Distal Humerus Fractures

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8.1 Introduction

Distal humerus fractures display seldom but severe injuries because of the complex distal humerus anatomy and often comminuted fracture types. They account for approximately 2–3 % of all fractures and for 17–30 % of fractures around the elbow. In younger patients, there is a predominance among males. The mechanism of accident is mostly a high-energy trauma in this population. In contrast, among elderly patients, distal humerus fractures concern mostly women with osteoporotic bone. Fractures are caused by a low-energy trauma such as a fall from standing height onto the outstretched or slightly flexed arm. These fractures are often severely comminuted. Because of the thin soft tissue envelope, many distal humerus fractures are open and additional injuries are common. The topographical proximity to the three main nerves and brachial artery are can lead to relevant lesions of these structures.

8.2 Diagnosis

The patient presents with severe pain at and possible deformation of the struck elbow. The elbow is checked for open wounds. Nerve and vessel injuries are excluded. Lateral and anteroposterior (a.p.) radiographs of the injured region are mandatory. The radiocapitellar view may be helpful in case of coronal shear fractures. For intra-articular fractures, a computed tomography (CT) scan is recommended to improve understanding of fracture morphology and preoperative planning. Duplex sonography and angiography are performed when an arterial injury is assumed. Alternatively, a CT angiography can be performed.

8.3 Classification

Although many different classifications have been published for distal humerus fractures, the AO classification is still the most commonly used classification system. Extra-articular fractures are graded as type A, intra-articular fractures affecting one column as type B, and intra-articular fractures affecting both columns as type C. Each type is subdivided in three more subtypes (Fig. 8.1).

Coronal shear fractures represent a special entity of distal humerus fractures. Dubberly in 2006 introduced a classification system based on three fracture types, that aims to give treatment guidelines:

Type I: capitellum fracture with optional involvement of lateral trochlear ridge

Type II: capitellum and trochlea fracture as on piece

Type III: capitellum and trochlea fractures as separate fragments, optionally comminuted

These fractures were further subdivided depending on the absence (A) or presence (B) of dorsal condylar comminution.

