



## Fracture-dislocation of the humeral condyles in adults : results of surgical treatment

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**Fracture-dislocation of the humeral condyle is exceptional in adults. The purpose was to analyze the results of surgical treatment by open reduction and internal fixation without ligamentous repair. There were six men with an average age of 31 years. According to the AO classification, five fractures were classified as AO type B1 and one as B2. Dislocation was reduced in emergency before osteosynthesis. Post-operatively, the joint was held immobile with a brace for 25.40 days. Five patients were reviewed after a mean follow-up of 52.96 months. The median arc of flexion/extension was 104.80° and 157.8° for pronation-supination. All elbows were stable and all fractures were consolidated. Two elbows were painful. The results were satisfactory in five patients. The elbow stability can be ensured only by the synthesis of bone structures. Surgical treatment should restore exact anatomy between the condyle and trochlea. This protocol may provide a joint stability and satisfactory results.**

**Keywords :** unicondylar fractures ; elbow ; dislocation ; distal humerus ; adults.

### INTRODUCTION

The traumatic elbow dislocations, whether isolated (without associated fractures) or associated with intra-articular fractures are well studied in literature (9,10,20). The complex elbow dislocations

were usually associated with fractures of the radial head, coronoid process or both (1,9,10,14,19,20,24). These lesions have both ligamentous and bony injuries. They are difficult to treat. The management of these injuries was to reduce the dislocation, synthesis of fractures and ligamentous repair (24). For others, the joint stability can only be ensured by repairing the fractured bone elements (10). However, fractures of the humeral condyle associated with elbow dislocation in adults are exceptional. Publications on this subject are rare (8,11,21). The mechanism of injury was well elucidated by Milch (21). This author has shown the importance of the integrity of the lateral wall of the trochlea in the occurrence of these lesions. Based on this data, we hypothesized that the stability of the elbow can be ensured only by the synthesis of bone structures, ensuring the recovery of the anatomical relationship

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between capitulum and trochlea. The main objective of this study was to evaluate the results of open reduction and internal fixation without ligamentous repair and, performed after urgent closed repositioning of the dislocated elbow, its influence on the stability of the joint and also to study frequency, mechanism of occurrence and therapeutic modalities of this lesion.

## MATERIALS AND METHODS

### Patient selection

This is a single-site retrospective study with prospective clinical review on six fracture-dislocations of the humeral condyles (unicondylar fractures of the distal humerus associated with elbow dislocation) (Fig. 1). There were six men with an average age of 31 years (range 21-43). These lesions were collected in a set of 179 consecutive fractures of the distal humerus in adult patients treated in our department between January 1st, 2000 and December 31, 2008. The inclusion criteria were a recent fracture-dislocation of the humeral condyles, isolated or not, non-pathological, in patients whose age exceeded 15 years and treated surgically at our institution. All patients were invited to return for clinical and radiological assessment. Subjective assessment of outcome was sought; we asked patients to rate their own results. It was considered satisfactory for the positive responses and unsatisfactory as otherwise. The institutional review board approved the protocol study. Five patients were reviewed at mean follow-up of  $52.96 \pm 12.15$  months (range 42.23-72.90). One patient was lost to follow-up.



**Fig. 1.**— Patient 2. (A, B). Pre-operative X-rays showing Fracture-dislocation of the humeral condyles (AO-Type-B1.3/Postero-lateral elbow dislocation). (C, D) Postoperative radiographs.

