

# Iatrogenic Propagation of Anterior Fracture-Dislocations of the Proximal Humerus: Case Series and Literature Review With Suggested Guidelines for Treatment and Prevention

Anil S. Ranawat, MD, Gregory S. DiFelice, MD, Michael Suk, MD, JD, MPH, Dean G. Lorch, MD, and David L. Helfet, MD

**F**racture-dislocations of the proximal humerus, though rare, are difficult to manage. An unfortunate and challenging subset of these injuries includes fractures that are iatrogenically created, or worsened, during reduction maneuvers for an anterior shoulder dislocation. Iatrogenic fracture-dislocations have 2 basic mechanisms. In the first, a shoulder dislocation with or without a concomitant tuberosity fracture or Hill-Sachs lesion is converted to a more complicated fracture-dislocation with the creation of a new fracture line during a reduction maneuver; in the second, a shoulder dislocation with an unrecognized neck fracture is converted to a more complicated fracture-dislocation with displacement or propagation of the neck fracture during a reduction maneuver. In both cases, the patient is left with a more complicated, higher-grade fracture-dislocation of the proximal humerus—an injury most likely significantly displaced and in need of surgical intervention.

In this article, we report on a series of 6 cases of iatrogenic fracture-dislocations. All 6 cases originally were anterior dislocations. Four of the 6 had concomitant greater

tuberosity fractures; the other 2 had large Hill-Sachs lesions. Five of the 6 were converted to severely displaced fracture-dislocations of the proximal humerus after unsuccessful reduction attempts; 4 of the 5 required a shoulder hemiarthroplasty, and the fifth required open reduction and internal fixation (ORIF). In the sixth and final case, we applied a new technique to prevent the complication of iatrogenic displacement: We used prophylactic percutaneous fixation to prevent fracture propagation so that we could safely perform closed reduction of the dislocation. In retrospect, at least 2 and perhaps 3 cases had unrecognized anatomical or surgical neck fractures.

## CASE SERIES

### Case 1

An 89-year-old right-hand-dominant man sustained a traumatic left anterior shoulder dislocation with a concomitant greater tuberosity fracture (Figure 1A). After numerous attempts at closed reduction (with intra-articular anesthesia) of this 2-part fracture-dislocation by the local emergency department (ED) staff, the patient's surgical neck was fractured with significant displacement (Figure 1B). Given the patient's age and degree of displacement, he went on to an uncomplicated left shoulder hemiarthroplasty under an interscalene block (Figure 1C).

Dr. Ranawat is Orthopaedic Trauma Resident, PGY-5, Hospital for Special Surgery, New York, New York.

Dr. DiFelice is Director, Orthopaedic Sports Medicine and Joint Reconstruction, Jacobi Medical Center, Bronx, New York.

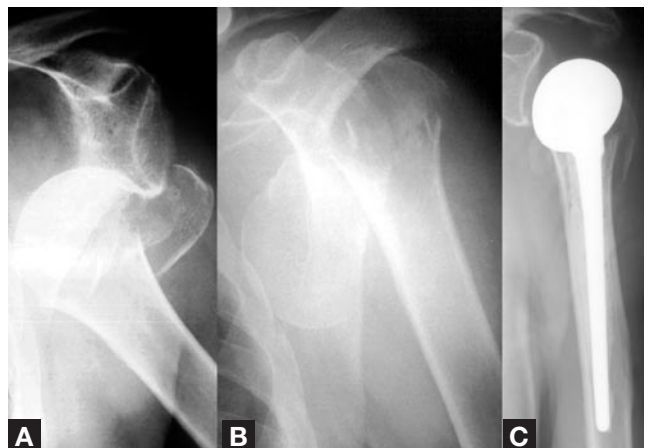
Dr. Suk is Director, Orthopaedic Trauma Service, University of Florida—Shands Jacksonville, Jacksonville, Florida, and Assistant Professor, Orthopaedic Surgery, University of Florida, Jacksonville, Florida.

