Open fractures of the proximal humerus treated with the Ilizarov method

12 patients followed 3–8 years

Vasfi Karatosun[1], Cebrail Alekberov[1], Önder Baran[1], Erhan Serin[2], Emin Alıcı[1] and Ceyhun Balcı[3]

Department of Orthopaedics, [1]Dokuz Eylül University, School of Medicine, İzmir, [2]Fırat University, School of Medicine, Elazıg, [3]Bornova State, Emergency& Traumatology Hospital, İzmir, Turkey. E-mail: vkaratosun@superonline.com
Submitted 00-07-03. Accepted 01-10-18

ABSTRACT – We followed 12 patients who had been treated with the Ilizarov method for open proximal humeral fractures for more than 3 years. No wound infection occurred. Avascular necrosis and nonunion were each detected in 1 patient. According to Neer's criteria, the outcome was excellent or satisfactory in 8 patients.

Treatment of open and displaced fractures of proximal humeral fractures is difficult. Reports on surgical approaches have emphasized minimum exposure and appropriate fixation to preserve vascularity of the articular segment (Sturzenegger 1982, Kristiansen and Kofoed 1987,1988, Jakob et al. 1991, Jaberg et al. 1992, Ko and Yamamato 1996, Altay et al. 1999).

A review of the literature revealed only a few reports on external fixation of proximal humeral fractures (Shved and Sysenko 1984, Kristiansen and Kofoed 1987, Ko and Yamamato 1996). We report 12 patients with open fractures of the proximal humerus treated with the Ilizarov method.

Patients and methods

From 1989 to 1997, we treated 12 patients (11 men) having open fractures of the proximal humerus with immediate Ilizarov type external fixation. Their median age was 28 (17–44) years. The causes of injury were traffic accidents (5), gunshot wounds (4) and falls from a height (3) (Table). The patients were otherwise healthy, except in case 3, who had acute membranous glomerulonephritis and was being given corticosteroid treatment.

According to the Neer classification (1970), 3 patients had two-part, 6 three-part and 3 four-part open fractures of the proximal humerus. There were 4 type I, 3 type II, and 5 type III open fractures (1 IIIA, 3 IIIB and 1 IIIC) using Gustilo et al.'s (1990) classification. 1 patient (no. 7) had injured his axillary artery which was repaired with a reverse saphenous vein interposition graft during the initial surgery. 2 patients (4 and 5) had an associated nerve injury. In patient 4, a lesion of the musculocutaneous nerve was repaired initially.

In all cases, soft tissue debridement and irrigation were done in the first 24 hours. The mean interval between the trauma and application of the Ilizarov apparatus was 1.8 days (range 8 hours to 5 days).

We reviewed the patients, on average, 5 (3–8) years later. The follow-up evaluation was based on the Neer scale (1970), which gives a maximum of 35 points for pain, 30 points for function, 25 points for motion, and 10 points for reconstruction of the anatomy, the maximum being 100 points. More than 89 points is considered an excellent result; 80–89 points a satisfactory one; 70–79 points an unsatisfactory one; and less than 70 points a failure.

Treatment. Tetanus toxoid and prophylactic antibiotics including cefazolin 4 × 1 g/day and gentamicin 2 × 80 mg/day were given on admission and

Copyright © Taylor & Francis *2002. ISSN 0001–6470. Printed in Sweden – all rights reserved.*

Details of patients

A	B	C	D	E	F	G	H	I	J	K					L	M
										1	2	3	4	5		
1	41	M	Gunshot	4	IIIA		3	17	94	170	35	105	60	T12	PTI	81
2	35	M	T.A	3	IIIB		2	–	38	90	20	80	20	gluteal	non-union	25
3	44	M	T.A.	2	I		5	27	43	176	45	175	64	T6		98
4	24	M	Gunshot	3	I	n. musculocutaneus	2	19	78	155	20	125	33	L5		36
5	22	M	Gunshot	4	IIIB	n. radialis	1	28	44	144	34	130	60	T6	AVN	71
6	36	F	Fall	3	II		1	20	53	175	40	170	60	T10		87
7	21	M	Gunshot	2	IIIC	a. axillaris	0	29	75	170	50	160	65	T6	PTI	88
8	24	M	Fall	3	II	left patella fracture	1	16	38	175	45	155	45	T6		95
9	17	M	T.A.	3	IIIB	rupture of spleen	1	24	49	160	5	170	50	T9		84
10	17	M	T.A.	2	I		3	20	62	145	40	162	45	L5	PTI	71
11	33	M	Fall	3	II	left calcaneus fracture	1	18	56	176	45	170	40	T11	1.5 cm shortening	88
12	19	M	T.A.	4	I		2	20	57	180	50	175	50	T9		96

