Comparative Study of Simple and Complex Open Elbow Dislocations

Jorge G. Boretto MD, Mario Rodriguez Sammartino MD,
Gerardo Gallucci MD, Pablo De Carli MD,
David Ring MD, PhD

Published online: 11 February 2014
© The Association of Bone and Joint Surgeons® 2014

Abstract

Background Open elbow dislocations are rare injuries. Most of the evidence related to these dislocations is found in case reports or in series with closed injuries. We reviewed the experiences of three centers in the treatment of open elbow dislocations.

Question/purposes We compared the results after operative treatment of simple and complex open dislocations in terms of (1) ROM, (2) functional score, and (3) complications.

Methods Eighteen patients were retrospectively included in this study: 11 with simple open elbow dislocations and

seven with complex open elbow dislocations. Mean age was 40 years. Thirteen were men. Eight patients presented neurovascular injuries. Evaluation included ROM of the elbow and forearm as measured by hand-held goniometer. We then classified the results using the 100-point Broberg and Morrey functional rating index based on ROM, grip strength, elbow stability, and pain. Scores of 95 to 100 were considered excellent, 80 to 94 good, 60 to 79 fair, and less than 60 poor. Complications were recorded. Minimum followup was 6 months (mean, 25 months; range, 6–72 months).

Results We found no differences between simple and complex open elbow dislocations related to ROM (median flexion/extension: 117° versus 110°, $p = 0.12$; forearm rotation: 160° versus 170°, $p = 0.67$). According to the Broberg and Morrey score, four patients had excellent results, five good, and one fair in the simple dislocation group, whereas in the complex dislocation group, four patients had excellent results, two good, and one fair ($p = 0.8$). No difference in complication rate was found between groups ($p = 0.63$). All complications in the simple dislocation group were neurovascular. In the complex dislocation group, there was one case of brachial artery occlusion, two cases of heterotopic ossification, one case of infection and nonunion, and one case of infection. No patients had recurrent elbow instability.

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research*® editors and board members are on file with the publication and can be viewed on request. Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained. The study was performed reviewing data from the medical records of the three institutions: Hospital Italiano de Buenos Aires (Buenos Aires, Argentina), Clínica de Fracturas y Ortopedia (Mar del Plata, Argentina), and Massachusetts General Hospital (Boston, MA, USA).

J. G. Boretto (✉), G. Gallucci, P. De Carli
Department of the Hand and Upper Extremity, Instituto de Ortopedia y Traumatología “Dr. Prof. Carlos Ottolenghi”, Hospital Italiano de Buenos Aires, Buenos Aires, Argentina
e-mail: jboretto@hotmail.com

M. Rodriguez Sammartino
Orthopedic and Traumatology Service, Clínica de Fracturas y Ortopedia, Mar del Plata, Argentina

D. Ring
Harvard Medical School, Orthopaedic Hand and Upper Extremity Service, Massachusetts General Hospital, Boston, MA, USA

Conclusions No differences between simple and complex open elbow dislocations were found in terms of ROM, functional results, and rate of complications. Complications in the simple dislocation group were related to neurovascular injuries in contrast to the complex dislocation group where complications were associated with the bony injury.

Level of Evidence Level IV, prognostic study. See Instructions for Authors for a complete description of levels of evidence.

Introduction

The annual incidence of elbow dislocations is between five and 13 per 100,000 persons [15, 24]. Simple elbow dislocations treated with early mobilization after closed reduction usually have good functional results despite the capsuloligamentous stabilizers of the articulation of the elbow being ruptured [19]. Complex elbow dislocations are when a simple elbow dislocation is associated periarticular fracture [13]. Treatment of these injuries is challenging and results depend on the correct restoration of elbow stability [22]. Postoperative complications and suboptimal results are mainly related to complexity of the osseous injury and involvement of the soft tissue stabilizers [5, 23].

Open simple and complex elbow dislocations are rare injuries and are usually associated with high-energy and severe soft tissue injuries. Most of the evidence related to open elbow dislocations is found in case reports and series of mixed open and closed injuries.

We review the experiences of three centers in the treatment of open elbow dislocation. Specifically, we compared the results after operative treatment of simple and complex open dislocations in terms of (1) ROM, (2) functional score, and (3) complications.

