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L. Eralp · M. Kocaoglu · C. Sar · A.C. Atalar

Surgical treatment of distal intraarticular humeral fractures in adults

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Abstract We reviewed 17 patients with distal intraarticular humeral type C fractures, treated by open reduction and internal fixation, followed by an early rehabilitation programme. The results, as judged by the criteria of Jupiter, were excellent in ten, good in five and fair in two. Non-union of the olecranon osteotomy occurred in one patient.

Résumé Nous avons revu 17 patients âgés en moyenne de 30 (19–71) ans traités pour fracture intraarticulaire de l'humérus distal. Tout avaient eu une réduction ouverte et une fixation interne dans les 48 h du traumatisme, suivies par un programme de rééducation précoce. Le délai moyen de suivi était de 35 (14–107) mois. Les résultats étaient excellents pour dix patients, bon pour cinq et médiocre pour deux en utilisant les critères de Jupiter. Il y eu un cas de pseudarthrose de l'ostéotomie olécranienne.

Introduction

Intraarticular fractures of the distal humerus comprise 1% of all fractures in adults. There is a high incidence of complications following the surgical treatment of these fractures. As it is an uncommon fracture, standard surgical treatment and protocols have not been developed. The results following various forms of treatment including immobilisation in a sling, functional splints, external and internal fixation have been reported [3, 7, 9]. The complications of treatment include non-union, malunion, decreased range of movement, instability, posttraumatic osteoarthritis of the elbow, heterotopic ossification, neuropraxia and avascular necrosis [1, 4]. A better understanding of the anatomy of the distal humerus with a description of the medial and the lateral columns which support the articular surface has recently led to a refinement of the surgical technique, with internal fixation which allows early rehabilitation [5].

In this study we evaluated the outcome after treating these difficult fractures with this technique.

L. Eralp (✉) · M. Kocaoglu · C. Sar · A.C. Atalar
Istanbul University, Istanbul School of Medicine,
Department of Orthopaedics and Traumatology,
34390 Çapa-Istanbul, Turkey
e-mail: yeralp@hotmail.com
Tel.: +90-212-6351235, Fax: +90-212-6352835

Patients and methods

Seventeen patients with intraarticular fractures of the distal humerus were treated with open reduction and internal fixation between December 1989 and June 1998. Their records were analysed retrospectively. The mean age of the patients was 30.8 (19–77) years and the mean follow-up was 35.1 (14–107) months. The mechanism of injury in all cases was direct trauma to the elbow. Surgical treatment was performed within 48 h of injury.

All patients had closed fractures and according to the AO classification system five patients were type C1, five type C2 and seven type C3. The dominant extremity (the right side) was involved in 11 patients. Associated injuries in five patients included chest injuries, radial and ulnar neurapraxia and forearm fractures (Table 1).

Surgical technique Reconstruction plates, cannulated screws, the Herbert screw system and circular external fixators were available. The iliac area was prepared in case bone graft was required. Under general anaesthetic, with a tourniquet, the patient was placed in the lateral decubitus or prone position with the elbow flexed to 90°. A longitudinal posterior skin incision was used and the ulnar nerve was exposed. The articular surface of the distal humerus was exposed either via a transverse intraarticular, or more recently a chevron type extraarticular olecranon osteotomy. The major fragments were reduced as anatomically as possible and held with K-wires, with particular attention being paid to the exact restoration of the joint surface. Fixation of the transverse column was then performed with a cannulated screw. Fragments involving the articular surface were fixed with Herbert screws, applied from the chondral surface. Osteosynthesis of the medial and lateral columns was then performed using two reconstruction plates. Iliac bone graft was added in cases with significant bone loss or comminution [7]. Osteosynthesis of the olecranon osteotomy was performed with K-wires and a tension band, and the ulnar nerve was transposed anteriorly. A long-arm POP cast was applied with the elbow flexed at 90° and the forearm in neutral rotation. Mobilisation started between 3 and 5 days postoperatively, with active and active assisted movements for flexion, extension, pronation and supination. It is difficult to regain full extension of the elbow after this injury and we encouraged our patients to rest the upper limb

