

Management of common upper limb fractures in adults

Edward Skinner
Veronica Conboy

Abstract

Upper limb fractures are common and can be disabling. We give an account of upper limb fractures in adults commonly encountered in the emergency department or fracture clinic, with an overview of classification, operative and non-operative management.

Keywords Classification; management; upper limb fractures

Introduction

With a lifetime prevalence of nearly 40% and an annual incidence of 3.6%, fractures are common. Upper limb fractures are the most common group within all fractures making up to 51%.¹

General treatment principles

These are the same for any patient presenting with trauma. In cases of systemic or multisystem trauma the patient requires stabilization and fractures require first aid in the form of alignment, splinting and analgesia. In the case of isolated injury and/or where the patient is able, a detailed history is undertaken, with particular reference to mechanism of injury and current social and mobility requirements. Initial examination of the limb with suspected fracture must rule out the presence of open fracture, and assess for neurological or vascular injury and where relevant, compartment syndrome. The injured limb is initially stabilized with a splint, cast or sling and further investigations undertaken, usually starting with plain radiography. Ongoing management in the form of further imaging, definitive stabilization and rehabilitation will follow.

Clavicle fractures

Most clavicle fractures result from a fall onto the affected shoulder, an outstretched hand/arm or a direct blow (less common). Mid-shaft fractures are the most common overall at 65.4%, followed by lateral fractures at 29.7% and medial fractures at 4.5%.²

Neurological and vascular status are relevant, particularly as the brachial plexus and subclavian vessels are in close proximity. The skin overlying the fracture assessed for integrity or skin tenting from fracture fragments. Imaging with simple

radiographs is normally adequate. An anteroposterior (AP) and AP cephalic-angled 15-30° cephalic (Figures 1 and 2) are the usual views.

Classification

Systems in common use include Allman or Neer (subdivided into medial, middle or distal thirds). Robinson devised a more detailed classification.³

Management

Initially clavicle fractures are managed with a sling supporting the elbow to reduce the effect of gravity pulling down the shoulder and the attached half of the clavicle.

For non-operative management, gentle range of movement can start from around 2 weeks with active range of movement generally from 6 weeks, followed by strengthening.

The following should be considered as absolute indications for fixation:

- open fracture
- multiple fractures resulting in a floating shoulder
- symptomatic mal/nonunion
- vascular compromise (in conjunction with vascular review).

Relative indications are brachial plexus dysfunction, more than 2 cm of shortening, high energy mechanism, the poly trauma patient, joint and ligament involvement/extension. These situations have previously been linked with increased incidence of non-union and/or compromised function if not stabilized. Recently published randomized trials^{4,5} indicate that non-union rates are likely to be higher with non-operative management. In addition operative fixation tends to allow earlier return to unrestricted activity.

Surgical fixation may include using a plate in locking or bridging mode (Figure 3), a specific hook plate for distal fractures where the bone fragment is too small for secure hold (Figure 4), or an intramedullary device. For very distal fractures it may be pertinent to consider this injury as akin to an acromioclavicular dislocation and manage accordingly; this is outside the scope of this article.

Post operative rehabilitation will depend on mode of fixation. Hook plates require removal at 12 weeks; otherwise plate removal is not required unless prompted by adverse symptoms.

Proximal humerus fractures

These are the third most common fractures in the elderly, and more common in women.

Assessment/initial management

The axillary nerve is at risk of injury and status requires careful documentation. Imaging should consist of at least two views, normally an AP and a lateral scapular 'Y' view, an axillary view can be particularly helpful if the patient is able to tolerate the examination. This is very much a three-dimensional problem and CT scan may be required as an adjunct to plain radiography. Concurrent dislocation adds to complexity. It is recommended in this case that the reduction be undertaken under good-quality sedation/anaesthetic and by an experienced clinician as iatrogenic nerve injury or further displacement are risks.

Edward Skinner MRCSEd is an ST4 in Orthopaedics at Torbay Hospital, Torquay, UK. Conflicts of interest: none declared.

Veronica Conboy BSc FRCS (Orth) is a Consultant Orthopaedic Surgeon at Torbay and South Devon NHS Foundation Trust, Torquay, UK. Conflicts of interest: none declared.