### Patients Characteristics (Table I)

The left arm was involved in six patients and was not dominant in any of them. The mechanism of injury was a high-energy trauma in 6 cases: one patient was injured in

Table I. — patients characteristics

Case	Age (Years)	Sex	Injured limb	Mechanism of injury	Fracture type	Dislocation type	Associated fractures	Fracture-associated injuries
1	25	M	Left	Traffic accident	B 2.2	Trans-olecranon	Olecranon	Open fracture
2	43	M	Left	Fall from elevated height	B 1.3	Postero-lateral	—	—
3	40	M	Left	Traffic accident	B 1.1	Postero-lateral	coronoid process type II	—
4	21	M	Left	Sport trauma	B 1.2	Posterior	—	—
5	27	M	Left	Traffic accident	B 1.3	Lateral	Olecranon	Fracture of the tibial tubercle
6	30	M	Left	Fall from a standing height	B 1.2	Lateral	—	—

a fall from an elevated height ; three patients were in a car accident and one was in sport trauma. One patient was injured in a fall from a standing height by direct shock on a flexed elbow. Associated bone lesions of the ipsilateral limb were noted in three patients : olecranon fracture in two cases and fracture of the coronoid process in another. No vessel or nerve injury was noted at diagnosis.

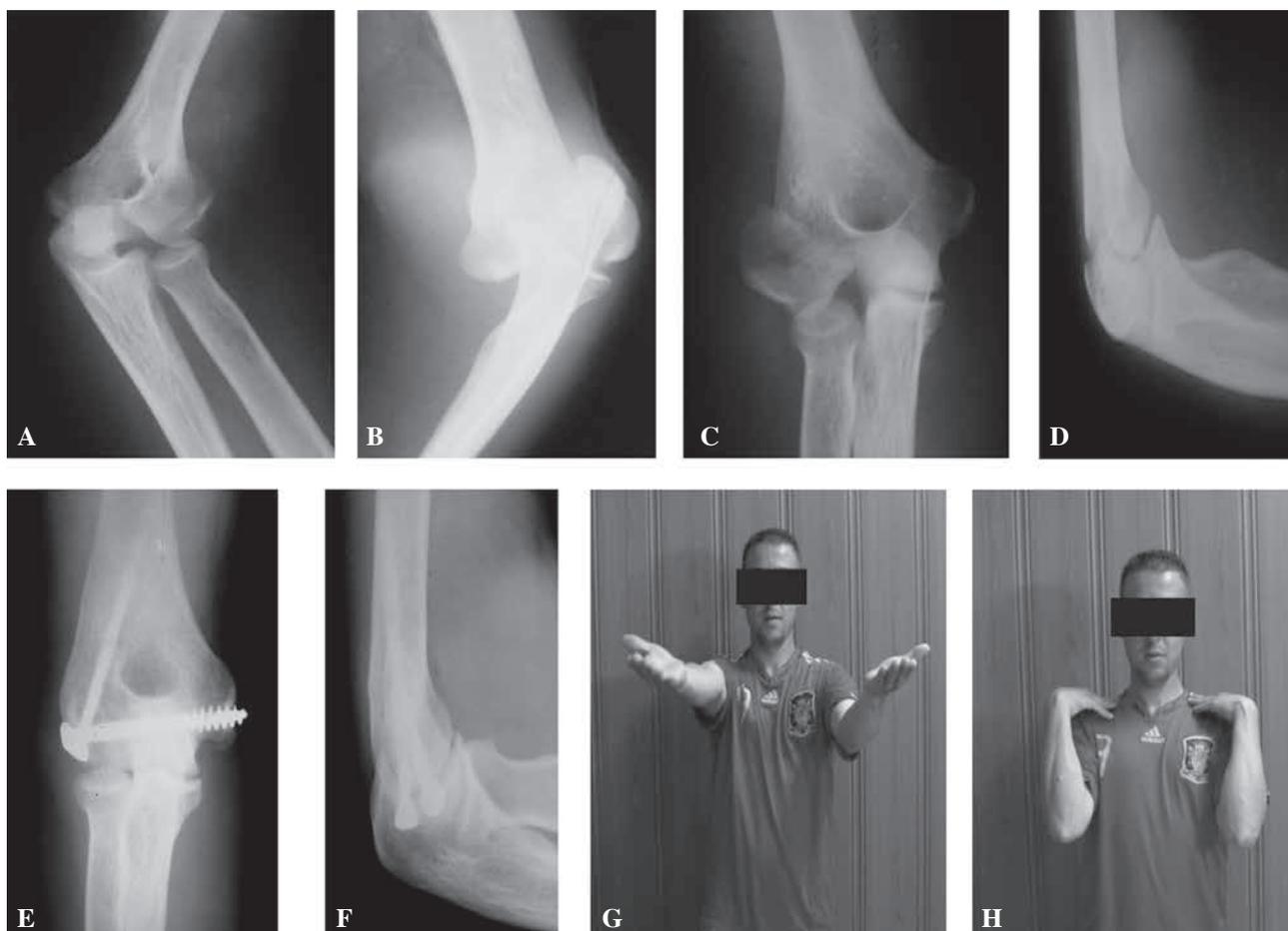
