

Full Text

[Save Article](#) [Text](#) [Email Article](#) [Text](#) [Print](#)
[Preview](#)

Closed Management and Percutaneous Fixation of Unstable Proximal Humerus Fractures

11

Author(s): Chen, Chao-Yu MD; Chao, En-Kai MD; Tu, Yuan-Kun MD; Ueng, Steve Wen-Neng MD; Shih, Chun-Hsiung MD

Issue: Volume 45(6), December 1998, pp 1039-1045

Publication Type: [Article]

Publisher: © Williams & Wilkins 1998. All Rights Reserved.

From the Department of Orthopaedic Surgery (C.-Y.C., E.-K.C., C.-H.S.) Chang Gung Memorial Hospital, Taoyuan, and Chang Gung Memorial Hospital-Keelung (Y.K.T., S.W.-N.U.), Taiwan.

Institution(s): Address for reprints: Chao-Yu Chen, MD, Department of Orthopaedic Surgery, Chang Gung Memorial Hospital, No.5, Fu-Hsin Street, Kweishan, Taoyuan 333, Taiwan, Republic of China.

Table of Contents:

- [Acute Psychosocial Impact of Pediatric Orthopedic Trauma with and without Accompanying Brain Injuries.](#)
- [Treatment of Closed Humeral Shaft Fractures with Intramedullary Elastic Nails.](#)

Links

- [Abstract](#)
- [Complete Reference](#)
- [Library Holdings](#)

Outline

- [Abstract](#)
- MATERIALS AND METHODS**
 - [Operative Technique](#)
 - [Reduction Maneuver](#)
 - [Pinning Technique](#)
 - [Technique of Cannulated Screw Fixation](#)
 - [Postoperative Care](#)

RESULTS

- Clinical Results
- Radiographic Evaluation
- Complication

DISCUSSION

REFERENCES

Graphics

Table 1

Figure 1

Figure 2

Figure 3

Table 2

Table 3

Abstract

Background: In dealing with displaced proximal humerus fractures, there is still much controversy in treatment modalities. The latest investigations emphasize the concept of minimal exposure and rigid fixation.

Methods: The technique of closed reduction and percutaneous fixation with cannulated screws and k-pins was performed on 19 patients with two- and three-part proximal humerus fractures. The outcomes were evaluated with a mean follow-up of 21 months.

Results: All except one case had a solid union of the fracture. Sixteen of 19 patients (84%) acquired good or excellent results according to Neer's classification. No further collapse or avascular necrosis was found.

Conclusion: The method of closed reduction and percutaneous fixation, although technically demanding, yields satisfactory results in displaced proximal humerus fracture. Cannulated screws provided rigid fixation that was the underlying tenet for early functional retrieval.

Key Words: Proximal humerus fracture, Percutaneous fixation, Neer's classification, Cannulated screw.

Proximal humerus fractures account for 4 to 5% of all fractures. [1] Complex and displaced fractures of the proximal humerus continue to pose challenging management problems for orthopedic surgeons. Neer [2] was among the first to recognize the deficiency of traditional methods in classification as well as standardization in treatment policy. He proposed two-, three-, and four-part fractures and fracture dislocation based on an observation first made by Codman in 1934. The degree of separation of fracture fragments has prognostic implications and, thus, is taken into account as adjustment of treatment regimens.

Based on Neer's work, hemiarthroplasty has become widely accepted for the management of four-part fractures and fracture dislocation of the proximal humerus. [3] However, the optimal treatment of displaced two- and three-part lesion has remained a matter of controversy. Nonsurgical treatment often results in severe malunion and poor functional results. Traditional open reduction may lead to more accurate anatomical reduction; however, extensive tissue dissection doubles the risk of avascular necrosis. [4]

We proposed a technique of closed reduction with percutaneous fixation, and treated 19 consecutive patients with unstable two- and three-part proximal humerus fractures. The technique was initially used in cases of isolated fractures of the greater tuberosity or surgical neck fracture, and was gradually extended to the management of unstable three-part fractures. It is the purpose of this prospective study to assess the outcome of 19 patients and to establish differences, if any, in results between various kinds of closed measures.

MATERIALS AND METHODS

From July of 1995 through August of 1996, 19 consecutive patients with displaced two- and three-part proximal humerus fractures received closed reduction and percutaneous fixation (Table 1). There were 12 male and seven female patients. The average age was 43 years (range, 8 to 89 years). All fractures were attributed to either a fall or a traffic crash. All of the fractures except three were stabilized within 24 hours of admission. The operations were delayed in two cases with associated injuries until hemodynamic status stabilized. The other patient with a delayed operation was an 8-year-old girl, and the delay was attributable to negligence of the parents.

