

Elbow dislocations

After the shoulder, the elbow is the most commonly dislocated major joint in adults (Schreiber et al, 2014), with an estimated incidence of elbow dislocations of 5.21 per 100 000 person-years (Stoneback et al, 2012). Dislocations are more likely to occur in patients under the age of 30 years with a male predominance (Josefsson and Nilsson, 1986; Stoneback et al, 2012).

The most common mechanism of injury is a fall onto an outstretched hand. Sporting activities account for nearly 50% of all acute elbow dislocations (Stoneback et al, 2012).

Anatomy

The elbow joint comprises three articulations within the same joint capsule:

1. The ulnohumeral joint (a highly congruent hinge joint)
2. The radiocapitellar joint (a ball and socket joint)
3. The proximal radio-ulnar joint (a pivot joint).

The medial collateral ligament consists of the anterior, posterior and transverse bundles. The anterior bundle is the most

Table 1. Primary and secondary static stabilisers of the elbow joint

Static stabilisers		Comment
Primary	Ulnohumeral articulation	Contributes up to 50% of elbow stability
	Anterior bundle of the medial collateral ligament	Primary constraint to valgus and posteromedial stress
	Lateral collateral ligament	Primary constraint to external rotation and posterolateral stress
Secondary	Radiocapitellar joint	Provides posterolateral stability
	Anterior capsule	Important restraint to valgus stress
	Common extensor and flexor origin	Provide valgus and varus stability

important restraint against valgus stresses. The lateral collateral ligament consists of the annular ligament, the radial lateral collateral ligament and the ulnar lateral collateral ligament.

The stability of the elbow joint depends on both static and dynamic stabilisers (also known as constraints). Dynamic stabilisers comprise four muscles (anconeus, brachialis, triceps and biceps) that cross the elbow joint and provide stability via joint compression and proprioception (Miyasaka, 1999). Static stabilisers can be further subdivided into primary and secondary, depending on their contribution to elbow stability (Table 1).

Biomechanics of the elbow

The principal function of the elbow is to place the hand in space, acting as a fulcrum to the forearm.

The normal range of elbow movement is a flexion–extension arc of 0–150°, 75° pronation and 85° of supination. For most activities of daily living the required range of motion was thought to be 30–130° in flexion–extension, 50° supination and 50° pronation (Morrey et al, 1981). However, modern day tasks require a greater range of motion (Sardelli et al, 2011). For example, up to 145° of elbow flexion may be required to use a mobile phone while up to 65° of pronation may be required to use a computer mouse (Sardelli et al, 2011).

Pathophysiology of elbow dislocations

The most common direction of elbow dislocation is posterior or posterolateral (Robinson et al, 2017). There are two postulated mechanisms which may cause an elbow dislocation:

1. Valgus external rotation theory (O'Driscoll et al, 1992): an elbow dislocation occurs as a result of falling onto an outstretched hand with the elbow extended (Figure 1).

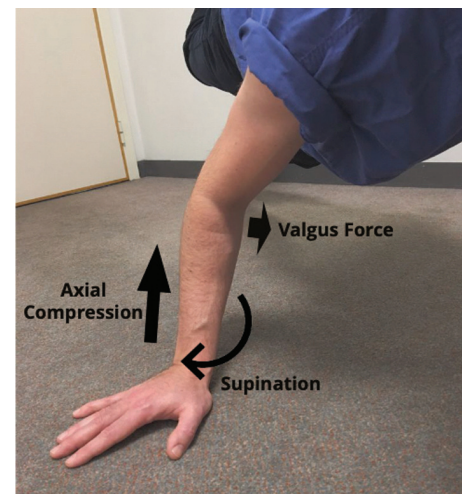


Figure 1. The forces responsible for a dislocation include external rotation of the forearm as the body approaches the ground, axial compression and valgus while the elbow undergoes passive flexion.

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2. Valgus hyperextension theory (Schreiber et al, 2014): the most common arm position at the time of dislocation is forearm pronation, shoulder abduction and forward flexion, with the elbow at near or full extension.