Table 1 Overview of clinical data

Case	Sex, age (years)	Time from injury to surgery (h)	Injured limb	Müller et al. classification	Internal fixation	Duration of follow-up (months)	Loss of extension (deg)	Flexion (deg)	Pain	Functional result after Jupiter et al.	Remarks
1	M, 19	2	R	C1	1 reconstruction plate, 2 4.5 mm cannulated screws	32	10	135	None	Excellent	Contralateral forearm fracture
2	M, 23	24	R	C1	1 reconstruction plate, 2 4.5 mm cannulated screws	43	14	145	None	Excellent	
3	F, 25	4	R	C1	1 reconstruction plate, 2 4.5 mm cannulated screws	19	20	125	Slight	Good	
4	M, 22	6	L	C1	2 reconstruction plates, 1 4.5 mm cannulated screw	25	5	132	None	Excellent	
5	F, 53	12	R	C1	2 reconstruction plates, 1 4.5 mm cannulated screw	22	7	135	None	Excellent	
6	M, 35	14	R	C2	2 reconstruction plates, 1 4.5 mm cannulated screw	27	15	130	None	Excellent	
7	M, 26	22	L	C2	2 reconstruction plates, 2 4.5 mm cannulated screws	107	20	123	Slight	Good	
8	M, 25	8	L	C2	2 reconstruction plates, 2 4.5 mm cannulated screws, 1 Herbert screw	19	25.5	120	Slight	Good	Preoperative ulnar nerve neuropraxia
9	M, 35	14	R	C2	2 reconstruction plates, 2 4.5 mm cannulated screws	23	15	133	None	Excellent	
10	F, 71	16	R	C2	2 reconstruction plates, 2 4.5 mm cannulated screws, 1 Herbert screw	53	15	130	None	Excellent	
11	F, 25	10	L	C3	2 reconstruction plates, 2 4.5 mm cannulated screws, 1 Herbert screw	14	39	90	With activity	Fair	Nonunion at the olecranon osteotomy site
12	M, 22	28	R	C3	2 reconstruction plates, 2 4.5 mm cannulated screws, 1 Herbert screw	37	15	131	None	Excellent	Initial thoracic trauma
13	M, 43	5	L	C3	2 reconstruction plates, 2 4.5 mm cannulated screws, 2 Herbert screws	32	29	123	Slight	Good	Transient postoperative ulnar nerve neuropraxia
14	M, 23	33	R	C3	2 reconstruction plates, 2 4.5 mm cannulated screws, 2 malleol screws	29	39	90	With activity	Fair	Preoperative ulnar nerve neuropraxia
15	F, 31	28	R	C3	2 reconstruction plates, 3 4.5 mm cannulated screws	48	28	121.5	Slight	Good	Preoperative ulnar and radial nerve neuropraxia
16	M, 24	40	L	C3	2 reconstruction plates, 2 4.5 mm cannulated screws, 1 Herbert screw	32	15	132	None	Excellent	
17	M, 22	42	R	C3	2 reconstruction plates, 3 4.5 mm cannulated screws	35	15	135	None	Excellent	

with the elbow in extension during the night; and the limb was rested in flexion splints immediately after physiotherapy to maintain the achieved range of elbow flexion. After the 6th week, resisted exercises were started and normal daily activities resumed. Strenuous physical exercise was only allowed after radiological evidence of union.

Results

The clinical results were graded according to the criteria of Jupiter, which reflect range of movement, pain and function [7]. Assessment for function included aspects of daily activities such as combing the hair, eating, washing and dressing; and revealed excellent results in ten patients, good results in five and fair results in two. In the C1 fracture type group, four patients achieved excellent, and one patient good results. In the C2 fracture type group, three patients achieved excellent and two patients good results. In the C3 fracture type group, three patients achieved excellent, three patients good and two patients fair results. An independent evaluation of range of movement revealed a mean loss of extension of 19.8° (5–39°) and a mean range of flexion of 125.3° (90–145°). The mean loss of extension was 13.2°, 18.1° and 25.7° in fracture type groups C1, C2 and C3, respectively. The mean ranges of flexion in the same groups were: 134.4°, 127.2° and 117.5°, respectively (Table 1).