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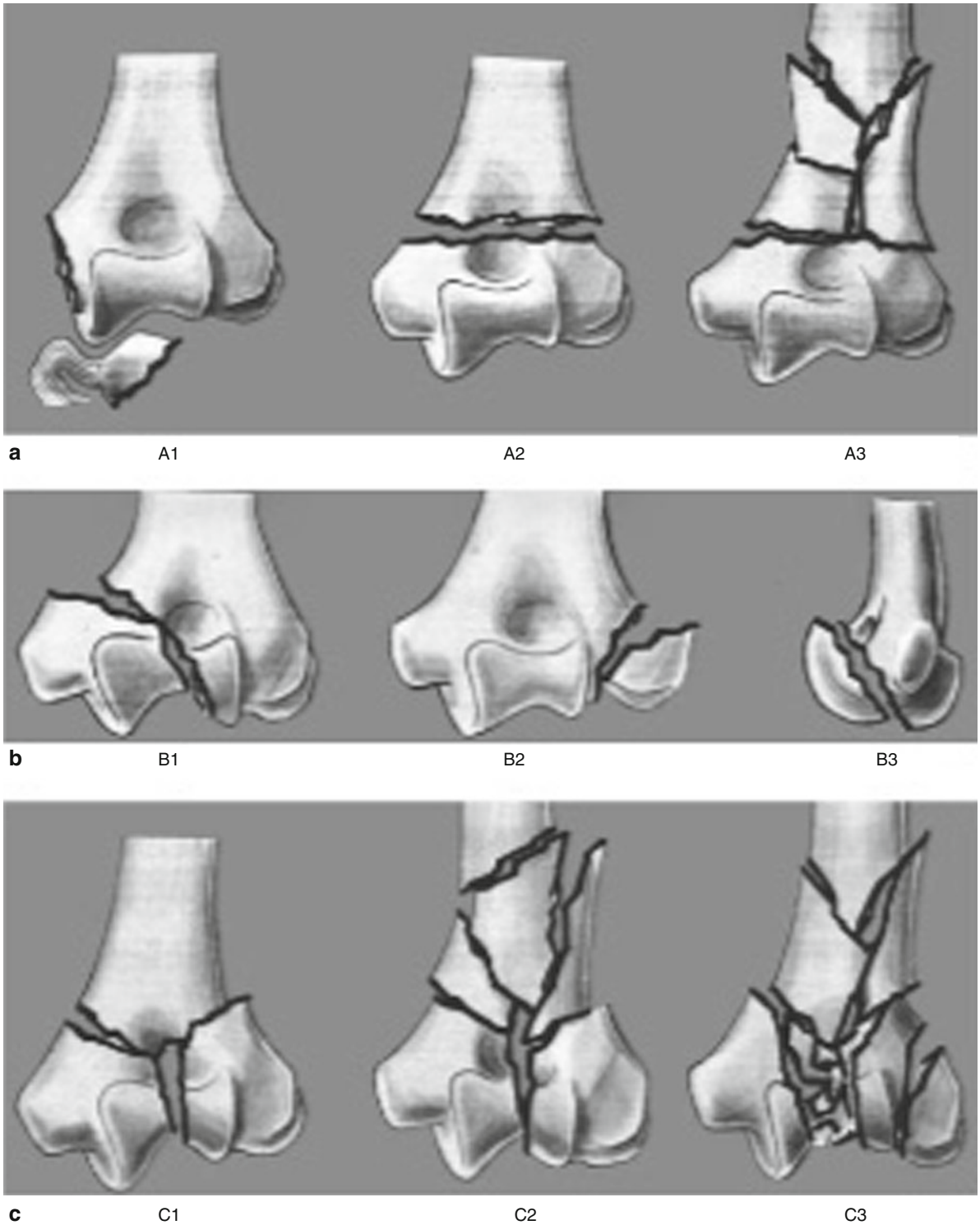


Fig. 8.1 AO-Classification of distal humerus fractures

8.4 Treatment

8.4.1 Conservative Treatment

As almost all adult distal humeral fractures are displaced, there is little place for conservative treatment. Because of the joint proximity of these fractures, functional bracing is not possible and joint immobilization of 6 weeks ends up in joint stiffness. Therefore, indications for conservative treatment are restricted to general contraindications for surgery, such as severe comorbidities or neurological diseases with an immoveable upper extremity.

In the seldom case of non-displaced coronal shear fractures a conservative treatment may be possible. A short period of immobilization should be followed by early functional treatment. However, close-meshed radiographic controls will be necessary to exclude secondary displacement. As coronal shear fractures of the distal humerus represent articular fractures the indication to ORIF should be made generously to provide an anatomic and stable elbow.

8.4.2 Operative Treatment

The aim of surgical intervention is the restoration of a painless and functional stable elbow joint to assure patients' independence in activities of daily living. Usually, these goals are achieved by open reduction and internal fixation (ORIF) with anatomical reconstruction of the articular surface of the elbow. To achieve these goals and to allow early physiotherapy, ORIF should be performed with double plate osteosynthesis. K-wire fixation does not provide sufficient stability. External fixation is used in multiple trauma patients and severe soft tissue injuries, which precludes an early internal fixation. Change to ORIF should be performed as early as possible to prevent elbow stiffness resulting from immobilization. Hinged external fixation may be helpful in case of insufficient stability despite adequate ORIF.

8.4.2.1 Open Reduction and Internal Fixation

Distal humerus fractures should be fixed as soon as possible within 1–2 weeks. Open fractures represent a case of emergency and should therefore be operated immediately. Surgical approach and implant use depend on the fracture type.