Case	Sex	Age	Fracture Type	Fixation Method	Time to Surgery	Outcome
1	M	45	2 part	ORIF	24	Good
2	F	65	2 part	ORIF	24	Good
3	M	55	2 part	ORIF	24	Good
4	M	40	2 part	ORIF	24	Good
5	M	60	2 part	ORIF	24	Good
6	M	50	2 part	ORIF	24	Good
7	M	45	2 part	ORIF	24	Good
8	M	55	2 part	ORIF	24	Good
9	M	65	2 part	ORIF	24	Good
10	M	40	2 part	ORIF	24	Good
11	M	50	2 part	ORIF	24	Good
12	M	60	2 part	ORIF	24	Good
13	M	70	2 part	ORIF	24	Good
14	M	80	2 part	ORIF	24	Good
15	M	89	2 part	ORIF	24	Good
16	M	45	3 part	ORIF	24	Good
17	M	55	3 part	ORIF	24	Good
18	M	65	3 part	ORIF	24	Good
19	F	8	3 part	ORIF	24	Good

Table 1. Data of 19 patients

[Help with image viewing]
[Email Jumpstart To Image]

Once the patient's general condition became stabilized, routine radiographs of the injured shoulder were taken, and the characteristics of the fracture were evaluated. The fractures were classified according to the criteria of Neer. [3] The indication for this procedure was a displaced two- and three-part fracture of proximal humerus. Fracture dislocation and head splitting fractures were excluded from this study. The prerequisites for percutaneous fixation were that (1) the patient could tolerate general anesthesia, and (2) there was no or minimal skin compromise of the injured shoulder. The treatment results were assessed according to the grading scale of Neer. [2] This system allows a total of 35 points for pain, 30 points for function, 25 points for motion, and 10 points for reconstruction of anatomy with a maximum of 100 possible points. More than 89 points constitutes an excellent result; 80 to 89 points, a good result; 70 to 79 points, a fair result; fewer than 70 points, a poor result. The radiographs were evaluated with special regard to maintenance of reduction, implant migration, and avascular necrosis of the humeral head.

Operative Technique

Reduction Maneuver

Closed reduction was performed under the guide of a c-arm image intensifier, which was placed beside the operation Table as near as possible to avoid impedance of manipulation. The operated shoulder and arm were suspended on a radiolucent side bar, and were disinfected with sterile preparation and draping.

Correction of valgus angulation was initiated by manipulation of humerus shaft near the elbow with varying degrees of internal and external rotation. Direct pressure or manipulation over the fracture site did not help and should be avoided. Smooth k-pins were used as joysticks for adjustment of relocation when reduction of fracture was inadequate, frequently because of anterior displacement of the head segment. Longitudinal traction force was

helpful with the shoulder in somewhat of an abduction position during manipulation. Special care was taken concerning posterior sagging of the humerus shaft caused by gravity. Confirmation of realignment was undertaken with adjustment of the c-arm of the image intensifier instead of rotation of the humerus. According to the study by Keene et al. of 25 control patients in 1983, [5] we defined eligibility criteria of "acceptable reduction" with regard to (1) neck-shaft angle on anteroposterior view of shoulder radiograph, and (2) posterior angulation on lateral view of scapular plane.

Pinning Technique

Temporary stabilization of head-shaft fragments was started with smooth k-pins inserted from the anterior and lateral sides. Special care was taken with respect to medial pin insertion to avoid neurovascular compromise. At least three k-pins with a widespread distribution were inserted. The entry points of k-pins were sufficiently far away from the fracture site to facilitate predrilling before cannulated screw insertion and to avoid axillary nerve injury. Once the headneck segment was stabilized, the greater tuberosity, which was frequently fragmented but not widely separated, was then relocated and fixed. The tip of each k-pin was inserted to purchase as much subchondral bone as possible, but penetration of articular cartilage was avoided.

Technique of Cannulated Screw Fixation

We applied cannulated screw fixation along the k-pins except in the children and the teenager whose physal plate has not yet closed. Intraosseous length of the k-pin was measured using another k-pin of equal length and was comparable to the length of the cannulated screw to be used. Cannulated screws of suitable length were inserted along the k-pins after predrilling and tapering (case 6, Figure 1). The greater tuberosity was stabilized with either k-pins or screws, or both. In the case of tuberosity fragmentation or tiny avulsion fragment that could not be rigidly secured by screws, temporary k-pin stabilization was used to engage the medial cortex (case 19, Figure 2). In the children and the teenager whose epiphyseal plate had not yet fused, fixation with multiple smooth k-pins was used instead of screws or threaded pins (case 14, Figure 3).



