Acute Elbow Dislocation: Evaluation and Management

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Abstract

Most elbow dislocations are stable after closed reduction. Treatment with an early range-of-motion program generally leads to favorable results. Care must be taken to rule out neurovascular involvement and associated osseous or ligamentous injury in the wrist. Late elbow instability and stiffness are rare after simple dislocations. Complex elbow dislocations with associated fractures may require surgical intervention to obtain joint stability; ligament and/or fracture repair is frequently necessary in this situation. Larger periarticular fractures adversely affect functional results. Potential late complications of elbow dislocation include posttraumatic stiffness, posterolateral joint instability, ectopic ossification, and occult distal radioulnar joint disruption.

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Elbow dislocations constitute 10% to 25% of all injuries to the elbow.[1] Among injuries to the upper extremity, dislocation of the elbow is second only to dislocation of the shoulder.[2] The mechanism of elbow dislocation is most commonly a fall on an outstretched hand. The elbow is usually extended, and the arm is abducted. Motor vehicle accidents, sports injuries, and other high-energy mechanisms account for most dislocations in young individuals. The median age for elbow dislocation is 30 years.[3]

Approximately 90% of dislocations occur with posterior or posterolateral displacement of the forearm relative to the distal humerus. Rarer injuries include lateral and anterior displacements of the forearm. A shallow olecranon fossa and a prominent olecranon tip may predispose patients to this injury.[4]

Associated fractures about the elbow with dislocation most frequently involve the radial head and the coronoid process of the ulna; occasionally, the humeral epicondyles are involved. When larger intra-articular fractures of the radial head, olecranon, or coronoid process occur with elbow dislocation, the injury is termed a "complex dislocation." Although prereduction and postreduction radiographs reveal periarticular fractures in 12% to 60% of cases, operative exploration documents unrecognized osteochondral injuries in nearly 100% of acute elbow dislocations.[5] Fortunately, the vast majority of small periarticular fractures do not require operative intervention.

Evaluation and Nonsurgical Treatment

The diagnosis of elbow dislocation is relatively straightforward. Patients present after an acute injury with soft-tissue swelling and deformity about the elbow. A thorough neurovascular examination is required before and after reduction of the joint. Although brachial artery injury and/or neurologic involvement is rare, the neurovascular status must nevertheless be properly evaluated and documented. The wrist and shoulder should be examined to rule out a concomitant upper-extremity injury, which occurs in 10% to 15% of cases.[2] The distal radioulnar joint and the interosseous membrane of the forearm should also be examined for tenderness and instability to rule out an interosseous membrane disruption (a variant of the Essex-Lopresti injury).

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After a thorough examination, radiographs must be carefully evaluated to determine the direction of the dislocation and to identify any associated periarticular fractures. Oblique views are usually helpful in this regard. Reduction requires adequate muscular relaxation and appropriate analgesia. This can usually be carried out in the emergency room with intramuscular or intravenous medication. Several reduction techniques have been described, all of them involving correction of the medial or lateral displacement followed by traction on the forearm. Firm pressure is applied posteriorly to the olecranon to bring it distally and anteriorly around the humeral trochlea. Muscular relaxation is the key to joint relocation. The quality of the reduction often provides a clue to postreduction stability. A palpable reduction "clunk" is a favorable sign of joint stability.

After reduction, the elbow must be taken through the range of motion. Most dislocated elbows are unstable to valgus stress (best tested in pronation to lock the lateral side). It is essential to evaluate the tendency for redislocation to occur in extension, which signifies a potentially unstable joint. Postreduction radiographs should then be evaluated to document concentric reduction of the elbow joint in two planes. This requires an anteroposterior view of the elbow centered on the proximal ulna and a true lateral view of the elbow joint. Widening of the joint space may indicate entrapped osteochondral fragments, which must be removed surgically, or posterolateral rotatory instability.

If the reduction is concentric and the joint is stable (which is most common), the elbow is splinted in 90 degrees of flexion or slightly more for 5 to 10 days. Immobilization for more than 3 weeks has been associated with a poor ultimate range of motion of the elbow.[1,6] Obtaining follow-up radiographs at 3 to 5 days and again at 10 to 14 days is recommended to document maintenance of reduction, as the unstable elbow can redislocate even within a well-molded splint or cast.