Dr. Lorch is Assistant Director, Orthopaedic Trauma Service, New York Presbyterian Hospital, New York, New York, and Assistant Professor, Orthopaedic Surgery, Weill Cornell University Medical College, New York, New York.

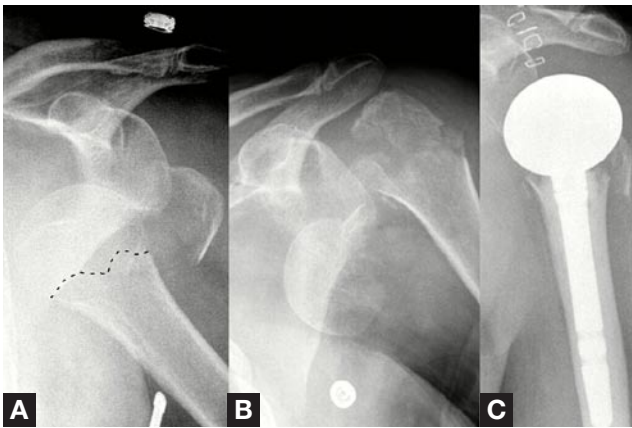
Dr. Helfet is Director, Orthopaedic Trauma Service, Hospital for Special Surgery and New York Presbyterian Hospital, New York, New York, and Professor, Orthopaedic Surgery, Weill Cornell University Medical College, New York, New York.

Requests for reprints: David L. Helfet, MD, Orthopaedic Trauma Service, Hospital for Special Surgery, 535 E 70th St, New York, NY 10021 (tel, 212-606-1888; fax, 212-628-4473; e-mail, helfetd@hss.edu).

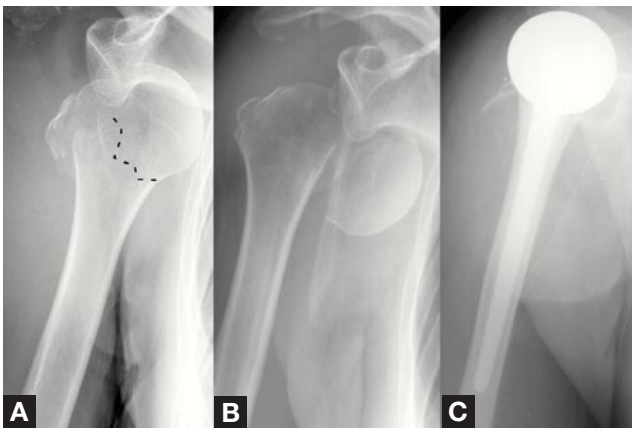
*Am J Orthop.* 2007;36(9):E133-E137. Copyright Quadrant HealthCom Inc. 2007. All rights reserved.



**Figure 1.** Case 1 x-rays: (A) injury, (B) postreduction attempt, (C) postoperative.



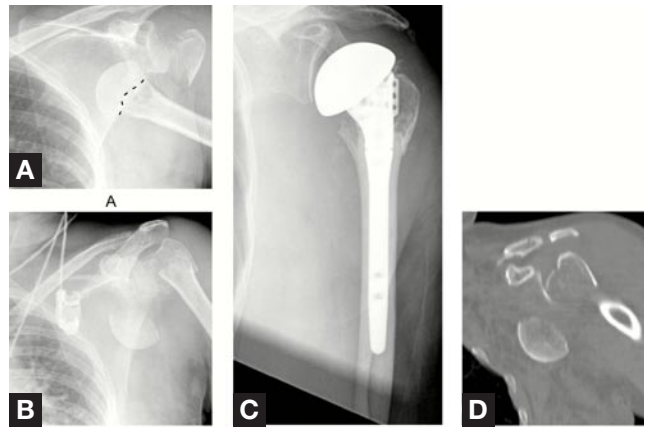
**Figure 2.** Case 2 x-rays: (A) injury, (B) postreduction attempt, (C) postoperative.