Patients and Methods

We retrospectively identified 20 patients in three hospitals with open elbow dislocations during a 10-year period (2001–2011). Inclusion criteria were an open elbow dislocation (simple or complex), data regarding functional results and complications, and a minimum of 6 months of followup. Two patients were excluded, one lost to followup and the other because of lack of data. Of the 18 patients who met the inclusion criteria, 11 had simple elbow dislocations and seven had complex elbow dislocation (Fig. 1). The mean age was 40 years (range, 21–66 years). There were 13 men with a mean age of 36 years (range, 21–54 years) and five women with a mean age of 51 years

(range, 25–66 years) (Table 1). The right arm was injured in nine patients (all dominant) and the left arm was injured in nine patients (two dominant). Four patients were injured in a fall from a height, four in a fall from a greater height, one had a crash injury, one patient was hit by a car, and eight patients were involved in motor vehicle accidents. Sixteen patients had one or more associated injuries (Table 1). Eight patients sustained neurovascular injury, one with an open fracture-dislocation and the other seven with open simple dislocations (Table 1). The mean followup was 25 months (range, 6–72 months).

The overall injury pattern was a posterior dislocation. Of the patients with fracture-dislocations, one had a medial column distal humerus fracture, one had a dislocation with a fracture of the olecranon, two had dislocations with fractures of the capitellum and trochlea, one had dislocation with supraintercondylar fracture of the humerus; and two had dislocations with fractures of the radial head (Table 1). Open fracture-dislocations were graded according to the classification of Gustilo and Anderson [11]. Open fracture-dislocations were Type I in one patient, II in two patients, IIIA in two patients, IIIB in one patient, and IIIC in one patient (Table 1).

We had intended to grade all patients according to the classification of open joint injuries of Collins and Temple [9]; however, not all patients could be classified. This classification was developed to grade and characterize the magnitude of intracapsular structures and extracapsular soft tissue injuries to provide a prognosis. Type I open joint injuries are single penetrations without extensive soft tissue damage, permitting uncomplicated joint and wound closure. Type II injuries are single or multiple penetrations with extensive soft tissue disruptions, often requiring secondary operations to attain closure. Type III injuries are open periarticular fractures with extension through the adjacent intraarticular surface. Type IV injuries are open dislocations or those with associated nerve or vascular injury requiring repair. According to this classification, there were 12 patients with Type IV injury and the remaining patients could not be classified (Table 1).

Thirteen patients had associated injuries (Table 1).

Operative Treatment

All 11 patients with open simple dislocations were treated with surgical débridement and articular reduction. Six of them had temporary stabilization with an external fixator, one had transfixation of the ulnohumeral joint with two Steinman pins, two had medial collateral ligament reattachment and immobilization in a posterior plaster splint, one had lateral collateral ligament reattachment and immobilization in a posterior plaster splint, and one had

Fig. 1 A flowchart shows the characteristics of the study cohort of patients with open elbow dislocations, including types of open fractures-dislocations according to the classification of Gustilo and

Anderson [11] and types of open joint injuries according to the classification of Collins and Temple [9]. OED = open elbow dislocations.

medial and lateral collateral ligament reattachments with immobilization in a posterior plaster splint.

In patients with open fracture-dislocation, treatment was related to the osseous injury. Five patients underwent open reduction and internal fixation of their fractures: two of the distal humerus, one of the olecranon, and one of the radial head. Of the remaining two patients, one had medial collateral ligament reattachment without fixation of the capitellum and trochlear fractures and the other had lateral collateral ligament reattachment and temporary stabilization with a hinged external fixator without radial head fixation.

Evaluation

ROM of the elbow and forearm was measured by a hand-held goniometer. Pain was measured on a four-grade scale (none, mild, moderate, severe). We classified the results with the Broberg and Morrey [8] functional rating index. This system classifies patients based on ROM, grip strength, elbow stability, and pain. Scores of 95 to 100 were considered excellent, 80 to 94 good, 60 to 79 fair, and less than 60 poor. Complications were also recorded.