Range-of-motion exercises are then initiated with interval splinting or with use of a sling for comfort and support. If the elbow feels unstable only in terminal extension, a cast brace or an orthosis with an extension block can be utilized. Extension is gradually increased over the ensuing 3 to 6 weeks. Therapy may be added, although vigorous passive motion is to be avoided because it can lead to swelling and pain inhibition and may be associated with the development of ectopic ossification.

Surgical Treatment

All complete elbow dislocations without large periarticular fractures result in rupture of the medial and lateral ligaments, which, in addition to maintaining bone congruence, are the primary stabilizers of the elbow joint. Only rarely, however, is surgical treatment indicated. Josefsson et al[7] evaluated 31 pure elbow dislocations under anesthesia and found that 9 elbows easily redislocated when extended. Surgical exploration of all 31 elbows revealed complete rupture of the medial and lateral ligaments in every case, most commonly at their humeral origin. The tendency of the elbows to redislocate under anesthesia correlated with the degree of muscular injury to the flexor-pronator and extensor origins at the humeral epicondyles. Thus, the muscular flexor and extensor origins represent secondary stabilizers of the elbow. When intact, they act (in combination with articular congruence) to provide adequate stability to allow ligamentous healing after dislocation. Prospective studies have shown no advantage of early collateral ligament repair over early motion after simple elbow dislocation.[8,9]

Surgery is indicated for acute elbow dislocations in two situations. The first occurs when the elbow requires flexion beyond approximately 50 to 60 degrees to remain reduced. The second occurs when elbow dislocation is associated with unstable fractures about the joint. Recurrent instability in simple elbow dislocations is extremely rare, occurring in fewer than 1% to 2% of cases.[1,8,9] In this setting, both the collateral ligaments and the secondary elbow stabilizers are disrupted. In the earlier literature, this instability was considered to be best approached from the lateral aspect of the joint, with repair or reattachment of the lateral ligaments and tendinous origins.[10,11] More recently, the medial collateral ligament has been identified as the prime stabilizer of the elbow joint, and repair of the medial ligament complex and flexor-pronator musculotendinous origins has been recommended to correct persistent instability.[12,13]

It is now recognized that both the medial and the lateral ligaments play a role in elbow stability. The medial ligaments are the primary stabilizers of the ulnohumeral joint.[14] The lateral ligamentous complex keeps the elbow from subluxating posteriorly and rotating away from the humerus in supination (posterolateral rotatory instability).[15] This manifests as posterior translation of the radial head on a lateral radiograph, with gaping of the ulnohumeral joint (Fig. 1). Therefore, both collateral ligaments are important in determining ultimate elbow stability and function.

Fig. 1 Lateral radiograph obtained after reduction of a posterolateral elbow dislocation shows evidence of posterolateral instability. Note posterior translation of the radial head, with gaping of the ulnohumeral joint.

In cases of persistent elbow instability after dislocation without a large periarticular fracture, the medial and/or lateral ligaments are surgically approached and repaired. Most commonly, the entire ligament and the flexor/extensor origins will be found to be torn from their humeral origin (Fig. 2). On the medial side, the ulnar nerve must be identified and protected. In most cases, the origin of the flexor/pronator mass will have pulled away from the medial epicondyle, and the underlying disrupted medial collateral ligament will be easily visualized. Both structures can be repaired with sutures through bone or with bone anchors. On the lateral side, a Kocher approach is used to evaluate and repair the torn ligament and the musculotendinous origins.

If the repair is deemed secure and the elbow is stable, early protected motion is started with a hinged elbow orthosis or with interval static splinting for comfort and support. If the elbow continues to show signs of instability after ligament repair (due to the poor quality of the tissue available for repair or compromised articular support), an orthosis or temporary splint will be inadequate to maintain joint stability. The unstable elbow will redislocate even within a well-fitting cast or splint (Fig. 3). In this situation, rigid external fixation with pins applied to the humerus and ulna is required to maintain joint reduction. Transarticular pin fixation is discouraged because of the joint-surface damage and the potential for pin breakage. Dynamic external fixators that allow motion while maintaining a reduced joint are now available.[16] These devices are difficult to apply and should be used only by surgeons experienced with the technique.