Figure 1 Clavicle fracture in AP.



Figure 2 Clavicle fracture in cephalic.



Figure 3 Clavicle plate.



Figure 4 Clavicle hook plate.

Classification

These fractures can be classified using the Neer classification (Figure 5).⁶ For fragments to be considered displaced they have to be displaced by more than 1 cm or angulated by more than 45°. As seen in Figure 5, a Neer one part fracture is undisplaced,

whereas a two part fracture has one displaced part and a four part fracture has three displaced parts with respect to the fourth.

Management

In planning management it is necessary to take into account the functional demands, social needs and physiological reserve of the patient as well as the fracture pattern. Non-operative management is the mainstay of treatment in the elderly patient with fragility fracture, in the form of a collar and cuff (gravity aids fracture alignment) for 2–3 weeks followed by progressive active rehabilitation. In a high-demand patient with 100% displacement or a comminuted fracture operative management may be a better option. The Proximal Fracture of the Humerus: Evaluation by Randomisation (PROFHER) trial has shown no clinical or statistical difference in managing displaced proximal humeral fractures non-operatively or operatively.⁷ This was a study of a heterogeneous cohort of patients with displaced fractures and does not suggest that operative management is contraindicated in this patient group; however, it is a salutary reminder that the outcome of operative fixation or hemiarthroplasty can have poor functional outcomes, despite good X-ray appearances, and non-operative management can have a reasonable functional result without showing an anatomically reduced fracture. The key is that shoulder function is very adaptable with a good global range of motion, and the outcome most strenuously to be avoided is stiffness.

If it is undertaken, operative management can be with plate fixation, screw fixation, intramedullary nail or joint replacement. This should be considered with severe soft tissue compromise, neurovascular injuries, pathological fractures and cases of multiple injuries (to benefit weight bearing/mobilization). In addition the vascularity of the humeral head should be considered: in four part fractures this will always be compromised and with significant displacement of this fragment revascularization is less likely. Postoperative rehabilitation following fixation is usually a period of 2–3 weeks of reduced range movement in a sling, followed by gentle active-assisted mobilization then active mobilization at 6 weeks.

Humeral shaft fractures

Humeral shaft fractures account for 3–5% of all fractures. They are generally of a bimodal distribution: elderly patients with low energy trauma and younger patients with high energy trauma.

Initial assessment/management

When assessing patients with humeral shaft fractures the nerve at greatest risk of injury is the radial nerve as it travels around the humerus in the spiral groove. This can be assessed by checking sensation at the dorsal first web space and motor function of the extensors at the fingers and wrist. It is injured in up to 16% of cases. Although function will normally recover, there is the potential that the nerve is involved within the fracture site and this may need to be explored. Radial nerve injuries are particularly prevalent in fractures at the junction of the middle and distal thirds of the humerus (the Holstein–Lewis fracture⁸), in which the nerve is caught over the sharp edge of the distal fragment as it traverses the lateral side of the humerus.

