Case Series Evaluating the Operative and Nonoperative Treatment of Scapular Fractures

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Take-Home Points

- The majority of patients with scapula fractures are multiply-injured.
- Despite being multiply-injured, most heal with minimal functional shoulder impairment.
- While concomitant injuries do not appear to affect shoulder function scores, tobacco use and alcohol abuse are associated with worse outcomes after scapula fractures.
- Most scapula fractures can be treated successfully without surgery.
- Although patients had higher average function scores after open reduction and internal fixation, further research should be done to define indications for fixation.

Scapular fractures occur frequently due to high-energy trauma, with concomitant injuries seen in approximately 90% of cases.1-4 As a result, treatment is often surrounded by other difficult medical decisions, and factors affecting outcomes can be multifaceted. The gaps in our understanding of long-term outcomes with current treatment modalities have recently come to light, especially when it comes to determining indications for surgery.

Specifically, there is very little literature on radiographic healing and long-term shoulder function in larger samples of scapular fractures; additionally, there is evidence that some patients do not experience full functional recovery.3-5,7 Studies assessing return of function in patients treated nonoperatively have shown decreased mobility and persistence of pain.2 Some of these findings could be due to variability in surgical indications.2-4 While the majority of fractures are treated nonoperatively, the decision to operate has recently been one of debate. Prior literature has suggested highly variable measurements of angulation and extra-articular...
displacement at which surgery is recommended. For example, indications for surgery measured by the medial displacement of extra-articular fractures range from >10 mm to >20 mm; similarly, the displacement of intra-articular fractures meriting surgery ranges from >2 mm to >5 mm, depending on the author.

The current debate over surgical indications for less severe scapular fractures, as well as the potential for chronic pain and stiffness calls for a thorough examination of factors affecting functional outcomes. The purpose of this study is to determine which patient factors, fracture patterns, and treatment modalities were associated with differences in healing and return of shoulder function. We hypothesized that certain aspects of the patient’s social history (tobacco, alcohol) as well as concomitant chest wall injuries may be associated with poor outcome scores and lower levels of function. We further hypothesized that glenoid fractures would affect function more than body fractures, and we did not expect to see a significant difference in outcomes between operative and nonoperative treatment.

Materials and Methods

This study was approved by the Institutional Review Board. A registry at our level 1 trauma center was queried to identify 663 skeletally mature patients with scapular fractures between 1999 and 2011. Forty-eight patients had died prior to the study, and 21 patients had insufficient radiography and/or clinical follow-up (Figure 1). To be included, patients were required to have at least 1 year of follow-up to assess healing. Data on patient demographics, fracture classification, etiology of injury, concomitant injuries (clavicle fractures, rib fractures, pulmonary injuries), comorbidities, alcohol use, and tobacco use were collected retrospectively for the remaining 594 patients. Patients were then prospectively contacted via telephone and mail, employing 3 Internet search engines as needed, in an attempt to obtain current contact information. Three patients declined to participate, and 438 were not reachable after multiple attempts. Outcome scores for the remaining 153 patients were determined with the Modified American Shoulder and Elbow Surgeons (ASES) Shoulder Form. Scores were measured out of 100, with 0 to 30 representing maximally impaired, 31 to 60 representing moderately impaired, and 61 to 100 representing minimally impaired shoulder function. Due to the retrospective identification of the patients, no pre-injury shoulder function scores were collected. Given that many patients were unreachable, or reachable but not living in close proximity to the hospital, patients did not routinely return for re-evaluation for this study.

Nonoperative management consisted of sling immobilization for comfort for up to 2 weeks, during which time Codman’s exercises and elbow, forearm, wrist, and hand motion were encouraged. Active and passive shoulder mobility without restriction were also recommended progressively as tolerated. Strengthening and unrestricted lifting activities were allowed after approximately 8 to 10 weeks following the injury. Decision for surgery was at the surgeon’s discretion. Surgical indications included articular displacement and severely displaced glenoid neck fractures. Open reduction and internal fixation was performed by 1 of 4 fellowship-trained surgeons. Concomitant surgical procedures were not undertaken in the same setting. Postoperative activity consisted of sling immobilization for comfort for up to 6 weeks, during which time active and passive shoulder mobility without restriction were also recommended progressively as tolerated. Strengthening and unrestricted lifting activities were allowed after approximately 12 weeks following surgery. We considered fractures as healed if either X-rays showed healing progression to complete union or early X-rays showing signs of healing with subsequent follow-up visits indicating clinical healing (absence of pain, absence of shoulder dysfunction).
**Statistical Analysis**

Statistical analysis was undertaken with GraphPad software. Associations were tested between positive predictive variables and functional outcomes. Variables included gender, mechanism, fracture classification, patient comorbidities, social factors, associated injuries, and type of treatment. A Mann-Whitney rank test was used to test for associations between nonparametric variables, including patient age. In all cases, $P < .05$ was considered significant.