Type A.1: These extra-articular epicondylar fractures represent mostly avulsion fractures of the collateral ligaments or forearm muscles. These fractures are often displaced and, even if undisplaced, would need long-term immobilization in case of conservative treatment. Therefore, ORIF with lag screws is recommended using a lateral or medial approach. Using the medial approach, the ulnar nerve should always be exposed to avoid nerve damage.

Type A.2 + 3: These extra-articular metaphyseal fractures should be fixed through a dorsal approach using a double plating technique, which will be described in detail later. A minimum of three bicortical screws proximal and two screws distal to the fracture in both plates should be placed to provide sufficient stability. Monocortical screws may be used with locking plates. An olecranon osteotomy is not required. In selected cases, antegrade unreamed humeral nailing can be performed, if the distal fragment is large enough.

Type B.1 + 2: These intra-articular monocondylar fractures may be stabilized through a medial or lateral approach with lag screws in case of good bone quality. In case of osteoporotic bone, single plate osteosynthesis should be performed, optionally with a locking plate.

Type B.3: Several operative treatment options have been described for coronal shear fractures of the distal humerus. In former times fragment excision has been reported to gain good results. However, current literature supports ORIF whenever possible to restore the lateral column of the elbow. Fragment excision should only be performed in case of very small bony fragments or thin cartilaginous bowls. Excision of bigger capitellar fragments may lead to valgus instability – especially in medial collateral ligament insufficient elbow.

ORIF represents the treatment of choice in order to reconstitute an anatomic and stable elbow. According to Dubberly´s classification type I fractures can be faced through a lateral muscle splitting approach. Type II fractures require a more extensive lateral approach with lateral collateral ligament division in order to expose the lateral trochlea. Type III fractures necessitate a dorsal approach with performance of an olecranon osteotomy to ensure a sufficient overview of the whole distal humerus articular surface. In case of posterior comminution autologous bone grafting may be considered to support osteosynthesis. Several implants have been described for the maintenance of capitellar and trochlear fractures such as K-wires, cortical and cancellous screws of various diameters optionally in lag screw technique, bioabsorbable screws and pins, and headless compression screws. Biomechanical studies support the use of 4.0 mm partially threaded cancellous screws in posteroanterior direction as these could provide higher