Non-union of the olecranon osteotomy was encountered in the 10th postoperative week in one patient who had had a transverse osteotomy. There was pain on active extension without interference of daily activities. Union was achieved after revision of osteosynthesis with bone grafting. The clinical evaluation of this patient was graded as fair. Transient ulnar nerve palsy which recovered completely within 6 weeks of surgery was seen in another patient. Complications such as delayed wound healing, infection, post-traumatic degenerative change, instability or heterotopic ossification were not seen.

Discussion

The appropriate management of intraarticular fractures of the distal humerus is controversial, with unsatisfactory results reported with both conservative and surgical treatment [3, 5, 6, 7, 8]. Watson-Jones [11] wrote, about four decades ago, that the major problem was the inability to restore movement despite anatomical reduction of the fracture. The surgical treatment of fractures of the distal humerus is associated with considerable technical problems relating to adequate exposure of the fracture which is often very extensive, and osteosynthesis of comminuted fragments; the bone in this region of the humerus is very weak and the neurovascular structures are within the surgical field [5]. Good results have been obtained only after exact anatomical definition of the fractures. The understanding of the importance of satisfactory reconstruction of the medial and lateral columns has led to improved osteosynthesis [2, 7]. Recent studies have emphasised the importance of surgical approach, rigid fixation and early rehabilitation [4, 5, 8, 10], giving satisfactory results in 65–100% of cases [5, 8, 9]. The most recent studies have shown that the articular surface should be fully exposed via an olecranon osteotomy [5, 7], allowing anatomical reconstruction. The reported rate of complications related to the olecranon osteotomy is 3% [7]. We have obtained excellent exposure with this method, and non-union was seen in only one patient (5.9%), and we believe that non-union in this case was related to the transverse osteotomy. We now prefer a chevron type osteotomy which creates increased bony contact and improved rotational stability.

Improvements in fixation techniques have led to better functional results. Osteosynthesis with reconstruction plates, which are adapted to the bony configuration of the distal humerus, is recommended in order to ensure satisfactory reconstruction of the medial and lateral columns [5]; and fixation of osteochondral fragments with Herbert screws or cannulated screws introduced over temporarily stabilising K-wires improves the stability of the reconstruction. Two reconstruction plates were used in most of our cases. Herbert screws (3 cases) and cannulated screws (12 cases) were used when required to obtain precise anatomical reduction with associated stability. Adequate fixation using this combination has previously been described [5, 7]. Appropriate rehabilitation is essential to obtaining good results. Long periods of immobilisation have been a major factor in causing unsatisfactory results [2]. In series reporting good results, the importance of early rehabilitation is emphasised [5, 8]. We have been able to restore a good range of movement by starting the rehabilitation programme on the 2nd postoperative day (Figs. 1, 2, 3). Helfet and Schmeling have reported a satisfactory outcome in 15 of 17 patients who had been compliant and completed the rehabilitation programme [5]. Pre- and postoperative neurological complications, particularly involving the ulnar nerve, have been reported [2, 5, 6]. All preoperative neurapraxias in our series were seen in association with type C2 and C3 fractures with considerable comminution after a high velocity injury. Exact documentation of preoperative nerve function and intraoperative exposure of the injured nerves is important. Postoperative ulnar neuropraxia, as was seen in one of our cases, may occur [3, 5, 6, 7, 9, 10]. We believe that anterior transposition should be performed in all cases to protect the nerve, particularly from the medial distal humeral plate. We did not encounter other previously reported complications such as ectopic ossification and delayed wound healing.

In conclusion, open reduction and stable osteosynthesis with early rehabilitation will give good results in patients with type C intraarticular fractures of the distal humerus.