### Classifications of injury

On the basis of plain radiographs and operative finding, according to the AO/ASIF system (23). (Arbeitsgemeinschaft Für Osteosynthesefragen/Association for the Study of Internal Fixation), two fractures were classified as AO type B1.3. (Communitated fractures). Two as B1.2. One as B1.1 and one as B2.2. We distinguished four patterns of elbow dislocations, Postero-lateral (one

case) ; lateral (three cases) ; posterior (one case) ; trans-olecranon (one case). The elbow dislocation was associated with fracture of the lateral condyle in 5 cases, and the medial condyle in only one case. Open fracture (one case) was classified by reference to Gustilo & Anderson classification (12) and that of Regan & Morrey (25) for fracture of the coronoid processes.

### Treatment

Elbow dislocations were reduced under general anesthesia and immobilized in a posterior plaster splint. The osteosynthesis was performed secondarily except for the open lesion. The average time from injury to operation was  $3.83 \pm 5.26$  days (0-14). Locoregional anesthesia was used in five patients. All interventions were carried out under pneumatic tourniquet. All fractures were stabilized with open reduction and internal fixation (ORIF)



**Fig. 2.** — Patient 4. Pre-operative X-rays (A, B), after closed reduction (C, D), showing the elbow fracture-dislocation (AO-Type- B1.2/ posterior elbow dislocation). (E-H). Results at 4.57 year follow-up.