Pathoanatomy

The concept of the circle of Horii considers the stabilisers of the elbow as a ring of structures that sequentially fail, resulting in a dislocation. According to O'Driscoll et al (1992):

1. The first structure that fails is the lateral collateral ligament, specifically the ulnar lateral collateral component
2. An injury of the capsule occurs, leading to a perched ulna where the joint subluxes but does not dislocate
3. Finally, medial structures are injured, namely the posterior medial collateral ligament, the anterior medial collateral ligament and common extensor origin, resulting in a grossly unstable joint.

Although the above model of progression is a useful way of considering this complex injury, it fails to explain all patterns of dislocations and does not apply to all patients. O'Driscoll et al (1992) produced complete elbow dislocation models with an intact anterior medial collateral ligament and Schreiber et al (2014) studied acute elbow dislocations with magnetic resonance imaging and proposed a mechanism whereby the medial side fails first and then the lateral side follows. These studies suggest that this pathology still has unknown variables; 'one size does not fit all' here.

Classification

A pragmatic classification scheme divides elbow dislocations into simple (no concomitant fracture) or complex, where there is an articular or juxta-articular fracture.

Identifying a fracture, often very subtle, in a radiograph of a dislocated elbow can be vital in its management after a reduction has been achieved. When considering complex dislocations, special mention should be made of the 'terrible triad' of the elbow. This pertains to a dislocation of the joint with a lateral ulnar collateral ligament tear, a radial head fracture and a coronoid process fracture. In an otherwise healthy and active patient, this injury should almost invariably be treated surgically in order to achieve the best possible functional outcome.

Dislocations may further be classified according to the direction of displacement of the forearm, relative to the humerus, into:

- Posterolateral
- Posteromedial
- Anterolateral
- Anteromedial.

Presentation

Elbow dislocations are usually evident on initial inspection. The forearm usually dislocates in a posterolateral direction, as opposed to a supracondylar humeral fracture in a child, where the forearm usually displaces posteromedially. An important sign of a dislocation is the loss of relationship between the olecranon and the medial and lateral epicondyles (Figure 2).

All patients presenting with an elbow dislocation should first be assessed for any life- or limb-threatening injuries. The initial history should focus on the mechanism of injury and the time from injury to initial presentation. A thorough neurovascular examination is mandatory. The most common vascular injury during an elbow dislocation is the brachial artery; perfusion should be noted by palpating the radial and ulnar pulses and assessing the capillary refill. Neuropraxia has been reported in up to 20% of elbow dislocations and usually involves either the anterior interosseous branch of the median nerve or the ulnar nerve. The anterior interosseous is a purely motor nerve that innervates the flexor pollicis longus muscle (responsible for thumb interphalangeal flexion) and the flexor digitorum profundus muscle to the index finger (responsible for index finger interphalangeal flexion).

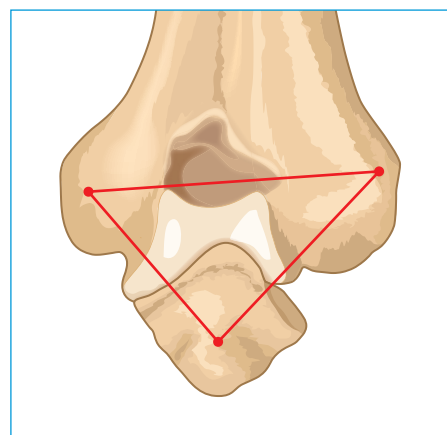


Figure 2. In a fracture, the triangle described between these three points is maintained; in a dislocation this triangle is no longer present.

The ulnar nerve provides sensation to the tip of the little finger and ulnar half of the ring finger, as well as motor function to the intrinsic muscles of the hand. This can be tested by evaluating abduction of the digits through the dorsal interossei. In addition, inspection of the soft tissues may yield valuable information, such as medial bruising as an indication of medial collateral ligament injury (Figure 3).

Imaging

Following physical examination, standard anterior posterior and lateral radiographs of the elbow should be obtained. Initial radiographs are important for confirming the direction of the dislocation and to assess for concomitant fractures. A computed tomography scan may be necessary if associated fractures are suspected or if intra-articular loose bodies are evident on radiographs following reduction (Figures 4–7).