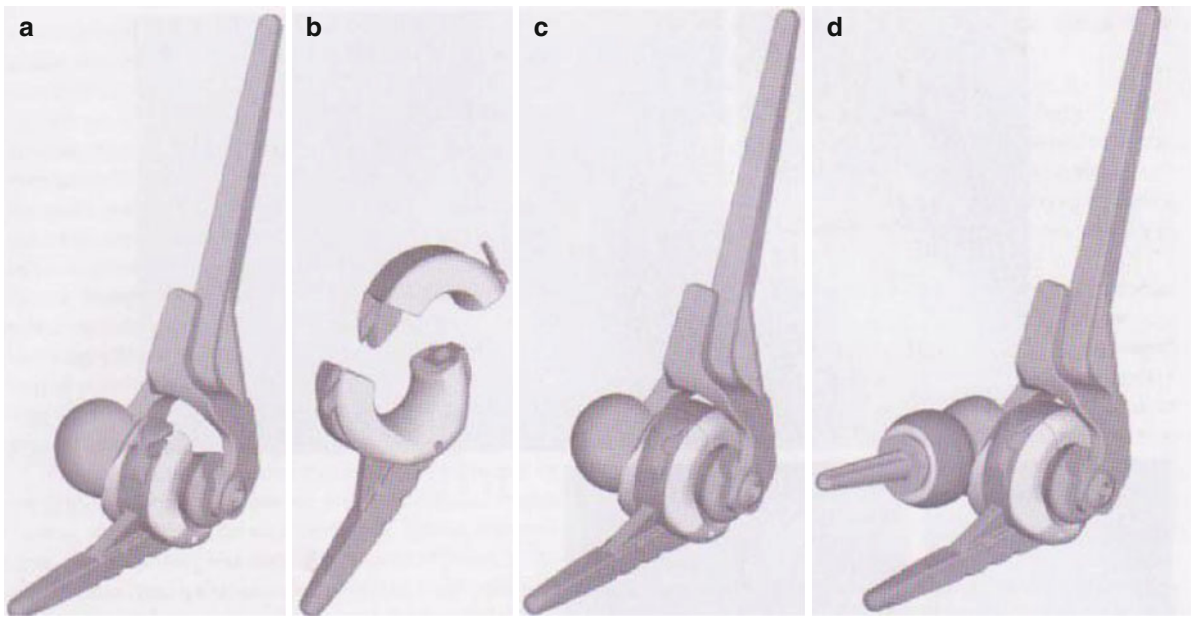


Fig. 8.2 The Latitude Total Elbow System (Tornier, France) is a modular, convertible implant. It allows the implantation of unlinked (**a**) and – by locking the ulnar component with the ulna cap (**b**) – linked (**c**) TEA and offers the opportunity of radial head replacement (**d**). Moreover, this system enables a resurfacing of the distal humerus only and can therefore be implanted as hemiarthroplasty. The aim of this prosthesis system is to reproduce and to mimic the elbow anatomy with reconstitution of the elbow kinematics. As it is a convertible implant, the Latitude HA can be transformed into a linked or an unlinked TEA at a later time point without a need for complete explantation of well-fixed components. With kind permission of Tornier

stability compared to first generation headless compression screws. However, more recent biomechanical in-vitro studies comparing conventional screws with new generation headless screws report equal or even higher compressive forces and stability whilst causing less cartilage damage for the headless compression screws. Threaded K-wires may be used to fix small fragments not amenable to screw osteosynthesis. Non-threaded K-wires should not be used due to their high risk of migration. Plate osteosynthesis may be performed in case of distinct posterior comminution. Stabilization of the coronal shear fractures may be performed arthroscopically by the experienced elbow arthroscopist, too. In the elderly patient with poor bone quality and fracture comminution, elbow arthroplasty may be required.

Type C.1–3: Intra-articular fractures are faced through a dorsal approach. The ulnar nerve is exposed and can be transposed anteriorly. Olecranon osteotomy is recommended to assure sufficient overview of the distal humerus articular surface. The articular surface should be reconstructed first. Afterwards, the articular surface block is fixed to the humeral shaft with two plates. In younger patients with good bone quality, nonlocking 3.5-mm reconstruction or 3.5-mm limited contact dynamic compression (LC-DC) plates may be used. Locking plates provide higher stability and are of advantage, especially in the elderly patient with poorer bone quality. Many implants and techniques have been described. Today, two techniques of double plating are mainly used: the Arbeitsgemeinschaft für Osteosynthesefragen (AO) technique with perpendicular plating and parallel plating introduced by O'Driscoll. The AO technique recommends perpendicular plating with one plate positioned medially on the ulnar column and one posterolaterally on the radial column. Long-standing experience exists for this technique and published series show excellent to good results. The concept of parallel plating is now recommended by some authors based on recent biomechanical studies, which reported significantly higher stability for parallel plating. Whether one of these techniques is superior to the other in a clinical setting is not known yet as no study exists comparing the two.

8.4.2.2 Arthroplasty

Comminuted distal humerus fractures in elderly patients with poor bone quality continue to pose a challenge to the treating surgeon. Complications such