A Case
B Age
C Sex
D Etiology
  T.A. traffic accident
E Type of fracture (Neer)
F Type of fracture (Gustillo et al.)
G Associated lesion
H Preoperative period (days)
I Time to union (weeks)
J Follow-up (months)
K Range of motion
  1 Flexion
  2 Extension
  3 Abduction
  4 External rotation
  5 Internal rotation
L Complication
  PTI pin-tract infection
  AVN avascular necrosis
M Score (Neer)

continued for 7 days after surgery. Then anteroposterior and axial radiographs of the injured shoulder were taken.

After induction of general anesthesia, the patients were placed in a beach chair position with a towel beneath the back. Wound treatment included irrigation and sterile dressing. We always used closed reduction preferably with continuous longitudinal traction by an assistant, with the elbow flexed to 90 degrees, and shoulder extended in adduction type fractures, and flexed and abducted in abduction type fractures. In types II and III open fractures, direct manipulation of the fragments with a finger was also part of the reduction maneuvers. The position of the fragments was checked by radiographs and, if satisfactory, fixed temporarily with small Kirschner wires. The largest fragment was fixed with permanent 2.0 mm Kirschner wires and a half frame was applied (Figures 1 and 2). If the direction of the wires endangered the neurovascular structures, we used a unilateral frame with 2.2 mm K-wires. If the tuberculum majus was also fractured, it was fixed preferably with an olive wire, from a proximal to a distal direction, introducing the end of the wire into the medullary canal (Figures 3 and 4).

Then 1 or 2 ring frames with 2 wires in each were applied, at least 2 cm distal to the fracture lines, depending on the soft tissue injury. The rings were constructed with rods and slight compression was applied, when necessary.

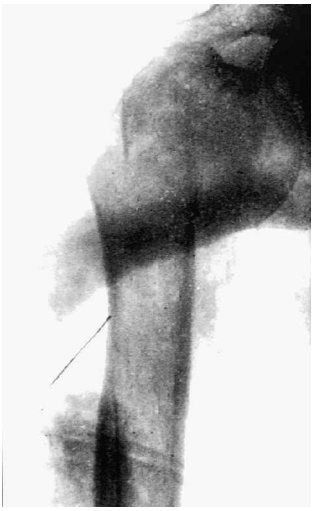
Active elbow and wrist motions were encouraged the day after surgery, and pendular shoulder exercises were permitted on the third postoperative day. Active shoulder movements were usually begun between the second and fourth postoperative weeks, depending on healing of soft tissue.

The frame was loosened and stability was checked when the radiographs showed solid union. If no pain could be elicited, the frame and wires were removed.

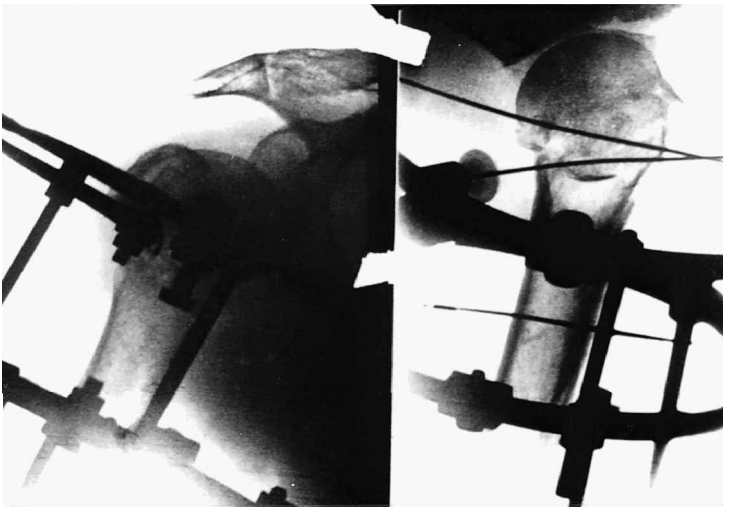
Results (Table)

