(ii) Distal humeral fractures — where are we now?

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Abstract

Distal humerus fractures are rare complex injuries. Their management is evolving. A working knowledge of the current evidence surrounding their management is useful for all practising orthopaedic surgeons.

The methods for treating these fractures have changed due to the increase in the range of osteosynthetic devices available and the use of total elbow replacement as a viable option.

In this article we discuss some of the issues and controversies and review the literature relating to their epidemiology, management and outcomes.

Keywords distal; elbow; fracture; humerus; intra-articular

Introduction

Distal humeral fractures in adults are rare injuries, with an incidence in the UK of 5.7 per 100 000 per year in those aged 12 and over. They constitute only 2% of fractures in adults. This incidence was calculated using detailed population census information supplied by the General Register of the Scottish Office. Over one-third of patients sustained a bicondylar fracture. The mean age of patients sustaining distal humeral fractures was 48.4 years. The incidence peaks in the young male population who are injured through sport and road-traffic accidents and in the elderly female population through simple falls. In males, the incidence declined with age until the seventh decade, when it increased again. In females, the incidence dropped slightly between the second and third decades, then increased with age. Less than 10% of the fractures were open, the majority of which were associated with the more severe fracture type.[1]

A study from Finland demonstrated that the incidence of distal humeral fractures in osteoporotic patients is increasing and is likely to continue to do so with an ageing population.[2] This group can be complex to treat due to compromised soft tissues and various co-morbidities. It is generally agreed that intra-articular fractures are best treated by stable anatomical internal fixation that allows early motion and restoration of function, although this is not always possible in the elderly. The use of elbow arthroplasty as the primary treatment is therefore gaining popularity.[3]

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Classification

Fractures of the distal humerus are classified according to AO:

- Supracondylar
- Transcondylar
- Intercondylar
- Fractures of both condyles
- Fractures of the articular surfaces (capitellum and trochlear)
- Fractures of the epicondyles

Anatomical considerations

The blood supply is important when considering the management of these injuries. Yamaguchi et al investigated the extra-osseous and intra-osseous arterial anatomy of the human adult elbow.[4] They studied 22 fresh adult cadaveric upper extremities and demonstrated consistent patterns of extra-osseous and intra-osseous vascular anatomy, which were organized into three vascular arcades: medial, lateral, and posterior. Watershed areas were apparent between the blood supplies to the medial and lateral aspects of the distal end of the humerus. The intra-osseous circulation of the elbow was derived mainly from perforating vessels that arise from neighbouring extra-osseous arteries. The capitellum and trochlea lateral to the trochlear groove were supplied by vessels penetrating the posterior portion of the lateral epicondyle and radiating anteriorly and medially.

A similar cadaveric study by Kimball et al again outlined the intra-osseous blood flow to the distal humerus.[5] They used the same techniques as Yamaguchi et al to study the intra-osseous vascular anatomy of nine fresh-frozen upper extremity cadaveric specimens. A large single nutrient artery entering the anterior medial diaphysis was consistently identified. The lateral column was supplied predominately by posterior segmental vessels, whereas the medial column was supplied by anterior and posterior segmental vessels. The posterior dominance of the blood supply to the distal lateral humerus suggests that when fractures are fixed with posterolateral plates, surgery should be performed with minimal periosteal elevation or, alternatively, plates should be avoided in this region to avoid damage to these perforating vessels.

Management

In the past these injuries were often managed closed with traction or manipulation and casting. Biomechanical advances in osteosynthesis have meant that more and more of these injuries can be treated with internal fixation and this has been shown to be associated with improved outcomes in many cases. A case series carried out by Zagorski et al clearly highlighted the benefits of anatomical reconstruction and rigid internal fixation.[6] They reviewed a consecutive series of 42 comminuted intra-articular bicondylar fractures of the distal humerus, between July 1975 and October 1981. Twenty-five patients underwent primary open reduction and internal fixation (ORIF), 11 patients were treated conservatively, four patients were treated with skeletal traction followed by open reduction and internal fixation, and two patients underwent primary excision arthroplasty. The average length of follow-up was 26 months with a range of 9–62 months. Patients were evaluated as to their functional results using the criteria defined by Bickel and Perry.[7] Seventy six percent of patients treated by open reduction and internal fixation had an excellent or good result whereas those not treated with primary ORIF, only 8% had an excellent or good result. This paper stressed the importance of anatomic reduction, as 88% of those patients with satisfactory anatomic reduction following internal fixation achieved excellent or good results.

Plate fixation of distal humeral fractures

There have been many methods described to fix these fractures. Cadaveric studies assessing the stability and fatigue strength of different constructs include that by Helfet et al.[8] Using cadaveric upper limbs they were apply to assess rigidity of screws alone, 'Y' plates, reconstruction plates, tubular plates and a mixture of reconstruction and tubular plates. Simulated fractures were created and the constructs tested in flexion and extension although not in any other plane. Double plating regardless of the type of plate was found to be the most rigid and improved fatigue failure profiles.