Fig. 8.3 (**a**) TEA spool allowing linked or unlinked total elbow arthroplasty. (**b**) Hemiarthroplasty spool mimicking the articular surface of the distal humerus. With kind permission of Tornier

as nonunion as well as secondary loss of fixation occur frequently. Therefore, total elbow arthroplasty (TEA) is increasingly gaining interest in the primary treatment of distal humerus fractures. The rate of primary TEA implantation is increasing and short-term results are encouraging. As elbow arthroplasty is not a widespread procedure and experience is still lacking, it must be regarded as a salvage procedure restricted to specialized trauma centers. TEA with linked components is used in TEA when the epicondyles cannot be reconstructed and ligamentous stability is therefore not provided. Many prostheses have been introduced to the market and good results have been reported for all of them. Long-term results are not yet available. The latest generation of TEA is now offered as a modular system and allows an intraoperative decision of whether to use a linked or unlinked implant with or without radial head replacement. In case of ligamentous stability and good condition of the articular surface of the proximal ulna and radial head, even hemiarthroplasty can be performed (Figs. 8.2 and 8.3).

Frankle et al. [1] even reported that TEA revealed a better functional outcome with lower duration of surgery in elderly women with osteoporotic distal humerus fractures in comparison with ORIF. Moreover, a prospective study of McKee et al. [2] revealed better clinical results with lower reoperation rates in patients treated with TEA. Mighel et al. [3] reexamined 28 patients, who were converted to TEA after failed ORIF. They reported a significant improvement of the clinical outcome after TEA.

8.4.2.3 Postoperative Rehabilitation

The aim of internal fixation of distal humerus fractures must be a stable elbow that allows early active physiotherapy. A dorsal splint may be useful during wound healing. In case of complex fractures and/or poor bone quality, a longer time of splinting may be required, depending on the surgeon's impression of the achieved stability. However, passive physiotherapy out of the splint should be started as early as possible to prevent joint stiffness.

8.4.2.4 Complications

Poor results after ORIF of distal humerus fractures can be found in 20–47 %, according to the current literature. Immobilization longer than 10 days, secondary definitive reconstruction, delayed initiation of physiotherapy, and concomitant traumatic brain injuries are factors affecting the outcome adversely. Most common complications include infections (especially after open fractures), heterotopic ossifications, osteoarthrosis, nonunion, and instability as well as secondary loss of fixation.

8.4.3 Outcome

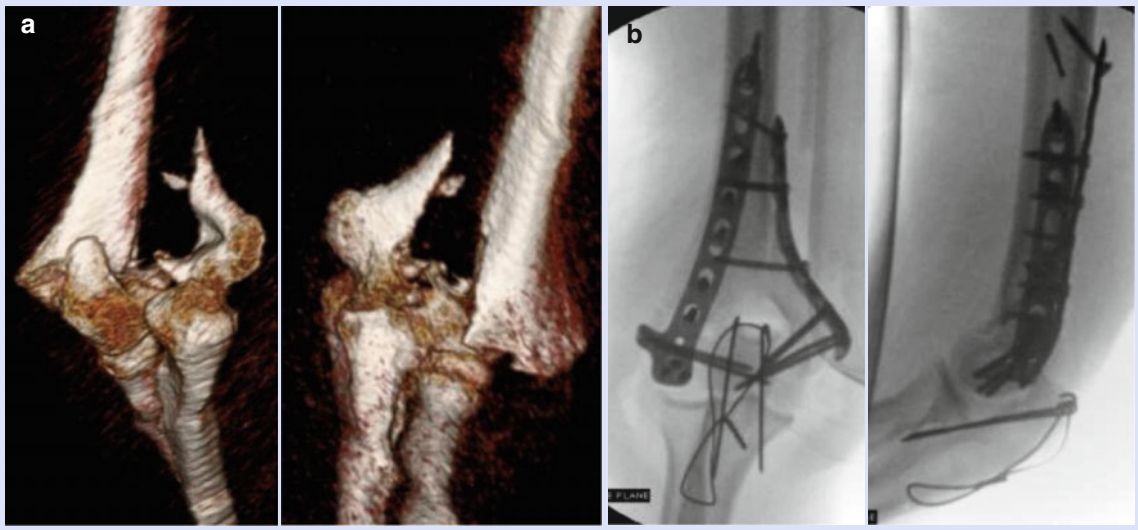
The aim of surgical intervention is the restoration of a painless and functional stable elbow joint to assure the patient's independence in activity of daily living. The functional arc of 100º, described by Morrey et al. [4] describes the range of motion (ROM) for the elbow that is needed to enable patients to fulfill activities of daily living. Usually the goals for this ROM are achieved by ORIF with anatomical reconstruction of the articular surface and stable fixation of the fracture area. In younger patients, good clinical results can be expected in as much as 80–90 %. A certain amount of joint stiffness is common, but the functional arc of 100º for extension/flexion as well as rotation is usually achieved.