**Figure 3.** Case 3 x-rays: (A) injury, (B) postreduction attempt, (C) postoperative.

### Case 2

A 78-year-old left-hand-dominant woman sustained a traumatic left anterior shoulder dislocation with a concomitant greater tuberosity fracture (Figure 2A). In the ED at an outside hospital, she complained of paresthesia in the extremity immediately after the injury. The orthopedics team evaluated the patient and noted that she had at least a 2-part fracture-dislocation with a dense brachial plexopathy and only some residual radial nerve function. She was given intravenous sedation and intra-articular anesthesia. However, multiple attempts at closed reduction were unsuccessful. The patient was then taken to the operating room, where an additional reduction maneuver was attempted (unsuccessfully) with the aid of full sedation and fluoroscopic visualization. Ultimately, the 2-part fracture-dislocation was converted to a 4-part fracture-dislocation (Figure 2B). The patient underwent an uncomplicated left shoulder hemiarthroplasty under general anesthesia with good result (Figure 2C). At time of surgery, it was noted that the articular fragment of the proximal humerus had buttonholed through the axillary capsule and remained displaced amid the axillary neurovascular structures. In retrospect, an unrecognized anatomical neck fracture was noticed in this case (Figure 2A).



**Figure 4.** Case 4: (A) injury x-ray, (B) postreduction-attempt x-ray, (C) postoperative x-ray, (D) postreduction-attempt computed tomography scan.

### Case 3

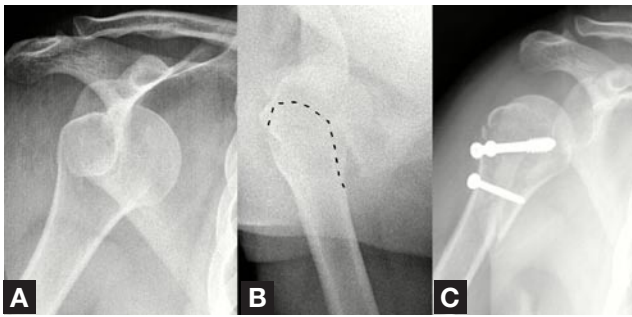
A 50-year-old right-hand-dominant woman fell and sustained a traumatic right shoulder dislocation with a concomitant greater tuberosity fracture (Figure 3A). After making numerous attempts at reduction with intra-articular anesthesia and conscious sedation, the local orthopedics team converted the injury from a 2-part to a 3-part fracture-dislocation with significant displacement (Figure 3B). Given the patient's age and degree of displacement, she underwent an uncomplicated left shoulder hemiarthroplasty with an interscalene block (Figure 3C). In retrospect, an unrecognized anatomical neck fracture was suspected in this case (Figure 3A).

### Case 4

A 67-year-old right-hand-dominant woman sustained a 2-part fracture-dislocation of the left shoulder when she fell down the stairs (Figure 4A). There was severe displacement of the head and shaft medially. A fracture line at the anatomical neck was suspected but could not be appreciated because of inadequate axillary x-rays. The orthopedics team was consulted. It decided to attempt closed reduction under conscious sedation with intra-articular anesthesia. The result was conversion to a 4-part fracture-dislocation with the articular surface fragment remaining severely displaced medially (Figure 4B). The patient then developed some decreased sensation to light touch in the distribution of the axillary nerve but was otherwise neurovascularly intact. Given the patient's age and degree of displacement, she underwent an uncomplicated left shoulder hemiarthroplasty under general anesthesia (Figure 4C). At time of surgery, it was noted that the articular surface of the proximal humerus had buttonholed through the axillary capsule and was lodged precariously amid the axillary neurovascular structures—also evident on preoperative computed tomography scan (Figure 4D).

