Open reduction and internal fixation of displaced intra-articular fractures of the glenoid fossa

BF Kavanagh, JK Bradway and RH Cofield
Open Reduction and Internal Fixation of Displaced Intra-Articular Fractures of the Glenoid Fossa*

BY BRIAN F. KAVANAGH, M.D.†, JOHN K. BRADWAY, M.D.†, AND ROBERT H. COFIELD, M.D.†, ROCHESTER, MINNESOTA

Investigation performed at the Department of Orthopedics, Mayo Clinic and Mayo Foundation, Rochester

ABSTRACT: Ten displaced intra-articular fractures of the glenoid fossa were treated with open reduction and internal fixation between 1980 and 1987. Nine patients were available for evaluation at an average of four years (range, two to ten years) after the operation. Eight patients had mild or no symptoms and little or no restriction of the motion of the shoulder. There were no infections or malunions. The only complication was heterotopic ossification in one patient. Radiographic evaluation showed no evidence of traumatic osteoarthrosis in any patient. Open reduction and internal fixation is a useful and safe technique for the treatment of selected, displaced fractures of the glenoid fossa, and it can restore excellent function of the shoulder.

Fractures of the scapula are relatively uncommon injuries, and most can be treated satisfactorily with non-operative methods2,7,9,11. Scapular fractures are often associated with multiple traumatic injuries, which may take priority, drawing attention away from the treatment of the scapular fracture2,7,9,11. However, for selected scapular fractures, the best results may be obtained with open reduction and internal fixation1-2,9,12. It is unclear which fractures should be treated with open reduction and internal fixation and, if an operation is to be performed, which approach is optimum. Open reduction with internal fixation has been accepted as the treatment of choice for displaced intra-articular fractures in many anatomical regions. At our institution, this philosophy has been extended to include the glenohumeral joint. The purpose of the current retrospective study was to assess the results and complications of treatment of displaced intra-articular fractures of the glenoid fossa with open reduction and internal fixation through a posterior operative approach that had been developed for the procedure.

Materials and Methods

Forty-one patients who had a glenoid fracture were seen at our institution between January 1980 and December 1987. Twenty-four patients had a fracture of the glenoid rim; thirteen of these fractures were anterior, seven were inferior, and four were posterior. Seven of the patients had a fracture of the glenoid fossa with slight displacement (two millimeters or less) that was treated with short-term immobilization and subsequent physiotherapy. Ten patients had injuries that included a displaced intra-articular fracture of the glenoid fossa.

All ten patients were managed with open reduction and internal fixation. The standard evaluation included a 40-degree posterior oblique radiograph, a 60-degree anterior oblique (scapular Y) radiograph, and an axillary radiograph. If the fracture was not clearly defined on these plain radiographs, anteroposterior tomography was used to further define the fracture fragments and the displacement in the plane of the scapula, and narrow-cut (three-millimeter) computed-tomography scans were used to assess the extent of the injury in the transverse plane. The greatest amount of displacement of the bone fragments was assessed on each of these images. The range of displacement of the major intra-articular fracture fragments was four to eight millimeters for these ten patients (Table I).

The major fracture line was vertical in two patients and transverse in six patients. In two patients, multiple fracture lines created a stellate pattern. In addition to involving the articular surface of the glenoid, the fracture lines extended to the axillary border of the scapula in four patients, to the superior border of the scapula in...
two, and to both the axillary and the superior borders in one patient. Two fractures included both the axillary and the vertebral borders of the scapula. In one patient, the fracture lines extended to all three scapular borders.

Nine of the ten patients were available for clinical and radiographic examination at an average of four years (range, two to ten years) after the operation. Seven patients were examined at the Mayo Clinic; two were examined elsewhere, and the reports were sent to us. Forty-degree posterior oblique radiographs, with external and internal humeral rotation, were made as part of the most recent assessment. In addition, an axillary radiograph was made for six patients, and a 40-degree posterior oblique, a 60-degree anterior oblique, and an axillary radiograph (a so-called shoulder-trauma series) were made for three patients. The one patient who was lost to follow-up had been last seen three months after the operation. He had no acute complications, but he subsequently died of an unrelated illness that precluded postoperative assessment of the shoulder.

The average age of the nine patients for whom the follow-up information was complete was thirty-five years (range, twenty-two to forty-nine years). Seven of these patients were men and two were women. The left shoulder was injured in seven patients and the right shoulder, in two. The injuries were caused by a motor-vehicle accident in seven patients, a fall from a height of about three meters in one, and an electric shock in one. Other major injuries, including fractures of the ribs, a lumbar burst fracture, an acetabular fracture, fractures of the lower extremities, and closed head injuries, were common in these patients. Operative treatment of the displaced fracture of the glenoid fossa was frequently delayed to allow stabilization of the patient's condition and treatment of other injuries and medical problems. The time from the injury to the operative intervention for the scapular fracture ranged from one to thirty-eight days. The duration of hospitalization for these patients ranged from seven to forty days and, with rare exceptions, was determined by the associated injuries rather than by the scapular fracture.