Plate configuration has also been a topic of much interest and research. Traditionally plates have been positioned in a perpendicular configuration, with a plate on the medial border and a plate at 90° positioned posterolaterally (Figure 1). However, Arnander et al[9] investigated the effect of positioning the plates parallel to each other on the medial and lateral borders. Repeated loading of epoxy resin humeri with simulated fractures revealed an increase in rigidity with this configuration compared with the more traditional perpendicular positioning.

Again Stoffel et al,[10] demonstrated through means of a cadaveric study increased stability in axial compression and external rotation through the use of locked parallel plates over a perpendicular plate construct.

Which plate to choose?

Although a rigid plate is preferable, DCP plates have fallen out of favour due to their bulky nature and difficulty in contouring. The use of 1/3 tubular plates allowed better contouring and were of lower profile, but did not allow sufficient stability. A series by Henley et al[11] in 1987 warned against their use in fractures with diaphyseal extension or comminution. In their case series of 33 patients they had five fixation failures with one-third tubular plates, leading to malunion and non-union. The patients with non-union subsequently went on to union following stabilization with 3.5 dynamic compression plates.

More recently locking plates have been developed and specifically locking plates contoured to the distal humerus. Schuster et al used an intra-articular distal humerus fracture cadaveric model to investigate the bone-implant-anchorage of three different plates using a 90-degree double-plate configuration.[12] The plates used were conventional reconstruction plates, locking compression plates, and distal humerus plates. All cadaveric specimens underwent peripheral quantitative computed tomography to calculate bone mineral density, so further information could be gleaned from performance in poor bone quality. Initially stiffness was measured in static extension and static flexion, followed by failure with cyclic flexion. Stiffness values in extension and in flexion were not significantly different between the three plates. In all groups, the fixation technique provided sufficient stability to avoid any intra-articular displacement during the entire test duration. There were no failures in the distal humerus plate group, which was significantly better than the conventional reconstruction plate group. Differences in the failure rate between the locking compression plate group and the conventional reconstruction plate group were not significant. In cases of poor bone mineral density, the distal humerus plates and locking compression plates provided superior resistance against screw loosening as compared to the conventional reconstruction plates, with the distal humerus plates performing better than the locking compression plates.

Parallel plating (Figure 2)

The use of parallel plates has been popularized by O'Driscoll.[13] The concept was developed in response to the theory that the lateral column fixation will fail first due to varus forces acting on

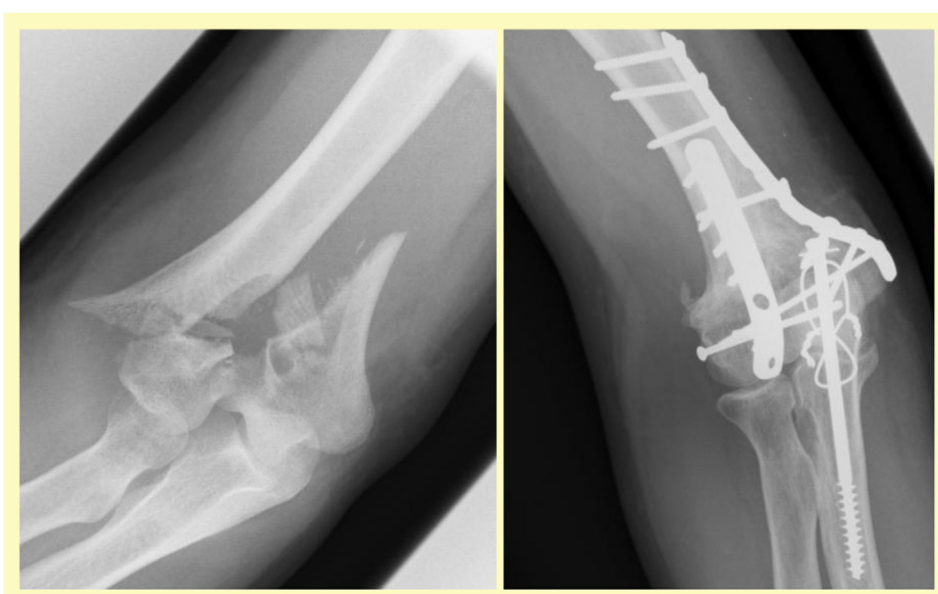

Figure 1 Radiograph of a comminuted intra-articular distal humerus fracture. Post-operative radiograph demonstrates 90° configuration of humeral plates. The reduction of the fracture was performed through an olecranon osteotomy which was then stabilized with an intramedullary screw and tension band.