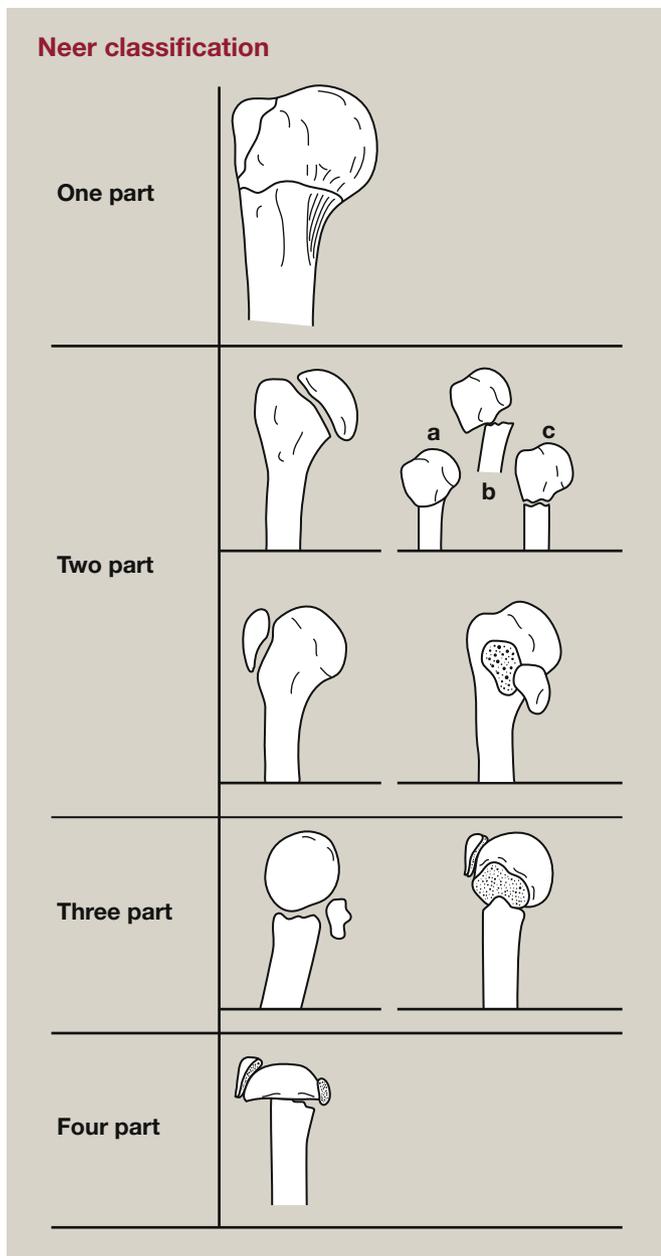


Figure 5

Imaging of these fractures is straightforward. An AP and lateral view will suffice. Initial immobilization may involve casting, bracing or a simple sling.

Classification

The main classification system used is the AO classification, as shown in Figure 6. It may also be helpful to describe the location by dividing the shaft into thirds as this is not included in the classification and this may have a bearing on the management.

Management

Non-operative management in a form of brace has very good results with low non-union rates. Given the excellent range of motion at the shoulder it is possible to compensate functionally for moderate mal-union: 20° of anterior bowing, 30° of varus

angulation and 15° of rotation can be accepted with up to 3 cm of shortening.

Some absolute indications for operative management include:

- open fractures
- vascular injury
- neurological injury with high index of suspicion for laceration or ongoing compression
- polytrauma
- floating elbow (fracture of humerus with an ipsilateral forearm fracture)
- progressive radial nerve deficit
- skin/soft tissue not amenable to bracing
- pathological fractures
- failed non-operative management.

Relative indications include inability to achieve or maintain reduction within usually acceptable limits. Surgery also gives the benefit of early controlled weight bearing for those needing to use walking aids, however this does depend on the patient, bone quality and fixation.

Operative management is either with plate fixation or an intramedullary nail (Figure 7). There are pros and cons to both plate fixation and intramedullary nailing. Nailing has smaller incisions, lower infection rate, and are used in pathological fractures when the whole bone needs to be stabilized. Pitfalls include the need to transgress the rotator cuff during insertion with resultant dysfunction, and only relative rotational stability. Plate fixation has marginally higher union rates. There have been studies into minimally invasive plate osteosynthesis (MIPO) techniques with good results, where two incisions are made either side of the fracture and the plate passed between them.⁹

Proximal third diaphyseal fractures are distinct from mid shaft fractures. A recent study has shown that it is very common (76%) for proximal third fractures to extend into the humeral head.⁸ This needs to be taken into account in interpretation of imaging and implant selection.

Distal third fractures, including Holstein–Lewis fractures, may be better managed with plate fixation, especially if the fracture extends into the elbow. This allows exploration of the radial nerve during fixation and allows better control of the fragments in the most distal portion of the shaft.

Distal humerus fractures

Fractures around the elbow account for 7% of all adult fractures, and distal humerus fractures account for 30% of that number.¹⁰ Distal humerus fractures are also of bimodal distribution, with peaks most likely related to younger men following high energy trauma and older women following low energy trauma.

Assessment/initial management

Assessment of these injuries should include a particularly careful assessment of neurovascular status: the brachial artery as well as radial, ulnar and median nerves are at risk of injury. Imaging should include AP and lateral radiographs of the humerus and elbow as well as the forearm. CT scans are also often performed for preoperative planning. Considered planning of fixation is particularly important for comminuted type C fractures.