Although a hinged external fixator has the advantage of allowing joint motion while protecting the ligament repair, a static external fixator is also an option in this setting if one is not experienced with the dynamic device. This can be used for 3 to 4 weeks to protect the ligaments and maintain a concentric reduction. Favorable results can be obtained with both methods. In the rare instances of joint instability after surgical repair, it is clearly better to have a concentrically reduced joint with potential stiffness (due to a slightly extended period of immobilization) than recurrent elbow instability. Posttraumatic elbow-joint stiffness can be addressed at a later time with a secondary capsular release procedure.

Residual elbow instability after reduction is most commonly associated with unstable fractures of the radial head, capitellum, or coronoid process. The loss of anterior or lateral osseous support (and collateral ligaments) will render the elbow grossly unstable after dislocation. Radial-head fractures have been reported to occur in approximately 10% of elbow dislocations.[17] Capitellar fractures are much less common (Fig. 4). Many of both of these types of fractures are comminuted and displaced. Fractures that do not compromise lateral elbow support (e.g., those involving less than 30% to 40% of the radial head) and are not associated with an unstable joint do not require early surgical intervention. Comminuted or unstable fractures with associated gross elbow instability are best approached operatively within 2 to 3 days of injury.

Fig. 2 Intraoperative photograph of the lateral epicondyle of an unstable elbow after dislocation. Note the complete avulsion of the collateral ligament and extensor tendon origins from the lateral epicondyle, which is a common finding in persistent posttraumatic elbow instability.

