in 5%, an acromion fracture (Table 2). Acromion fractures (A1) had slightly more often radiographs only.

Two investigators not involved in the patients' care reviewed medical records retrospectively and recorded age, sex, race, employment before the accident, trauma mechanism, ISS,¹⁷ treatment (non-operative or operative), time between accident and surgery (in days), surgical approach and fixation technique, as

Table 1. Demographic overview of 330 extra-articular scapular fractures.

Parameter		
Age (years)	Mean $\pm$ SD	48 $\pm$ 20
	Range	18 to 93
ISS	Mean $\pm$ SD	17 $\pm$ 10
	Range	4 to 54
Sex	Female	79 (24%)
	Male	251 (76%)
Race	White	267 (81%)
	Black	19 (5.8%)
	Asian	4 (1.2%)
	Latin American	14 (4.2%)
	Unknown	26 (7.9%)
Employment	Working	160 (49%)
	Retired	43 (13%)
	Unemployed	45 (14%)
	Disabled	11 (3.3%)
	Unknown	71 (22%)
Mechanism of injury	MVC passenger	154 (47%)
	MVC pedestrian	17 (5.2%)
	Work	24 (7.3%)
	Sport	27 (8.2%)
	Fall	81 (25%)
	Direct blow	16 (4.8%)
	Unknown/other	11 (3.3%)
Side	Left	187 (57%)
	Right	143 (43%)
Concomittant injuries	Present in	292 (89%)
Radiographic examination		
X-ray	Performed in	303 (92%)
Computed tomography	Performed in	280 (85%)

ISS, injury severity score; MVC, motor vehicle collision.

Table 2. AO/OTA classifications of 330 extra-articular scapular fractures.

AO/OTA classification	n	Rate (%)
I4-A1.1 Acromion, noncomminuted	11	3%
I4-A1.2 Acromion, comminuted	5	2%
I4-A2.1 Coracoid, noncomminuted	16	5%
I4-A2.2 Coracoid, comminuted	2	1%
I4-A3.1 Body, noncomminuted	159	48%
I4-A3.2 Body, comminuted	137	42%

well as follow-up duration. The fractures were classified on radiographs and computed tomography according to the AO/OTA classification¹⁸ by an orthopaedic trauma trained surgeon (one of the two investigators).

We measured the fractures according to the radiographic criteria of Cole and colleagues for operative treatment (Table 3). Radiographic measurements were performed with Aquarius Viewer (TeraRecon Inc., Foster City, CA, USA) on 3D computed tomography reconstructions simulating anteroposterior (AP) and scapular Y views or anteroposterior and scapular Y radiographs when CTs were not available. The criteria of Cole and colleagues that we used in the present study were: (i) more than 20 mm of lateral displacement of the inferior body fragment in comparison to the superior fragment of the fracture on a 3D scapula, virtually rotated till the 3D model represents a true AP radiograph showing the largest width of the scapular body (or more than 15 mm of lateral displacement with more than 30° of angulation) (Fig. 1);^{19,20} (ii) a glenopolar angle less than 22° measured on the same true AP rotated 3D reconstruction as the angle between a line defined by the inferior and superior edges of the glenoid and a line defined by the superior edge of the glenoid and the inferior angle of the scapula (Fig. 2);^{13,20} (iii) an angle greater than 45° between the distal and proximal body main fragments on a rotated 3D scapula (Neer Y-view) (Fig. 3);^{1,12,19,20} and (iv) translation between the anterior cortex of the proximal fragment and the anterior cortex of the distal fragment so that there is no apposition of the fragments on the same scapular Y view (Fig. 4).^{1,20} The reliability of these standardized measurements have proved acceptable among and within observers.²⁰

Only descriptive statistical analyses were performed. The means, SDs, range and frequencies of the different demographic variables were calculated.

Table 3. Radiographic measurements of 330 extra-articular scapular fractures.

Parameter	Mean ± SD	Range
Medial/lateral displacement (mm)	4.6 ± 8.9	0 to 40
Translation (mm)	5.6 ± 3.0	0 to 30
Angulation (°)	6.2 ± 10	0 to 42
Glenopolar angle (°)	36 ± 8.0	0 to 59

Figure 1. Measurement of the lateral displacement (mm) of the inferior body fragment in comparison to the superior fragment of the fracture on a 3D scapula, virtually rotated until the 3D model represents a true anteroposterior radiograph showing the largest width of the scapular body.

Results

According to the criteria of Cole and colleagues, 62 patients (19%) had one or more radiographic indications for operative treatment (Table 4). The majority of these patients had one (14%) or two (4.2%) indications, and three patients (0.9%) had three radiographic indications for operative treatment of the scapular fracture. Thirty-one patients (9.4%) had more than 20 mm of lateral displacement; 15 (4.5%) had substantial translation; None of the patients had more than 45° of angulation, three patients (0.9%) had the combination of more than 15 mm of lateral displacement and more than 30° angulation between the distal and proximal body; and, in 14 patients (4.2%), the glenopolar angle was less than 22°.

