Surgical Treatment of Ideberg Type III Glenoid Fractures With Associated Superior Shoulder Suspensory Complex Injury

HUI QIN, MD; CHUAN-ZHEN HU, MD; XIAN-LONG ZHANG, MD; LONG-XIANG SHEN, MD; ZI-CHAO XUE, MD; ZHI-QUAN AN, MD

abstract

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Ideberg type III glenoid fractures with associated superior shoulder suspensory complex (SSSC) injuries are rare, and related treatments have not been reported in the literature. The purpose of this study was to evaluate the clinical outcomes of such injuries treated with open reduction and internal fixation (ORIF).

Between July 2007 and April 2012, ten patients with Ideberg type III glenoid fractures were surgically treated using ORIF with 2 cannulated screws or a screw combined with a metacarpal plate through an anterior approach. Patients with associated SSSC injuries underwent ORIF with K-wires or plates. Information was available for 9 patients with a mean follow-up of 24.1±18.2 months. Mean bone-healing time was 8.4±2.2 weeks. At last follow-up, mean forward flexion of the operative shoulder was 157.8°±7.5°, mean external rotation was 62.9°±7.9°, and mean internal rotation was thoracic level T6±0.8. Mean Constant score was 84.1±3.7 points, which was a mean of 92.7%±3.4% of that seen in the contralateral shoulder. Mean UCLA score and Disabilities of the Arm, Shoulder and Hand score were 33.6±1.7 and 16.6±7.7, respectively.

The results show that Ideberg type III glenoid fractures with associated SSSC injuries can be successfully treated using ORIF through an anterior approach. Glenoid fractures and SCCC injuries should be treated simultaneously.

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deberg type III glenoid fractures are rare and typically present with a transverse fracture line spanning from the superior glenoid articular surface to the superior border of the scapular notch.1 Surgical treatment is usually recommended for displaced Ideberg type III fractures.2 They are often treated using arthroscopic-assisted reduction and percutaneous cannulated screw fixation.3 These fractures are often associated with superior shoulder suspensory complex (SSSC) injuries,4 including acromial, acromioclavicular joint, and distal clavicular fractures. To the authors’ knowledge, no articles report the treatment of Ideberg type III glenoid fractures with associated SSSC injuries. This article reports the outcomes of 9 Ideberg type III glenoid fractures with associated SSSC injuries treated with open reduction and internal fixation (ORIF) through an anterior approach.

**MATERIALS AND METHODS**

Between July 2007 and April 2012, ten patients with Ideberg type III glenoid fractures with associated SSSC injuries were surgically treated at the authors’ institution. Patients included 8 men and 2 women with a mean age of 34.4 ± 9.9 years (range, 23-52 years). Three left-sided and 7 right-sided injuries occurred, with causes including road traffic accidents (n=7), falls (n=2), and being crushed by a heavy object (n=1).

All patients had Ideberg type III fractures1 and associated SSSC injuries (single disruption in 6 patients and double disruption in 4 patients). Six patients had a Rockwood type III acromioclavicular joint injury (2 were combined with acromial fractures and 1 was associated with a lesser tuberosity fracture); 2 patients had a Rockwood type II acromioclavicular joint injury (1 associated with acromial fracture); 1 patient had a Rockwood type V acromioclavicular joint injury5; and 1 patient had an acromial fracture combined with a distal clavicular fracture. No neurologic injuries were identified. Mean time from injury to surgery was 5.4 ± 2.9 days (range, 3-10 days) (Table 1).

**SURGICAL TECHNIQUE**

The patient was placed in the beachchair position. A small pad was placed under the operative shoulder. The forearm was draped free so it could be mobilized during the procedure. A straight incision was made from the superior margin of the clavicle, passing the tip of the coracoid process, to the axillary fold. The interval between the pectoralis major and the deltoid muscle was developed. The cephalic vein was retracted laterally with the deltoid muscle. If necessary, the cephalic vein can be tied off and divided.