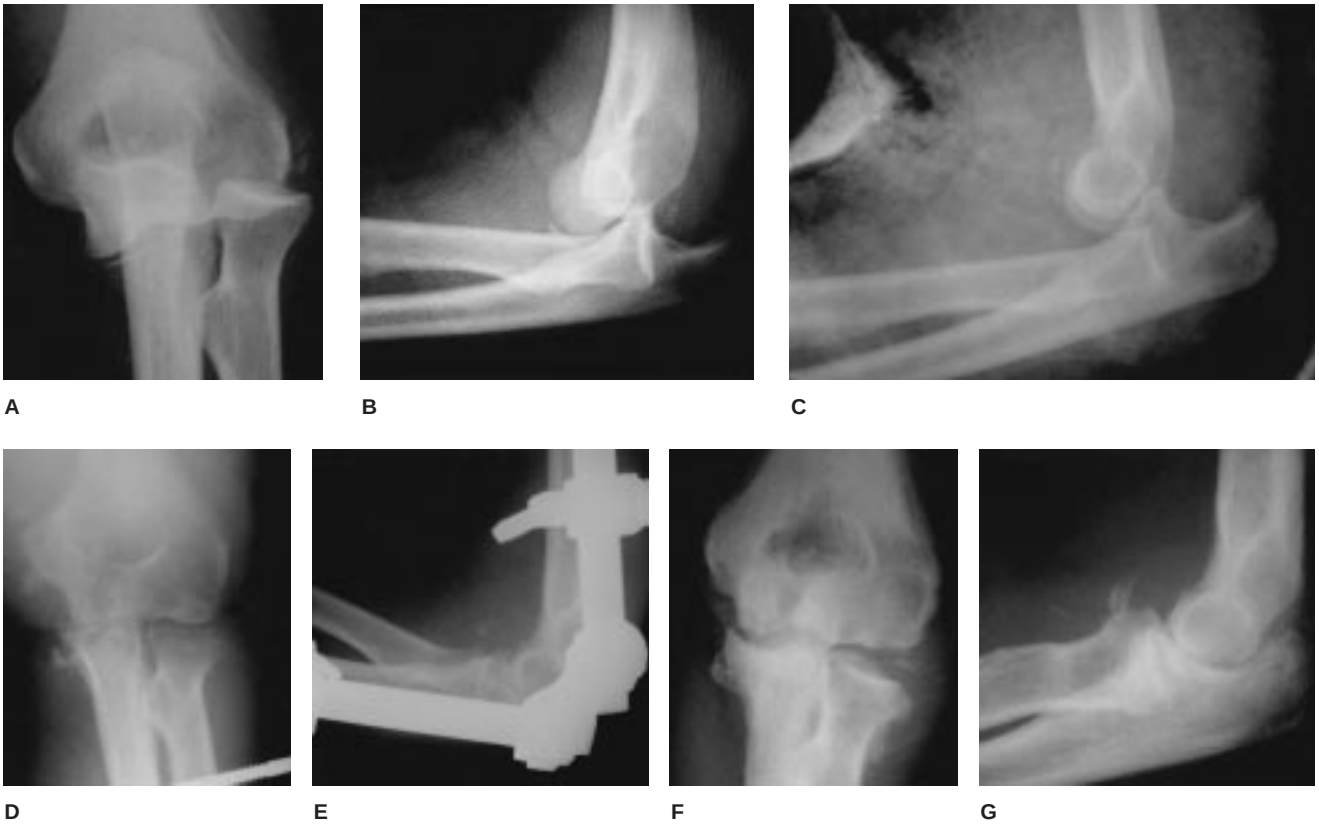

Fig. 3 Prereduction anteroposterior **(A)** and lateral **(B)** radiographs of the elbow of a 65-year-old woman with a fracture-dislocation. The elbow was concentrically reduced and placed in a splint, but the tendency toward redislocation in extension was noted at the time. **C,** Follow-up film of the splinted elbow 2 days later revealed redislocation. The patient underwent medial and lateral ligament exploration and repair. Because of the poor quality of the tissues, the repair was protected with use of a static external fixator for slightly over 3 weeks. Anteroposterior **(D)** and lateral **(E)** radiographs revealed a concentric reduction with the fixator in place. At the final examination 1 year after treatment, anteroposterior **(F)** and lateral **(G)** radiographs showed that concentric reduction was maintained. The patient had minimal complaints and an adequate functional result, with full elbow flexion and extension to 20 degrees.

Reconstruction of the radial head by open reduction and internal fixation will reestablish lateral osseous support and restore its anterior buttressing effect, resisting posterior joint subluxation. The radial head is most easily approached through a Kocher incision between the anconeus and the extensor carpi ulnaris. Deep to this interval, the supinator muscle is visualized as covering the lateral collateral ligament. The collateral ligament blends with the annular ligament laterally to insert on the proximal ulna[18] (Fig. 5). A deeper incision through the collateral and annular ligament complex should be made anterior to the midline of the radial head. An incision slightly anterior preserves the posterior fibers of the lateral collateral ligament complex and allows for subsequent repair by leaving an adequate tissue margin on the ulna.[17,18]

Care must be taken to avoid vigorous retraction around the radial neck to prevent an injury to the posterior interosseous nerve. If wider exposure of the radial head and neck is deemed necessary, a modified Pankovich approach can be used.[19] With this approach, the supinator is released from its ulnar origin and is retracted anteriorly and distally, exposing the radial neck and protecting the posterior interosseous nerve.

Fixation of the radial head is often difficult. Provisional Kirschner-wire fixation is useful. The minimum amount of hardware is then utilized to obtain stability of the head and neck. Herbert screws (with differential pitch and no head) or 1.5- to 2.0-mm minifragment screws are useful in fixing radial-head fragments with an intact neck. The maximum screw length required is approximately 20 mm (based on the average diameter of the adult male radial head).

