13 Distal Radius Fractures

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13.1 Epidemiology

The incidence of distal radius fractures is approximately 0.7/1,000/Y people in males and 2.1/1,000/Y in females.

13.2 Anatomy

The articular surface of the distal radius is biconcave and triangular in shape with the apex of the triangle directed towards the styloid process, while the base represents the sigmoid notch for articulation with the ulnar head. The surface is divided into two hyaline cartilage-covered facets for articulation with the carpal scaphoid and lunate bones. The articular end of the radius slopes in an ulnar and palmar direction (Fig. 13.1). There are six dorsal compartments that are together with the convex dorsal aspect of the radius and are of extreme importance in surgical approaches. Eighty percent of axial load is transferred to the radius through the carpus. Rotation of the radius about the ulna is accompanied by a translational movement such that in supination the ulnar head is displaced anteriorly in the notch, whereas in pronation it moves dorsally. At the ulnar aspect of the lunate facet arises the triangular fibrocartilage, which extends onto the base of the ulnar styloid process, functioning as an important stabilizer of the distal radioulnar joint. It is situated between the ulnar head and carpal triquetrum. Its volar and dorsal margins are thickened, blending into the dorsal and volar radioulnar ligaments. The surfaces are biconcave and covered with hyaline cartilage.

Additional secondary stabilizers of the distal radioulnar joint include the interosseous membrane of the forearm, the pronator quadratus muscle, and the tendons and sheets of the extensor and flexor carpi ulnaris muscles.

13.3 Classification

The most complex and often used classification is that of the AO. Type A fractures are extraarticular, B are partial articular, and C are complete articular fractures. The A 1 fractures are extraarticular fractures of the ulna with an intact radius and they increase in severity from A 1.1 to A 1.3 [17] (Fig. 13.2).

The A 2 fractures are extraarticular, either undisplaced A 2.1, with dorsal tilt A 2.2 or with volar tilt A 2.3. Any extraarticular fractures with metaphyseal comminution falls into the A 3 group, with increasing comminution from A 3.1 to A 3.3, with A 3.3 fractures being those with comminution extending into the diaphysis. The A 3.2 fracture is the typical Colles' fracture with metaphyseal comminution.

The B type are partial articular. The B 1 fractures are sagittal fractures of the radius (B 1 is the styloid process fracture), B 2 are fractures of the dorsal rim, and B 3 affect the volar rim [17].

The C fractures are complete articular where the articular surface is fractured and totally separated from the metaphysis. C 2 fractures are simple articular with metaphyseal comminution, and C 3 fractures

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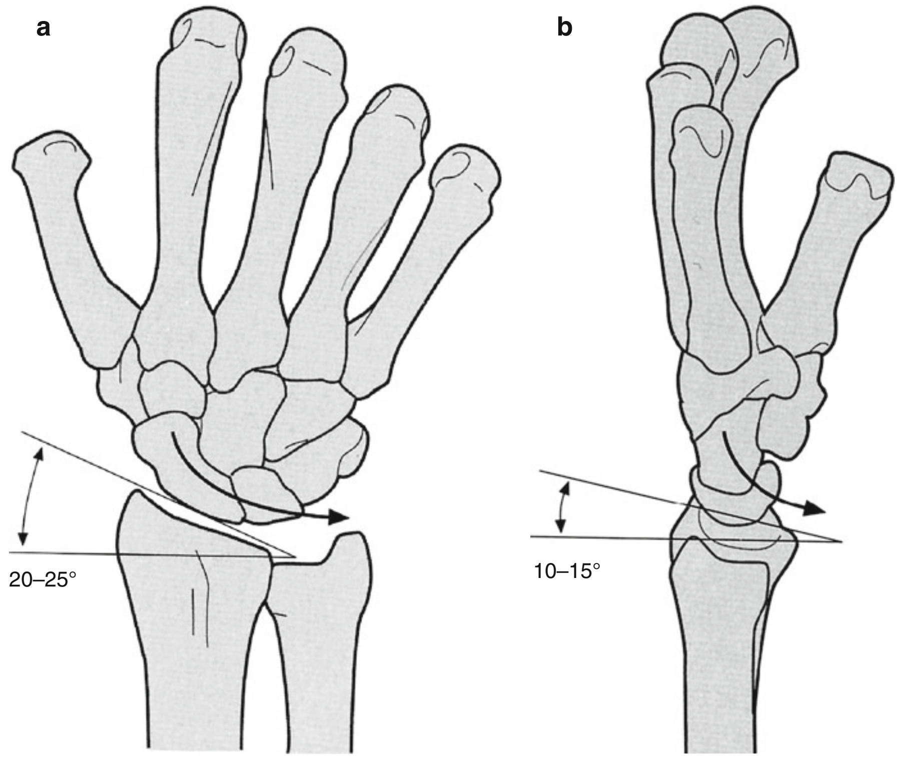

Fig. 13.1 The articular end of the radius slopes in an ulnar and palmar direction. The carpus will thus have a natural tendency to slide in an ulnar direction, resisted for the most part by the intracapsular and interosseous carpal ligaments arising from both the radius and the ulna

are the most complex, with multiple articular fracture lines and increasing metaphyseal comminution. Additionally, there are several classification systems only for intraarticular fractures. Melone described four possible parts: the radial shaft, the radial styloid, and the dorsal and volar portions of the lunate facet, which he termed the medial complex. Type 1 injuries are stable and type 2 occur when the radial styloid splits from the intact medial complex. Type 3 injuries are like type 2 but with a volar spike, which may damage the soft tissue. Type 4 injuries occur when, along with other features, the dorsal and volar parts of the medial complex are split. In 1993, Melone added a type 5, which he described as an explosion injury with severe articular comminution [15] (Fig. 13.3).

13.4 Mechanism of Injury

A fall on an extended hand is the classical cause of distal radius fractures. The force of the body weight is transmitted through the carpus directly to distal metaphysis, where the cortex is thinnest.

13.5 Diagnostic Features

Besides pain and swelling, the typical bayonet or fourchette position is often seen. There is a possibility of concomitant injuries such as scaphoid fractures, SL ligament lesions, and radial head fractures.

13.5.1 Radiology

Plain radiographs remain the mainstay in diagnostics. The posteroanterior view (PA) obtained in neutral variance as well as a lateral view with a beam that is inclined 20° will assess ulnar variance and effectively visualize the articular surface. A 45° pronated oblique view is helpful in that it profiles the dorsal ulnar cortex and lends insight into this biomechanically important region. Sometimes, improved fracture visualization through computed tomography is valuable (Fig. 13.4). A high number of fractures classified as extraarticular by standard radiographs are revealed to be intraarticular injuries. Special angles and lengths characterize the fracture pattern [7, 24].