The coracoid process with the attachment of the short head of the biceps, the coracobrachialis, and the pectoralis minor were exposed. The conjoined tendon of the short head of the biceps and the coracobrachialis was tied off and divided 1 cm from their insertion in the coracoid process. The divided tendons were retracted inferiorly and medially. With the shoulder in external rotation, the subscapularis and lesser tuberosity were exposed. The subscapularis tendon and the capsule beneath it were vertically dissected 2 cm medial to the bicipital groove and then tagged with sutures. The lower edge of the subscapularis tendon was kept intact to prevent injury to the axillary nerve. The humeral head was retracted posteriorly to expose the articular surface fractures of the glenoid fossa. The extra-articular part of the main fragment was exposed using blunt dissection and by inferiorly retracting the subscapularis muscle from the ventral aspect of scapula,

<table>
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<tr>
<th>Patient No./ Sex/Age, y</th>
<th>Affected Side</th>
<th>Cause</th>
<th>Ideberg Classification</th>
<th>Acromioclavicular Joint Injury</th>
<th>Associated Fractures</th>
<th>Time From Injury to Surgery, d</th>
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<tr>
<td>1/M/27</td>
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<td>III</td>
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<td>III</td>
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<td>7</td>
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<tr>
<td>3/M/32</td>
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<td>Fall from height</td>
<td>III</td>
<td>III</td>
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</tr>
<tr>
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<td>III</td>
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<tr>
<td>5/M/43</td>
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<td>Crushed by heavy object</td>
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<td>II</td>
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<tr>
<td>6/F/23</td>
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<td>Acromion and lesser tuberosity</td>
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</tr>
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<td>III</td>
<td>Acromion</td>
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<td>Fall from height</td>
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<td>Acromion and distal clavicle</td>
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<tr>
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<td>Road traffic accident</td>
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<td>II</td>
<td>Acromion</td>
<td>10</td>
</tr>
<tr>
<td>10/F/27</td>
<td>R</td>
<td>Road traffic accident</td>
<td>III</td>
<td>V</td>
<td>None</td>
<td>3</td>
</tr>
</tbody>
</table>

**Table 1**

Demographic Data

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without injury to attachment of capsule. The acromioclavicular joint and the distal end of clavicle were exposed by extending the incision cephalically.

The dislocated acromioclavicular joint and the fracture of the distal end of clavicle were first reduced and fixed. In these patients, the acromioclavicular joint was fixed with one or two 2-mm transarticular K-wires in 7 patients, whereas the clavicle fracture was fixed with a 2.4-mm volar distal radial plate in 1 patient. The acromial fracture was reduced and fixed with a 2-mm metacarpal plate in 4 patients and was strengthened by a tension-band wire in 1 patient using a posterior approach starting from the acromion to the junction of middle and medial third of scapular spine. In 1 patient, the acromioclavicular joint injury was treated using manipulation and was immobilized with an abduction splint.

After completing the fixation of SSSC injuries, the glenoid fractures were then checked and reduced. A 2-mm K-wire was inserted into the main fragment of the glenoid fossa as a joystick to assist the reduction. With the help of the K-wire and pointed reduction forceps placed on the tip of coracoid process, the displaced articular fragments of the glenoid fossa were first reduced under the direct visualization and then temporarily stabilized with 1.5-mm K-wires. The extra-articular part of the main fragment was then checked, reduced, and temporarily fixed with a 1.5-mm K-wire inserted from the coracoid process to the scapula body. If the fractures were anatomically reduced, 1.2-mm guidewires were introduced under the subchondral bone perpendicular to the fracture line and 4-mm cannulated screws were then inserted along the guidewires. The stability of internal fixation was then checked by manipulation of the clavicle. If the articular fragment was unstable, a 4- or 5-hole remodeled metacarpal plate was placed proximally on the basis of the coracoid pass through the fracture line and distally on the ventral aspect of the scapular body to fix the extra-articular part of the main fragment. At the end of each step, C-arm fluoroscopy was used to check the fracture reduction, the position of the guidewire and plate, and the length of screws on the standard anteroposterior and axillary views of the scapula.