### Case 5

A 32-year-old left-hand-dominant woman presented to an outside hospital ED with new-onset seizures and a right shoulder dislocation after a fall. She was reduced by the



**Figure 5.** Case 5 x-rays: (A) injury, (B) postreduction attempt, (C) postoperative.

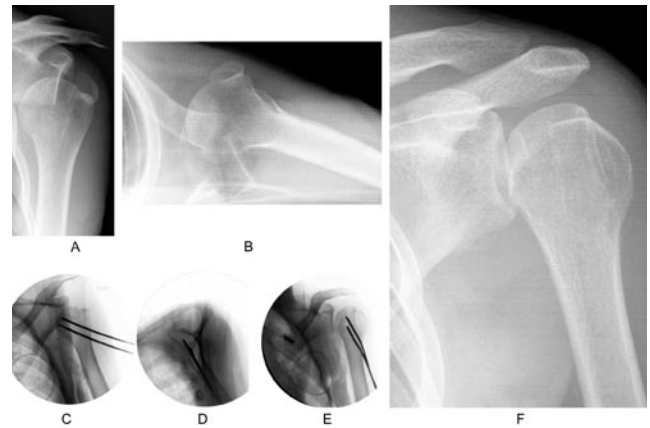
ED staff under conscious sedation and sent home in a sling for follow-up. Subsequently, she had her second episode of seizures and redislocated the shoulder (Figure 5A). After the ED staff had made numerous unsuccessful reduction attempts, the orthopedics team was consulted. It was then noted that the patient had a large Hill-Sachs lesion (Figure 5A). This lesion had not been recognized, as the original x-rays did not include an axillary view. During the numerous reduction attempts, the Hill-Sachs lesion was propagated anteriorly, including a shear of the articular surface and a part of the humeral neck. When an axillary view was taken, the lesion was then more easily identifiable (Figure 5B). The orthopedics team felt it was impossible to safely reduce the fracture in closed fashion and so prepared the operating room. The patient urgently underwent ORIF (with screws) using a deltopectoral approach under general anesthesia (Figure 5C).

### Case 6

A 32-year-old man with schizophrenia presented 3 weeks after new-onset seizures that resulted in an unrecognized anterior shoulder dislocation. Radiographic evaluation (Figures 6A, 6B) revealed a large Hill-Sachs lesion and a coracoid fracture. Given the subacute nature of the presentation and the fracture pattern, it was felt that there was a high risk for propagating a fracture (as in case 5). In addition, significant medical comorbidities made the surgical risk associated with open reduction unacceptably high. In the operating room, using general anesthesia and fluoroscopic guidance, we percutaneously placed 2 terminally threaded large external fixation pins into the humeral head to fortify against fracture propagation (Figure 6C). Reduction maneuvers were then successfully applied, the patient was placed in sling and swathe, and the pins were removed (Figures 6D-6F). The patient was managed with strict immobilization for 6 weeks and then pendulum exercises and slow progression with physical therapy.

## DISCUSSION

The best treatment of an anterior fracture-dislocation of the proximal humerus is controversial. The numerous treatment methods include closed reduction in the ED, closed reduction under fluoroscopy in the operating room, and formal open reduction. Although each treatment decision must be made respecting the particular personality of the injury, the patient,



**Figure 6.** Case 6: (A,B) injury x-rays, (C) postpinning fluoroscopic image, (D,E) postreduction fluoroscopic images, (F) final postoperative x-ray.

and the institution, one of the best treatments is prevention. In certain cases, iatrogenic propagation can be prevented. It is essential that a careful radiographic examination be performed so that fracture lines are recognized before any reduction maneuvers are performed. This examination includes the standard shoulder trauma series: true anteroposterior view of the glenohumeral joint (anteroposterior oblique in neutral rotation, or modified Grashey view), scapular-Y view, and an axillary view (or trauma variant; ie, Velpeau axillary<sup>1</sup>) with proper radiographic technique. Once a dislocation is verified both clinically and radiographically, internal/external rotation views may be unnecessary and may in fact propagate a large Hill-Sachs lesion (as in case 5). Most important, the examiner must be cognizant of unrecognized or subtle fractures of the surgical and anatomical neck regions, which, if displaced, will add significantly to the morbidity of the injury.