**Operative Procedure**

A posterior operative approach was used for nine shoulders and an anterior approach, for one shoulder. The anterior approach was exceptionally difficult, and we do not recommend it. Early in this series, the posterior incision was made parallel to the spine of the scapula, but later a more vertical incision was used (Fig. 1-A). This more vertical, posterior incision began from a position just proximal to the junction of the lateral one-third and medial two-thirds of the spine of the scapula and continued downward at a slight medial angle for fifteen centimeters. The deltoid muscle was released from its origin on the spine of the scapula and reflected laterally (Fig. 1-B). The axillary nerve was identified and protected. The distal border of the infraspinatus muscle was defined, and an incision was made along this border (Fig. 1-C). In some patients, better exposure was obtained with an additional vertical incision through the tendinous portion of the infraspinatus muscle and the underlying capsule of the shoulder. The infraspinatus muscle was elevated proximally, and the teres minor muscle was retracted distally to expose the scapular fracture (Fig. 1-D). A transverse incision was made through the joint capsule of the shoulder to identify the intra-articular aspect of the displaced fracture, and a vertical capsular incision was added for additional exposure. During this dissection, the supraspinatus nerve was identified coursing through the spinoglenoid notch and on the undersurface of the infraspinatus muscle.

The fracture was then reduced under direct vision of both the intra-articular and extra-articular aspects of the fracture. The fragments were held temporarily in the reduced position with small-diameter Steinmann pins. In one patient, this fixation seemed to be adequate, but subsequently the pins had to be removed because of irritation of the soft tissue. The pins in four patients were replaced with interfragmentary compression screws.

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### TABLE 1

**Data on Patients Who Had Open Reduction and Internal Fixation of a Displaced Intra-Articular Fracture of the Glenoid Fossa**

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>Age (Yrs)</th>
<th>Injured Side</th>
<th>Cause of Injury</th>
<th>Displacement of Articular Surface (mm)</th>
<th>Fracture Pattern</th>
<th>Duration of Follow-up (Yrs)</th>
<th>Flexion (Degrees)</th>
<th>Abduction (Degrees)</th>
<th>External Rotation (Degrees)</th>
<th>Internal Rotation (Vertebra)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>44</td>
<td>R</td>
<td>Fall</td>
<td>8</td>
<td>Stellate</td>
<td>2</td>
<td>185</td>
<td>180</td>
<td>60</td>
<td>T8</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>49</td>
<td>L</td>
<td>Motor-veh. acc.</td>
<td>7</td>
<td>Transverse</td>
<td>6</td>
<td>140</td>
<td>110</td>
<td>40</td>
<td>T8</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>22</td>
<td>L</td>
<td>Motor-veh. acc.</td>
<td>4</td>
<td>Transverse</td>
<td>4</td>
<td>180</td>
<td>180</td>
<td>40</td>
<td>T8</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>41</td>
<td>L</td>
<td>Electric shock</td>
<td>7</td>
<td>Transverse</td>
<td>5</td>
<td>175</td>
<td>170</td>
<td>60</td>
<td>T8</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>25</td>
<td>L</td>
<td>Motor-veh. acc.</td>
<td>6</td>
<td>Vertical</td>
<td>2</td>
<td>170</td>
<td>170</td>
<td>70</td>
<td>T9</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>43</td>
<td>R</td>
<td>Motor-veh. acc.</td>
<td>4</td>
<td>Transverse</td>
<td>3</td>
<td>180</td>
<td>180</td>
<td>65</td>
<td>T6</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>28</td>
<td>L</td>
<td>Motor-veh. acc.</td>
<td>5</td>
<td>Stellate</td>
<td>3</td>
<td>170</td>
<td>170</td>
<td>80</td>
<td>T6</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>33</td>
<td>R</td>
<td>Motor-veh. acc.</td>
<td>4</td>
<td>Transverse</td>
<td>2</td>
<td>160</td>
<td>160</td>
<td>45</td>
<td>T8</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
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<td>L</td>
<td>Motor-veh. acc.</td>
<td>5</td>
<td>Transverse</td>
<td>10</td>
<td>180</td>
<td>180</td>
<td>60</td>
<td>T8</td>
</tr>
</tbody>
</table>

*The internal rotation was measured according to the vertebra that the patient was able to reach with the thumb.*
Fig. 1-A through 1-D: Drawings illustrating the operative procedure. (Reprinted with permission from the Mayo Foundation.)