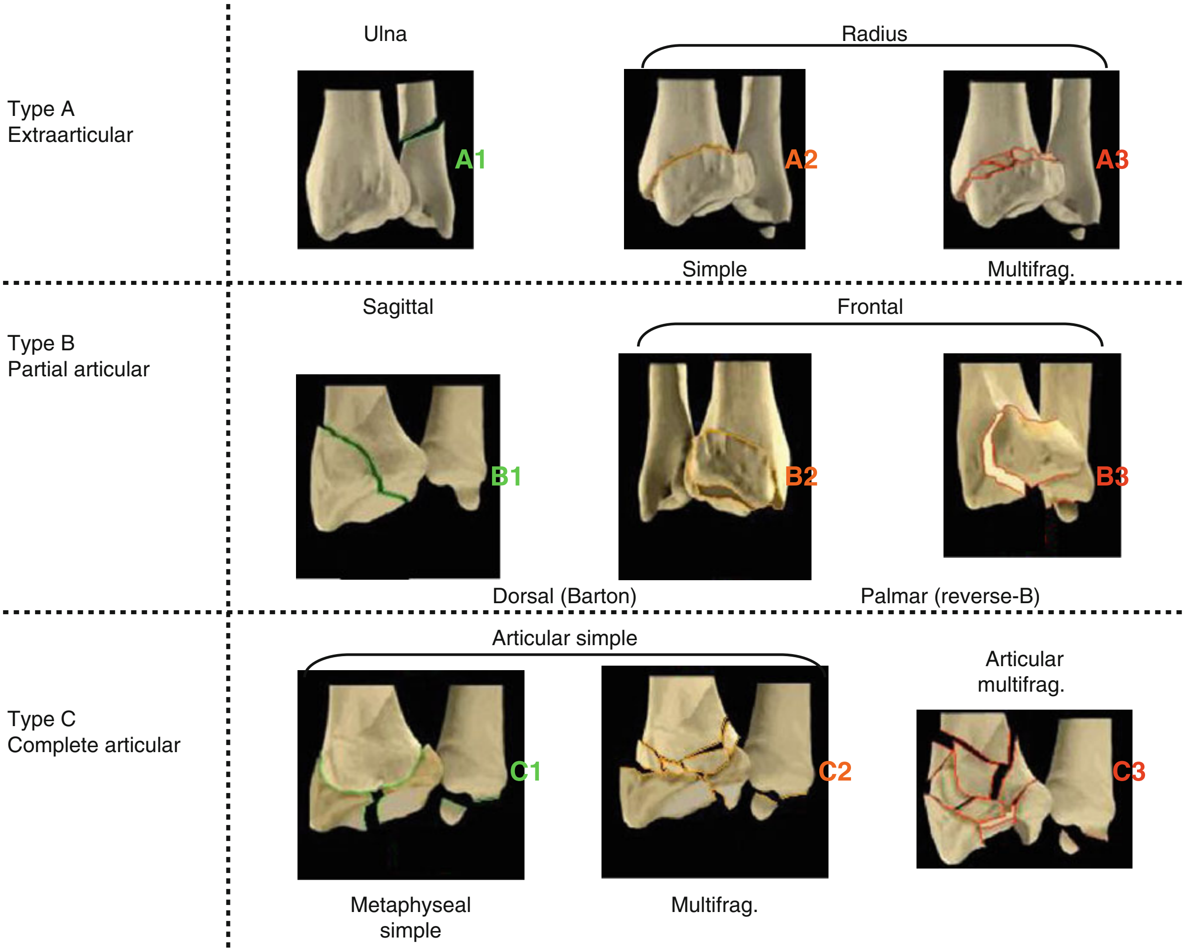

Fig. 13.2 AO classification of distal radius fractures

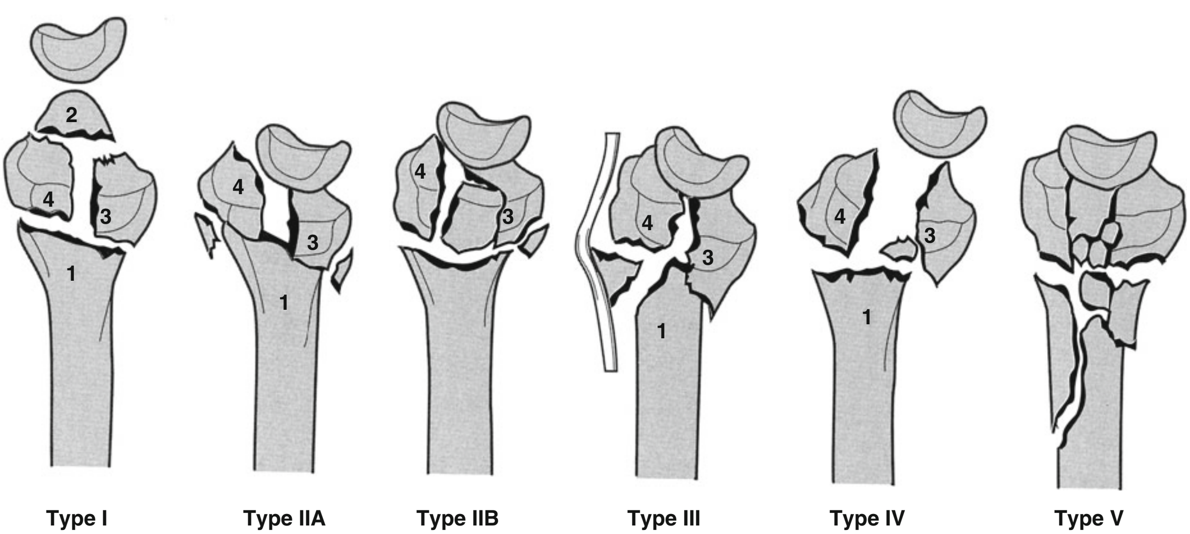

Fig. 13.3 Classification of intraarticular fractures according to Melone. 1 radial shaft, 2 radial styloid, 3 dorsal medial fragment, 4 palmar medial fragment. The medial fragments ande their strong ligamentous attachments with the proximal carpal bones and the ulnar styloid have been termed the "medial complex " by Melone

Fig. 13.4 CT gives information about step in the articular surface and SL lesion

13.5.1.1 Radial Length (Fig. 13.5a)

Radial length is measured on the a.p. radiograph. This measurement (in millimeters) represents the distance between a line drawn at the tip of the styloid radial process, perpendicular to the long axis of the radius with a second perpendicular line at the level of the distal articular surface of the ulnar head. The normal length is 10–12 mm.

13.5.1.2 Radial Slope

In the frontal view, the slope or inclination of the distal end of the radius is represented by the angle formed by a line drawn from the tip of the radial styloid process to the ulnar corner of the articular surface of the distal end of the radius and a line drawn perpendicular to the longitudinal axis of the radius. The average inclination is between 22° and 23° (Fig. 13.5b).

13.5.1.3 Palmar Inclination

To obtain the palmar inclination of the distal radius in the sagittal view, a line is drawn connecting the most distal point of the dorsal and volar cortical rims. The angle that this line creates with a line drawn perpendicular to the longitudinal axis of the radius reflects the palmar inclination. This angle has an average inclination between 10° and 12° (Fig. 13.5c).

13.5.1.4 Ulnar Variance

The vertical distance between a line parallel to the articular surface of the ulnar head and a line parallel to the proximal surface of the lunate facet of the distal radius has been referred to as the ulnar variance. The ulnar head and the medial corner of the radius are normally at the same level bilaterally.

With fracture displacement, the ulnar head will commonly be in a distal relationship (positive variance).

13.5.1.5 Radial Width, Shift

This width is the distance in mm from the most lateral tip of the radial styloid process to the longitudinal axis through the center of the radius on the a.p. radiograph.

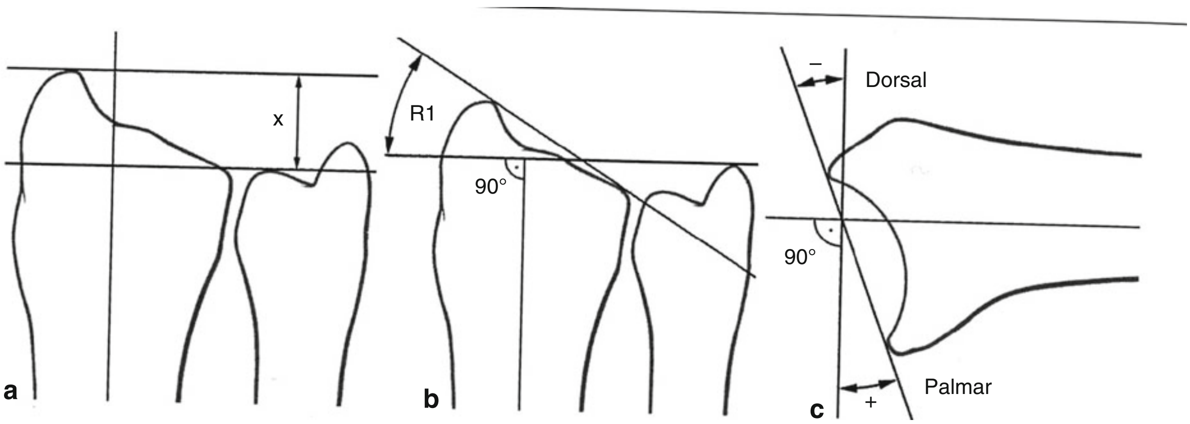

Fig. 13.5 The radial length (**a**) (*height*) averages in the frontal plane 11–12 mm in reference to the distal radioulnar joint 1. Line tangential to the top of the radial styloid and perpendicular to the long axis of the radius 2. Line perpendicular to the long axis of the radius and tangential to the ulnar head. The ulnar inclination (**b**) is measured from a coronal view as the angle between a line connecting the most distal points of the radial and rims of the articular surface and a perpendicular to the long axis of the radius. The palmar tilt or inclination (**c**) is measured from a sagittal view as the angle between a line connecting the most distal of the dorsal and palmar rims of the articular surface and perpendicular to the long axis of the radius

13.6 Conservative Treatment

While clinical practice guidelines are not able to recommend one form of treatment over another, there has been a rise in surgical treatment of distal radius fractures [10, 27].