Treatment in the emergency department

Closed reduction of the dislocated elbow should be attempted in the emergency department with the use of conscious sedation and muscle relaxation. The patient is either in a seated or a supine position. In the correct sequence of events:

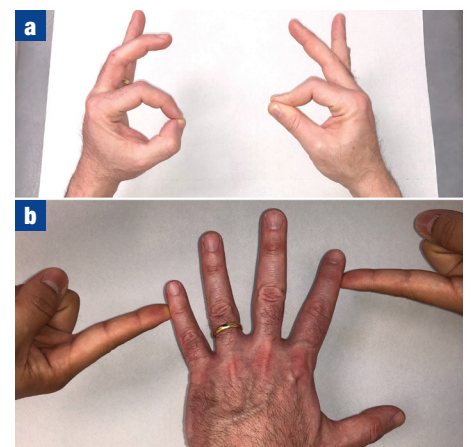


Figure 3. In testing the anterior interosseous nerve, the patient is asked to form an 'O' with the tips of the index finger and thumb. Inability to do so will result in the pulps of the digits apposed instead. **a.** The right hand has an anterior interosseous nerve lesion whereas the left hand has normal anterior interosseous nerve function. Resisted abduction of the digits is made possible through the dorsal interossei, which are innervated by the ulnar nerve. **b.** A normal ulnar nerve.

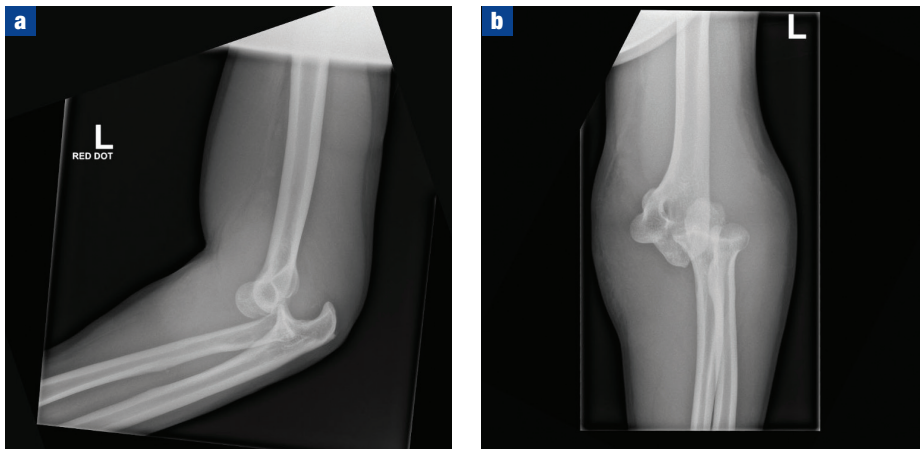


Figure 4. a. Antero-posterior and **(b)** lateral radiographs of simple elbow dislocation. Note the posterolateral direction of the dislocation.

1. An assistant applies longitudinal traction with the forearm in supination
2. The operator should apply both thumbs on the olecranon and interlock the fingers around the distal humerus (Duckworth and Blundell, 2010)
3. The elbow is then gently passively flexed
4. Reduction is palpable and often audible (Figure 8).

Following reduction, the elbow should be taken through a gentle range of motion to assess joint stability and determine optimal position for immobilisation. Most simple elbow dislocations are stable in elbow flexion and forearm pronation and therefore can be placed in an above elbow backslab in 90° of flexion and full pronation.

Post-reduction radiographs are mandatory to confirm the reduction. It is important to note the congruency of the ulnohumeral joint on post-reduction radiographs. An incongruent joint indicates an incomplete

reduction, the presence of gross ligamentous instability or the interposition of soft tissue (neurovascular structures or the capsule) between the articulating surfaces (Armstrong, 2015) (Figure 9).



Figure 6. Imaging of 'terrible triad' injury. Note the radial head fracture and the subtle coronoid process fracture.