Fig. 1-A: A vertical skin incision was preferred for exposure of fractures involving the intra-articular portion of the glenoid. The incision begins just proximal to the junction of the lateral one-third and medial two-thirds of the spine of the scapula and extends downward and slightly medially for fifteen centimeters.

Fig. 1-B: The deltoid is released from the spine of the scapula by incision of the fascia between the trapezius and the deltoid muscles and by elevation of the fascia of the deltoid attachment from the spine of the scapula. Often, the most medial aspect of the deltoid is divided, which eliminates the need to extend the dissection medially.

Fig. 1-C: The distal border of the infraspinatus muscle is defined, and the interval between the infraspinatus muscle and the teres minor muscles is developed. For a number of these fractures, an adjunctive vertical incision through the tendons of the infraspinatus and teres minor muscles augments the exposure of the infraspinous fossa and lessens the need for strong retraction of the muscles.

(Figs. 2-A, 2-B, and 2-C) and, in four other patients, the pins were replaced with screws and a plate (Figs. 3-A through 3-D). The plate was used to add support to the fixation of the glenoid fracture fragments in all four patients, and it secured a transverse fracture of the scapular body and a fracture involving the axillary border in one patient each. Intraoperative radiographs were used to confirm anatomical reduction in all patients.

The incision in the capsule of the shoulder was closed. The infraspinatus muscle was then repositioned in its fossa. The vertical incision was repaired, and the muscle was sutured to the teres minor and to surrounding soft tissues. The deltoid muscle was then sutured to the spine of the scapula. A suction drain was placed, and the skin wound was closed.

After the operation, the arm was positioned in a humeral abduction splint set at 45 degrees. Approximately one week after the operation, a single shoulder-spica cast was applied with the arm in 45 degrees of abduction, neutral flexion-extension, and 0 to 10 degrees of external rotation. The cast was worn for six to eight weeks. The cast was not used to support the osseous fixation but to protect the posterior repair of the shoulder capsule and the repositioning and repair of the muscles (the external rotators and the posterior aspect of the deltoid).

After the cast had been removed, a program of gentle active-assisted range-of-motion exercises, which of-
A forty-one-year-old man sustained a transverse fracture of the glenoid fossa after an electric shock. The fracture of the glenoid fossa had healed without incongruity of the joint. The component of the fracture that extended into the body of the scapula was incompletely healed and in a malaligned position. Functional recovery was excellent.

Results

Accurate determination of healing in metaphyseal areas is difficult. In the patients in the present series, the osseous position obtained at the operation was maintained, and fracture-healing was judged to have occurred at an average of 3.5 months (range, two to six months) after the operation. None of the nine patients reported that they had pain with daily use of the extremity. Two patients reported mild aching with changes in the weather, and two were uncomfortable sleeping on the repaired shoulder. All of the patients were pleased with the result at the most recent follow-up examination.

Active abduction averaged 167 degrees and ranged from 110 to 180 degrees. Flexion of the shoulder was slightly greater, averaging 171 degrees and ranging from 140 to 185 degrees (Table I). External rotation with the arm at the side ranged from 40 to 80 degrees. With the arm in 90 degrees of abduction, upward or external rotation ranged from 60 to 100 degrees. Internal rotation with the arm at the side ranged from the ability of the thumb to touch the sixth thoracic vertebra to the ability of the thumb to touch the ninth thoracic vertebra. At 90 degrees of abduction, downward or internal rotation ranged from 60 to 100 degrees.

Strength, which was measured isometrically with manual muscle-testing, was normal in flexion, extension, abduction, adduction, internal rotation, and external rotation for seven patients after use of the postoperative external support and the graduated rehabilitation program. Two patients had mild, generalized weakness of the shoulder girdle in all of the directions tested, as evidenced by the fact that the active range of motion was equal to the passive motion but the patient could not maintain the position of the arm isometrically against firm manual pressure applied by the examiner.

Radiographs showed no displacement of the articular surfaces and no evidence of migration or loosening of the screws or plates. As mentioned earlier, the patient who had internal fixation with the Steinmann pins had removal of those pins. We elected not to remove the screws or plates from the other patients because there was no indication that the internal fixation was a source of symptoms.

The only complication in the series was the formation of heterotopic bone in one patient (Case 2). This was first seen three months after the operation. The ossification was in continuity with the axillary border of the scapula and, on the anteroposterior radiograph, it was seen to extend to within 0.5 centimeter of the humeral neck. This patient had had a closed head injury and ipsilateral fractures of the ribs, and the time from the injury to the operation had been five days. The most recent range of motion was less than that in the other patients in the series.