Table 1. Demographics and characteristics of patients with open elbow dislocations

Patient	Type of dislocation	Age (years)	Sex	Mechanism of injury	Limb (dominant)	Type of dislocation	Type of fracture-dislocation	Gustilo and Anderson type [11]	Collins and Temple type [9]	Associated injuries
1	Simple	56	Female	Fall from standing height	(L)	Posterior	NA	NA	IV	None
2	Simple	35	Male	Fall from standing height	(R)	Posterior	NA	NA	IV	Ipsilateral carpal fracture-dislocation
3	Simple	42	Male	Motor vehicle accident	(R)	Posterior	NA	NA	IV	Hemopneumothorax, multiple ribs fractures
4	Simple	38	Male	Fall from standing height	(R)	Posterior	NA	NA	IV	None
5	Simple	27	Male	Motor vehicle accident	(L)	Posterior	NA	NA	IV	Ankle fracture, right hip dislocation
6	Simple	21	Male	Motor vehicle accident	L	Posterior	NA	NA	IV	None
7	Simple	45	Female	Motor vehicle accident	(R)	Posterior	NA	NA	IV	Ipsilateral open radial shaft fracture, ipsilateral forearm degloving, ipsilateral ankle fracture
8	Simple	65	Female	Fall from height	L	Posterior	NA	NA	IV	Ipsilateral open distal radius and ulna fractures
9	Simple	33	Male	Motor vehicle accident	(R)	Posterior	NA	NA	IV	None
10	Simple	44	Male	Crush injury	L	Posterior	NA	NA	IV	Ipsilateral both forearm bone open fractures
11	Simple	54	Male	Fall from height	(R)	Posterior	NA	NA	IV	None
12	Complex	46	Male	Pedestrian hit by car	L	Posterior	Medial column distal humerus fracture	I	NA	Right shoulder dislocation, right pneumothorax, open right tibia and fibula fractures, liver laceration
13	Complex	31	Male	Motor vehicle accident	(R)	Posterior	Olecranon fracture	IIIA	NA	Subtrochanteric fracture of the right femur, medial shearing pilon-type fracture of the right ankle
14	Complex	27	Male	Fall from height	L	Posterior	Radial head fracture	IIIC	IV	Ipsilateral open radiocarpal fracture-dislocation, forearm compartment syndrome
15	Complex	26	Male	Motor vehicle accident	(R)	Posterior	Complex capitellum/trochlea fracture	IIIB	NA	Open left tibial fracture, open left femoral shaft fracture, left femoral neck fracture, patellar fracture

Table 1. continued

Patient	Type of dislocation	Age (years)	Sex	Mechanism of injury	Limb (dominant)	Type of dislocation	Type of fracture-dislocation	Gustilo and Anderson type [11]	Collins and Temple type [9]	Associated injuries
16	Complex	66	Female	Fall from standing height	L	Posterior	Complex capitellum/trochlea fracture	II	NA	Soft tissue injury to the left leg
17	Complex	45	Male	Fall from height	L	Posterior	Radial head fracture	II	NA	Scaphoid fracture
18	Complex	25	Female	Motor vehicle accident	(R)	Posterior	Supraintertcondylar	IIIA	NA	Open ipsilateral shaft radius and ulna fractures

NA = not applicable.

Statistical Analysis

Continuous variables are described as medians and ranges. Nominal and ordinal variables are described as percentages. Because data distribution was not normal according to the histogram analysis, nonparametric tests were applied. We used the Wilcoxon test to compare continuous variables and the Fisher test to compare nominal and ordinal variables between groups. The significance threshold was 5%.

Results

There was no difference in postoperative ROM between the simple and complex open elbow dislocations (ulnohumeral ROM: $p = 0.12$; forearm rotation: $p = 0.67$) (Table 2). Among the 11 patients with open simple elbow dislocations, the median arc of ulnohumeral motion was 117° (range, 90° – 145°) and median forearm rotation was 160° (range, 120° – 170°). Of the seven patients with open complex elbow dislocations, the median arc of ulnohumeral motion was 110° (range, 0° – 135°) and median forearm rotation was 170° (range, 50° – 170°).

The mean postoperative Broberg and Morrey score for the whole series was 90 points (range, 65–100 points) (Table 2). The categorical ratings were eight excellent, seven good, and one fair. Of the 11 patients who had simple open elbow dislocations, the median Broberg and Morrey score was 93 points (range, 77–100 points). The categorical ratings were four excellent, five good, one fair, and one was not available because she underwent a partial amputation of the hand. For the seven patients who had complex open elbow dislocations, the mean Broberg and Morrey score was 95 points (range, 65–100 points). The categorical ratings were four excellent, two good, and one fair. There was no difference between groups ($p = 0.8$).

Overall, 12 patients had complications: eight in the open simple elbow dislocation group and four in the open complex dislocation group (Table 2). No differences were found between groups ($p = 0.63$). All complications in the simple dislocation group were neurovascular (Fig. 2). In the complex open elbow dislocations group, there was one case of brachial artery occlusion, two cases of heterotopic ossification, one case of infection and nonunion, and one case of infection. No patients had recurrent elbow instability.