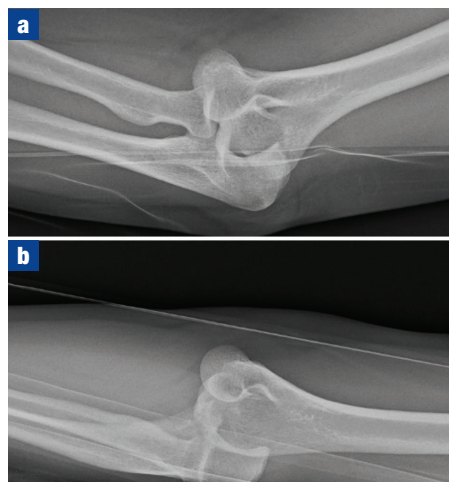


Figure 5. a. Antero-posterior and **(b)** lateral radiographs of posteromedial elbow dislocation.



Figure 7. Imaging of elbow dislocation with a concomitant radial head fracture.



Figure 8. In reducing the elbow, first fully supinate the forearm with the elbow in 20–30° from full extension. Proceed with flexion, while applying direct pressure on the olecranon.



Figure 9. Lateral radiograph of a reduced incongruent elbow. This was found to be secondary to rupture of both the lateral ulnar collateral ligament and the anterior bundle of the medial collateral ligament.

Management after emergency treatment

Patients should be seen in a fracture clinic within 1 week of the injury. They are encouraged to actively move the elbow and an inability to do so may be a sign of significant ligament injury.

Non-operative management

Most simple dislocations do not need to be immobilized for more than 5–7 days (Iordens et al, 2017) and therefore the elbow can usually be placed into a sling at this point. Radiographs should be repeated at this stage to ensure that congruent reduction is maintained.

Operative management

The role of surgery in the management of acute simple elbow dislocations is controversial (Robinson et al, 2017). Surgery may be indicated when:

1. There is evidence of a significant lateral collateral ligament injury
2. There is joint incongruity on post-reduction radiographs
3. There is a concomitant fracture, suggesting residual instability.

Testing the integrity of the collateral ligaments in clinic can be unreliable because of pain preventing a complete examination of the elbow and its stability (Robinson et al, 2017). Magnetic resonance imaging may be a useful adjunct in assessing for ligament injury (Robinson et al, 2017) but is rarely available in the acute setting. As a result, many surgeons prefer to perform

an examination under anaesthesia within 2 weeks of the injury, to assess for stability. Under fluoroscopy, the elbow is assessed in full extension and 30° of flexion, in full pronation and supination, and under varus and valgus stress (Robinson et al, 2017). If there is significant lateral joint line opening on fluoroscopic stress testing, then an acute lateral collateral ligament repair and common extensor repair is performed (Figure 10).

In contrast to simple elbow dislocations, complex fractures or dislocations are commonly associated with residual instability and invariably require surgery. Treatment of these injuries typically involves, in order of sequence (Figure 11):

- Lateral approach and surgical fixation or replacement of the radial head fracture
- Repair of the lateral collateral ligament and possibly also fixation of the coronoid fracture through the lateral approach
- If there is persistent instability despite fixation of the osseous anatomy and lateral ligamentous repair, then the medial collateral ligament will also need to be repaired, through a medial approach
- In rare cases, there still remains residual instability despite addressing the lateral and medial ligaments. In such cases, a spanning external fixator is required for 3–4 weeks in order to allow for soft tissue healing in concentric alignment.