In these patients, the articular fragments were fixed with 2 cannulated screws in 6 patients and with a cannulated screw combined with a metacarpal plate in 4 patients. The lesser tuberosity was fixed using two 4-mm cannulated screws in 1 patient. At closure, the anterior joint capsule, subscapularis tendon, and conjoined tendon were securely reattached with nonabsorbable sutures. The torn anterior capsule was found intraoperatively and repaired with an anchor in 1 patient.

Postoperative Management
Postoperatively, the affected shoulder was immobilized with a sling for 3 weeks, except in 1 patient with acromioclavicular joint injuries, who was immobilized with an abduction splint. Active forward flexion and abduction except external rotation were encouraged 3 weeks postoperatively. Free range of motion was allowed 6 weeks.
postoperatively when the transarticular K-wires were removed. Strengthening exercises were initiated 3 months postoperatively using 1.5- to 3-kg weights, with no restrictions after 3 months of exercise. High-impact sports were allowed 6 months postoperatively.

Postoperative Evaluation
All patients were followed up by an independent surgeon (Z.-Q.A) every 6 weeks for the first 3 months, every 2 months thereafter for the first year, and every 6 months until 2 years postoperatively. At each follow-up, anteroposterior and axillary radiographs were reviewed.

Operative time, defined as the time from skin incision to closure, was recorded. Union was defined as the obscurity of the fracture line between fragments in the scapular body region. Shoulder functions were evaluated using the Constant score, the University of California, Los Angeles (UCLA) score, and the Disabilities of the Arm, Shoulder and Hand (DASH) score.

Statistical Analysis
Data were analyzed using SPSS version 18.0 statistical software (SPSS, Inc, Chicago, Illinois).

RESULTS
Mean operative time was 180±70.1 minutes (range, 90-300 minutes). No wound or axillary nerve complications were noted. One patient was lost to follow-up; the remaining 9 patients were followed for a mean of 24.1±18.2 months (range, 7-66 months). All fractures achieved union at a mean bone healing time of 8.4±2.2 weeks (range, 6-12 weeks). A broken K-wire was found in 1 patient 4 months postoperatively and was removed without complication. One patient had a K-wire tract infection that healed after removal. Residual Rockwood type III acromioclavicular joint injuries were identified in 2 patients, but a significant limitation in forward flexion of the shoulder was not observed.

At last follow-up, mean forward flexion of the shoulder was 157.8°±7.5°, which was 12.2°±7.5° less flexion compared with the contralateral shoulder. Mean external rotation was 62.9°±7.9°, which was 15°±5.9° less external rotation compared with the contralateral shoulder. Internal rotation was thoracic level T6.1±0.8 in the operative shoulder and thoracic level T4.2±0.7 in the contralateral shoulder (Figures 1-4). Mean Constant score was 84.1±3.7 points (range, 78-89 points), which was 6.6±3.1 points (range, 3-12 points) lower compared with the contralateral shoulder. Mean rate of the Constant score on the operative shoulder was 92.7%±3.4% (range, 86.7%-96.7%) compared with 90.7%±2.0% (range, 86%-92%) in the contralateral shoulder. Mean UCLA score was 33.6±1.7 points (range, 30-35 points), resulting in an excellent outcome in 5 patients and a good outcome in 4. Mean DASH score was 16.6±7.7 points (range, 6-27 points) (Table 2).

DISCUSSION
Scapular fractures account for only 1% of all fractures. Of these, 10% involve the
Glenoid fractures can occur as the result of a violent force applied laterally to the proximal humerus, driving the humeral head into the glenoid fossa. When the force of the humeral head is directed somewhat superiorly, it will result in Ideberg type III glenoid fractures, creating a transverse fracture of the fossa that exits along the superior border of the scapula. If the force is large enough, it will disrupt the SSSC. Ideberg type III glenoid fractures associated with SSSC injuries require surgery secondary to the instability of the glenohumeral joint.

Ideberg type III glenoid fractures and related reports are rare. Yang et al reported the outcomes of 18 patients with isolated Ideberg type III glenoid fractures treated with arthroscopic-assisted reduction and percutaneous cannulated screw fixation who were followed for at least 2 years. Mean forward flexion was 162.8°, external rotation was 0°, abduction was 67.2°, and internal rotation was thoracic.