Discussion

Among injuries to the upper extremity, dislocation of the elbow is second only to dislocation of the shoulder. In

Table 2. Functional results and complications after operative treatment of open elbow dislocations

Patient	Type of dislocation	Flexion (°)	Flexion contracture (°)	Arc of pronation and supination (°)	Broberg and Morrey score (points)	Complications
1	Simple	140	20	160	97	None
2	Simple	120	30	125	83	Median nerve palsy
3	Simple	130	15	150	82	Ulnar nerve entrapment
4	Simple	140	20	170	90	None
5	Simple	120	20	145	85	None
6	Simple	130	30	120	77	Neuropraxia median and ulnar nerve
7	Simple	140	10	106	NA	Brachial artery occlusion
8	Simple	140	0	170	100	Brachial artery occlusion
9	Simple	145	0	170	93	Ulnar nerve laceration
10	Simple	140	5	140	100	Posterior interosseous nerve palsy
11	Simple	135	5	170	99	Ulnar nerve palsy
12	Complex	130	40	170	84	Heterotopic ossification
13	Complex	130	20	170	95	Infection
14	Complex	130	15	140	95	Brachial artery occlusion
15	Complex	90	90	50	65	Infection, nonunion, heterotopic bone (ankylosis)
16	Complex	140	5	170	100	None
17	Complex	140	15	140	97	None
18	Complex	130	45	170	90	None

NA = not applicable.

simple dislocations, early mobilization after closed reduction is associated with a low risk of redislocation [14]. On the other hand, in complex dislocations, the risk of recurrent or chronic instability is increased. Consequently, dealing with the osseous stabilizers in the complex elbow dislocation is the main goal of treatment [10, 20, 23]. Despite the preponderance of literature on traumatic injuries about the elbow, there are relatively few data specifically addressing open elbow dislocations, whether simple or complex [1, 2, 4, 6, 12, 16, 18]. Owing to the paucity of published data in this type of injuries, we performed this study to compare the results after operative treatment of simple and complex open elbow dislocations in terms of (1) ROM, (2) functional score, and (3) complications.

Our study has certain limitations. First, it is retrospective due to the relatively low prevalence of open elbow dislocation. Although retrospective studies may be associated with several biases, it is difficult to evaluate interventions designed to compare rare events due to the sample size in randomized control trials. Designing trials with a large number of patients may be impossible in terms of the time needed to recruit them and the funding needed to accomplish it [7]. Another limitation is related to the variability in treatment related to patients recruited from the three centers. However, all patients were treated according to the principles of care of simple and complex elbow dislocations.

Fig. 2 A photograph shows a simple open elbow dislocation with the distal humerus extremity fully exposed. Note the median nerve pulled in the trochlear notch.

We found no differences in ROM, either ulnohumeral flexion or forearm rotation, between simple and complex open elbow dislocations. Excellent and good results were achievable in most of the simple and complex open elbow dislocations according to the Broberg and Morrey score. This

is in accordance with the literature, which shows good to excellent results in 75% to 100% of patients with simple elbow dislocations [3, 17]. On the other hand, when elbow dislocations are associated with fractures, the results are adversely affected [23]. Although we found no difference between simple and complex open elbow dislocations, this could be due to Type II error because of the small sample size.

Similar rate of complications were seen in both simple and complex open elbow dislocations. Nevertheless, neurovascular complications were seen mainly in simple dislocations in contrast to those found in complex dislocations. This distribution is in agreement with the literature in relation to fracture-dislocations [21–23, 25]. However, neurovascular injury prevalence is higher in open dislocations than in closed dislocations [4].

In this study, we have presented, to our knowledge, the largest series of adult patients with open elbow dislocations, whether simple or complex. Some important information about this troublesome pattern of injury can be gleaned from this series. No differences in ROM, functional results, or rate of complications were found. However, the type of complications differs between simple and complex dislocations. In simple dislocations, all the complications were neurovascular in contrast to the complex dislocations where complications were related to the bony injury.