Case 1

An 85year-old female suffered a Type-A.2 fracture as a result of a fall from standing height (**a**). The fracture was fixed with double plate osteosynthesis according to the AO technique using 2.7/3.5 mm precontoured locking plates (Synthes, Switzerland) (**b**). Olecranon osteotomy was not required. (© Klaus Burkhart, Lars Müller, Köln; Pol Rommens, Mainz)

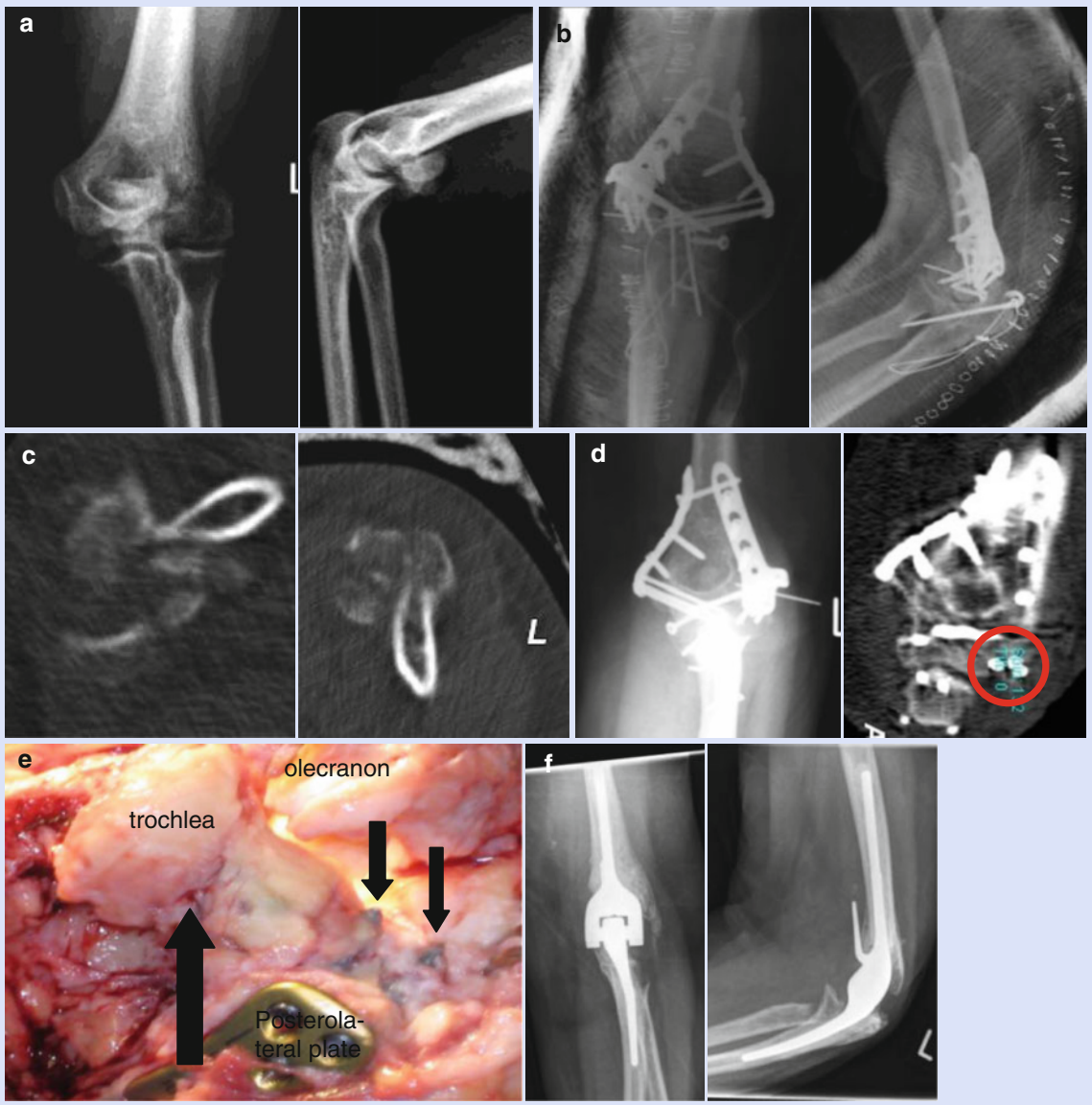
Case 2

A 47-year-old male suffered an AO C.3 fracture after a fall from a ladder (**a**). Olecranon osteotomy was performed and the fracture was fixed with double plate osteosynthesis according to the AO technique using 2.7/3.5 mm precontoured locking plates (Synthes, Switzerland) (**b**). (© Klaus Burkhart, Lars Müller, Köln; Pol Rommens, Mainz)



Case 3

A 70-year-old female with an AO C3 fracture (**a**, **b**) that was stabilized with double plate osteosynthesis according to the AO technique using 3.5 mm pre-contoured locking plates (Synthes, Switzerland) (**c**). She suffered secondary loss of fixation. The radiograph shows dislocation of the K-wire, the CT scan reveals the lacking capitellum with bare screws inside the joint (*ring*) (**d**). The intraoperative photograph shows these bare screws (two *arrows*) resulting from the dislocated capitellum and necrotic areas of the trochlea (*bold arrow*) (**e**). Conversion to TEA was performed with a Coonrad-Morrey prothesis (Zimmer, USA) (**f**). (© Klaus Burkhart, Lars Müller, Köln; Pol Rommens, Mainz)



Case 4

An 80-year-old female with a first-degree open AO C3 fracture of the distal humerus (**a**, **b**) was treated with linked TEA with radial head replacement. A humeral shaft fissure was stabilized with cerclage. (© Klaus Burkhart, Lars Müller, Köln; Pol Rommens, Mainz)

