Injuries of the humeral shaft

Anatomy and function

The humeral shaft is triangular in cross section and runs from just proximal to the insertion of pectoralis major to the metaphyseal flare and supracondylar ridge distally. It is the long bone of the arm connecting the shoulder to the elbow joint.

The midshaft of the humerus has a notable groove posteriorly, the spiral groove. This is the landmark for the course of the radial nerve traversing from the medial to the lateral side of the humerus. The nerve is tethered as it emerges from the groove and pierces the intermuscular septum. It is at this point that it is most prone to injury in humeral shaft fractures (*Figure 1*).

Mechanism of injury

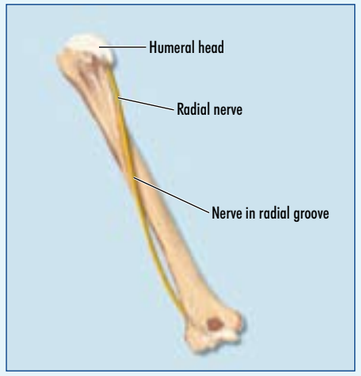
Fractures to the humeral shaft constitute about 1% of all fractures. They occur either as a result of direct blows, which lead to transverse or short oblique fractures with or without a butterfly fragment, or as a result of a fall on the outstretched hand with a twisting injury which causes a spiral fracture.

Clinical picture

Patients present with a history of trauma, pain in the affected limb, swelling and inability to use the limb, and may or may not have an obvious clinical deformity depending on the degree of injury to the soft tissues overlying the bone in the affected individual.

Clinical evaluation of the patient, after taking an appropriate history, should involve assessment of the whole limb. The brachial, radial and ulnar pulses should be evaluated. The functional status of all the nerves should be assessed, most especially the radial nerve.

Figure 1. Humerus showing course of radial nerve in spiral groove.



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Radial nerve injuries

Injuries to the radial nerve occur in 18% of humeral shaft fractures. This is usually either a middle third fracture or a Holstein–Lewis fracture (an oblique fracture of the distal third). The radial nerve supplies the muscles to the extensor compartment of the forearm. Evaluation of the nerves function includes the patient's ability to extend the wrist (extensor carpi radialis longus, extensor carpi radialis brevis, and extensor carpi ulnaris), extend the fingers (extensor digitorum communis, extensor indicis proprius) and extend the thumb (extensor pollicis longus). The sensory distribution of the radial nerve is the skin of the first dorsal web space of the hand.

Injury can either be laceration of the nerve by the fracture fragments, entrapment of the nerve in the fracture site or a traction injury causing a neuropraxia. About 90% of radial nerve palsies following a humeral shaft fracture recover in 3– 4 months. Nerve conduction studies and electromyography can be performed at 4–6 weeks to assess nerve recovery.

Figure 2. a. Anteroposterior and (b) lateral radiographs of spiral comminuted fracture of the right proximal humerus.

Both anteroposterior (AP) and lateral radiographs of the humerus should be requested, with the shoulder and elbow joint included on each (*Figures 2* and *3*).

Classification

Humeral shaft fractures are classified descriptively:

1. Open or closed
2. Position in shaft (proximal, middle or distal third)
3. Transverse, oblique, spiral, segmental
4. Butterfly fragment or comminution
5. Angular, translational or rotational deformity or shortening.

Figure 3. a. Anteroposterior and (b) lateral radiographs of spiral fracture of the right distal humerus.

Knowledge of the muscle attachments to the humerus can help in the understanding of the main deforming forces following fractures at different levels. In fractures above the level of the pectoralis major insertion the proximal fragment tends to abduct and internally rotate because of the pull of the rotator cuff muscles, while the distal shaft is displaced medially and anteriorly by pectoralis major. In fractures below the deltoid insertion the proximal fragment is abducted and pulled forward by deltoid and coracobrachials while the distal fragment is drawn upward. These fractures are commonly displaced and override.

Initial management

If the fracture is open then it should be treated as any open injury with intravenous antibiotics, surgical debridement of the wound and fracture stabilization.

Closed injuries require fracture reduction and immobilization. When the fracture is undisplaced the arm can be immobilized with a U slab (a moulded plaster slab around the medial and lateral aspects of the arm from the shoulder to the elbow). For displaced fractures the application of a hanging cast will help to correct angular deformities.

A hanging cast is useful in fractures that occur distal to the deltoid insertion as it can help in fracture reduction, as described by Caldwell in 1940. It involves using the weight of the forearm in association with a lightweight cast to act as traction to bring about fracture reduction. A lightweight cast is applied from approximately 3 cm proximal to the fracture site to the wrist with the elbow at 90° and the forearm in neutral. A plaster loop is applied at the wrist on the radial border of the forearm to support the sling. The patient should not support the elbow in any way and he/she should sleep upright to maintain the traction force on the fracture. Positioning of the sling loop is important to correct angular deformities at the fracture site.

Once the cast is applied check radiographs are taken. If there is lateral angulation at the fracture site then the loop should be placed on the dorsum of the wrist, if there is medial angulation the loop should be positioned on the volar aspect of the wrist. The rotation of the forearm then allows the angular deformity to be corrected. The length of the sling is also critical. If the sling is too long, allowing the forearm to drop below the horizontal, then the distal fragment will tilt posteriorly leading to anterior angulation at the fracture site. If the sling is too short then the reverse occurs, giving posterior angulation of the fracture. Hanging casts are useful in the initial treatment and reduction of displaced oblique or spiral fractures. If used for transverse fractures they tend to distract the fragments and lead to a non-union.

Definitive management

Treatment of humeral shaft fractures is conservative with a union rate of over 90%.

Functional braces are the most common method of fracture immobilization, either initially or following fracture reduction in a hanging cast for a couple of weeks (Sarmiento et al, 1977). This is a functional orthosis, which brings about fracture reduction by compression of the soft tissue envelope, allowing for elbow and shoulder movement.

Some malalignment of humeral fractures can be accepted without compromising function or cosmetic appearance: 10–20° of anterior angulation, 10–30° of varus and 2 cm shortening do not compromise the limb function because of the wide range of movement that is possible at the shoulder (Klenerman, 1969).

Operative intervention is indicated in some circumstances (*Table 1*). Options are open reduction and internal plate fixation, intramedullary nailing or external fixation (*Figure 4*). BJHM

Table 1. Operative indications for diaphyseal fractures of the humerus

Open fractures
Association with vascular injuries
Segmental fractures
Floating elbow
Pathological fractures
Polytrauma
Failure of conservative management
Radial nerve dysfunction following fracture manipulation

Figure 4. a. Anteroposterior and (b) lateral radiographs of transverse fracture of the right humerus following intramedullary nailing.

KEY POINTS

- Humeral shaft fractures are common injuries.
- Careful evaluation of radial nerve function, both sensory and motor, is required in all patients who sustain humeral shaft fractures.
- The treatment of closed humeral shaft fractures is non-operative.

Conflict of interest: none.

Caldwell JA (1940) Treatment of fracture of the shaft of the humerus by hanging cast. *Surg Gynecol Obstet* **70**: 421

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Sarmiento A, Kinman PB, Galvin EG, Schmitt RH, Phillips JG (1977) Functional bracing of fractures of the shaft of the humerus. *J Bone Joint Surg* **59-A**: 596–601