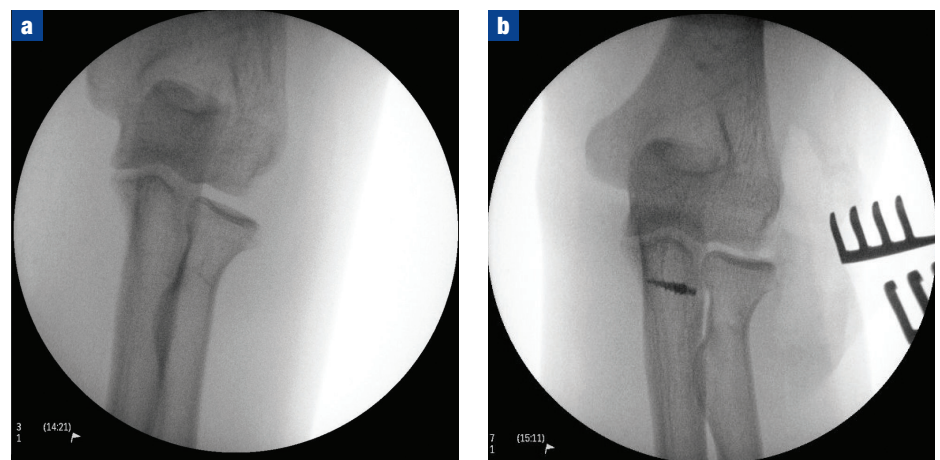


Figure 10. a. Note the lateral joint line opening on varus stressing. b. A repeat varus stress after lateral ulnar collateral ligament repair demonstrates a stable lateral elbow.

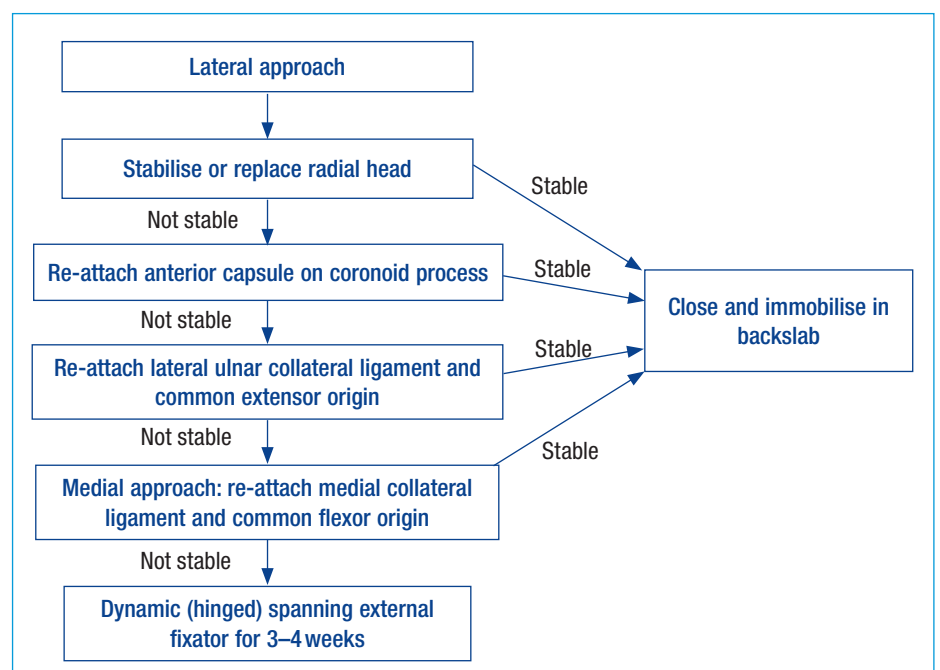


Figure 11. Sequence of operative stabilisation of acute elbow dislocations.

KEY POINTS

- The elbow is the second most commonly dislocated major joint in the body.
- In the majority of cases, elbow dislocations can be treated with immediate reduction in the emergency department and placed in a backslab in 90° of flexion and forearm pronation.
- Dislocations with concomitant fractures or persistent instability following attempted reduction require further imaging with computed tomography.
- Surgery is rarely required for simple dislocations but is invariably necessary for complex dislocations.

These principles were applied in the cases presented in *Figures 12* and *13*, as explained in the figure legends.

Conclusions

Elbow dislocations are common injuries and should be immediately identified and reduced in the emergency department. The presence of a fracture should alert the treating clinician to the potential for residual instability and should prompt further imaging and assessment. Surgery is often required for complex dislocations. **BJHM**

Conflict of interest: none.