Case 5

A 70-year-old female with a C-fracture of the distal humerus was primarily treated with a lag screw and K-wire osteosynthesis (**a**). Olecranon osteotomy was not performed. K-wires do not provide sufficient stability and the patient developed a painful nonunion in malposition (**b**). When the patient was introduced to us, stable re-osteosynthesis of the articular surface was not possible. Hemiarthroplasty was performed using the Latitude system. The medial epicondyle was reconstructed and fixed with two lag screws to provide sufficient ligamentous stability (**c**). (© Klaus Burkhart, Lars Müller, Köln; Pol Rommens, Mainz)

Conclusion

Distal humerus fractures in adults remain a challenging problem due to anatomic complexity of the articular surface, comminuted fracture morphology, and a short distal fragment. The goals of a painless, stable, and functional elbow are achieved by ORIF with anatomical reconstruction of the articular surface in younger patients. The maintenance of distal humerus fractures in elderly patients with poor bone quality remains problematic and controversial. Despite improvement of osteosynthesis implants, secondary loss of reduction, heterotopic ossifications, and nonunion are common complications. Elbow arthroplasty is gaining importance as it has been proven to achieve good clinical results. Because elbow arthroplasty is not yet a widespread procedure and experience is still lacking, it should be regarded as a salvage procedure limited to use in specialized trauma centers. Long-term results are not yet available.

Literature

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