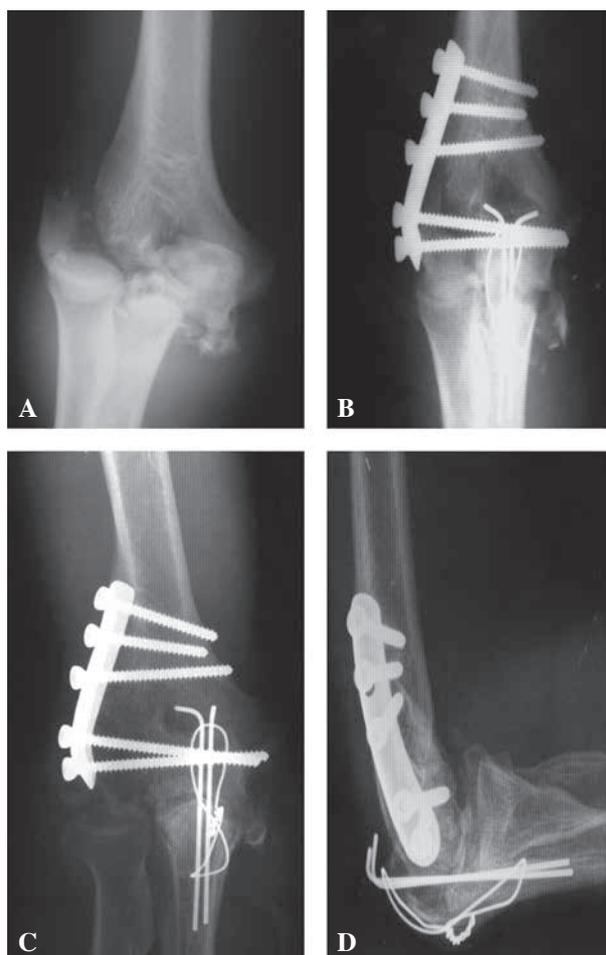
without repair of the medial collateral ligament (MCL). We used the lateral approach to expose isolated unicondylar fractures in 4 cases. The patient was in supine position with the arm supported on a hand-table. The skin incision was vertical, it begins three fingers above the lateral epicondyle, and we pass between the vastus lateralis posteriorly, the brachioradialis and extensor carpi radialis anteriorly. The capsule is incised vertically and the capitulum, and lateral aspect of the trochlea is exposed. In two patients with complex elbow fracture-dislocation and associated olecranon fracture, the distal part of the humerus was approached through an olecranon fracture. Patients were placed in a lateral decubitus position and the arm resting on a support. Temporary fixation was performed with smooth K-wires after dissection and protection of the ulnar nerve. The definitive fixation varied according to the fracture type. This was achieved by screws in 4 cases (cancellous and 4.5-mm cortical screw for fixation of the unicondylar fractures without comminution) (Fig. 2E). The comminuted condylar fractures classified as B1.3 (2 cases) or B2.2 were stabilized by three cortical screws (3.5 mm) (Fig. 1C), K-wires, or precontoured plate (Fig. 3B). Fracture of the coronoid process classified as type II according to Regan & Morrey (25) was stabilized by K-wire. Olecranon fractures were stabilized by two parallel K-wires and figure-of-eight tension band wiring. One fracture-dislocation was open and classified as grade 2, according to Gustilo & Anderson classification (12). Treatment consisted in stabilizing the elbow by K-wires, achieved after irrigation and debridement of the wound. Antibiotic treatment was also established for this lesion.

### Postoperative management

Postoperatively, the elbow joint was held immobile with a brace. The average postoperative immobilization was  $25.40 \pm 9.76$  days (15-40). Functional rehabilitation of the elbow has been followed by three patients ; the others were content to self-rehabilitation. All patients with close injury were followed-up weekly in the first month after surgery. The material was removed for two patients after bone healing.

### Evaluation

Clinical outcome was studied using the Mayo Elbow Performance Index (MEPI) (22). This score looks at the several criteria for the function of the elbow : pain, stability and possibility of habitual gestures of daily life (Table II). We have grouped the excellent and good



**Fig. 3.** — Patient 5. lateral elbow dislocation with fracture of lateral humeral condyle (AO-Type-B1.3). (A). Pre-operative X-rays. (B). Postoperative radiographs. (C-D). Results at 4.17-year follow-up.

results in satisfactory results, the fair and poor results in unsatisfactory results. A subjective assessment of patient satisfaction was graded as satisfied or unsatisfied. Bone healing, secondary osteoarthritis and heterotopic ossification were assessed on plain X-rays. Heterotopic ossifications were graded using the classification of Kundel (16) ; Grade 1 : isolated patches ; Grade 2 : confluent streaks ; Grade 3 : fusion. Posttraumatic osteoarthritis was classified according to the system of Broberg & Morrey (4), which ranks results in four stages of increasing severity. Grade zero, normal elbow joint, grade one, slight joints-space narrowing with minimum osteophyte formation ; grade two, moderate joint-space narrowing with moderate osteophyte formation and grade 3 ; severe degenerative change with gross destruction of the joint.