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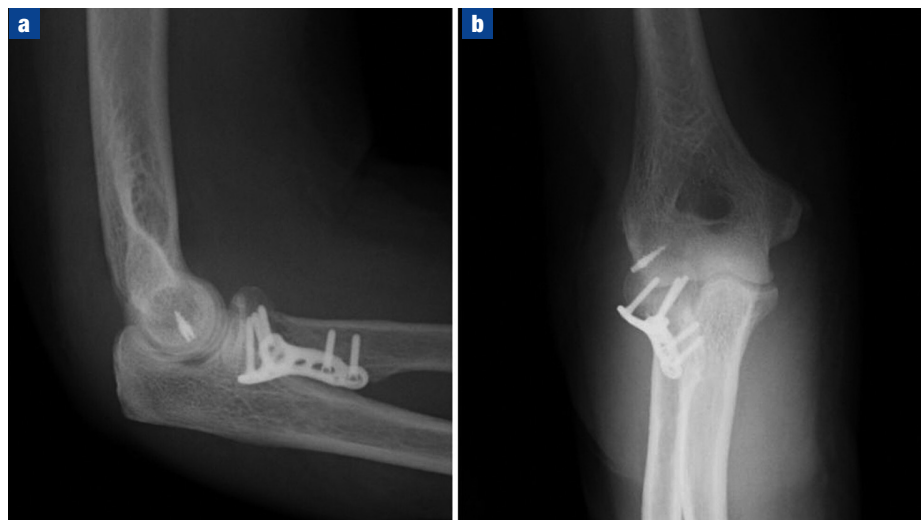


Figure 12. In this case, the radial head was stabilised and the lateral ulnar collateral ligament repaired. This resulted in a stable, congruent joint, as shown on (a) the lateral and (b) antero-posterior (b) radiographs.

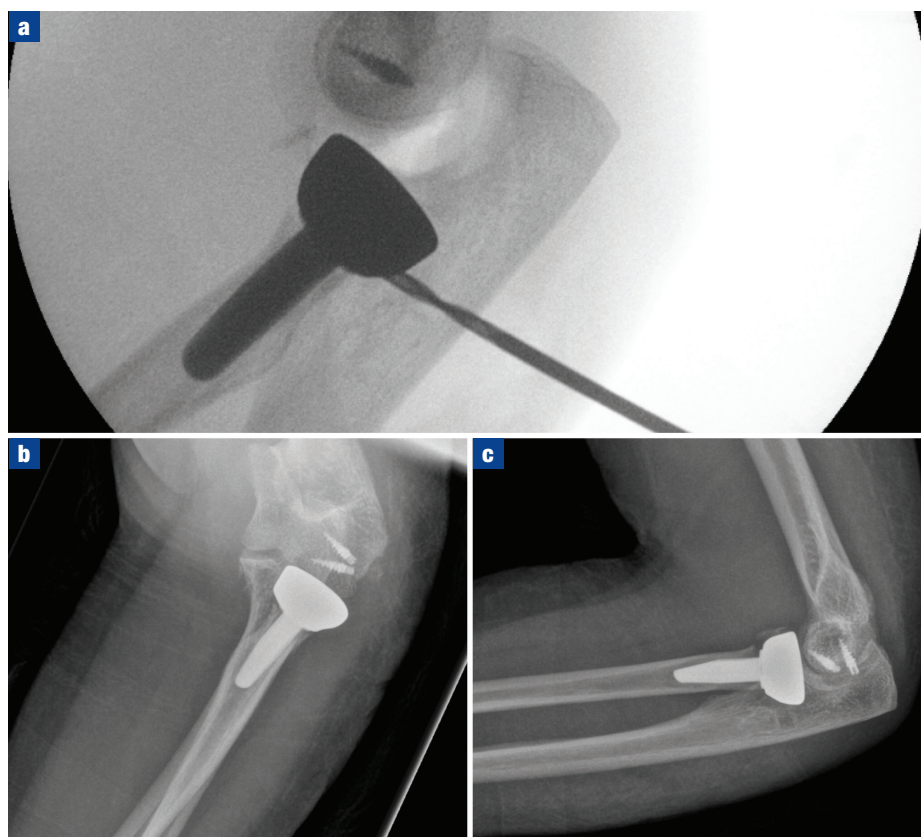


Figure 13. a. This patient remained unstable after a radial head replacement and lateral ulnar collateral ligament repair. The common extensor origin and the anterior capsule were reattached onto the coronoid process and this stabilised the joint as evident in (b) and (c).

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