Figure 1. A 50-year-old man (case 6) with a two-part proximal humerus fracture. (A) Preoperative radiograph shows a surgical neck fracture with displacement and metaphysis comminution. (B) Radiographs of lateral view and anteroposterior view at 3 months after the operation show the status of realignment and callus formation. (C) Radiograph at 6 months shows good union and remodeling of fracture site.

[\[Help with image viewing\]](#)

[\[Email Jumpstart To Image\]](#)



Figure 2. A 42-year-old man (case 19) with a three-part proximal humerus fracture. (A) Preoperative radiograph shows an anatomical neck fracture with a subluxed head segment. (B) Radiographs immediately after the operation show the status of realignment and fixation. (C) Radiograph at 3 months after the operation shows union of fracture sites. (D) Photograph at 3 months after the operation shows the status of functional recovery. (E) Radiograph at 9 months after the operation shows good union.

[\[Help with image viewing\]](#)

[\[Email Jumpstart To Image\]](#)

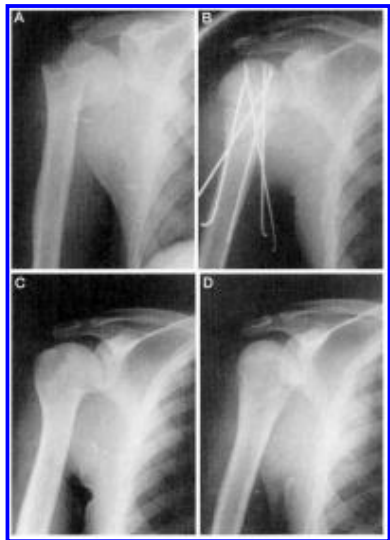


Figure 3. A 15-year-old teenager (case 14) with a two-part proximal humerus fracture. (A) Preoperative radiograph shows a surgical neck fracture with displacement. (B) Radiograph immediately after the operation shows the status of realignment and k-pins fixation. (C,D) Radiographs of anteroposterior view and lateral view at 1 year show solid union and good remodeling.

[\[Help with image viewing\]](#)

[\[Email Jumpstart To Image\]](#)

Postoperative Care

Passive and pendulum exercises were initiated as soon as pain and swelling subsided and the wound started to heal. Serial radiographs were taken at 1-month intervals until there was radiographic evidence of complete union and consolidation. The proximal k-pins through the greater tuberosity were removed 4 weeks after the operation. More aggressive motion and rotation exercises were then instituted to regain the range of motion of the shoulder (Figure 2D). The remaining k-pins were removed at 2 months when there was radiographic evidence of early union.

RESULTS

Clinical Results

The operation time from induction of general anesthesia to extubation averaged 87 minutes with a range of 45 to 126 minutes. Eighteen of the 19 patients were available for follow-up for an average of 21 months (range, 14-29 months) postoperatively. Twelve patients had two-part fractures, and six patients had three-part fractures. The patient lost to follow-up was a case of two-part surgical neck fracture. He suffered a second trauma caused by falling after the operation, which resulted in metaphyseal comminution and screw loosening because of osteoporosis. The patient refused a further operation; therefore, no revision surgery was performed, but bracing was undertaken.

(Table 2) shows the grading scales according to the criteria of Neer. None of the 18 patients whose fractures acquired solid union had residual pain or any symptom compromising daily life. Less satisfactory function was achieved in case 3 and case 8 with a function score of 19 and 12, respectively. Both had ipsilateral forearm injury, and this finding may account for the lower function scores. Overall, 16 patients (84%) had good or excellent results; two patients (10%) had fair results; one patient (5%) had a poor result. Eleven two-part fractures (84%) and five three-part fractures (83%) had excellent or good results. No significant correlation of fracture type to functional results were noted in our series ($p > 0.05$, Table 3). None of patients with three-part fractures had poor results. Only one patient who had a two-part fracture had a poor result attributable to refracture.