Initial management should include reduction and stabilization in an above elbow plaster or brace.



Figure 6



Figure 7 Humeral nail.

Classification

The most commonly used and most comprehensive classification system is the AO classification (Figure 8).

Management planning is dictated by the functional needs of the patient and degree of displacement. Non-operative management involves holding the elbow in flexion using brace or sling for 2 to 3 weeks followed by progressive mobilization. Very elderly patients with undisplaced two-part fractures need close watching if managed non-operatively as there is a higher risk of late displacement and symptomatic non-union.

There are two main options when considering operative management. Open reduction/internal fixation (ORIF) and total elbow arthroplasty (TEA). ORIF should be considered in all patients for whom surgery is indicated; however, in the case of the elderly patient with poor bone quality this can be challenging. For patients with fractures that are deemed non-reconstructable TEA is the other surgical option. TEA does carry long term risks for loosening, periprosthetic fracture and limited survivorship as well as having a permanent lifetime 5-lb lifting limit. However for the frail elderly patient it is a definitive single surgical procedure with early functional recovery.

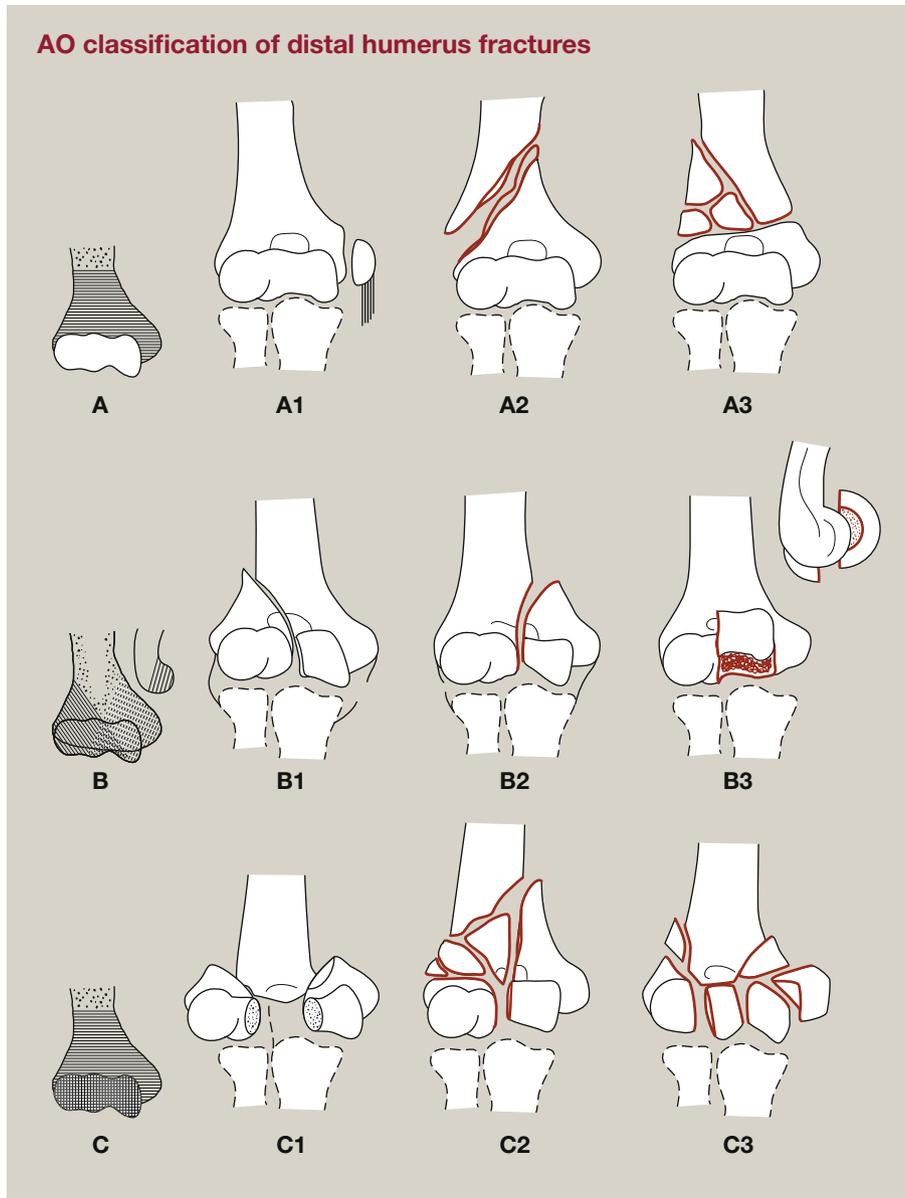


Figure 8

Fixation of intercondylar fractures is achieved using perpendicular or parallel double plating. A biomechanics study has shown that parallel plating demonstrated increased mechanical stability; however it is not clear that that has a bearing on clinical outcomes. The decision of configuration should be made related to fracture pattern and surgeon preference.

Forearm fractures

Forearm fractures are less common than other upper limb fractures in adults. Mechanism of injury may be axial load from a fall, or from a direct blow.

Initial assessment/management

Assessment and clear documentations of neurological and vascular status are important. Compartment syndrome should be considered in high energy trauma. AP and lateral radiographs are

adequate initial investigation; it is very important to have the distal radial ulnar joint (DRUJ) and elbow joint in both AP and lateral.

Classification

Broadly speaking there are three main fractures in the forearm. Isolated single bone fracture, both bone fracture, fracture dislocations (Monteggia/Galeazzi). Distal radius fractures will be covered separately.

A Monteggia fracture (Figure 9) is an ulna shaft fracture with associated dislocation of the radial head whereas the Galeazzi fracture (Figure 10) is a fracture of the radial shaft with associated disruption/dislocation of the DRUJ. Isolated ulna or radial shaft fractures should only be diagnosed after excluding an associated dislocation.

When considering management of these injuries, the forearm should be treated as a joint as well as a long bone, meaning that



Figure 9 Lateral view of a Monteggia fracture, AP.