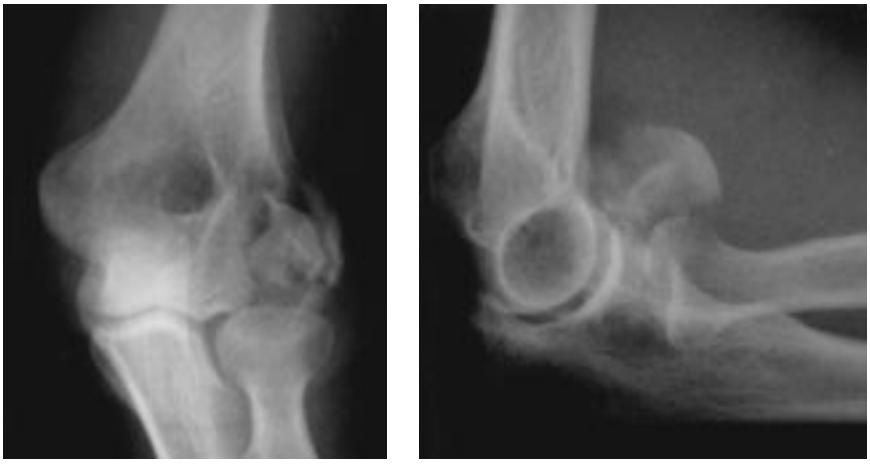

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Fig. 4 Anteroposterior **(A)** and lateral **(B)** radiographs of a 69-year-old woman with a fracture-dislocation of the elbow show a severely comminuted fracture of the capitellum.

When the radial head and neck are involved, minifragment plates are frequently required (Fig. 6). The plate must be applied to the "nonarticular safe zone" of the radial head, which comprises 90 degrees of the 360-degree head circumference. Although pronation of the forearm is described for the Kocher approach to safely displace the radial nerve from the operative field, plates cannot be applied with the forearm pronated. They must be placed posteriorly with the forearm in full supination, or they will impinge and block rotation of the forearm. Bone grafting is frequently required to support depressed articular fragments or replace comminuted defects of the radial neck.

If the radial head cannot be reconstructed, it is excised, and the lateral collateral and/or extensor origin is repaired. Unfortunately, Silastic radial-head spacers cannot provide lateral support of the unstable elbow. Silicone rubber has a low modulus of elasticity and offers little compressive resistance in this setting.[20,21] Newer metallic radial-head replacements or allografts may offer the best alternative, but further study is needed before routine use can be recommended.[22]

When the radial head requires excision, the lateral ligaments must be repaired. Elbow stability is then evaluated by taking the elbow through the range of motion on the operating table. If adequate stability exists, early motion in a hinged orthosis or protected motion with the elbow kept in a static splint between exercises is the treatment of choice. If the elbow is unstable,

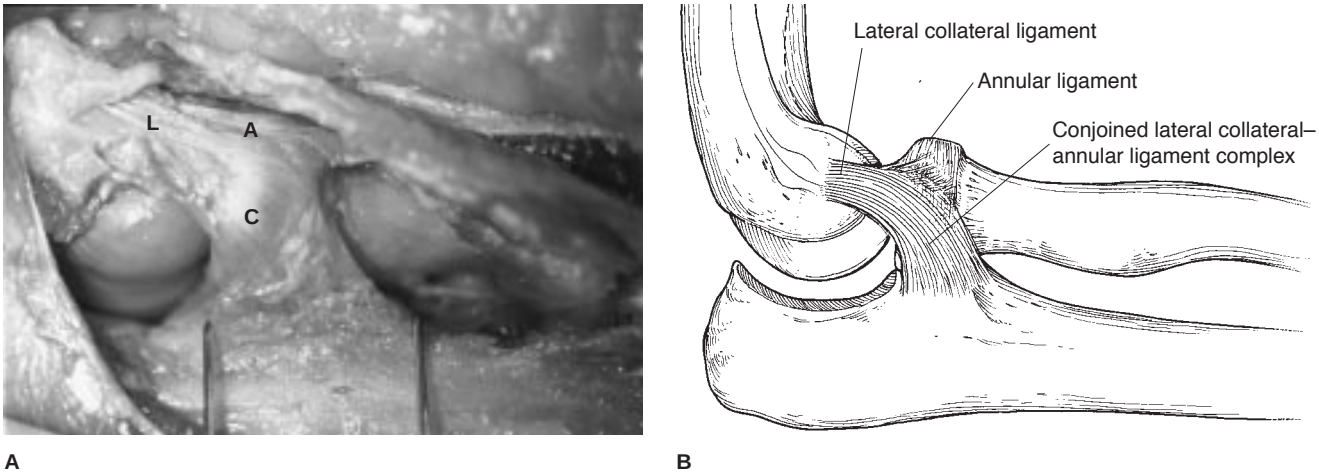

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Fig. 5 Cadaveric specimen **(A)** and diagram **(B)** illustrate the lateral collateral ligament complex of the elbow. The lateral collateral ligament (L on part **A**) arises from the humeral epicondyle and blends with the annular ligament (A) to insert in a conjoined fashion (C) on the proximal ulna.[18] Incisions placed slightly anterior through this ligament complex leave the posterior fibers intact. Meticulous repair of the lateral ligaments after radial-head fixation or excision is important in reestablishing lateral elbow support.

