15 Radial Neck Fracture

Pierre Journeau and Nicolas Moh-Ello

15.1 General

15.1.1 Epidemiology

Radial neck fractures are very infrequent in children; actually, they only account for 1% of all fractures and 5–14% of elbow fractures. They involve all age groups from childhood to prepuberty, with a peak incidence at around 9–10 years of age. They occur at a younger age in girls than in boys (approximately, 2 years earlier) [1].

15.1.2 Mechanisms of Injury and Classifications

The mechanism of injury is usually an indirect one. It results from a hard fall on an outstretched hand in which the elbow is extended or slightly flexed and a valgus force is applied to the elbow joint. According to the Jeffery classification, which is based on the mechanism of injury, it is a Type I injury. The head of the radius is driven against the capitulum. As the radial head is essentially cartilaginous, it is more resistant to trauma; this is why isolated radial head fractures and epiphyseal separations are so rare. Typically, the proximal radial metaphysis cannot withstand the sudden axial compression forces to which it is subjected and breaks.

Another mechanism is fracture of the radial neck associated with dislocation of the elbow: it is a Jeffery Type II injury [2]. It may occur during posterior dislocation of the elbow, and in this case, the radial head remains in an anterior position [3]. It may also occur during reduction of the dislocation, and in this case, the radial head will remain posteriorly dislocated (posterior to the capitulum). This form of fracture adversely affects the prognosis because of the associated vascular risk, not to mention the fact that the procedure itself is significantly more challenging.

There are two anatomic types of radial neck fracture. The most common is by far the pure metaphyseal fracture of the radial neck with subsequent Salter II epiphyseal separation. The other types of epiphyseal separation, particularly those with intra-articular fracture extension (Salter Type III and Type IV) are exceptional.

Associated injuries are frequent, from fracture of the olecranon, which occurs in an extended elbow, to dislocation of the elbow joint with or without avulsion of the medial epicondyle in an elbow that is slightly flexed at impact. But skin lesions and neurovascular injuries are exceptional.

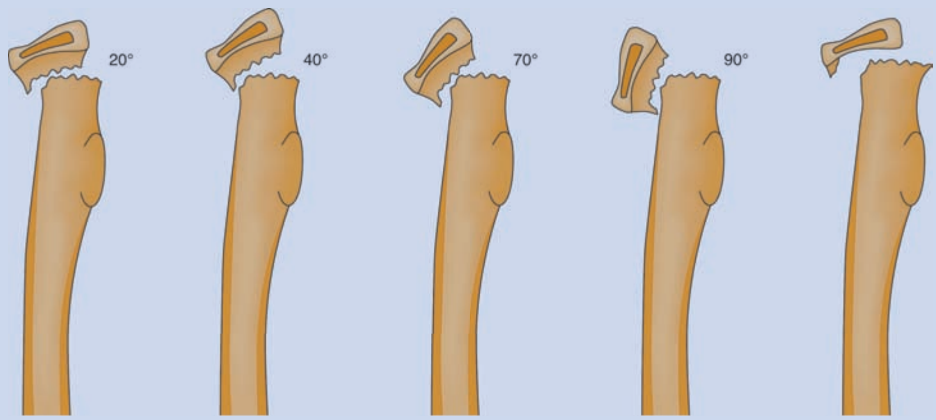
Many classifications have been developed for radial neck fractures. All of them are interesting in their own way: Jeffery classifies according to the mechanism of injury; Judet combines translation and type of fracture in its classification system (the earliest one); Métaizeau classifies according to translation and influence on prognosis (Table 15.1) [4]. Wilkins classification, which combines mechanism of injury and anatomic type of injury, has no prognostic value, and is therefore seldom used in France [1].

During displacement, a metaphyseal periosteal flap often remains attached to the radial head. Preservation of this sleeve, which contributes to the vascular supply to the radial head, is critically important for two reasons: first, to preserve the blood vessels it contains and second, because once tensioned, this piece of tissue will assist in maintaining the reduction (Fig. 15.1).