13.6.1 Reduction

Many fractures are simply reduced by traction. Classically, dorsal bending fractures are reduced by applying longitudinal traction, palmar flexion, ulnar deviation, and pronation. Another reduction technique introduced the concept of multiplanar ligamentotaxis, in which longitudinal traction is combined with palmar translation. Palmar translation creates a moment force in which the capitate will rotate the lunate palmarily. This, in turn, will produce a rotatory force that can effectively tilt the distal radial fragment in a palmar direction. Radioulnar translation is advocated to realign the distal fragments with the radial shaft.

13.6.2 Immobilization

The immobilization technique by L. Böhler [4] is based on the concept of a three-point cast.

Displaced but intrinsically stable extraarticular dorsal bending fractures can be effectively maintained initially in a sugar tong splint followed by a below-elbow immobilization, provided care is taken to apply appropriate molding of the cast [22]. Cast immobilization carries with it concerns regarding restricted range of motion, muscle weakness, and long-term disability [19].

13.6.2.1 Duration of Immobilization

Most well-reduced extraarticular dorsal bending fractures will heal by 4–5 weeks postinjury.

13.6.3 X-Ray Control

After 48 h, 7 days, 14 days, and 28 days, X-ray controls are recommended for conservative treatment.

The reasons are to avoid malunion resulting from secondary displacement, either by a second reduction and conservative treatment or by changing the procedure from conservative to operative management.

13.7 Operative Technique

13.7.1 Indications and Contraindications of Operative Treatment

Because of a high degree of secondary displacement and malunion, sympathetic reflex dystrophy, and other complications after conservative treatment, a change to operative treatment of displaced distal radius fractures has happened (Table 13.1).

Table 13.1 The treatment of distal radius fractures has changed to internal fixation. The indication, the surgical approach (palmar, dorsal, combined palmar and dorsal) and the choice of implants must be based on patients history, pathomechanics of the fracture, fracture pattern (x-ray), bone quality and the demands of the individual patient

A2	Angle stable plate	K-wire
A3	Angle stable plate	K-wire
B1	Screw Fixation	(Lag screw)
B2	Angle stable plate	
B3	Angle stable plate	
C1	Angle stable plate	
C2	Angle stable plate	
C3	Ext. Fix and K-wires, Angle stable plate	

Open reduction of articular fractures of the distal radius is indicated when intraarticular congruity of the fracture cannot be achieved by closed manipulation, joint distraction, or percutaneous reduction maneuvers in manually active patients with good bone quality and absence of preexisting wrist pathology. Open reduction and internal fixation is also indicated in open fractures and in fractures with associated carpal disruption and tendon or nerve injuries because immediate skeletal stability is a prerequisite for undisturbed soft tissue healing. Delayed open reduction may be indicated for secondary intraarticular displacement in a fracture that undergoes loss of reduction after a conservative trial with closed reduction and plaster fixation. Articular fractures in elderly inactive patients and those with massive osteoporosis indicate open reduction and fixation with angular stable plates. Contraindications, not related to the fracture itself, may include the general condition of the patient, associated diseases, and the presence of degenerative changes of the wrist joint prior to injury (e.g., nonunion of the scaphoid, Kienböck's disease, rheumatoid arthritis). Operative treatment might be contraindicated in unreliable, unmotivated, and noncooperative patients.

13.7.2 K-Wire Fixation

The method of Willenegger [26] is based originally on the description of Lambotte.

13.7.2.1 Reduction

A tourniquet should be applied if limited or formal open reduction becomes necessary. With the image intensifier properly draped, a classical closed manipulation with traction, palmar flexion, and ulnar deviation is performed. The quality of reduction is assessed under fluoroscopy, while traction is maintained by the surgeon and countertraction by the assistant. Alternatively, horizontal longitudinal traction can be applied using sterile finger traps with 2.5–5 kg weights and countertraction across the upper arm. This frees both the surgeon's hands for manipulation and pinning.

13.7.2.2 Surgical Technique

An open or closed procedure is possible. The advantage of the open procedure is the identification of superficial radial nerve by a 2 cm incision over the styloid process. After identification of the nerve and closed reduction, three 1.8mm K-wires are inserted via the tip of the styloid process into the distal fragment. The pins should cross in both planes. An additional forearm cast is necessary. Implant removal usually is performed after 6 weeks (Fig. 13.6).

13.7.2.3 Principles of Intrafocal Pinning and Surgical Technique

Traditionally, fractures of the distal end of the radius were fixed, after manual reduction, with pins drilled through the distal fragment and pinned into the proximal one. Quickly, because of the pins' flexibility, the distal fragment moves back until the pins bump into the inferior edge of the proximal fragment.

In the original method of intrafocal pinning, a smooth K-wire is inserted after a manual reduction, through a short skin incision, directly into the fracture line [12, 13] (Fig. 13.7). In this way, any subsequent tilt of the distal fragment is prevented. Secondary displacement is made impossible by the immediate contact of the distal fragment with the pins, which are working as an abutment, not as a resistance component. Additional cast immobilization is not necessary with this technique, allowing immediate rehabilitation and, therefore, better functional results [23]. A good fixation needs three pins, inserted at precise points. The first pin is pushed laterally between the tendons of the extensor carpi radialis and that of the extensor pollicis brevis; the second pin is inserted postero-laterally, close to Lister's tubercle, and, taking great care to avoid the extensor pollicis longus, the third is postero-medially set, passing between the extensor digitorum tendons and the extensor carpi ulnaris tendon. Clearly, this approach needs to avoid the tendons.