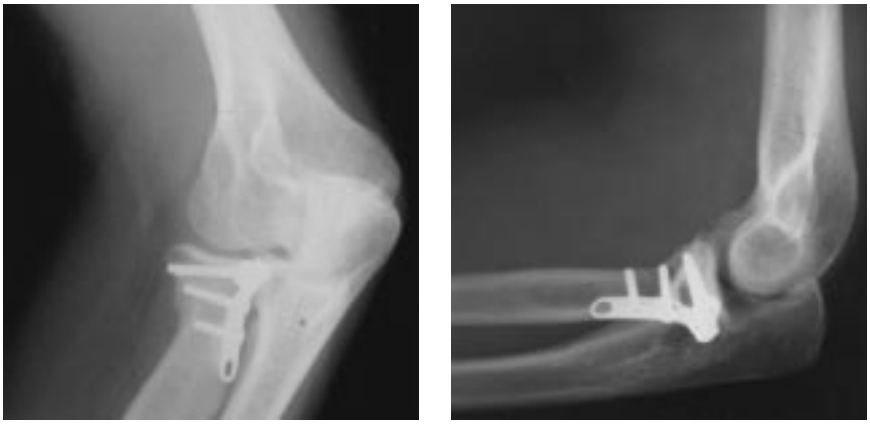

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Fig. 6 Anteroposterior **(A)** and lateral **(B)** radiographs of an elbow in which a minifragment plate has been used to treat an unstable fracture-dislocation. Plates must be placed in the "safe zone" of the radial head to avoid a mechanical block to forearm rotation.

consideration must be given to medial ligament (and flexor-pronator origin) repair. Most commonly, the elbow becomes stable after this. When it does not, external fixation may be required to maintain a concentric reduction.

Coronoid fractures are uncommon in elbow dislocations, occurring in only 2% to 18% of cases. Most involve fractures of the tip of the coronoid and are of little functional consequence. These are not brachialis tendon avulsions; rather, they represent capsular avulsions or shear fractures, as the brachialis inserts well distal to the tip of the coronoid process on the proximal ulna. Larger fractures of the coronoid involving more than 50% of the process require fixation if associated with elbow instability after a fracture-dislocation.[17] This is particularly important when a concomitant unstable radial-head fracture is present. Reestablishing articular congruence and the anterior buttressing effect of the coronoid process is particularly important when soft-tissue restraints have been injured by dislocation.

Complications

Neurovascular Injury

Brachial artery disruption rarely occurs in closed dislocations of the elbow. Fewer than 30 cases have been reported in the literature. Although the pulse may be diminished on presentation, in most cases it rapidly returns after joint reduction. Brachial artery injury most often occurs with open dislocations and in the presence of associated fractures. Once identified, prompt surgical intervention is warranted. Arterial exploration is performed through an anteromedial approach with direct end-to-end repair or by use of an interposition vein graft. When reconstruction is delayed and ischemia time exceeds approximately 4 hours, forearm fasciotomies should be performed to reduce the risk of compartment syndrome.

Nerve injury is also uncommon in elbow dislocation. The ulnar nerve is most often involved due to a stretch injury mechanism. Dysfunction usually resolves with conservative management. Because of the proximity of the median nerve to the brachial artery, compromise of the median nerve is most often associated with concomitant vascular disruption. A case of median-nerve entrapment in the joint after reduction has been reported.[2]

Stiffness

Posttraumatic stiffness is much more common than instability after elbow dislocation. Most patients will lose the terminal 10 to 15 degrees of elbow extension after dislocation. Arthrofibrosis limiting a functional arc of motion will develop in a subset of patients after dislocation of the joint. The elbow has a great propensity toward stiffness, usually secondary to thickening and fibrosis of the anterior joint capsule. Early active mobilization (within the first 2 to 3 weeks) is helpful in avoiding this complication. Dynamic elbow splints or patient-adjusted progressive static splints should be tried if motion is not steadily improving by 4 to 6 weeks after injury. If therapeutic modalities are ineffective after 6 months and an elbow contracture greater than approximately 30 to 40 degrees remains, an elbow capsular release can be considered.[23]

Heterotopic Ossification

Calcification of the soft tissues is common after elbow dislocation (reported in approximately 75% of cases[24]) but rarely limits motion. The most common sites of periarticular calcification are the anterior elbow region and the collateral ligaments.