anatomical reduction of the fracture is desirable. Rotational dysfunction is a risk if this element is overlooked. Isolated ulnar fractures are commonly caused by a direct blow whereas isolated radial fractures from a rotational force. The isolated ulnar fracture, even if undisplaced, has a relatively high risk of non-union if managed non-operatively, and this should be kept in mind when planning management. If either single bone fracture is unstable it should be managed with open reduction and internal fixation.

Deformed or displaced bone, Galeazzi and Monteggia fractures should all be treated operatively. With simple fractures compression plating will be feasible to achieve anatomical reduction and subsequent primary bone healing. In the case of the fracture dislocation it will allow appropriate length to be



Figure 11 A Colles' fracture.



Figure 10 Lateral views of a Galeazzi fracture.

determined to stabilize the affected joint; this can be difficult to achieve in complex/comminuted fractures. More often than not when the fracture is fixed the affected joint is stabilized. If that is not the case additional stabilization of the joint is required either with soft tissue repair or stabilization with a wire. Mobilization of the limb after fixation depends largely on the fracture patterns and fixation. Both bone fractures with absolute stability following plate fixation can be mobilized as early as one week after soft tissue recovery. The complex fractures and fracture dislocations may require additional protection or limited rehabilitation in the early weeks.

Distal radius fractures

This is the most common upper limb fracture in middle age to elderly adults. It is more common in women when over the age of 65. Normally sustained from a fall but can be related to higher energy trauma in younger patients.



Figure 12 A volar Barton's fracture.

Initial assessment/management

As always, a good history including mechanism, exclusion of open fracture and documentation of neurological status, are required. Initial immobilization requires a padded splint, backslab or cast. AP and lateral radiographs are sufficient for initial diagnosis and management; CT may be required for pre-operative planning in complex cases.

Classification

A number of systems are in use: Fernandez system based on mechanism of injury, Frykman's based on joint involvement, the AO system or commonly used eponyms.¹¹

The most common is a Colles' fracture: an extra-articular dorsally displaced distal radius fracture (Figure 11). The next is a Smith's fracture which is the reverse of a Colles as it is volar displacement of the distal radius. The third is a Barton's fracture (Figure 12). This is an intra-articular fracture with associated dislocation of the radiocarpal joint. It can be either volar or dorsal in nature, which is describing the displacement of the fracture and the carpus. These are inherently unstable injuries. There are of course intra-articular fractures that do not have an associated dislocation.