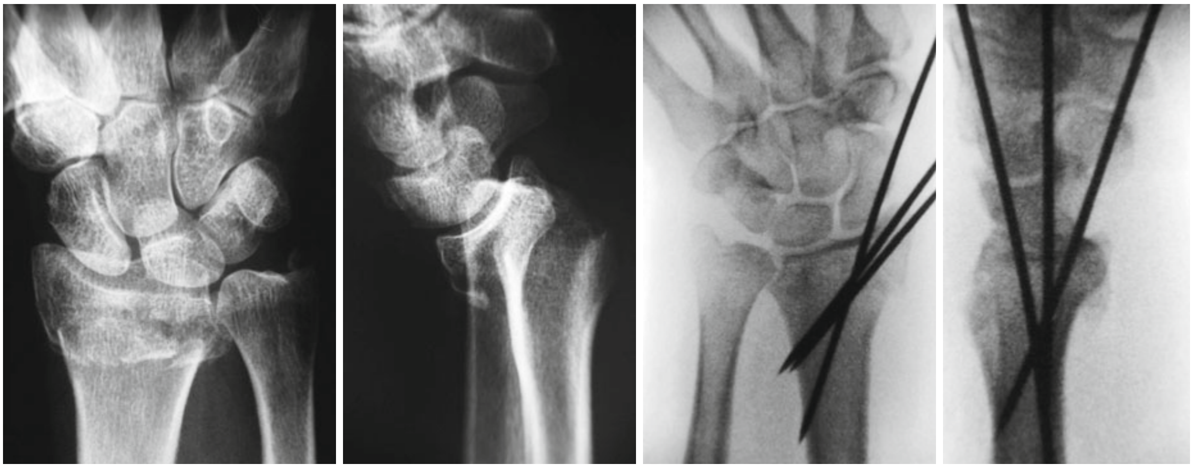

Fig. 13.6 A3 Fracture K-wire fixation. Crossing wires in both planes

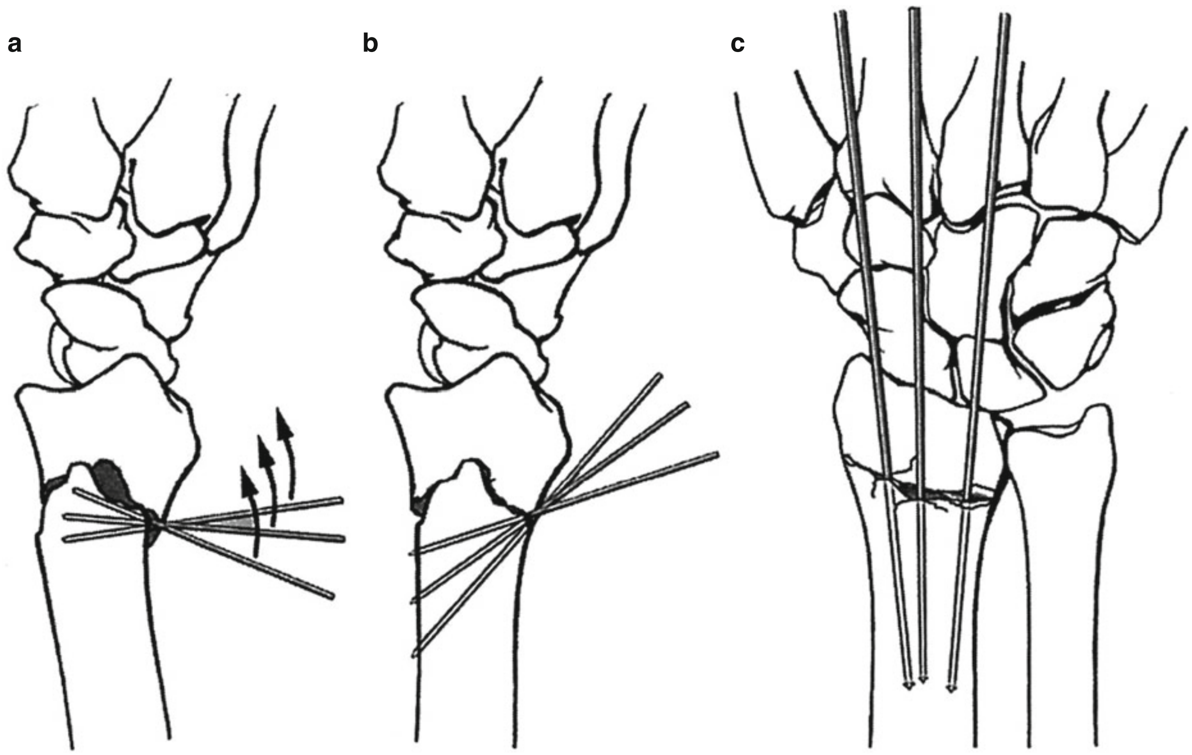

Fig. 13.7 Intrafocal pinning (Kapandji). This technique remains most effective in those unstable fractures without substantial volar comminution.3 pins (**a**) are placed into the fracture line, functioning to help reduce the fracture as well as to provide an internal splint, under reduction the pins (**b**) are directed approximately at a 45° angle to the long axis of the radius and driven to the intact proximal cortex.The pins (**c**) are located between ext carpi rad. and ext. pollicis brevis, between ext. pollicis longus and ext. indicis and between ext. digit. and ext carpi ulnaris tendons

13.7.3 External Fixator in C 3-Fractures

13.7.3.1 Reduction

Restoration of radial length, volar tilt, and articular congruity is assessed by closed reduction. If there is no metaphyseal comminution and reduction of the joint fragments is acceptable, a conventional percutaneous pinning of the fracture is carried out. If reduction of the "medial complex fragments" [8] is anatomic with no articular step-off, additional pinning from the radial styloid towards the sigmoid notch is performed using 1.5-mm Kirschner wires, with care not to enter the radio-ulnar joint. If a satisfactory reduction of the dorso-medial fragment cannot be achieved by radial deviation and palmar flexion [8], then a 2-cm-long skin incision is placed between the fourth and fifth dorsal compartments and, with a minimum of soft tissue dissection, an awl or periosteal elevator is introduced. Under fluoroscopy, the displaced fragment is reduced against the lunate and pinned transversely as described above. When the medial fragments are split into dorsal and volar components (four-part fracture) and the volar fragment is severely displaced, the limited open reduction through a volar approach is mandatory. This volar ulnar fragment cannot be reduced anatomically by closed manipulation or traction because of its tendency to rotate dorsally when tension is applied to the volar capsule. When the articular fracture shows a considerable degree of metaphyseal and even diaphyseal comminution, external fixation is the most reliable method of stabilization to prevent radial shortening. However, if radiocarpal and radio-ulnar congruity cannot be achieved with external fixation alone, a percutaneous or formal open reduction of the joint surface should be used, in combination with the external fixator [9]. Before applying the external fixator, the gross displacement of the fracture is reduced with a conventional closed manipulation, and the quality of reduction is assessed with the image intensifier.

13.7.3.2 Technique External Fixator

If satisfactory reduction is obtained with adequate correction of the radial inclination and radial length, as well as the volar tilt, a temporary percutaneous fixation of the radial styloid is performed. Then, two 2.5-mm half-threaded pins are inserted into the base and the shaft of the second metacarpal. The pins are inserted through small stab wounds, spreading the underlying soft tissues with a hemostat and using a protection guide. If the bone is osteoporotic, the pins may be inserted directly; otherwise, predrilling with a 2-mm drill-bit is advisable. In the second metacarpal the pins are inserted in a converging manner, at 40–50° to each other, to increase their holding power in the bone. A second pair of pins is then inserted into the distal third of the radius, just proximal to the bellies of the abductor pollicis longus and extensor pollicis brevis muscles. Again, the use of small skin incisions, blunt dissection of the soft tissues, and the protection guide will minimize iatrogenic lesions of the superficial radial nerve branch at this level (Fig. 13.8).

After tightening the fixator clamps, the quality of joint reduction is again assessed under fluoroscopy. If articular congruity is unacceptable (more than 1–2 mm step-off), a percutaneous or formal open reduction, as described previously, is performed with the fixator in place. The choice of surgical approach depends on the localization of the fragment needing additional reduction. Most commonly, the approach between the third and fourth extensor compartments is used. The proximal part of the extensor retinaculum is divided up to the level of the radiocarpal joint and the extensor pollicis longus tendon is freed at the level of Lister's tubercule. The wrist joint capsule is opened transversely and the fragments are manually elevated and reduced against the scaphoid and lunate.

The remaining bone defect after reduction of the fragment could be grafted with autologous iliac bone graft. Bone grafting not only provides additional mechanical support for the articular fragments, but also accelerates bone healing. Even in cases where adequate joint congruity has been obtained with ligamentotaxis alone, primary bone grafting is strongly recommended if massive metaphyseal defects persist after the application of the wrist fixator, since grafting enhances fracture healing and permits early removal of the fixator, allowing early wrist rehabilitation. The use of transverse Kirschner wire fixation from the radial styloid towards the distal radio-ulnar joint depends on the size of the fragments.

Another possibility is the change from an external fixator to angular stable plate after 10–14 days. Cancellous bone grafting is often not necessary.

13.7.4 Volar Plating

Plate fixation results in less radial shortening than external fixation, as well as less pain and improved functional outcomes and grip strength.