True ectopic ossification (the formation of mature bone in nonosseous tissues) that limits motion is rare after elbow dislocation, occurring in fewer than 5% of cases. It will be evident on radiographs by 3 to 4 weeks after injury, usually anterior to the joint in the region of the brachialis muscle. Ectopic bone is associated with delayed surgical

intervention, closed head injury, and aggressive passive joint manipulation after dislocation. In patients at high risk, prophylaxis with a nonsteroidal anti-inflammatory medication or low-dose irradiation should be considered. Resection is best delayed until the ossification appears mature on plain radiographs, as evidenced by well-defined cortical margins with linear trabeculation. This usually occurs at least 6 months after the initial trauma.[25]

Distal Radioulnar Joint Instability

Elbow dislocations with radial-head fractures can be associated with obvious or occult disruptions of the distal radioulnar joint (Fig. 7). This is a variant of the Essex-Lopresti injury,[26] which was originally described as a radial-head fracture and distal radioulnar joint disruption without an associated elbow dislocation. These injuries frequently occur as a consequence of falls from heights. The mechanism is similar to that of elbow dislocation, but the force, if continued, can result in proximal migration of the radius due to disruption of both the triangular fibrocartilage and the interosseous membrane of the forearm.[27]

Once identified, the elbow dislocation and radial-head fracture are treated according to the guidelines already outlined. The combined injury makes radial head reconstruction and fixation especially important for both elbow stability and axial stability of the forearm. When the radial head is not reconstructible, a metal prosthesis or an allograft radial head will provide the best axial support to the radius and will lend valgus stability to the elbow. Temporary pin fixation of the distal radioulnar joint in neutral position may be added to neutralize the tendency toward proximal radial migration. This is best performed with two 0.062-mm Kirschner wires placed just proximal to the articular surface of the distal radioulnar joint. It is important to remember that distal radioulnar joint fixation does not obviate the critical need for maintenance or reconstruction of the radial head in this setting. With the interosseous membrane rendered incompetent, proximal migration of the radius will occur unless a proximal buttress is restored.

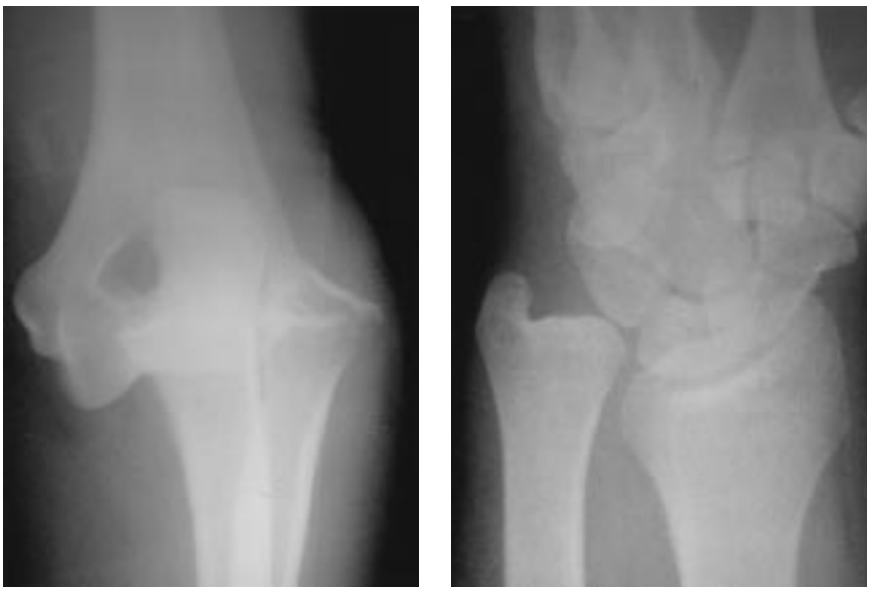

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Fig. 7 **A,** Radiograph of an elbow dislocation with an associated radial-head fracture and interosseous membrane disruption. **B,** Posteroanterior film of the wrist depicts migration of the radius (a variant of the Essex-Lopresti injury[26]).