Discussion

Non-operative treatment has generally been recommended for scapular fractures, and it has been well established that operative treatment is rarely necessary. Nonetheless, several authors have recently proposed that displaced fractures that create an incongruity of the glenoid fossa may be best treated with operative intervention, which minimizes the possibility that traumatic...
Internal fixation was performed with a plate and interfragmentary screws. At the three-year follow-up examination, anteroposterior and axillary radiographs demonstrated healing of the fracture with no evidence of degenerative changes.

Osteoarthrosis will develop. Unfortunately, the orthopaedic literature contains only a few reports dealing with open reduction and internal fixation of displaced intra-articular fractures of the glenoid fossa, and, generally, these reports did not provide details. Aulicino et al. described the findings in two patients who had been followed for two and three years after the operation. Both patients had an excellent result, with a full, painless range of motion of the shoulder, and neither had traumatic osteoarthrosis. To our knowledge, Hardegger et al. reported on the largest series of operatively treated scapular fractures, which included twelve glenoid fractures. These authors recommended operative reduction and fixation of all incongruent fractures of the glenoid fossa; however, the results for this specific type of fracture were not separated from those of the group as a whole. Aston and Gregory reported on three operatively treated fractures of the glenoid that had been associated with dislocation of the shoulder. They documented good results after the operations, and they stressed that fixation prevented future instability of the shoulder. They did not provide long-term follow-up data. Several other authors have reported on the operative treatment of these fractures, but they provided few details relative to the indications for the operation, the methods of fixation, and the findings at the follow-up evaluation.

Information on the non-operative treatment of displaced intra-articular fractures of the glenoid has also

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FIG. 3-A  FIG. 3-B

Figs. 3-A through 3-D: Case 7. A twenty-eight-year-old woman sustained a second lumbar burst fracture and a stellate-type fracture of the left glenoid fossa in a motor-vehicle accident.

Fig. 3-A: Anteroposterior radiograph showing a stellate fracture pattern with both vertical and transverse components.

Fig. 3-B: A vertical fracture line with major displacement was confirmed on a computed tomography scan.

**FIG. 3-C**  **FIG. 3-D**

Internal fixation was performed with a plate and interfragmentary screws. At the three-year follow-up examination, anteroposterior and axillary radiographs demonstrated healing of the fracture with no evidence of degenerative changes.
been very limited. Wilber and Evans reported on three such glenoid fractures from a series of fifty-two scapular fractures of all types. However, they did not report the amount of displacement at the time of the fracture or after the fracture had healed. Two of the three patients were considered to have had a fair result, with slight pain and less than 25 per cent loss of motion; the third patient was considered to have had a poor result, with moderate pain and more than 25 per cent loss of both flexion and abduction. Wilber and Evans suggested immobilization of the arm in abduction, followed by physiotherapy, as a more aggressive form of treatment of intra-articular fractures of the glenoid.

The posterior operative approach described in the present report allowed excellent visualization of both the intra-articular and the extra-articular components of the fractures of the glenoid fossa. We do not advocate this approach for fractures limited to the anterior rim of the glenoid; however, for the transverse, vertical, and stellate fractures with minimum comminution that were sustained by the patients in this series, the approach allowed easy recognition and temporary and final fixation of the fracture. The approach does require disruption of the origins of the posterior aspect of the deltoid, the infraspinatus, and, often, the teres minor. In addition, the posterior aspect of the shoulder capsule is divided. If these soft-tissue structures do not heal well, major weakness of external rotation of the shoulder or posterior instability of the joint may develop. For these reasons, we protected these repairs in a spica cast. We were concerned that glenohumeral stiffness might develop, but it did not. Also, the graduated, prolonged program of rehabilitation that supplemented the early external support prevented clinically apparent weakness of the muscles in seven of the nine patients.

Little clinical data are available on which to base decisions regarding treatment of displaced intra-articular fractures of the glenoid. The patients in this series were all healthy, young or middle-aged adults who wished to remain physically active. All had substantial displacement of the articular surfaces. The operative procedure involved extensive dissection of muscles, and the program of rehabilitation was prolonged. However, there were few complications, and the results, with one exception, were excellent. This led us to conclude that open reduction and internal fixation should be seriously considered for patients who have this type of injury and wish to remain active. However, we offer this recommendation with several caveats. When patients are seen with a scapular fracture, they should be thoroughly evaluated for other serious injuries. These other injuries can be fully addressed before treatment of the glenoid fracture because a delay before the operation does not seem to compromise the final result. It remains uncertain how much incongruity of the glenoid articular surface can be accepted without the long-term sequelae of pain, stiffness, or traumatic osteoarthrosis. Certainly, additional studies are needed to clarify this issue. However, considering the rarity of this type of fracture, the needed information may be difficult to acquire.

References