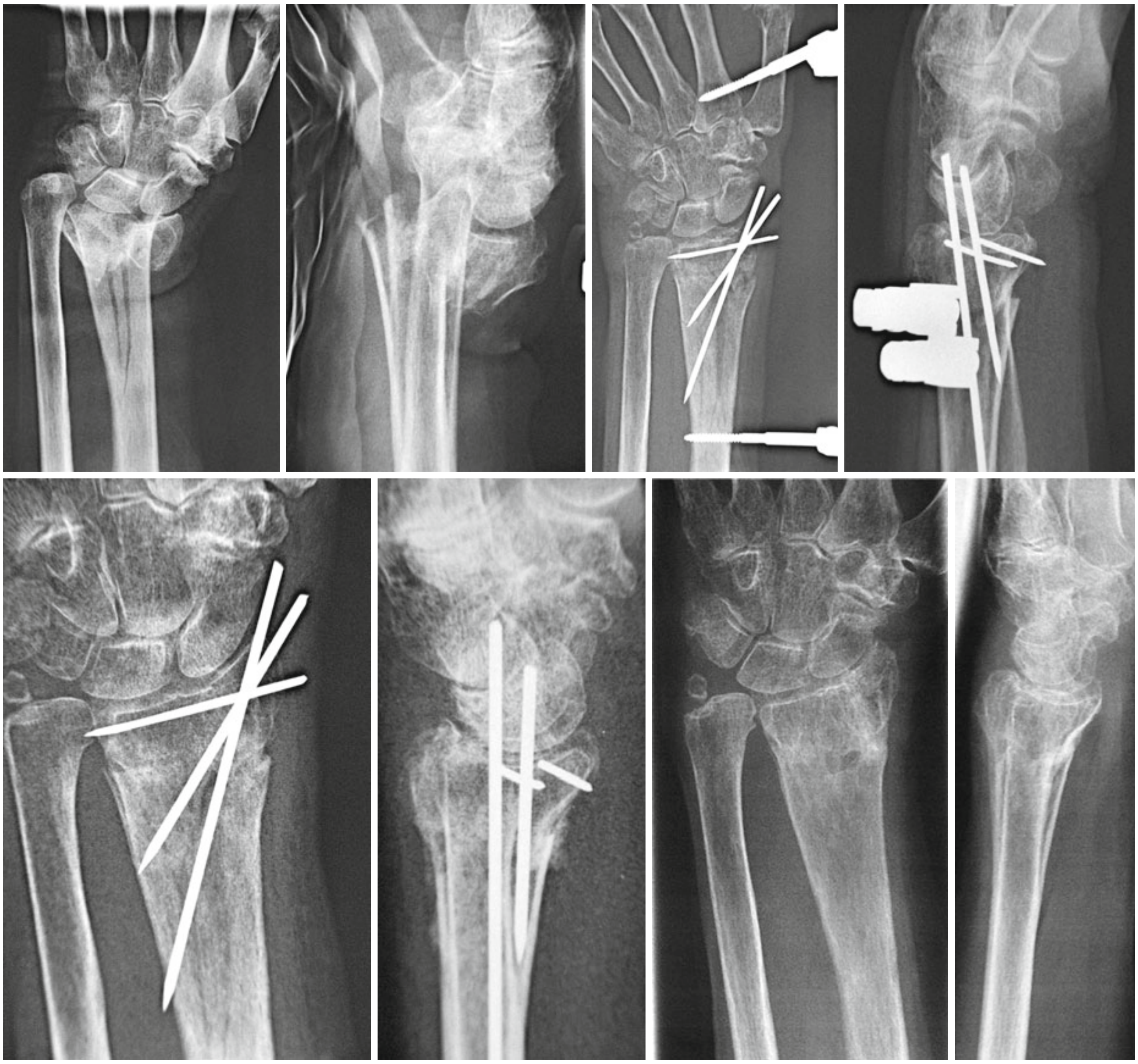

Fig. 13.8 C3 fracture in an 85-year-old woman. External fixator and K-wire fixation. After implant removal undisturbed function

13.7.4.1 Patient Preparation and Positioning

Position the patient supine on the table, with the extremity extended and supported on a hand table. A nonsterile pneumatic tourniquet is placed on the proximal arm.

13.7.4.2 Surgical Approach

Henry's modified palmar approach to the distal radius is used. A straight incision is made between the radial artery and the tendon of the flexor carpi radialis muscle.

Dissection is performed between the radial artery and the flexor carpi radialis tendon. The forearm fascia is divided and the pronator quadratus muscle is detached from the radial bony insertion. The fracture is visualized [18, 20, 21].

13.7.4.3 Reduction

The fracture is reduced manually. Because the palmar cortex is of sufficiently good quality even in very osteoporotic bone, radial length and axial alignment can be restored anatomically. Manual reduction is usually sufficient to restore palmar tilt. To correct the residual dorsal displacement and restore palmar tilt, the distal fragment can be reduced indirectly. The locking plate is fitted/equipped with the threaded drill sleeve and placed in position, where the drill sleeve and the radiocarpal joint line cover a dorsally open

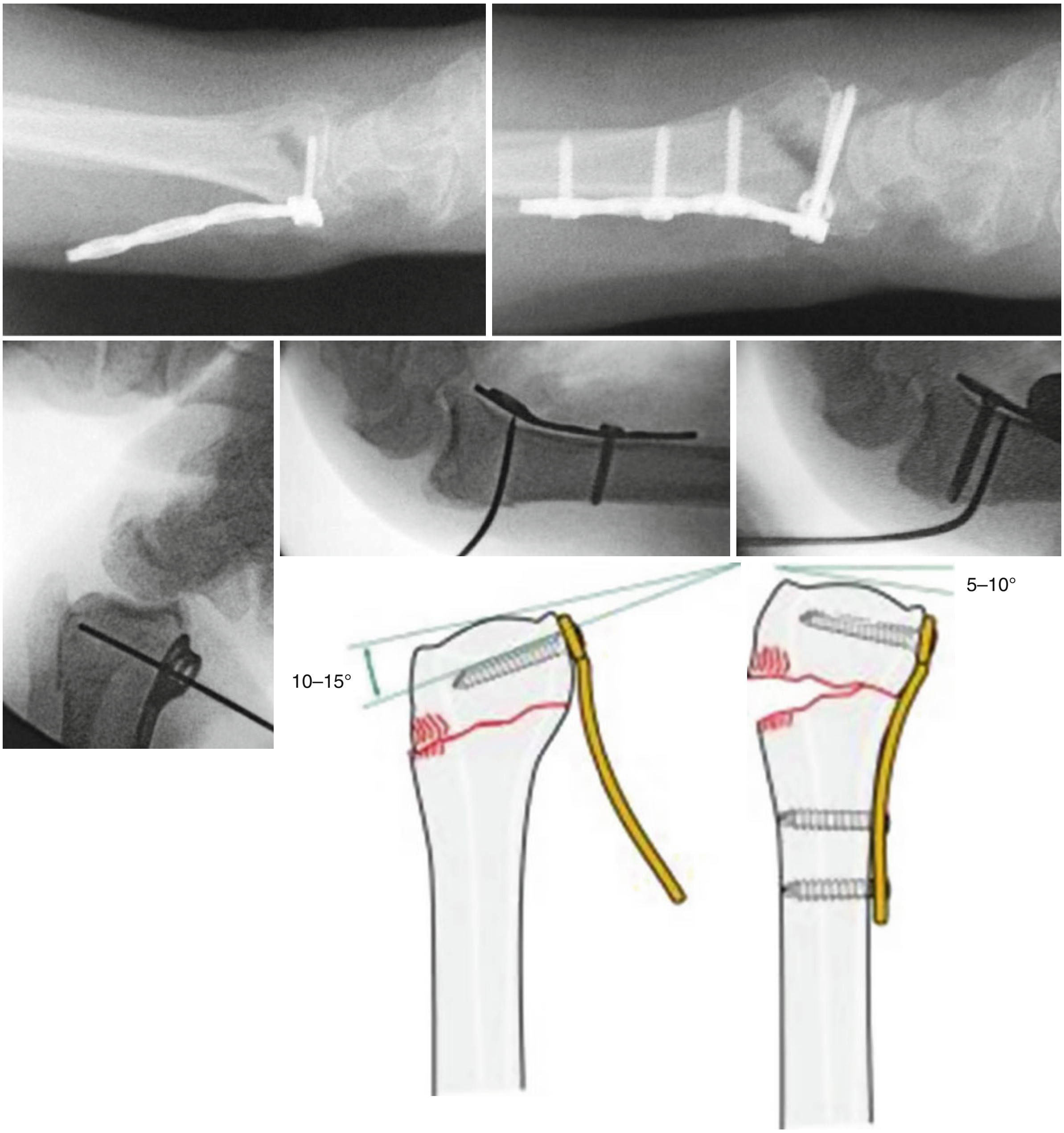

Fig. 13.9 Reduction technique with a plate. The distal screw hole is drilled according to the desired angulation of the distal radius articular surface. Alternatively, K-wires can be used from dorsal into the fracture line or from palmar into the distal fragment

angle of 10°. A K-wire, an LHS, or both are used to fix the plate in this position. The plate is now away from the radial shaft proximally. The shaft of the plate is reduced to the shaft of the radius manually, and the distal fragment is thereby brought into the desired position of slight palmar flexion. The plate acts as an angled blade plate.