Lateral Elbow Instability

Insufficiency of the lateral elbow ligaments can lead to subtle instability of the elbow after dislocation. In this condition, described as posterolateral rotatory elbow instability, the ulnohumeral joint does not dislocate but rather pivots, opening up laterally in supination.[15] Lateral radiographs may reveal posterior translation of the radial head with widening of the ulnohumeral joint space, especially if the films are obtained with the elbow in supination (Fig. 1). This instability pattern has been attributed to insufficiency of the lateral collateral ligament but most probably involves loss of secondary lateral supports as well.[18] It occurs principally in elbow supination, as rotatory instability reduces with forearm pronation.

All simple elbow dislocations result in lateral and medial elbow-ligament disruption. When patients are examined under anesthesia, all such dislocations show instability to valgus stress; 25% to 50% reveal laxity to varus stress to a lesser degree.[7,8] Posttraumatic rotatory elbow instability is likely related to associated injury to the secondary restraints of the lateral elbow as well as the lateral collateral ligament complex.[18] Without lateral stabilizers to hold the ulna reduced to the humerus, it can sag,

resulting in insufficient lateral joint support. If clinical or radiographic signs of lateral elbow instability are noted after acute elbow dislocation, patients should refrain from supination past neutral for approximately 4 to 6 weeks to allow healing of the lateral soft-tissue restraints. A hinged elbow orthosis that maintains the wrist in pronation or a cast brace can be used in this situation. Fortunately, very few patients show signs of lateral ligament insufficiency after elbow dislocation, and most of them can be treated nonoperatively with use of the rehabilitation guidelines that have been outlined.

Results

Most patients who suffer simple elbow dislocations regain function with an adequate arc of motion. Good to excellent results have been reported in 75% to 100% of cases in follow-up studies.[27] Fractures of the radial head and coronoid process adversely affect results.[6,27] Flexion returns first, with maximum improvement usually taking 6 to 12 weeks. Extension returns more slowly and can continue to improve for 3 to 5 months. A minor loss of 5 to 15 degrees of terminal extension of the elbow joint is typical.[24] Pronation and supination are characteristically unaffected unless a fracture of the radiocapitellar joint is present. Prolonged rigid immobilization has been associated with the least satisfactory arc of elbow motion.[1,6]

Even long after healing, approximately 50% of patients followed up over time complain of discomfort or residual symptoms attributable to their elbow after dislocation.[1] This is predominantly reported during heavy loading of the affected extremity. The cause is most likely related to the degree of soft-tissue damage associated with the dislocation. Cartilage abrasions and intra-articular loose bodies, seen in 100% of cases treated operatively,[5] may also account for some of these symptoms. They may also lead to posttraumatic radiographic changes seen late in many patients.[24]

Approximately 60% of patients do not feel the injured elbow is as "good" as the contralateral noninjured elbow.[8] Mechanical testing confirms a 15% average loss of elbow strength.[6] Although late complaints of elbow instability are rare, subtle joint laxity on loading may lead to diminished strength during activities that impart varus/valgus or rotatory stress to the elbow joint.

Summary

Elbow dislocations result in a great deal of injury to the soft tissues about the elbow and often result in marginal or larger periarticular fractures. Fortunately, the vast majority of these injuries are stable after closed reduction, and patients do well if started on an early rehabilitation program. The rare unstable elbow that requires flexion beyond approximately 50 to 60 degrees to remain reduced warrants consideration for surgical intervention. Surgery is also indicated for unstable periarticular fractures that result in a loss of osseous support to the injured joint. The functional prognosis for a simple elbow dislocation is more favorable than that for a fracture-dislocation.

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