Case	Age	Sex	Fracture	Union	Months	Pain	Result
1	64	M	2-Part	Yes	10	None	Excellent
2	66	M	2-Part	Yes	10	None	Good
3	65	M	2-Part	Yes	10	Forearm	Fair
4	65	M	2-Part	Yes	10	None	Excellent
5	65	M	2-Part	Yes	10	None	Good
6	65	M	2-Part	Yes	10	None	Excellent
7	65	M	2-Part	Yes	10	None	Good
8	65	M	2-Part	Yes	10	Forearm	Fair
9	65	M	2-Part	Yes	10	None	Excellent
10	65	M	2-Part	Yes	10	None	Good
11	65	M	2-Part	Yes	10	None	Excellent
12	65	M	2-Part	Yes	10	None	Good
13	65	M	2-Part	Yes	10	None	Excellent
14	65	M	2-Part	Yes	10	None	Good
15	65	M	2-Part	Yes	10	None	Excellent
16	65	M	2-Part	Yes	10	None	Good
17	65	M	2-Part	Yes	10	None	Excellent
18	65	M	2-Part	Yes	10	None	Good
19	65	M	2-Part	Yes	10	None	Excellent

Table 2. Neer's scores in 19 patients

[\[Help with image viewing\]](#)

[\[Email Jumpstart To Image\]](#)

Results	Two Part	Three Part	Total
Excellent	9 (69%)	4 (57%)	13 (68%)
Good	2 (15%)	1 (17%)	3 (16%)
Fair	1 (8%)	1 (17%)	2 (11%)
Poor	1 (8%)	0	1 (5%)

Table 3. Comparison of results between two-part and three-part fractures^a

^a $p > 0.05$ (chi-square) test.

[\[Help with image viewing\]](#)

[\[Email Jumpstart To Image\]](#)

Although some patients ultimately had some residual angulation, no interference with shoulder function was found. There was no neurovascular complication or nonunion.

Radiographic Evaluation

All except one patient achieved complete union of fractures. The final neck-shaft angles averaged 141 degrees with a range of 130 to 160 degrees. Further displacement after fixation was seen in only one patient who had a two-part surgical neck fracture. Although the displacement led to malunion, she regained full shoulder motion 6 months after the operation (case 15).

In the seven patients who received percutaneous pinning, there were no further displacements during the follow-up period. However, k-pin migration was noted in two cases whose k-pins were removed as soon as the radiographs showed evidence of early union.

Technically adequate fixation was defined as at least three pins or screws with wide placement in the proximal fragment and purchase of subchondral bone as much as possible. The most common technical error was placement of k-pins or screws too close together so that only a portion of the head fragment was fixed. Another technical error was insertion of a k-pin or screw at a point so near the fracture site as to result in further fragmentation of metaphysis.

In the 19 patients, all except one patient showed radiographic union at 8 to 12 weeks postoperatively. The patient who withdrew from the follow-up study

had metaphyseal comminution caused by a second trauma and had no radiographic evidence of union during the final follow-up examination.

Complication

There were no superficial or deep infections. One patient who received k-pin fixation had tenting and irritation of the skin by one of the fixation pins 8 weeks after the operation. The skin healed after pin removal. No pin or screw breakage occurred during aggressive physical therapy. None of the 19 patients had avascular necrosis during the longest follow-up.

DISCUSSION

There has been a great controversy about management of complex fractures of the proximal humerus. Many articles dealing with displaced fractures of the proximal humerus present varied opinions based on the classification of Neer. Despite lack of interobserver and intraobserver reliability as criticized by many authors, [6,7] Neer's classification bears the comprehensive advantage of prognostic implication and remains the standard. According to the recommendation of Neer, operative approaches with minimal dissection and rigid fixation have been emphasized with the objective of preservation of vascularity to the articular segment. The method of closed reduction and percutaneous fixation bears the inherent advantage of minimizing tissue destruction that, hence, preserves vascularity to the humeral head and facilitates early tissue healing. However, it is advisable to identify the actual fracture type, which fulfills the criteria for closed management. A meticulous assessment of the residual soft tissue linking the various fragments before and during operation is imperative to allow full benefit from ligamentotaxis.

The method of closed management for displaced proximal humerus fracture was proposed in 1984. [8] Results have been improving because various kinds of fixation techniques continue to evolve. Initial closed pinning techniques were proposed in the early 1990s. The goal of closed management was achieved, however, at the expense of insufficient fixation, which led to some complications and, thus, inhibited functional recovery. [9,10] In a biomechanical cadaver study for humerus surgical neck fracture, Kirschner wires provided the least resistance to displacement. [11] Schanz screws were ranked as the third best in providing stability and ultimate strength of fixation and were inferior only to two kinds of open methods. Although no cancellous screw was included in this study, full-threaded cannulated screws, which are similar in structure and diameter to 7-mm cancellous screws, can, theoretically, yield superior strength and stability to Schanz screws and may be the optimal choice in the closed pinning technique.

Although the higher portion of our patients who had two-part fractures may account for favorable results, there was no significant difference in results between the two groups (Table 3, $p > 0.05$). This procedure makes sense not only because rigid fixation was acquired but also because limited tissue dissection minimized surgical complication and facilitated early rehabilitation. Other investigators have suggested that open reduction with limited dissection and minimal fixation may reduce the prevalence of avascular necrosis. [12] However, minimal exposure can seldom be achieved without the expense of insufficient fixation that may hinder the initiation of early rehabilitation.