At most institutions, reduction of an uncomplicated anterior shoulder dislocation is considered an ED procedure to be performed with either intra-articular analgesia or conscious sedation.<sup>2</sup> In 5 of the 6 cases presented here, the displaced humeral neck fracture resulted from multiple failed closed-reduction attempts in the ED. In retrospect, there were nondisplaced surgical neck fractures initially present in 2 cases, and likely present in 1 or 2 others, though initial imaging was inadequate to be sure. There is no substitute for an adequate and complete radiographic shoulder series before reduction attempts are made to evaluate carefully for any nondisplaced or potential fractures of the surgical or anatomical neck.

A shoulder dislocation with a greater tuberosity fracture or a large Hill-Sachs lesion and/or severe medial displacement should be a “red flag” to the treating physician. The implication is that there is a higher degree of injury and an increased potential for propagation of fractures, especially of the surgical or anatomical neck—evident in the cases presented here and as supported by the literature. Hersche and Gerber<sup>3</sup> reported on 7 shoulder fracture-dislocations in which an iatrogenic displacement of the humeral head occurred with attempted closed reduction of an anterior shoulder dislocation. Five of the 7 patients initially presented with anterior shoulder dislocations with greater tuberosity fractures. Demirhan and colleagues<sup>4</sup>

reported on 6 cases in which an iatrogenic displacement of the humeral head occurred with closed reduction of shoulder dislocations, all with greater tuberosity fractures. Ferkel and colleagues<sup>5</sup> reported on 2 anterior shoulder dislocations that were iatrogenically displaced. Both also presented with greater tuberosity fractures, and in retrospect one had unrecognized neck fractures. Ferkel and colleagues<sup>5</sup> and Ilahi<sup>6</sup> claimed that greater tuberosity fractures can be displaced in upwards of 15% or more of all anterior shoulder dislocations. Of additional concern, in a recent retrospective review, Ogawa and colleagues<sup>7</sup> noted a missed greater tuberosity fracture rate of 59% (58/99) for shoulders presenting initially with localized tenderness to the lateral wall near the greater tuberosity. Although these were isolated greater tuberosity fractures, this finding emphasizes the difficulty in accurately diagnosing tuberosity fractures.

In addition, many case reports of irreducible anterior shoulder dislocations have involved injury patterns that are potential precursors to iatrogenic fracture-dislocation injuries. The most common potential hindrances to safe reductions were isolated greater tuberosity fractures,<sup>8-10</sup> greater tuberosity fractures with Hill-Sachs lesions, and greater tuberosity fractures with isolated Hill-Sachs lesions impacting the glenoid. In other cases, soft tissue (eg, subscapularis tendon, long head of biceps, anterior capsule) can prevent reduction.<sup>6,11,12</sup> The labrum and rotator cuff have also been implicated.<sup>13,14</sup> In these circumstances, osseous fracture patterns and amount of medial displacement should be recognized so that further injury can be prevented.

Iatrogenic conversion of a simple nondisplaced fracture-dislocation of the proximal humerus to a 3- or 4-part fracture-dislocation is potentially disastrous, especially in younger, active patients.<sup>15,16</sup> The long-term implications of avascular necrosis are debilitating. According to a recent study report, avascular necrosis rates were 39% to 89% for 3- and 4-part proximal humerus fracture-dislocations.<sup>17</sup> Hersche and Gerber<sup>3</sup> reported an avascular necrosis rate of 100% for 5 patients with iatrogenic fracture-dislocations, all treated with ORIF. Three of these 5 patients were younger than 60. All 6 of the iatrogenic shoulder fracture-dislocations in the series reported by Demirhan and colleagues<sup>4</sup> were treated with primary shoulder hemiarthroplasty, and 3 of these patients were younger than 60. In our series, 2 of the 5 patients who received a hemiarthroplasty were younger than 60. With safe and successful shoulder reduction, these salvage procedures might not have been necessary, and the sequelae of avascular necrosis and the limitations of shoulder hemiarthroplasty could have been avoided in these young patients.