Figure 3: A 28-year-old man's right shoulder was stuck by a car, resulting in an Ideberg type III glenoid fracture. Preoperative anteroposterior radiograph (A) and 3-dimensional computed tomography scan (B) showing the displaced Ideberg type III glenoid fracture combined with an acromial fracture and an acromioclavicular joint dislocation. Immediate postoperative anteroposterior radiograph showing 3- and 4-mm cannulated screws used to fix the displaced glenoid fracture. A 2-mm 6-hole plate was used to fix the acromial fracture and was strengthened by a tension-band wire. An anchor was used to repair anterior joint capsule. Dislocation of the acromioclavicular joint was retained with no fixation (C).

Figure 4: Anteroposterior (A) and lateral (B) radiographs of the patient presented in Figure 3 taken 1 year after injury. Photographs showing satisfactory shoulder joint mobility in the patient's final forward flexion (C), external rotation (D), internal rotation (E), and abduction (F).
In the current retrospective study, the authors report outcomes of 9 patients with Ideberg type III glenoid fractures with associated SSSC injuries treated with ORIF for both the glenoid fracture and SSSC injuries. Mean range of motion of the operative shoulders at final follow-up was 157.8° in forward flexion, 62.9° in external rotation, and thoracic level T6.1 in internal rotation. The mean Constant score was 96.8, and mean UCLA score was 34.3 points.

The outcomes of these 9 patients (1 patient was lost to follow-up) demonstrated that, in Ideberg type III fractures, both the glenoid fracture and SSSC injuries should be reduced and internally fixed. The fixation process involves both a posterior and anterior approach. The fractures, including the intra- and extra-articular components, the scapular notch, and the subscapularis and its capsule and elevation of the subscapularis from the ventral aspect of the scapular body, were reduced and fixed through an anterior approach. The outcomes for all 9 patients show that subscapularis dissection had no significant limitation on internal rotation of the affected shoulder.

Table 2

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Approach</th>
<th>Fixation</th>
<th>Operative Time, min</th>
<th>Follow-up, mo</th>
<th>Time to Union, wk</th>
<th>Forward Flexion, deg</th>
<th>External Rotation, deg</th>
<th>Internal Rotation, deg</th>
<th>Constant Score</th>
<th>UCLA Score</th>
<th>DASH Score</th>
<th>Complication</th>
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<tbody>
<tr>
<td>1</td>
<td>Anterior</td>
<td>Cannulated screw</td>
<td>210</td>
<td>66</td>
<td>6</td>
<td>170 (170)</td>
<td>79 (84)</td>
<td>T5 (T3)</td>
<td>89 (92)</td>
<td>35</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Anterior</td>
<td>Cannulated screw</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Anterior</td>
<td>Cannulated screw</td>
<td>180</td>
<td>36</td>
<td>12</td>
<td>155 (170)</td>
<td>64 (78)</td>
<td>T7 (T5)</td>
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<td>33</td>
<td>11</td>
<td>K-wires broke 4 mo postop</td>
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<tr>
<td>4</td>
<td>Anterior</td>
<td>Cannulated screw</td>
<td>120</td>
<td>27</td>
<td>8</td>
<td>150 (170)</td>
<td>54 (63)</td>
<td>T6 (T4)</td>
<td>86 (92)</td>
<td>35</td>
<td>23</td>
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</tr>
<tr>
<td>5</td>
<td>Anterior</td>
<td>Small plate</td>
<td>270</td>
<td>27</td>
<td>8</td>
<td>165 (170)</td>
<td>65 (80)</td>
<td>T6 (T5)</td>
<td>84 (90)</td>
<td>33</td>
<td>22</td>
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<td>Anterior</td>
<td>Cannulated screw+small plate</td>
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<td>13</td>
<td>6</td>
<td>155 (170)</td>
<td>60 (74)</td>
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<td>81 (86)</td>
<td>34</td>
<td>17</td>
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<tr>
<td>7</td>
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<td>190</td>
<td>13</td>
<td>12</td>
<td>150 (170)</td>
<td>57 (78)</td>
<td>T7 (T4)</td>
<td>85 (92)</td>
<td>35</td>
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<td>Acromioclavicular joint dislocation</td>
</tr>
<tr>
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<td>15</td>
<td>8</td>
<td>165 (170)</td>
<td>68 (90)</td>
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<td>Anterior+posterior</td>
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<td>90</td>
<td>13</td>
<td>8</td>
<td>160 (170)</td>
<td>54 (67)</td>
<td>T6 (T4)</td>
<td>81 (92)</td>
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<tr>
<td>10</td>
<td>Anterior</td>
<td>Small plate</td>
<td>110</td>
<td>7</td>
<td>8</td>
<td>150 (170)</td>
<td>65 (87)</td>
<td>T6 (T4)</td>
<td>78 (90)</td>
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</table>