**Results**

Complete clinical and radiographic data were available for 594 patients. This included 462 men and 132 women, with a mean age of 42.8 years (range, 15-92 years). Twenty-four patients (4.0%) sustained bilateral fractures, and 31 fractures (5.0%) were open. All fractures healed primarily. A total of 153 patients completed the ASES questionnaire at a mean of 62 months after injury (Table 1). This group was similar to the entire population with respect to age, gender, and type of treatment. In all, 135 patients had been injured by a high-energy mechanism (88%), and the fracture pattern as per the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification consisted of 14A (no glenoid involvement) (n = 139; 91%) and 14B/C (glenoid involvement) (n = 14; 9.2%). The mean ASES score for our entire sample was 79.3 (minimally functionally impaired). In all, 117 patients (76%) reported minimal functional deficit (ASES, 61-100), 29 (19%) reported moderate functional deficit (ASES, 31-60), and only 7 (4.6%) reported maximum functional deficit (ASES, 0-30). Gender and age were not associated with functional outcome scores.

Fifteen patients (9.8%) were treated surgically. They had a higher mean ASES score vs non-surgically treated patients (92.1 vs 77.9; $P = .03$) (Table 2). However, when patients were divided into 14A and 14B/C fracture patterns, there was only a significant advantage in outcome scores for operative vs nonoperative care in the 14B/C classification (96.0 vs 75.7; $P < .05$); meanwhile, surgery for scapular body fractures (14A) was not associated with better outcome scores (90.2 vs 78.3; $P = .14$). Unfortunately, assessment of these comparisons within classification groups resulted in underpowered analyses for these small groups.

Table 3 shows the ASES scores for patients with various types of associated chest and shoulder injuries. Only 7 patients (4.6%) had injuries isolated to the scapula. Thirty-three patients (22%) had associated clavicle fractures, and 102 patients (67%) sustained concomitant chest wall injuries, including rib fractures (n = 88) and pulmonary injuries (n = 71). Patients with associated chest wall injuries did not have worse mean ASES scores than those without chest wall injuries (80.9 vs 78.2; $P = .49$). Additionally, patients who had concomitant clavicle fractures did not report worse scores than those who did not (83.2 vs 78.6; $P = .46$).

The majority of patients were self-reported smokers (54%) and alcohol drinkers (64%) (Table 4). Aspects of social history were associated with differences in functional outcome scores. Non-smokers had a higher mean ASES score than both current smokers (84.5 vs 72.8; $P = .02$) and patients with any lifetime history of smoking (84.5 vs 73.3; $P = .01$) (Figure 2). There was no significant difference in shoulder function scores between patients identified as non-drinkers and those who reported consuming alcohol at moderate levels (83.9 vs 78.9; $P = .26$); however, patients who had a documented history of alcohol abuse had lower mean ASES scores than those who reported being non-drinkers (70.3 vs 83.9; $P < .05$).
Discussion

Patients with scapular fractures often require a complex set of treatment decisions due to high rates of concomitant injuries. A lack of large studies on long-term scapular function, as well as evidence that some patients treated conservatively for scapular fractures experience functional deficit and pain, inspired us to investigate the recovery process after scapular fractures through radiographs and the ASES survey. Further, we attempted to identify any factors that may be associated with poor functional results. Our review of long-term outcomes after scapular fractures demonstrates that they not only heal well but also have a good functional outcome in most cases. Over 95% had acceptable ASES scores, with both 14A and 14B/C having similar return of function. While both operatively and nonoperatively treated patients had scores indicating minimal functional impairment, those treated surgically had better scores overall. Surprisingly, concomitant injuries, including chest wall injuries, did not portend a worse shoulder outcome in our patients. The factors that were associated with worse outcome were tobacco use and alcohol abuse.

Beyond these findings, we attempted to comment on surgical indications, which have been highly debated. For example, the medial displacement at which studies suggest extra-articular fractures merit surgery ranges from >10 mm to >20 mm; similarly, the indication for surgery based on displacement of intra-articular fractures ranges from >2 mm to >5 mm, depending on the author. Glenoid articular fractures or neck fractures are other potential indications for operative treatment. In fact, a review of 520 scapular fractures from multiple studies found that 80% of those with glenoid involvement were treated operatively, while only 52% of those with exclusive acromion and/or coracoid involvement, and 1% of those with exclusive scapular body involvement were treated operatively. Some reports indicate that 14B/C fractures, especially those that are displaced or complex, show good functional outcomes and low complication rates after fixation. In this study, articular fractures of the glenoid were treated operatively more often than extra-articular fractures. We attempted to determine the impact of surgical care on functional outcomes according to fracture type, but we were limited by the small number of surgical patients when reviewing the 14A and 14B/C groups. As a whole, surgical patients had better outcomes than non-surgical patients. We believe this difference is clinically relevant and suggests a potential group of patients who may benefit from fixation. Further investigation is needed to better characterize these injuries and to develop specific recommendations.