Treatment of anterior shoulder dislocations with or without concomitant fractures should be critically focused on accurate diagnosis of fracture patterns and prevention of displacement of surgical or anatomical neck fractures with reduction maneuvers. Most simple dislocations, once accurately identified, can be handled in the ED. Certain high-risk fracture patterns must be recognized and handled more carefully. These patterns include anterior shoulder dislocation with greater tuberosity fractures, significant medial or inferior (subglenoid) displacement, large Hill-Sachs lesions, coracoid fractures, and nondisplaced anatomical or surgical neck fractures. Other characteristics to be factored in are time from initial injury to evaluation, body

habitus, and medical comorbidities. Given these factors, ideal treatment in many cases, especially those involving younger patients, consists of closed reduction with adequate anesthesia with fluoroscopic guidance in the operating room. Fluoroscopic imaging can show potential sources of displacement and help the surgeon prevent unnecessary harm. Should it become apparent that closed reduction is not possible, operative intervention can be easily initiated. Similarly, should a nondisplaced surgical or anatomical neck fracture be identified, percutaneously pinning the neck fracture before closed reduction may help prevent displacement (as in case 6). Ceroni and colleagues<sup>18</sup> expressed similar concerns and recommended that all subglenoid dislocations with associated greater tuberosity fractures be treated under general anesthesia to avoid head-splitting fractures.

The technique for lateral pin placement was well described in an anatomical study by Rowles and McGrory.<sup>19</sup> These authors indicated that the lateral starting point should be at least twice the distance of the height of the humeral head down the shaft to avoid injury to the anterior branch of the axillary nerve as it crosses the humerus. Our technique is similar, using a lateral, distal approach. Under fluoroscopic guidance, proper height is established. A small stab wound is made and spread bluntly through the deltoid to the lateral humeral cortex. A 15.0-mm triple trocar from a large AO external fixator set (both made by Synthes™ Paoli, Pa) is placed on the cortex, and 2 pins are placed across the neck region into the humeral head under fluoroscopic guidance to avoid any penetration into articular cartilage. The precise pin configuration, which can be varied, depends on the fracture pattern to be fortified and reduced. The pins are used both to stabilize any nondisplaced fractures and to assist (as joysticks) in the reduction maneuver. Of course, the shoulder dislocations in our series were anterior, but the height of the anterior branch of the axillary nerve should not be significantly affected. Should any concern arise, we do not hesitate to lengthen the incision to gain better exposure and ensure that neurovascular structures are protected.

Iatrogenic fracture-dislocations of the proximal humerus, though uncommon, are associated with a morbidity that can be prevented, first by recognizing high-risk patterns. In addition, surgeons may require new management guidelines and techniques, such as performing prophylactic percutaneous pinning before proceeding with reduction maneuvers in high-risk situations. With nondisplaced fractures, percutaneous fixation can be considered an adjunct to the treatment armamentarium. Most simple anterior shoulder dislocations should still be primarily handled in the ED. However, clinicians—whether orthopedic attendings or residents or ED physicians—must be aware of the high-risk patterns so they can prevent iatrogenic displacement during reduction. In these circumstances, the resources of the operating room should be utilized. A continuum of management should be established from the ED to a monitored environment (conscious sedation) to the operating room, on the basis of fracture pattern and injury severity. For any high-risk patient or fracture pattern, the resources of the operating room should be used as tools to safely reduce and prevent iatrogenic injury and avoid unnecessary surgery, not merely to salvage reduction failures with ORIF and shoulder hemiarthroplasty.

## AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

## REFERENCES

- Pavlov H, Burke M, Giesa M, Seager K, White ET. *Orthopedist's Guide to Plain Film Imaging*. New York, Thieme, 1999.
- Miller SJ, Cleeman E, Auerbach J, Flatow EL. Comparison of intra-articular lidocaine and intravenous sedation for reduction of shoulder dislocations: a randomized, prospective study. *J Bone Joint Surg Am*. 2002;84-A(12):2135-2139.
- Hersche O, Gerber C. Iatrogenic displacement of fracture-dislocations of the shoulder. A report of seven cases. *J Bone Joint Surg Br*. 1994;76(1):30-33.
- Demirhan M, Akpınar S, Atalar AC, Akman S, Akalin Y. Primary replacement of the humeral head in iatrogenically displaced fracture-dislocations of the shoulder: a report about six cases. *Injury*. 1998;29(7):525-528.
- Ferkel RD, Hedley AK, Eckardt JJ. Anterior fracture-dislocations of the shoulder: pitfalls in treatment. *J Trauma*. 1984;24(4):363-367.
- Ilahi OA. Irreducible anterior shoulder dislocation with fracture of the greater tuberosity. *Am J Orthop*. 1998;27(8):576-578.
- Ogawa K, Yoshida A, Ikegami H. Isolated fractures of the greater tuberosity of the humerus: solutions to recognizing a frequently overlooked fracture. *J Trauma*. 2003;54(4):713-717.
- Davies MB, Rajasekhar C, Bhamra MS. Irreducible anterior shoulder dislocation: the greater tuberosity Hill-Sachs lesion. *Injury*. 2000;31(6):470-471.
- Eachempati KK, Dua A, Malhotra R, Bhan S, Bera JR. The external rotation method for reduction of acute anterior dislocations and fracture-dislocations of the shoulder. *J Bone Joint Surg Am*. 2004;86-A(11):2431-2434.
- Oni OO. Irreducible acute anterior dislocation of the shoulder due to a loose fragment from an associated fracture of the greater tuberosity. *Injury*. 1983;15(2):138.
- Bridle SH, Ferris BD. Irreducible acute anterior dislocation of the shoulder: interposed scapularis. *J Bone Joint Surg Br*. 1990;72(11):1078-1079.
- Lam SJ. Irreducible anterior dislocation of the shoulder. *J Bone Joint Surg Br*. 1966; 48(1):132-133.
- Seradge H, Orme G. Acute irreducible anterior dislocation of the shoulder. *J Trauma*. 1982;22(4):330-332.
- Tietjen R. Occult glenohumeral interposition of a torn rotator cuff. A case report. *J Bone Joint Surg Am*. 1982;64(3):458-459.
- Neer CS. Displaced proximal humeral fractures. I. Classification and evaluation. *J Bone Joint Surg Am*. 1970;52(6):1077-1089.
- Neer CS. Displaced proximal humeral fractures. II. Treatment of three-part and four-part displacement. *J Bone Joint Surg Am*. 1970;52(6):1090-1103.
- Wijgman AJ, Roolker W, Patt TW, Raaymakers EL, Marti RK. Open reduction and internal fixation of three and four-part fractures of the proximal part of the humerus. *J Bone Joint Surg Am*. 2002;84-A(11):1919-1925.
- Ceroni D, Sadri H, Leuenberger A. Radiographic evaluation of anterior dislocation of the shoulder. *Acta Radiol*. 2000;41(6):658-661.
- Rowles DJ, McGrory JE. Percutaneous pinning of the proximal part of the humerus. An anatomic study. *J Bone Joint Surg Am*. 2001;83-A(11):1695-1699.

---

*This paper will be judged for the Resident Writer's Award.*

---