The average operation took 134 (90–250) min-

Figure 1. Case 3. Two-part fracture with Gustilo Type I fracture after a traffic accident.



a. Preoperative view.



b. Frame applied, postoperative view (12 weeks).



c. Postoperative view (last follow-up).

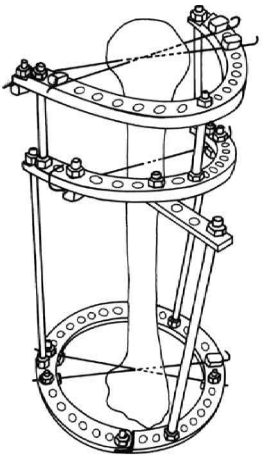


Figure 2. Line-drawing of the frame used for two-part fractures.

utes. There were no neurovascular complications caused by surgery. Mild superficial pin-tract infection occurred in 3 patients (cases 1, 7 and 10), but all resolved with local wound care and antibiotic therapy.

11 of the fractures united without further intervention after average 22 (16–29) weeks.

Avascular necrosis of the humeral head was detected in 1 patient (case 5) 10 months after the operation. This patient also had an injury to the radial nerve, but refused further treatment. Although his result was regarded as unsatisfactory at the latest follow-up, he had a painless shoulder motion, enough for his activities.

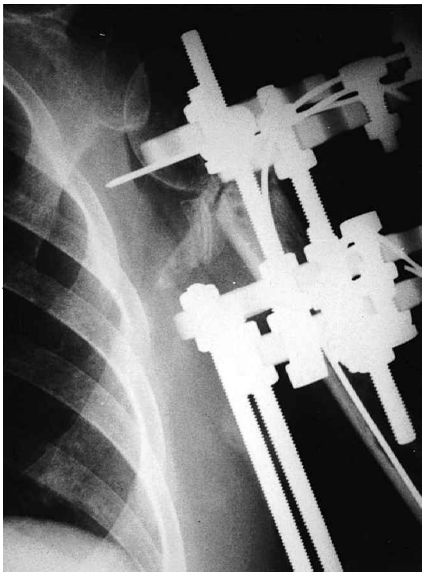
Nonunion was detected in 1 patient (case 2) and he was regarded as a failure with painful shoulder. He also refused further treatment.

The mean Neer score was 77 (25–98). There were 3 excellent, 5 satisfactory, 2 unsatisfactory results and 2 patients were failures.

Figure 3. Case 1. Four-part fracture with Gustilo Type IIIA wound.



a. Preoperative appearance.



b. Frame applied, postoperative view at 4 weeks.



c. Postoperative view (last follow-up).

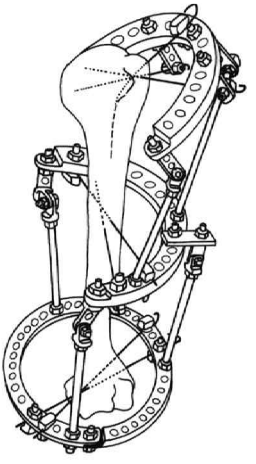


Figure 4. Computer-constructed drawing of the frame for three- or four-part fractures.

Discussion

Several reports have been published concerning external fixation of closed proximal humeral fractures using circular (Shved and Sysenko 1984) and unilateral fixators (Kristiansen and Kofoed 1987, 1988).

We found that the Ilizarov fixator provided stable fixation and adequate management of soft tissues. No wound infection occurred. Pin-tract infection, in 3 patients, resolved with local wound care and antibiotherapy. This rate of pin-tract infection is similar to that reported for closed proximal humeral fractures treated with external fixation (Kristiansen and Kofoed 1987, 1988).