P. Lascombes, *Flexible Intramedullary Nailing in Children,*
DOI: 10.1007/978-3-642-03031-4_15, © Springer-Verlag Berlin Heidelberg 2010

Table 15.1 Judet classification with Métaizeau modification

Grade	I	II	III	IV	V
Radial head angulation	<20°	20–45°	45–80°	>80°	Epiphyseal separation
Translation	<3 mm	<50%	>50%	>100%	



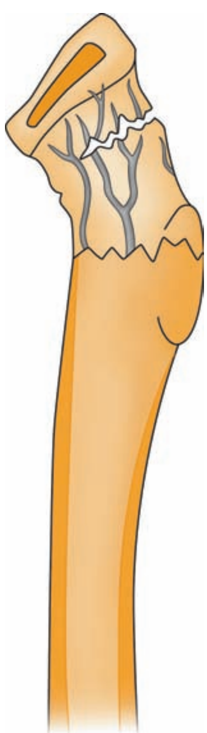


Fig. 15.1 Translation most often occurs in the posterolateral direction, leaving an intact periosteal hinge at the angulation. This hinge acts as a vascular carrier which maintains vascularity of the epiphysis

15.2 Retrograde FIN Technique

15.2.1 Anesthesia

As is often the case in trauma surgery, retrograde FIN (flexible intramedullary nailing) [5, 6] should be preferably performed under general anesthesia instead of regional anesthesia for ease of postoperative monitoring (one compartment syndrome was reported in the Nancy series). Furthermore, reduction is best achieved with the patient under general anesthesia as it permits complete relaxation of muscles.

15.2.2 Patient Positioning

The child is positioned supine on the operating table with the injured upper limb placed on an attached radiolucent arm table. A tourniquet is placed at the upper arm. It is not systematically inflated but it may prove useful should open reduction be required.

15.2.3 Image Intensifier

An image intensifier is usually placed parallel to the operating table and perpendicular to the arm table, at the level of the child's axilla. In this position, the surgeon can face the image intensifier and the posterolateral compartment of the elbow, and has a straight-shot access to the radial head and an easy access to the distal radial metaphysis. The assistant stands at the end of the arm table, perpendicular to the surgeon, and performs the traction-reduction maneuvers. Reduction is performed under fluoroscopic guidance. For the AP projection, the elbow is extended in a mid-pronation position. For the lateral projection, it is flexed 90° in a mid-pronation position, and the shoulder is positioned in full external rotation. This avoids repeated manipulation of the forearm in pronation-supination, which might compromise the stability of the reduction (Fig. 15.2).

15.2.4 Operative Field

The entire upper limb is prepped. A sterile upper extremity drape is used, which extends down to the tourniquet, and covers the child's body, including the trunk and the lower limbs.

15.2.5 Closed Reduction

Once prepping and draping are completed, closed reduction is attempted. As a matter of fact, the FIN technique is used either to stabilize the reduced fracture or (and this is the most common) to reduce and stabilize the radial neck.

Fig. 15.2 Injured *upper limb* is placed on an arm table, with image intensifier placed at the level of the child's axilla

Two different reduction maneuvers can be used, but prior to anything else, the surgeon must determine the plane of maximal displacement of the radial head. This is achieved using image intensification at progressively larger angles, from supination to full pronation. The plane of maximal displacement is found when the radial head forms an almost perfect rectangle, with a clearly and entirely visible physis. It is generally translated in the posterolateral direction, so that the plane of maximal displacement is best visualized in 20–40° of pronation (with reference to a full supination position).

The first maneuver was described by Patterson: the assistant places a varus stress on the extended elbow and applies traction to restore the joint space [7], while the surgeon places his/her thumb on the assumed position of the radial head (i.e., in the plane of maximal displacement) and gives a firm push in an upward and medial direction to return the radial head to its normal position. In this method, the forearm is supinated, but many variants have been designed. According to other authors, the elbow should be slightly flexed for better muscle relaxation. Jeffery recommends a small amount of pronation of the forearm to ensure that the push is applied in the plane of maximal displacement.

For the second maneuver, the thumb is replaced by a punch. It is important to place the punch on the radial head, not on the radial neck, in order to avoid damage to the blood vessels, which run through the periosteal flap. Correct position for the punch is determined using image intensification. The elbow is positioned in mid-flexion and slight pronation to allow forward shift of the radial nerve, which courses around the radial neck. This minimizes the risk of damaging the radial nerve with the instrument (Fig. 15.3). A simple lever movement helps reposition the radial head to assess stability. If stability is satisfactory, the upper limb is immobilized in a long-arm cast with the elbow flexed 90° and the forearm pronated. If it is not satisfactory, intramedullary nailing is necessary [8].