Fig. 1a,b AO type C2 distal humerus fracture in a 21-year-old male patient

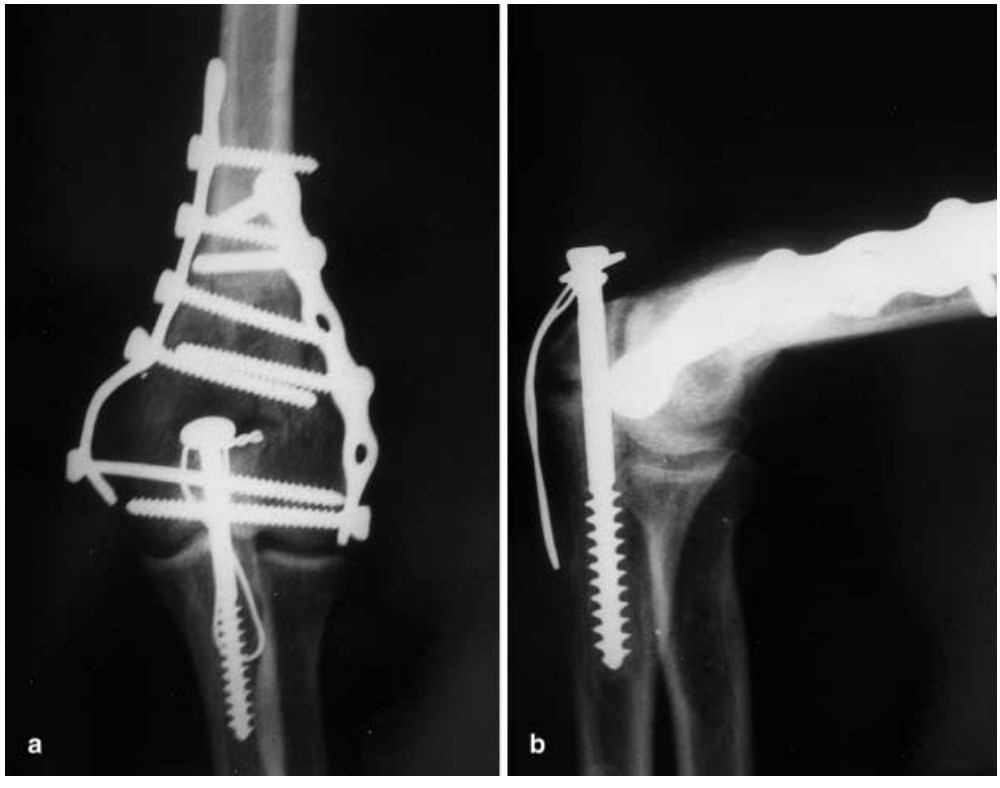

Fig. 2a,b Postoperative radiological result showing complete union of the fracture and olecranon osteotomy site after 8 months

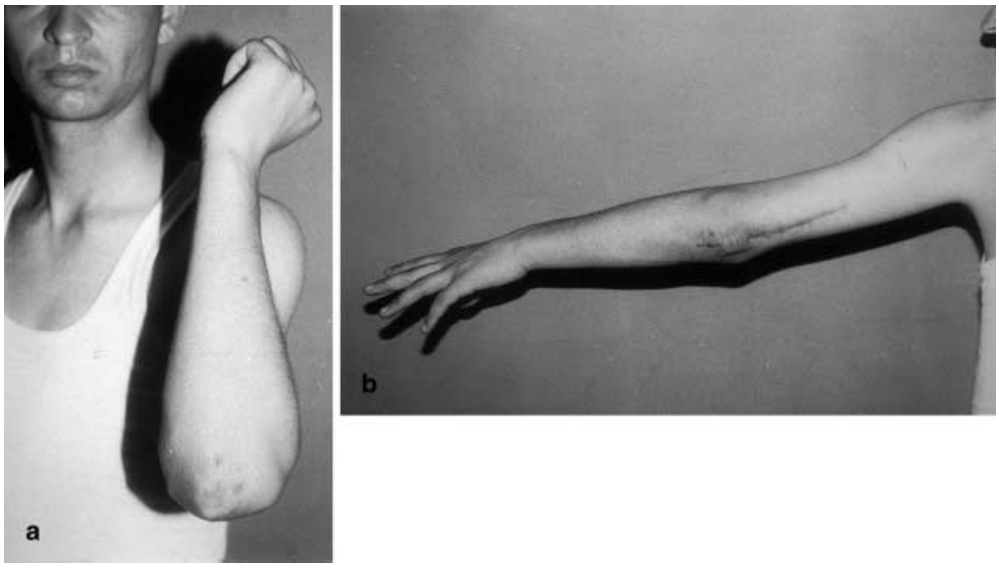

Fig. 3a,b Excellent functional result of the same patient as in Figs. 1 and 2 at the end of the 24th month

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