Table II. — Mayo Elbow Performance Score (MEPS)

Function	Points	Definition	Points
Pain	45	None	45
		Mild	30
		Moderate	15
		Severe	0
Motion	20	Arc > 100°	20
		Arc > 50-100°	15
		Arc > 50°	5
Stability	10	Stable	10
		Moderate instability	5
		Gross instability	0
Function	25	Comb hair	5
		Feed	5
		perform hygiene	5
		Done shirt	5
		Done shoe	5
Total	100		

### RESULTS (TABLE III)

In a set of 179 fractures of the distal end of the humerus collected over a period of 9 years (January 2000 to December 2008), unicondylar fractures of the distal humerus associated with elbow dislocation accounted for 3.35% with a male predominance. Our patients were young ; the average age at the time of the accident was 31 years (21-43). Three (50%) were aged less than 30 years.

### Clinical and radiological results

Five were reviewed after a mean follow-up of  $52.96 \pm 12.15$  months (range 42.23 to 72.90 months). The mean arc of flexion/extension was  $104.80^\circ \pm 18.68^\circ$  (range  $80^\circ$ - $128^\circ$ ). Mean flexion was  $131.60^\circ \pm 7.79^\circ$  ( $124^\circ$ - $140^\circ$ ) and mean extension deficit was  $-26.80^\circ \pm 12.53^\circ$  ( $-12^\circ$ - $46^\circ$ ). The pronation range was  $73.00^\circ \pm 16.80^\circ$  ( $45^\circ$ - $85^\circ$ ), and the average supination was  $84.80^\circ \pm 11.62^\circ$  ( $64.00^\circ$ - $90^\circ$ ). The average MEPI score was  $92 \pm 9.08$  points (80-100). The results were satisfactory in all patients (4 excellent and 1 good). Two patients had mild pain ; these did not require medication. All elbows were stable. One patient was dissatisfied. All fractures were healed. One patient had osteonecrosis of the lateral condyle. According to the scale of Broberg & Morrey (4), for assessment of the post-traumatic arthritis, two patients exhibited moderate joint impingement (Grade 2). Ossifications were noted in two patients classified as stage I and II respectively according to the classification of Kundel (16).

### Complications

Complications were noted in only one patient (a surgical site infection and stiff elbow), who was admitted with an open fracture-dislocation (grade 2), according to Gustilo & Anderson classification (12) necessitating surgical debridement and irrigation with intravenous antibiotics. Removal of the

Table III. — Results of the study

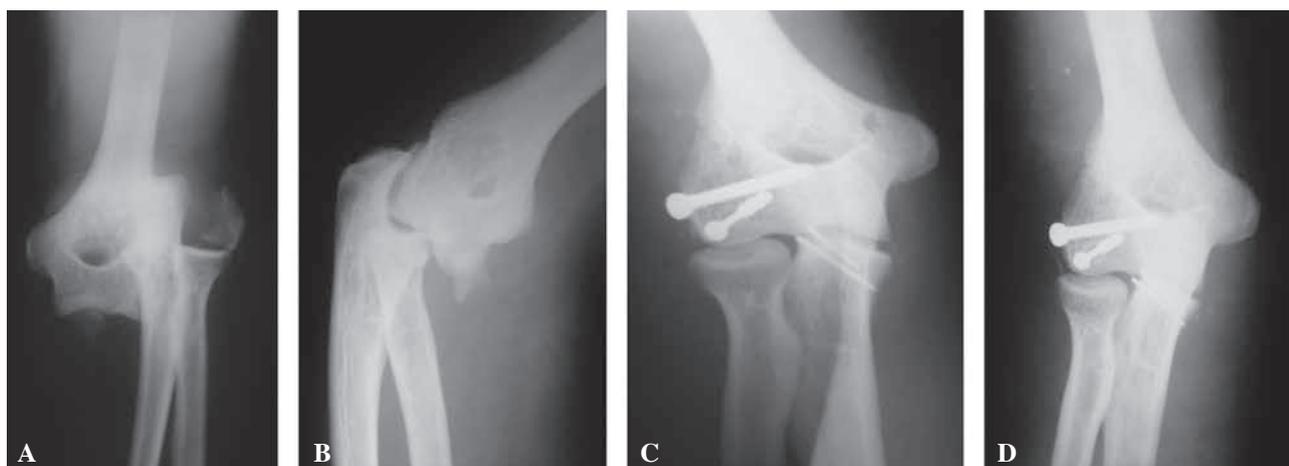
Case	Age (years)	Sex	Fracture Type	Dislocation Type	Day of Surgery	Surgical Approach	Osteosynthesis	Follow-up (Month)	Flexion Arc°	Pronation /Supination	Pain	MEPI	Subjective Results
1	25	M	B 2.2	Trans-olecranon	0	Trans-olecranon	K-Wire	72.90	128	70/64	None	Excellent	Satisfied
2	43	M	B 1.3	Postero-lateral	5	Lateral	Screw	44.80	100	85/90	Mild	Good	Satisfied
3	40	M	B 1.1	Postero-lateral	1	Lateral	Screw & Kwire	-	-	-	-	-	-
4	21	M	B 1.2	Posterior	2	Lateral	Screw	54.80	118	80/90	None	Excellent	Satisfied
5	27	M	B 1,3	Lateral	14	Trans-olecranon	Lateral plate	50.07	80	45/90	None	Excellent	Satisfied
6	30	M	B 1.2	Lateral	1	Lateral	K-Wire	42,33	98	85/90	Mild	Excellent	Unsatisfied