As an option, K-wires and Weber clamps can be used to temporarily hold the reduction (Fig. 13.9). The articular surface can be reduced through the fracture

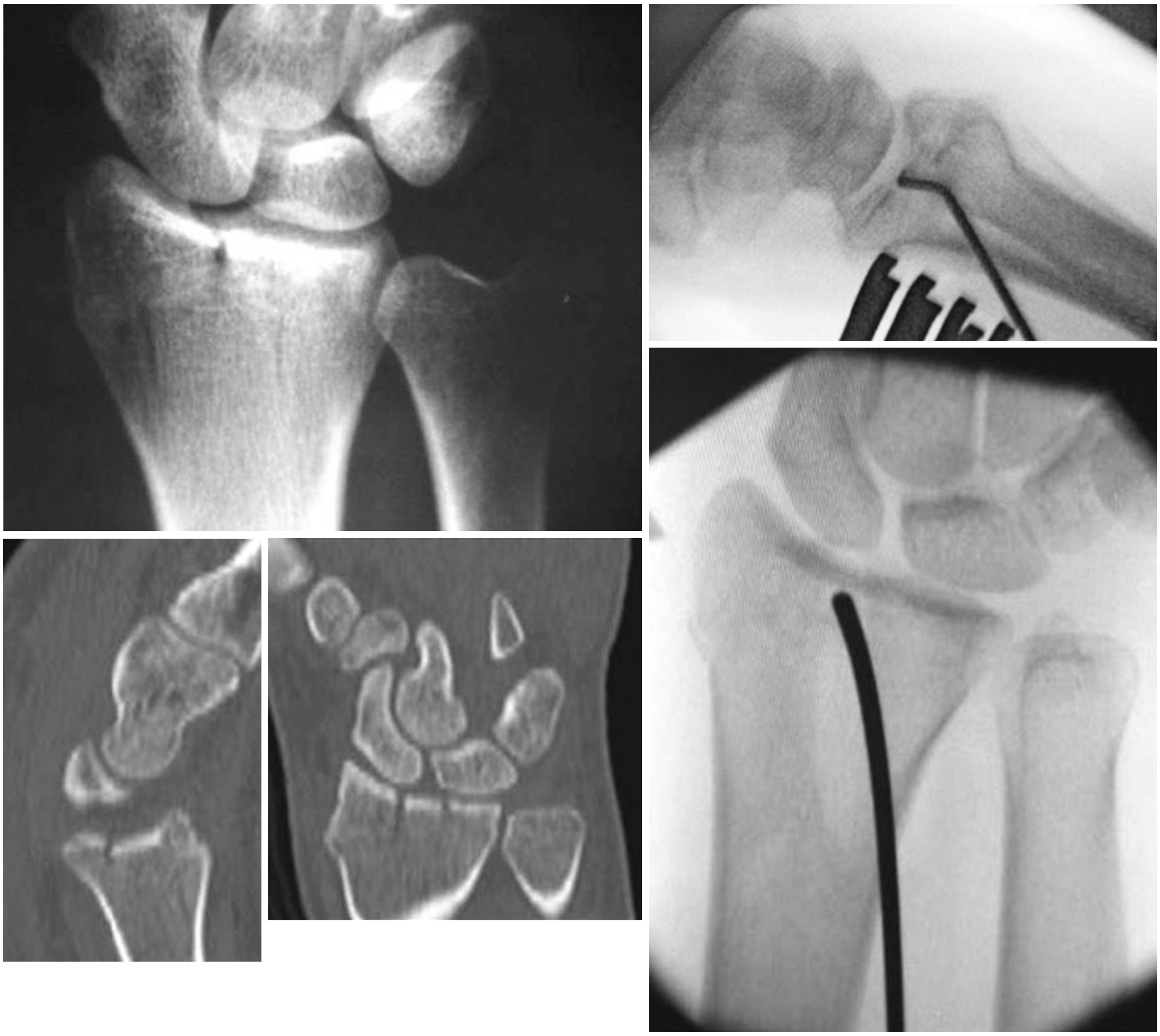

Fig. 13.10 Reduction of the articular surface with the opposite end of a K-wire

gap (Fig. 13.10). Arthroscopy may be helpful for the reduction.

13.7.4.4 Fixation

After manual reduction, the plate is placed in the correct position and fixed with a first cortex screw in the elongated plate hole in the radial shaft. Reduction and plate position are checked by fluoroscopy. As the correct plate position is determined and reduction is completed and secured using a K-wire (optional), the plate is definitively fixed with a second cortex screw of LHS in the most proximal hole of the plate. Internal fixation is completed by inserting the LHS in the distal part of the plate using the threaded drill guide. Care is to be taken when inserting the screws in order to obtain perfect purchase of the screw head in the threads of the plate. In osteoporotic bone, insertion of three distal locking head screws is recommended. After documentation of the osteosynthesis by X-ray, the wound is closed and drained. A palmar or dorsal plaster can sometimes be applied until the wound is healed (Fig. 13.11).

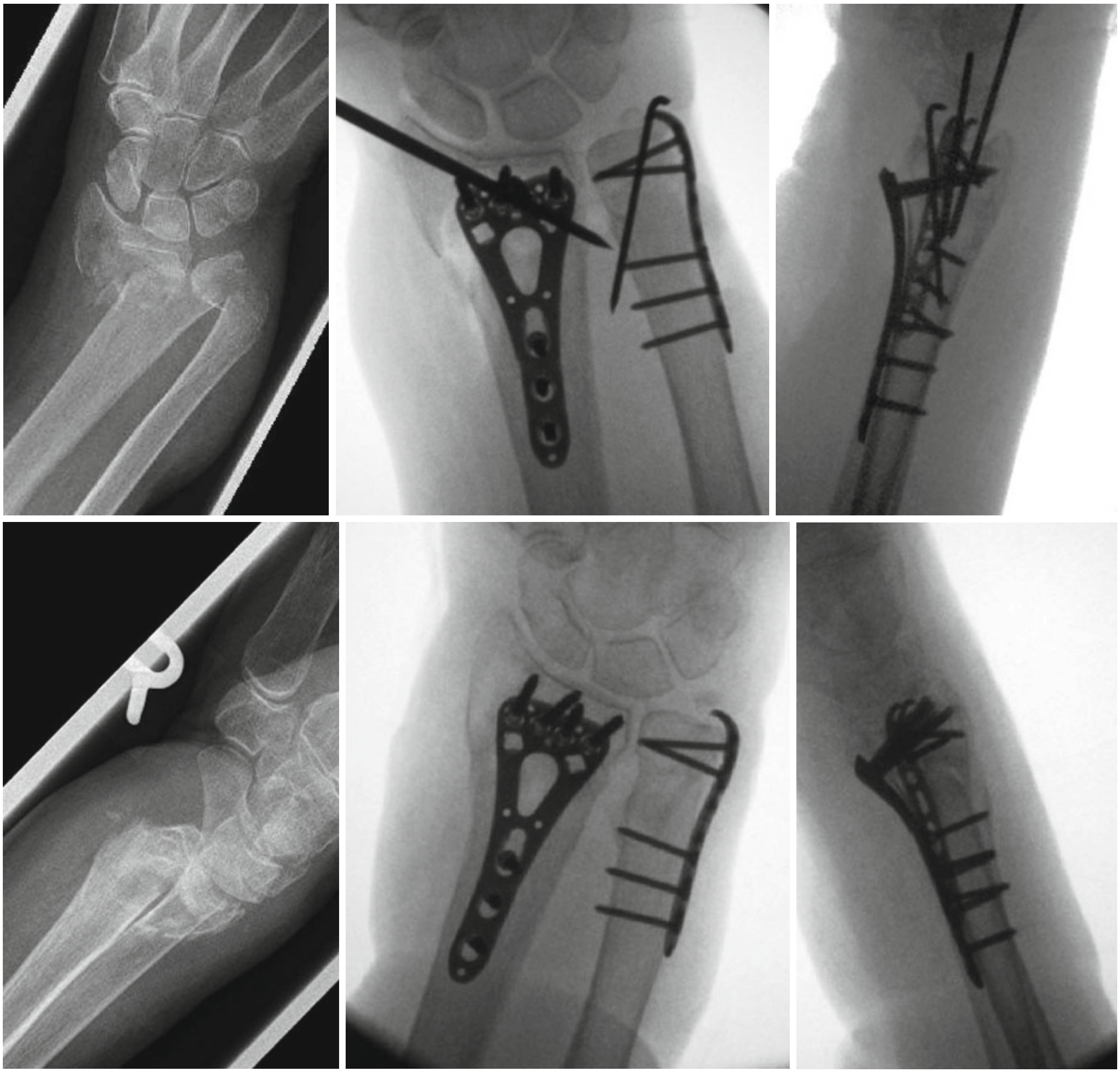

Fig. 13.11 C3 type fracture, reconstruction of the articular surface with 2 K-wires, and plate of fixation of the distal radius and ulna

13.7.4.5 Rehabilitation

Rehabilitation consists of immediate early motion out of the plaster splint under an instruction of a physiotherapist. The hand is used for unloaded daily activities such as eating, personal hygiene, tying a tie, and holding paper. After 6 weeks fracture healing is documented by X-ray and the patient can usually begin loaded activities.