Mean ±SD

- Forward Flexion: 157.8±7.5 (170)
- External Rotation: 62.9±7.9 (78.6±7.4)
- Internal Rotation: T6 ±1.2 (T4±0.7)
- Constant Score: 84.1±3.7 (90.7±2)
- UCLA Score: 33.6±1.7
- DASH Score: 16.6±7.7

Abbreviations: DASH, Disabilities of the Arm, Shoulder and Hand; postop, postoperative; UCLA, University of California, Los Angeles.
glenoid fractures and SSSC injuries.

No recommendations regarding fixation of SSSC injuries that occur with glenoid fractures were found in the literature. In the current study, K-wires were used to fix the acromioclavicular joint dislocation and plates were used for distal clavicular and acromial fractures. One patient with an acromioclavicular dislocation, which was related to the surgeon’s lack of experience in the early phase of his or her learning curve, was treated with a splint without reduction; acromioclavicular joint fixation failure in another patient was due to K-wire rupture during the follow-up period. These 2 patients also presented with an unsatisfactory reduction of extra-articular fragments.

Complications with K-wire fixation of the acromioclavicular joint, such as K-wire fracture or migration, have been reported. In the current study, K-wires were used to fix the acromioclavicular joint because it is a simple and effective method to maintain reduction of the acromioclavicular joint. K-wires can also be easily removed, usually occurring 6 weeks postoperatively when the glenoid fracture has clinically achieved union. One instance of a broken K-wire was reported in the current study. The patient returned to the authors’ hospital 4 months postoperatively with pain in his right shoulder. The broken K-wire was removed. Although an acromioclavicular dislocation remained in this patient, the results of all 9 patients were satisfactory. The best technique for acromioclavicular joint fixation in these types of injuries requires future research.

Izadpanah et al recommended that in the surgical treatment of double disruptions of the SSSC, 1 disruption could be repaired. Ideberg type III fractures involve both the articular surface and the superior portion of the scapular body, near the scapular notch. The coracoclavicular ligament remains intact; the superior displacement of the clavicle leads to displacement of the extra-articular portion of the fragment through the coracoclavicular ligament and the coracoid process. The articular surface could be reduced smoothly; however, the extra-articular portion of the main fragment may not be anatomically reduced. Thus, displacement of extra-articular fragments caused by superior movement of the clavicle can be reduced by fixation of both the glenoid fractures and SSSC injuries. The fixation of SSSC injuries could be helpful in ORIF of glenoid fractures. Therefore, the authors suggest fixing glenoid fractures and repairing the associated SSSC injuries at the same time. In the current study, 2 cannulated screws were used to fix the articular fragment in 5 patients. A metacarpal plate combined with a cannulated screw was used in 4 patients. All fractures achieved union with satisfactory shoulder function despite 2 residual acromioclavicular joint dislocations.

According to the current results, in the surgical treatment of Ideberg type III fractures associated with SSSC injuries, the disrupted SSSC and the glenoid fractures should be anatomically reduced and fixed simultaneously. However, only 10 patients were included in the current study, and the number of fractures fixed using screws and plates was small. More data obtained during the follow-up period are required to make the study more robust.

**CONCLUSION**

Open reduction and internal fixation of Ideberg type III glenoid fractures with combined SSSC injury can achieve good results. Reduction and fixation of the intra- and extra-articular portions of glenoid fractures and complete treatment of SSSC injuries are recommended.

**REFERENCES**