One cause of avascular necrosis of the humeral head is extensive soft tissue dissection during surgery (Sturzenegger et al. 1982, Bigliani et al. 1998). Limited exposure with minimal dissection is recommended to avoid this complication (Jaberg et al. 1992, Cordasco and Bigliani 1997, Resch et al. 1997, Altay et al. 1999). In open fractures, this complication is more likely. Stabilization with

indirect reduction by means of external fixation should lower the risk, since only 1 of our patients had avascular necrosis.

One of the advantages of external fixation is that these systems, either circular or monolateral, permit early motion (Shved and Sysenko 1984, Ko and Yamamato 1996). Sometimes, transfixing of the muscles slows down postoperative mobilization which, however, can be avoided by proper pin placement (Szyszkowitz et al. 1993).

Another advantage of the Ilizarov technique is that re-reduction can be done without anesthesia which reduces the rate of malunion (Shved and Sysenko 1984). The external fixator's pins can also be removed on an outpatient basis (Kristiansen and Kofoed 1988).

Our patients were relatively young with a median age of 28 years, which was probably one reason for our good results. We conclude that open proximal fractures of the humerus can be successfully managed with the Ilizarov fixator. This technique permits good soft tissue management and surgery of associated neural injuries.

We thank Professor Cengiz Çekil and Tanzer Kantik, of the Faculty of Fine Art of Dokuz Eylül University for their help with illustrations.

No funds have been received to support this study.

Altay T, Ozturk H, Us R M, Gunal I. Four-part posterior fracture-dislocations of the shoulder. Treatment by limited open reduction and percutaneous stabilization. Arch Orthop Trauma Surg 1999; 119 (1-2): 35-8.

Bigliani L U, Flatow E L, Pollock R G. Fractures of the proximal humerus. In: The Shoulder (Eds. Rockwood CA, Matsen III FA). Vol 1. WB Saunders, Philadelphia etc. 1998: 337-89.

Cordasco F A, Bigliani L A. Complications of proximal humerus fractures. Tech Orthop 1997; 12 (2): 42-50.

Gustilo R B, Merkow R L, Templeman D. Current concept review. The management of open fractures. J Bone Joint Surg (Am) 1990; 72 (2): 299-304.

Jaberg H, Warner J P, Jakob R P. Percutaneous stabilization of unstable fractures of the humerus. J Bone Joint Surg (Am) 1992; 74 (4): 508-15.

Jakob R P, Miniaci A, Anson P S, Jaberg H, Osterwalder A, Ganz R. Four-part valgus impacted fractures of the proximal humerus. J Bone Joint Surg (Br) 1991; 73 (2): 295-8.

Ko J Y, Yamamato R. Surgical treatment of complex fracture of the proximal humerus. Clin Orthop 1996; 327: 225-37.

Kristiansen B, Kofoed H. External fixation of displaced fractures of the proximal humerus. Technique and preliminary results. J Bone Joint Surg (Br) 1987; 69 (4): 643-6.

Kristiansen B, Kofoed H. Transcutaneous reduction and external fixation of displaced fractures of the proximal humerus. A controlled clinical trial. J Bone Joint Surg (Br) 1988; 70 (5): 821-4.

Neer CS 2nd. Displaced proximal humerus fractures. Part 1. Classification and evaluation. J Bone Joint Surg (Am) 1970; 52 (6): 1077-89.

Resch H, Povacs P, Froclich R, Wambacher M. Percutaneous fixation of three- and four-part fractures of the proximal humerus. J Bone Joint Surg (Br) 1997; 79 (2): 295-300.

Shved S I, Sysenko I M. Treatment of fractures of the proximal end of the humerus in middle-aged and elderly patients by Ilizarov method. Vestn Khir 1984; 132 (5): 80-2. (In Russian).

Sturzenegger M, Fornaro E, Jakob R P. Results of surgical treatment of multifragmented fractures of the humeral head. Arch Orthop Trauma Surg 1982; 100 (4): 249-59.

Szyszkowitz R, Seggl W, Schleifer P, Cundy P J. Proximal humeral fractures. Management techniques and expected results. Clin Orthop 1993; 292: 13-25.