This study yielded interesting results related to substance abuse. It has previously been shown that tobacco smoking and alcohol abuse have both been associated with poor bone health. Studies have suggested that exposure to nicotine and other chemical components in cigarettes can lead to delayed healing, higher rates of nonunion, and decreased mechanical strength of bone. Additionally, alcohol abuse has been associated with decreased bone mass and poor bone formation. Although we did not measure bone density or quantitate time of healing, this study provides added insight in that the healed fractures of smokers and patients with a history of alcohol abuse showed lower levels of shoulder function, as measured by ASES scores after similar initial injuries and similar follow-up periods. These results suggest that chemical, social, or a combination of these factors affect muscular recovery, other aspects of post-fracture recovery, and/or levels of baseline physical or mental impairment beyond those detailed in previous studies of bone health and substance abuse. For example, return to work was a scored category in the ASES survey that we used to assess the return of shoulder function, and several studies have shown that factors such as education level, coping abilities, and baseline functioning (cognitive, social, and physical) all have a significant impact on rates of return to work, independently of injury type. It is possible, then, that other aspects of the ASES survey are affected by factors that may be more
prevalent in populations engaging in substance abuse. From both perspectives, these data highlight the importance of addressing tobacco use and alcohol abuse as a part of caring for all trauma patients, including those with scapular fractures, regardless of their high rates of radiographic healing. They also provide insight for prognosticating and setting patient expectations after scapular fractures.

This study addressed the relationship between concomitant chest wall injuries and recovery of shoulder function after scapular fracture. Previous studies have suggested that concomitant chest wall injuries, such as rib fractures, cause more pain and may adversely impact the return of function in patients who have sustained scapular body fractures. These results, however, occurred in the setting of a much shorter follow-up, in which Disability of Arm, Shoulder, and Hand (DASH) surveys were distributed 6 months post-injury, 12 months post-injury, and once at last follow-up (<3 years). At our significantly later average follow-up, chest wall injuries did not portend a worse return of shoulder function, in contrast to our hypothesis. Our lack of findings of a worse return of function in patients with chest wall injuries, in light of previous literature, suggests that this association could become less distinct as the initial injury becomes more remote and has had more time to heal. Farther out from injury, patients seem to function similarly, regardless of chest wall injury history.

This study was limited by several factors. First, the surgically treated group was considerably smaller than the nonoperative group, which made drawing statistically significant comparisons between them challenging. Although there were no apparent differences between the group who completed ASES surveys and those who did not, only collecting ASES data on 153 of the 663 patients introduces a possible selection bias in this analysis. Additionally, due to the retrospective nature of this study, we were not able to ascertain the specific surgical indications used by individual surgeons. Again, the nature of this study also made it implausible to separate fractures beyond the simple 14A vs 14B/C classification. For example, we did not routinely have access to computed tomography scans to provide exact measurements of displacement, angulation, or step-off; therefore, we were unable to compare our fracture parameters to those mentioned in studies with more specific surgical indications. We also did not have information regarding pre-existing shoulder dysfunction, which could negatively affect ASES scores. Finally, accurate measures of certain social history factors can be difficult to achieve; smoking, alcohol consumption, and alcohol abuse may be subject to underreporting.

**Conclusion**

We assessed parameters that may affect return of shoulder function after scapular fracture. Our results indicate that both 14A and 14B/C fractures have similarly high rates of healing and minimal functional impairment. Patients treated operatively typically had better shoulder functional outcomes. Current or past tobacco use or alcohol abuse was associated with worse functional outcome scores. This could suggest chemical, social, or a combination of these factors affecting muscular recovery and/or greater levels of baseline functional impairment. Finally, concomitant chest wall injuries may not negatively affect shoulder outcome, contrasting with data from previous studies on the more immediate post-injury period.

**Key Info**
Figures / Tables:

**Figure 1.** Flowchart demonstrating patient selection. Initially there were 663 patients in the data set. Overall, 594 patients met criteria, and 153 patients participated in American Shoulder and Elbow Surgeons (ASES) surveys.
Table 1. Patient Demographics and Etiology of Scapula Fractures.