13.7.4.6 Complications

In some cases, the radial "ear" of the T-arm of the plate should be bent back to avoid painful interference with the skin.

Correct positioning of the plate must be checked by fluoroscopy to be sure that the radiocarpal joint is not penetrated by the distal LHS. The LHS must be directed carefully in the correct direction in order to have perfect purchase of the screw heads in the plate hole. The screws must not be overtightened. In very old people with osteoporotic bone and mental alteration, the osteosynthesis should be protected by a closed plaster cast. Correct length of the screws is necessary to avoid interference or rupture of extensor tendons.

Bone grafting is not necessary. The technique is applicable also in osteoporotic bone. A dorsally displaced Colles' fracture with simple, nondisplaced extension of the fracture into the radiocarpal joint can be treated in the same way. These injuries are usually caused by low-energy bending forces and respond to manual ligamentotaxis for reduction.

13.7.5 Dorsal Plating

13.7.5.1 Indication and Approaches

High-energy axial forces lead to impaction of articular fragments into the metaphyseal cancellous bone. According to the three column model, the intermediate column (IC) is divided into two main fragments–dorso-ulnar and palmar-ulnar. The dorso-ulnar fragment is centrally impacted. The radial styloid is separated (radial column RC). These articular fragments do not respond to ligamentotaxis. Formal open revision is indicated to reconstruct the radiocarpal joint surface (IC) under vision. Additionally, this type of injury can be combined with a relevant ligamentous injury to the proximal carpal row. These ligaments can be revised during the dorsal approach by arthrotomy [29].

13.7.5.2 Patient Preparation and Positioning

Supine forearm on hand table, nonsterile pneumatic tourniquet, and prophylactic antibiotics are sometimes required. A straight dorsal incision is performed, centered over the distal radius. The subcutaneous tissue is divided. To access the intermediate column, the extensor retinaculum is incised along the course of the extensor pollicis longus (EPL) tendon. The Z-shape incision spares the distal portion of the tendon sheath to preserve the deflected course of the tendon and allows a flap drawn to the underneath of the EPL tendon during closure in order to protect this tendon from the plate. The EPL tendon is freed and retracted with an elastic thread. Preparation of the intermediate column is now strictly subperiosteal. The second compartment is not touched.

Access to the radial column by preparing between the skin flap and retinaculum towards the radial side, taking care of the superficial radial nerve, which is always visible in the skin flap. The first compartment is incised and the abductor pollicis longus and extensor pollicis brevis tendons are freed enough for an S-plate to be slipped underneath in order to buttress the radial column. Note that the second compartment is left untouched.

As a general rule, the approaches should be extensile, offering sufficient exposure to accomplish the surgical goals and heal with limited scarring. The approaches to the dorsum of the end of the radius and wrist are exposed between the extensor compartments (Fig. 13.12).

13.7.5.3 Reduction

A transverse arthrotomy exposes the radiocarpal joint surface at the level of the lunate facette and partially exposes the scaphoid facette. The proximal carpal row can be revised for any ligamentous injury. The radiocarpal joint is now reconstructed under direct vision by levering the articular fragments towards the carpal row. Any step-off or gap should be eliminated. The dorsal cortical shells help to define length and serve as a buttress after reduction. Single fragments can optionally be fixed temporarily with small K-wires. Distraction of the wrist using an external fixator is helpful during reconstruction of the joint surface. Reduction is checked by image intensification.

13.7.5.4 Fixation

After reduction and preliminary fixation of the intermediate column, a LCP L-plate or T-plate is chosen according to the anatomical configuration and need for fixation of fragments. The plate is precontoured and usually it must be bent back at the distal end and twisted into itself. The plate is fixed with a first cortex screw in the elongated plate hole in the radial shaft. Next, the radial column is buttressed with a precontoured S-plate slipped underneath the tendons of the first compartment. The plate is fixed with a first cortex screw in the elongated plate hole in the radial shaft. Reduction and plate positioning is checked by fluoroscopy.

After correct reduction and plate positioning has been documented by fluoroscopy, the position of the plate is secured by applying a second cortex or locking head screw in the most proximal hole in the shaft. Only then is placement of the distal locking head screws started. The distal locking head screws in the transverse part of the T- or L-plate support the radiocarpal joint surface. An additional bone graft to fill the metaphyseal defect is not required.

The wound is closed in layers. The EPL tendon is partially transposed subcutaneously by creating a retinaculum flap that covers the plate. Suction drainage is used. Only now is the external fixator, if applicable, withdrawn. A removable plaster splint is applied until the wound is clean and the pain has subsided.

13.7.5.5 Rehabilitation

Early motion with assistance of a physiotherapist is started immediately. The plaster splint is changed to a

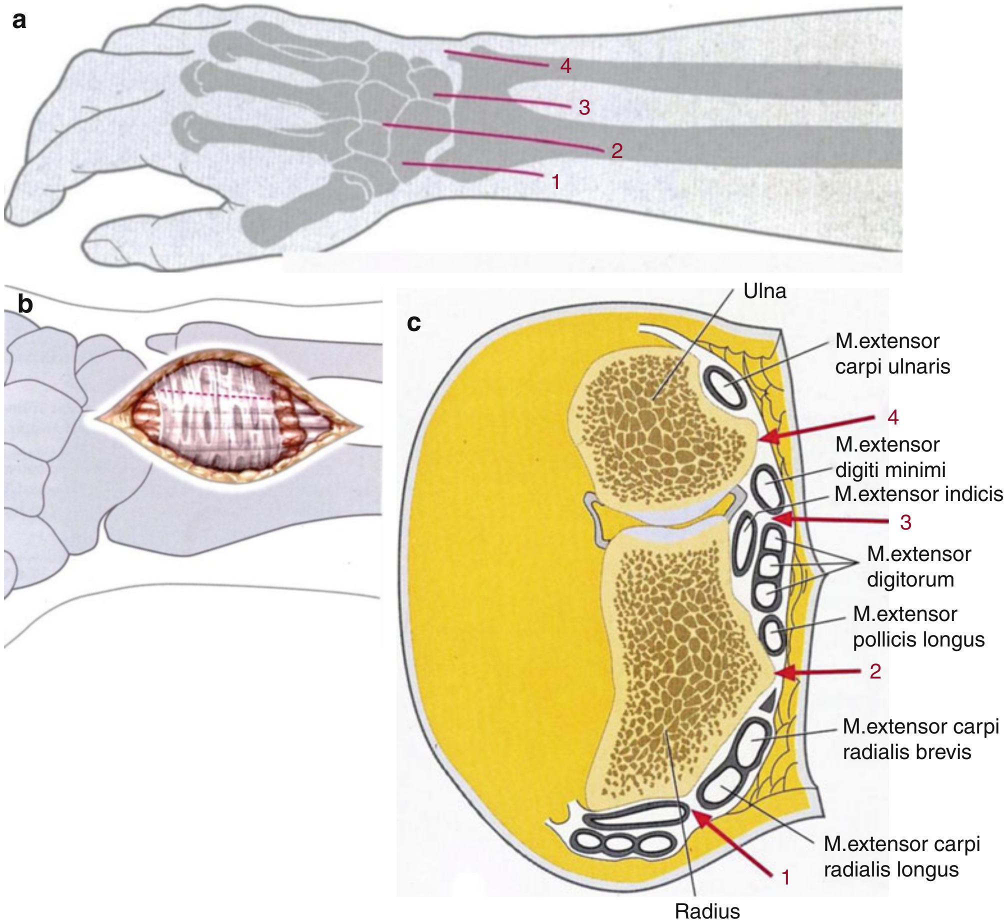

Fig. 13.12 The most common dorsal extensile approaches. Approach 1 for reduction and fixation of radial styloid fractures develops the interval between the first and second extensor compartments. Approach 2 lies between the third and the fourth extensor compartments and is chosen for complex articular fractures. Approach 3 lies between the fourth and the fifth extensor compartments and is preferred when limited open reduction of fractures affecting the lunate facet is required. Approach 4 lies between the fifth and sixth dorsal extensor compartments and is useful for the open reduction of distal ulna and/or repair of the triangular complex (**a, c**). After skin incision, the extensor retinaculum is split. Between extensor digitorum and mextensor digiti minimi on the ulnar side, the distal radius is reached (**b**)

removable Velcro splint. The hand is used for unloaded daily activities such as eating, personal hygiene, tying a tie, and holding paper. After 4–5 weeks, fracture healing is documented by X-ray and the patient can usually start loaded activities.