References

1. Ahmad R, Ahmed SM, Annamalai S, Case R. Open dislocation of the elbow with ipsilateral fracture of the radial head and distal radius: a rare combination without vascular injury. *Emerg Med J*. 2007;24:860.
2. Alonso JA, Roy BR, Shaw DL. Open antero-lateral dislocation of the elbow: a case report. *BMC Musculoskelet Disord*. 2002;3:1.
3. Anakwe RE, Middleton SD, Jenkins PJ, McQueen MM, Court-Brown CM. Patient-reported outcomes after simple dislocation of the elbow. *J Bone Joint Surg Am*. 2011;93:1220–1226.
4. Ayel JE, Bonneville N, Lafosse JM, Pidhorz L, Al Homsi M, Mansat P, Chaufour X, Rongier M, Bonneville P. Acute elbow dislocation with arterial rupture: analysis of nine cases. *Orthop Traumatol Surg Res*. 2009;95:343–351.
5. Bachoura A, Guitton TG, Smith RM, Vrahas MS, Zurakowski D, Ring D. Infirmity and injury complexity are risk factors for surgical-site infection after operative fracture care. *Clin Orthop Relat Res*. 2011;469:2621–2630.
6. Bachy M, Leroux J, Pegot A, Abu Amara S, Lechevallier J, Bachy B. [Open elbow dislocation with distal ischemia: a therapeutic emergency] [in French]. *Arch Pediatr*. 2012;19:624–627.
7. Black N. Why we need observational studies to evaluate the effectiveness of health care. *BMJ*. 1996;312:1215–1218.
8. Broberg MA, Morrey BF. Results of delayed excision of the radial head after fracture. *J Bone Joint Surg Am*. 1986;68:669–674.
9. Collins DN, Temple SD. Open joint injuries: classification and treatment. *Clin Orthop Relat Res*. 1989;243:48–56.
10. Forthman C, Henket M, Ring DC. Elbow dislocation with intra-articular fracture: the results of operative treatment without repair of the medial collateral ligament. *J Hand Surg Am*. 2007;32:1200–1209.
11. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg Am*. 1976;58:453–458.
12. Henderson RS, Robertson IM. Open dislocation of the elbow with rupture of the brachial artery. *J Bone Joint Surg Br*. 1952;34:636–637.
13. Hildebrand KA, Patterson SD, King GJ. Acute elbow dislocations: simple and complex. *Orthop Clin North Am*. 1999;30:63–79.
14. Josefsson PO, Johnell O, Wendeberg B. Ligamentous injuries in dislocations of the elbow joint. *Clin Orthop Relat Res*. 1987;221:221–225.
15. Josefsson PO, Nilsson BE. Incidence of elbow dislocation. *Acta Orthop Scand*. 1986;57:537–538.
16. Kilburn J, Sweeney JG, Silk FF. Three cases of compound posterior dislocation of the elbow with rupture of the brachial artery. *J Bone Joint Surg Br*. 1962;44:119–121.
17. Lansinger O, Karlsson J, Korner L, Mare K. Dislocation of the elbow joint. *Arch Orthop Trauma Surg*. 1984;102:183–186.
18. Martin DJ, Fazzi UG, Leach WJ. Brachial artery transection associated with closed and open dislocation of the elbow. *Eur J Emerg Med*. 2005;12:30–32.
19. Mehlhoff TL, Noble PC, Bennett JB, Tullos HS. Simple dislocation of the elbow in the adult: results after closed treatment. *J Bone Joint Surg Am*. 1988;70:244–249.
20. Morrey BF, An KN. Stability of the elbow: osseous constraints. *J Shoulder Elbow Surg*. 2005;14:174S–178S.
21. Pugh DM, Wild LM, Schemitsch EH, King GJ, McKee MD. Standard surgical protocol to treat elbow dislocations with radial head and coronoid fractures. *J Bone Joint Surg Am*. 2004;86:1122–1130.
22. Ring D, Jupiter JB. Fracture-dislocation of the elbow. *J Bone Joint Surg Am*. 1998;80:566–580.
23. Ring D, Jupiter JB, Zilberfarb J. Posterior dislocation of the elbow with fractures of the radial head and coronoid. *J Bone Joint Surg Am*. 2002;84:547–551.
24. Stoneback JW, Owens BD, Sykes J, Athwal GS, Pointer L, Wolf JM. Incidence of elbow dislocations in the United States population. *J Bone Joint Surg Am*. 2012;94:240–245.
25. Wiggers JK, Helmerhorst GTT, Brouwer KM, Nickel MC, Nunez F, Ring D. Injury complexity factors predict heterotopic ossification restricting motion after elbow trauma. *Clin Orthop Relat Res*. 2013. doi:10.1007/s11999-013-3304-0.