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>119</td>
<td>(77.8%)</td>
</tr>
<tr>
<td>Women</td>
<td>34</td>
<td>(22.2%)</td>
</tr>
<tr>
<td>Motorcycle crash</td>
<td>48</td>
<td>(31.4%)</td>
</tr>
<tr>
<td>Motor vehicle collision</td>
<td>38</td>
<td>(24.8%)</td>
</tr>
<tr>
<td>Fall from stand</td>
<td>14</td>
<td>(9.2%)</td>
</tr>
<tr>
<td>Fall from height</td>
<td>13</td>
<td>(8.5%)</td>
</tr>
<tr>
<td>Pedestrian vs vehicle</td>
<td>11</td>
<td>(7.2%)</td>
</tr>
<tr>
<td>Crush</td>
<td>7</td>
<td>(4.5%)</td>
</tr>
<tr>
<td>Gunshot</td>
<td>5</td>
<td>(3.3%)</td>
</tr>
<tr>
<td>Other</td>
<td>17</td>
<td>(11.1%)</td>
</tr>
</tbody>
</table>

Table 2. Number of ASES Surveys Completed and Mean ASES Score for Each Treatment Type and
Fracture Classification

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mean ASES</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical (total)</td>
<td>15</td>
<td>92.1a</td>
<td>3.5</td>
</tr>
<tr>
<td>Surgical 14A</td>
<td>10</td>
<td>90.2</td>
<td>4.9</td>
</tr>
<tr>
<td>Surgical 14B/C</td>
<td>5</td>
<td>96.0a</td>
<td>3.2</td>
</tr>
<tr>
<td>Non-surgical (total)</td>
<td>138</td>
<td>77.9a</td>
<td>2.1</td>
</tr>
<tr>
<td>Nonsurgical 14A</td>
<td>129</td>
<td>78.3</td>
<td>2.2</td>
</tr>
<tr>
<td>Nonsurgical 14B/C</td>
<td>9</td>
<td>75.7a</td>
<td>6.5</td>
</tr>
</tbody>
</table>

^aP < 0.05.

Abbreviation: ASES, American Shoulder and Elbow Surgeons.

Table 3. Concomitant Injuries and Mean American Shoulder and Elbow Surgeons (ASES) Scores

<table>
<thead>
<tr>
<th>Injuries</th>
<th>n</th>
<th>Mean ASES</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clavicle fracture</td>
<td>33 (21.6%)</td>
<td>83.2</td>
<td>3.6</td>
</tr>
<tr>
<td>No clavicle fracture</td>
<td>120 (78.4%)</td>
<td>78.6</td>
<td>2.2</td>
</tr>
<tr>
<td>Chest wall injury</td>
<td>102 (66.7%)</td>
<td>80.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Rib fracture</td>
<td>31 (20.3%)</td>
<td>82.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Lung Injury</td>
<td>14 (9.2%)</td>
<td>80.8</td>
<td>5.5</td>
</tr>
<tr>
<td>Rib Fracture + Lung Injury</td>
<td>57 (37.3%)</td>
<td>80.2</td>
<td>3.0</td>
</tr>
<tr>
<td>No chest wall injury</td>
<td>51 (33.3%)</td>
<td>78.2</td>
<td>3.8</td>
</tr>
<tr>
<td>Isolated scapula fracture</td>
<td>7 (4.6%)</td>
<td>92.4</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Table 4. Substance Use and Functional Outcome Scores

<table>
<thead>
<tr>
<th>Substance Use</th>
<th>n</th>
<th>Mean ASES</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-smoker</td>
<td>57 (46.3%)</td>
<td>84.5a</td>
<td>2.9</td>
</tr>
<tr>
<td>History of smoking</td>
<td>66 (53.7%)</td>
<td>73.3a</td>
<td>3.0</td>
</tr>
<tr>
<td>Smoker</td>
<td>45 (36.6%)</td>
<td>72.8a</td>
<td>3.8</td>
</tr>
<tr>
<td>Former</td>
<td>21 (17.1%)</td>
<td>74.6</td>
<td>5.1</td>
</tr>
<tr>
<td>No alcohol consumption</td>
<td>46 (36.2%)</td>
<td>83.9a</td>
<td>3.1</td>
</tr>
<tr>
<td>Moderate alcohol use</td>
<td>65 (51.2%)</td>
<td>78.9</td>
<td>2.9</td>
</tr>
<tr>
<td>Alcohol abuse</td>
<td>16 (12.6%)</td>
<td>70.3a</td>
<td>7.3</td>
</tr>
</tbody>
</table>

^aP < 0.05.

References
References


**Multimedia**

**Product Guide**

**Product Guide**

- BioComposite SwiveLock Anchor
- BioComposite SwiveLock C, with White/Black TigerTape™ Loop
- BioComposite SwiveLock Anchor, With Blue FiberTape Loop
- Knotless SutureTak® Anchor

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