material, arthrolysis and a skin graft were performed after radiographic assessment of consolidation of the fracture. At the last follow-up, the functional result was graded as excellent.

## DISCUSSION

The complex elbow dislocation can be recognized by the association of elbow dislocation and intra-articular fractures of the proximal end of one of the two bones of the forearm as the radial head or coronoid process. The lesions usually associated with elbow dislocations are represented by fractures of the radial head, coronoid process, and olecranon (24). These varieties of lesions are well studied in the literature (10,14,24,7). However, fracture-dislocation of the humeral condyle is frequent in pediatric trauma (3,6). Publications in adults are rare (8,11,21) even in large published series (17,26). On a set of 503 fractures of the distal humerus collected during the round table SOFCOT (17), the authors do not mention this lesion. The annual incidence of complex elbow dislocations in children and adults is 1.6 per 100,000 (13). In the current series, fracture-dislocations of the humeral condyles represent 3.35 %, of all fractures of the distal humerus in adults, which is in agreement with literature data (11,26). The lesion involved more frequently the lateral condyle than the medial condyle (21,26). Isolated fracture of the medial condyle of the humerus associated with elbow dislocation is rare in adults. Such associations have not been reported in adult patients. Only one case was found in the literature (11). This was an anterior dislocation of the medial condyle associated with an intercondylar humerus fracture classified as AO-Type-C1. We also found a majority of left elbows affected against the right side. These same findings were reported in the literature (9,13). The cause of preponderance of the non dominant side is unknown, but it could be the results of the unconscious protection of the dominant arm during a fall (18). The type of dislocation varies with the mechanism of injury. Most frequently it follows from a fall on an outstretched hand with the elbow in extension and abduction. The combination of valgus, supination, and axial forces applied to the elbow would be responsible for