Figure 2. The glenopolar angle was measured on the same true anteroposterior rotated 3D reconstruction as the angle between a line defined by the inferior and superior edges of the glenoid and a line defined by the superior edge of the glenoid and the inferior angle of the scapula.

Figure 3. Measurement of angulation between the distal and proximal body main fragments on a rotated 3D scapula (Neer Y-view).

Figure 4. Translation was measured between the anterior cortex of the proximal fragment and the anterior cortex of the distal fragment on the same scapular Y-view.

Table 4. Actual versus theoretical treatment.

Actual treatment	
Non-operative	328 (99%)
Operative	2 (1%)
Treatment recommendation according to Cole's criteria	
Non-operative	258 (78%)
Operative	72 (22%)
If operation, number of radiographic parameters indicative for operative treatment	
1	45 (14%)
2	14 (4.2%)
3	3 (0.9%)

No patients had operative treatment of a body or neck fracture of the scapula. Two patients had operative treatment of an acromion fracture: one with a comminuted fracture of scapula and acromion (AO type 14-A3.2) and no indication for surgery of the scapular body according to the criteria of Cole and colleagues; the second with a displaced fracture of the acromion (AO type 14-A1.2) and no indication for surgery according to the criteria of Cole and colleagues.

Discussion

There are advocates of operative treatment for extra-articular scapula fractures. In extra-articular fractures, a medialization of greater than 20 mm, a glenopolar angle less than 22° and/or an angulation of the body in the Neer view more than 45° were identified by Cole and colleagues as portending a poor outcome and benefiting from surgery. Process fractures displaced more than 1 cm are also recommended for operative treatment.^{1,2,12–14,21} We knew that we tended not to operate on these patients and we were curious what percentage of patients would have had surgery using Cole's criteria.

Some drawbacks of the present study should be noted. First, the retrospective design of our study is a limitation. Second, not all patients had CT scans of their scapula fracture (measurements on conventional radiographs may be higher than on CT scans). Third, radiographic measurements are somewhat subjective. Finally, the study did not correlate clinical outcome with radiographic parameters, since many patients were evaluated for a limited time in the medical record.

Almost one in five patients with an extra-articular fracture of the scapula at our centres would have had operative treatment according to the Cole's criteria, but none did. Two patients that had operative treatment of an acromial fracture, they did not meet any of Cole's criteria. This striking discrepancy indicates a substantial divide between theoretical concerns and actual clinical treatment.

Published data about decision-making and treatment success are mostly retrospective and do not compare operative versus non-operative treatment. Some surgeons recommend operative treatment in deformed scapula fractures or malunions,^{13,14,22,23} and other surgeons prefer non-operative treatment even for severely displaced fractures.^{5,6,15,24} Zlowodzki et al. concluded in one large review of 520 fractures in 22 case series (all retrospective) that 99% of all isolated scapula body fractures were treated non-operatively with good or excellent results in 86%.⁴ They were unable to make a valid comparison between operative and non-operative treatment. Lantry and colleagues reviewed 17 studies (all retrospective) about operative treatment of

scapular fractures; most of the cases were yet glenoid fossa or scapular neck fractures.²⁵ They reported good to excellent results in 85% and a 4.2% infection rate; however, shoulder stiffness and implant failure were important complications. There is one meta-analysis of operative versus non-operative treatment in scapular neck fractures, showing favourable results for faster recovery, less pain and better radiographic outcome in the operatively treated group; however, there was a better range of motion in the non-operative group.⁸ We found one case-matched study: Jones et al. retrospectively reviewed 62 patients in a case-matched design and compared operative versus non-operative treatment of displaced scapular fractures.¹⁶ Although operative fixation and realignment strongly stabilized the scapula fractures, both operative and non-operative treatment had good outcome and minimal complications. They do not recommend operative treatment for scapular fractures with less than 20 mm of displacement. We are aware of one prospective study in patients with acute extra-articular scapula fractures, all treated non-operatively and with satisfactory functional outcomes.¹⁵

In summary, scapula fractures were not quite as rare as expected. There are insufficient data available to date to determine whether operative treatment according to these criteria leads to fewer symptoms and a lower magnitude of disability in patients with extra-articular fractures. The correct rate of surgery is debatable. The present study simply establishes the current divide between what is performed (at least in two level 1 trauma centres in the USA) and what is recommended by advocates. Scapula fractures are uncommon and difficult to study, although our sense is that it will take more than theoretical concerns to change practice. There will need to be a clear demonstration by prospective studies that the risks of surgery are balanced by sufficient benefit. If there is not a large benefit, there will still be room for discussion and a shared decision with the patient.

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