In this series, more than 80% of the patients had good outcomes graded according to the criteria of Neer. Despite the wide variance in operation time, which suggests a learning curve, the overall results are satisfactory. It is encouraging, especially because no later subsidence of fracture sites or avascular necrosis of head segments was noted during the longest follow-up period. Satisfactory function was achieved in most patients, although some of them showed residual angulation on radiographs. Residual angulation or minor malunion is not substantially correlated with functional results unless further displacement or collapse occurs. One of our patients had a poor result. This case was a two-part surgical neck fracture with osteoporosis, which rendered the bone susceptible to minor trauma.

In conclusion, the technique of closed reduction and percutaneous fixation is regarded as a reasonably alternative treatment modality with comparable

results in displaced proximal humerus fracture. Despite being technically demanding, satisfactory realignment and sufficient fixation can be accomplished with meticulous radiographic assessment before and during the operation. Proper placement of the k-pins facilitates later application of cannulated screw and is crucial for rigid fixation. Advertent patient selection is also imperative to achieve a successful outcome and to avoid unwanted complications. Ineligibility criteria include head-splitting fracture, fracture dislocation, and osteoporosis. Four-part fractures are also excluded because there is too much variation in the degree of fragmentation and separation to be standardized into a single reduction technique.

REFERENCES

1. Lind T, Kroner TK, Jensen J. The epidemiology of fracture of the proximal humerus. *Arch Orthop Trauma Surg.* 1989;108:285. [Bibliographic Links](#)
[Library Holdings](#) [\[Context Link\]](#)
2. Neer CS II. Displaced humeral fractures: part I. *J Bone Joint Surg Am.* 1970;52:1077. [\[Context Link\]](#)
3. Neer CS II. Displaced humeral fractures: part II. *J Bone Joint Surg Am.* 1970;52:1090. [\[Context Link\]](#)
4. Hagg O, Lundberg BJ. Aspects of prognostic factors in comminuted and dislocated proximal humerus fractures. In: Bateman JE, Welsh RP, eds. *Surgery of the Shoulder.* Philadelphia: Decker; 1984. [\[Context Link\]](#)
5. Keene JS, Huizenga RE, Engber WD, Rogers SC. Proximal humeral fractures: a correction of residual deformity with long-term function. *Orthopedics.* 1983;6:173. [\[Context Link\]](#)
6. Sidor ML, Zuckerman JD, Lyon T. Neer classification system for proximal humeral fracture: an assessment of inter-observer reliability and intra-observer reproducibility. *J Bone Joint Surg Am.* 1993;75:1745. [\[Context Link\]](#)
7. Siebenrock KA, Gerber C. The reproducibility of classification of fractures of the proximal end of the humerus. *J Bone Joint Surg Am.* 1993;75:1751. [\[Context Link\]](#)
8. Leyshon RL. Closed treatment of fractures of the proximal humerus. *Acta Orthop Scand.* 1984;55:48. [Bibliographic Links](#) [Library Holdings](#) [\[Context Link\]](#)
9. Kocialkowski A, Wallace WA. Closed percutaneous k-wire stabilization for displaced fractures of the surgical neck of the humerus. *Injury.* 1990;21:209. [Bibliographic Links](#) [Library Holdings](#) [\[Context Link\]](#)
10. Jaberg H, Warner JJP, Jakob RP. Percutaneous stabilization of unstable fractures of the humerus. *J Bone Joint Surg Am.* 1992;74:508. [Bibliographic Links](#) [Library Holdings](#) [\[Context Link\]](#)
11. Koval KJ, Blair B, Takei R, Kummer FJ, Zuckerman JD. Surgical neck fractures of the proximal humerus: a laboratory evaluation of ten fixation techniques. *J Trauma.* 1996;40:778. [Ovid Full Text](#) [Bibliographic Links](#) [Library Holdings](#) [\[Context Link\]](#)
12. Gerber C, Schneeberger AG, Vinh TS. The arterial vascularization of the humerus head. An anatomical study. *J Bone Joint Surg Am.* 1990;72:1486. [Bibliographic Links](#) [Library Holdings](#) [\[Context Link\]](#)



Wolters Kluwer | OvidSP

Images in OvidSP online help

Help Tools: | [A](#) | [A](#) | [A](#) | [Print this topic](#) | [Return to searching](#)

*Copyright © 2000-2008 Wolters Kluwer Health
Version 01.02.00*