In particularly complex or comminuted fractures a CT scan may be beneficial for preoperative planning.

Management of distal radius fractures varies. Options include splints, casts, Kirschner wires (K-wires) and fixation with buttress or locking plates. Stable and simple fractures are likely to be treated conservatively with a cast following manipulation to reduction under regional or general anaesthesia. It should be noted that surprisingly good function can be achieved with significant malunion of the distal radius, and the age and functional demands of the patient are often more significant than X-ray appearances in deciding management. Younger patients with high functional demands and/or those with incongruent articular surfaces require more stringent re-education criteria. Following reduction ongoing monitoring with repeat radiographs is required until union.

Unstable fractures may be amenable to K-wire or plate fixation. Despite increasing popularity of locked volar plates in recent years, a recent randomized control trial looking at K-wire versus plate fixation for dorsally displaced distal radius fractures showed no difference in patient outcomes or complications between groups.¹²

Volar Barton type fractures, as unstable joint injuries, need operative fixation. They may be suitable for simple buttress plating, but stability would need to be assessed on the operating table.

Medium-term complications of wrist fractures include extensor pollicis longus rupture, paradoxically more common in undisplaced fractures in the elderly, and CRPS. ♦

REFERENCES

- 1 Curtis EM, Van der velde R, Moon RJ, et al. Epidemiology of fractures in the United Kingdom 1988-2012: variation with age, sex, geography, ethnicity and socioeconomic status. *Bone* 2016; **87**: 19–26.
- 2 The National Institute for Health and Care Excellence (NICE). Fractures (non-complex): assessment and management: NICE Guideline [NG38]. 2016. Available from: <https://www.nice.org.uk/guidance/ng38/resources/fractures-noncomplex-assessment-and-management-pdf-1837399081669> (accessed 4 November 2018).
- 3 Robinson CM. Fractures of the clavicle in the adult. Epidemiology and classification. *J Bone Jt Surg Br* 1998; **80**: 476–84.
- 4 Qvist AH, Væsel MT, Jensen CM, Jensen SL. Plate fixation compared with nonoperative treatment of displaced midshaft clavicular fractures: a randomized clinical trial. *Bone Jt Lett J* 2018; **100-B**: 1385–91.
- 5 Ahrens PM, Garlick NI, Barber J, Tims EM. The clavicle trial: a multicenter randomized controlled trial comparing operative with nonoperative treatment of displaced midshaft clavicle fractures. *J Bone Jt Surg Am* 2017; **99**: 1345–54.
- 6 Neer CS. Displaced proximal humeral fractures. I. Classification and evaluation. *J Bone Joint Surg Am* 1970; **52**: 1077–89.
- 7 Rangan A, Handoll H, Brealey S, et al. Surgical vs nonsurgical treatment of adults with displaced fractures of the proximal humerus: the PROFHER randomized clinical trial. *J Am Med Assoc* 2015; **313**: 1037–47.
- 8 Stedtfeld HW, Biber R. Proximal third humeral shaft fractures – a fracture entity not fully characterized by conventional AO classification. *Injury* 2014; **45**(suppl 1): S54–9.
- 9 Jiang R, Luo CF, Zeng BF, Mei GH. Minimally invasive plating for complex humeral shaft fractures. *Arch Orthop Trauma Surg* 2007; **127**: 531–5.
- 10 Angelen J. Distal humerus fractures. *J Am Acad Orthopaedic Surgeons* 2005; **13**: 291–7.
- 11 Shehovych A, Salar O, Meyer CE, Ford DJ. Adult distal radius fractures classification systems: essential clinical knowledge or abstract memory testing? *Ann Royal Coll Surgeons Engl* 2016 Nov; **98**: 525–31.
- 12 Costa ML, Achten J, Plant C, et al. UK DRAFFT: a randomised controlled trial of percutaneous fixation with Kirschner wires versus volar locking-plate fixation in the treatment of adult patients with a dorsally displaced fracture of the distal radius. *Health Technol Assess* 2015; **19**: 1–124 [v-vi].