13.7.5.6 Complications

Rotational deformities can be difficult to handle from a dorsal approach. Hyperextended palmar articular fragments are difficult to control from a isolated dorsal approach. They usually need a palmar plate. Centrally depressed fragments do not response to ligamentotaxis.

The concepts allow for early functional rehabilitation and help to avoid dystrophy. Bone graft is not necessary because of locking implants. Injuries are usually caused by low-energy bending forces and respond to manual ligamentotaxis for reduction.

13.8 Distal Radioulnar Joint Instability

Distal radioulnar joint (DRUJ) instability is commonly associated with a radius fracture.

The primary stabilizer of the DRUJ is the triangular fibrocartilage complex (TFCC). Additional stabilizers such as the ulnocarpal ligaments, extensor carpi ulnaris subsheath, and interosseous membrane have a secondary role. Radial shortening of 5–7 mm can stretch the dorsal and palmar radioulnar ligaments and result in ligament tears. Distal radius fracture angulation also affects the biomechanics of the DRUJ. More than 20°dorsal angulation has also been associated with incongruency of the DRUJ in addition to altered TFCC kinematics, leading to tearing at its peripheral attachments [24]. As the amount of displacement and angulation increases, secondary constraints to joint stability are injured as well, such as the ulnocarpal ligaments, extensor carpi radialis subsheath, and interosseous membrane [24].

13.8.1 Diagnostic

Radiographic findings include ulnar styloid base fracture, widening of the DRUJ interval on PA radiographs, and dislocation of the DRUJ on lateral radiographs. A computed tomography scan can provide additional insight. Axial views of the DRUJ can be compared with the contralateral side. Subluxation or frank dislocation may often be identified, in addition to bony fragments suggestive of palmar or dorsal radioulnar ligament avulsions [24].

After fracture stabilization, DRUJ may be examined under anesthesia and compared with the contralateral side. The most common cause for DRUJ instability is via a fracture through the base of the ulnar styloid and requires the determination of instability after radius fracture internal fixation through manual testing. When managing this fracture, greater than 1 cm of dorsal to palmar translation mandates instability presumption [24].

13.8.2 Treatment

Distal radioulnar joint instability is then addressed through open reduction and internal fixation of the ulna styloid fracture. The styloid ulnar fracture is not addressed if the DRUJ is stable after fixation of the radius and using either fixation of the ulnar styloid or reduction and supination splinting if the DRUJ is unstable [28].

13.9 Complications of Distal Radius Fractures

13.9.1 Malunion

Malunion of distal radial fractures is the most common complication of the injury and is often the underlying cause for other complications such as median neuropathies and distal radioulnar joint problems. The reasons for malunion may be dorsal collapse, loss of radial length, or lunate facet dislocation. Symptomatic malunion is correctable by radial osteotomy with or without ulnar procedures. Restoration of volar tilt will correct carpal alignment [25] and may improve radial length. Osteotomy combined with ulnar procedures is recommended in cases of limited forearm rotation or ulnocarpal impingement [8]. Intraarticular osteotomy may be indicated in patients with intraarticular malunion before arthrosis has developed. Despite the available techniques, however, early intervention with prevention of malunion is a preferable course. Dorsal collapse may be prevented when using a volar-fixed angle plate by inserting at least four screws within the distal fragment. The distal screws of a volar locking plate should be placed within 3 mm of the subchondral bone. Anatomic reduction of the articular fragments can be confirmed by tilted views or arthroscopy or arthrotomy.

13.9.2 Compression Neuropathy

Compression neuropathy of the median, ulnar, or radial nerves is reported as occurring in 8–17 % of distal radial fractures, with the median nerve being most common [1, 5, 14] Median neuropathy may be related to the original injury, particularly in displaced fractures, to immobilization in extreme flexion causing increased carpal tunnel pressures to fracture fragments compressing the nerve [5, 8] or to malunion of the distal radius [1]. Guidelines for the management of median neuropathy associated with distal radial fracture should follow the principles that recommend decompression if a complete lesion persists after reduction of a fracture, if an incomplete lesion deteriorates at any stage or persists unchanged for longer than 7 days, or if the fracture requires operative intervention [8]. In cases with malunion, osteotomy should be considered in conjunction with median decompression. Ulnar and radial neuropathy are less common and are usually treatment related, either from cast compression or fixator pins [5]. Injury of the superficial branch of the radial nerve can be seen in K-wire fixation, external fixator, or volar plate fixation. There exists no safe zone for placement of a percutaneous K-wire. Therefore, a mini-open approach with protection of soft tissues and nerve is recommended.

Injury to the ulnar nerve is rare (2 %). The DCUN (dorsal subcutaneous branch of the ulnar nerve) is noted at a mean of 0.2 cm proximal to the tip of the ulnar styloid. Because of palmar and radial displacement with full pronation at the wrist, this position is recommended for initial skin incision around the distal ulna.

13.9.3 Reflex Sympathetic Dystrophy/ Complex Regional Pain Syndrome

The reported incidence of reflex sympathetic dystrophy varies considerably, from 1.4 to 37 % [2, 3], probably related to different diagnostic criteria. Its underlying cause is obscure, although carpal tunnel syndrome has been implicated in its etiology [8, 12]. Diagnosis is based on several criteria. At least four of the following features should be present: unexplained diffuse pain, diffuse swelling, difference in skin colour and temperature relative to the opposite side, and a limited active range of movement. In addition, these symptoms and signs should be present in an area larger than the area of primary injury and should increase with use.

Treatment should be as early as possible and may be by sympathetic blockade, intravenous guanethidine, corticosteroids, hydroxyl-radical scavengers, vitamin C up to 500 mg/day for 50 days, and intensive physiotherapy. Despite active treatment, the outcome is often poor.

13.9.4 Tendon Rupture

Both flexor and extensor tendon ruptures occur after distal radial fracture, although the former are extremely rare. Extensor pollicis longus rupture is by far the most common, although its incidence is usually less than 1 % [5]. Various mechanisms of injury have been proposed, although the most popular is probably a combination of attrition and impaired blood supply [11].

Most tendon ruptures occur several weeks to months after injury [5] and may be associated with minimally displaced or undisplaced fractures. Direct tendon repair is not usually possible because the abnormality extends over several centimeters. Treatment is most often by extensor indicis proprius transfer, which yields good functional results (Hove 1994). To avoid extensor tendon injuries, dorsal plates should be covered by extensor retinaculum; symptomatic dorsal plates or volar screws should be removed. Drilling should be performed carefully with volar plate fixation. Pronator quadratus closure over a volar plate may decrease irritation to the flexor tendons.

13.9.5 Treatment-Related Complications

Complications related to treatment of distal radial fractures are, unfortunately, common occurrences [6]. Some of the complications discussed above may be treatment related, such as carpal tunnel syndrome induced by a cast. It must be remembered that cast complications are as frequent as operative complications and that the permanent disability caused by poor cast application may prove more serious than that caused by skeletal deformity [5].

Tightness of a cast can lead to swelling of the hand and fingers, which, if not relieved, may lead to intrinsic contractures and finger stiffness. This must be prevented by elevation, splitting, or removing the cast, and early finger movements. A cast must not be applied over the metacarpophalangeal joints, as this will contribute to finger stiffness.

Pin-related problems, usually infection or radial neuritis, may be caused by external fixation or percutaneous pinning. They are rarely serious and are usually preventable with good techniques such as open pin placement and meticulous pin track care. Other surgical complications are discussed in the relevant sections.

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