the occurrence of dislocation resulting in a posterior displacement of the olecranon against the humerus. In complete dislocations, the critical lesion must involve the MCL (24). The high-energy trauma was dominant in our series, with a young and male population. The occurrence of this lesion only in men is probably the result of high energy trauma. In four patients, the mechanism of injury was an indirect shock by a fall of a variable height onto the hand. Associated lesions of the ipsilateral elbow were noted in three patients. This type of injury reflects the violence of the trauma, it is probably the result of the combination of two opposing forces, and the most important was directly applied to the posterior elbow. This explains the frequency of associated lesions (50%) and skin lesions (16.66%). The mechanism of fractures and fracture dislocations of humeral condyles was elucidated by Milch (21). It appears that the integrity of the lateral wall of the trochlea is of critical importance. In isolated fractures, the lateral wall of the trochlea remains attached to the distal humerus and prevents the onset of elbow dislocation. On the other hand, in the fracture-dislocation of each humeral condyle, the lateral wall of the trochlea is part of the fracture fragment. In the present study, the lateral wall of the trochlea was not included in the fractured fragment in only one case (Fig. 4A). The dislocation is probably due to the combination of the fracture of the coronoid process. The treatment of simple elbow dislocations is performed under anesthesia by close reduction (1,7,9,10,14,19,20,24). In isolated fractures of the distal humerus, restoring proper function of the elbow is only possible by ORIF (2,11,15). However, fractures of the distal humerus associated with elbow dislocation are more difficult to reduce and require more extensive exposure (11). The intact bony surface is the primary constraint for stability along with the anterior band of the MCL and the ulnar half of the lateral collateral ligament (LCL) (24). However, opinions remain controversial in the treatment of common forms of elbow fracture-dislocations. In this lesion further stabilization with ligamentous repair, reconstruction, and fracture fixation can lead to satisfactory results (24). For others, this attitude is not necessary in fracture-dislocations of the elbow with associated intra-



**Fig. 4.** — Patient 3. Fracture-dislocation of the humeral condyle (AO-Type-B1.1 and fracture of the coronoid process/Postero-lateral elbow dislocation). (A, B). Pre-operative radiographs ; (C). After surgery. (D). Radiographs at 12-month follow-up.

articular fractures, provided that the articular fractures and the LCL are repaired or reconstructed (10,21). In our unit, all closed fracture-dislocations of the humeral condyles were reduced under general anesthesia in emergency before being operated on secondarily. Initial radiographs are often difficult to interpret, for on the other hand, those made after reduction allow better diagnostic approach. The surgical approach was dictated by the type of lesion. Surgical treatment consisted of stabilization of the fracture by ORIF via a lateral approach in simple fracture-dislocations or trans-olecranon approach in complex fractures without repair of the MCL. Some authors recommend this approach (7,10). The reconstruction of the MCL is unnecessary in the treatment of dislocation of the elbow with associated intra-articular fractures (10). Reconstruction of the fractures of the humeral condyles can be achieved through postero-medial approach (2) or trans-olecranon approach (15). For our part, the trans-olecranon approach was used in the presence of an associated fracture of the olecranon. Our surgical management has been summarized in bone synthesis restoring the relationship between the condyle and the trochlea and postoperative immobilization by a splint. Our results are consistent with the only previously published case (8). At the final examination, all lesions were stable. We found many complications such as extension deficit, posttraumatic osteoarthritis, osteonecrosis of the lateral condyle and hetero-

topic ossification, especially in complex fracture dislocation (AO-Type-B1.3 with olecranon fractures). These results are consistent with the very few other studies of fracture-dislocation of the humeral condyle in adults. They are less favorable in the complex elbow fracture-dislocations (5,24,25). Good results are seen in isolated dislocations of the elbow (7,9,24). The limitation of this study is that it is a retrospective study and the small number of patients does not allow conclusions about the results. However, it should be considered that this association is extremely unusual in adult patients and to our knowledge has not been reported. In addition, patients were evaluated by methods of validated objective and subjective assessments. In conclusion, this paper extends the existing literature on complex elbow fracture-dislocation in adults ; these complex shapes, usually associate with elbow dislocation a fracture of the lateral condyle. The mechanism of injury can be indirect shock by a fall onto the hand in most cases or direct shock on a flexed elbow. The results depend on associated injuries, stable internal fixation and early rehabilitation. Extension deficit, posttraumatic osteoarthritis, heterotopic ossifications, and osteonecrosis of the condyle are the most common complications. The management must be preceded by a closed reduction. Surgical treatment should restore exact anatomy between condyle and trochlea by ORIF through the lateral or transolecranon approach according to associated fractures.

This treatment may provide joint stability and proper elbow function.

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