15.2.6 Selection and Preparation of the Implants

Sharp or tapered stainless steel or titanium nails are used as they literally pin the epiphyseal-metaphyseal fragment, and provide a firm anchorage during the a b c d e

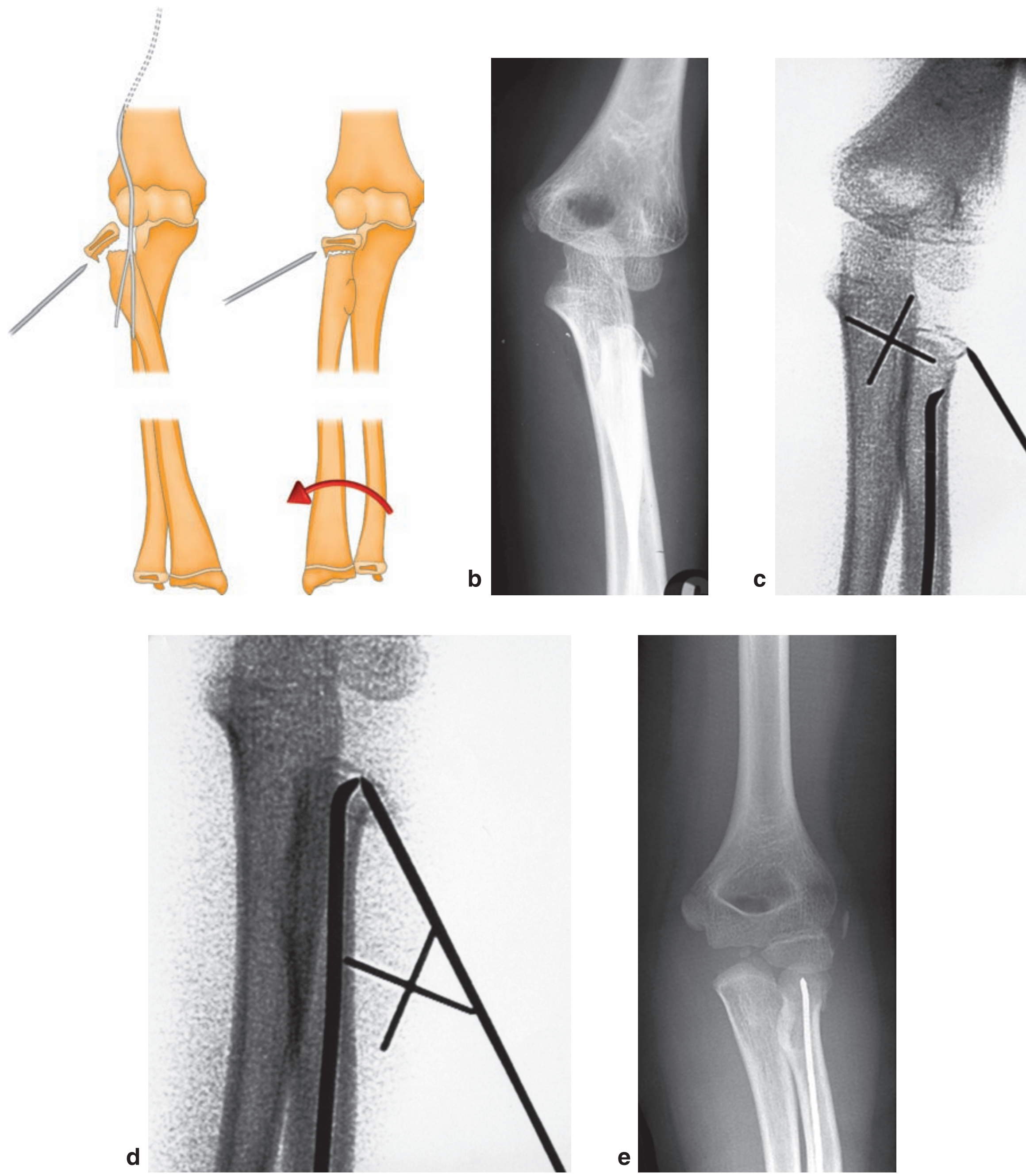


Fig. 15.3 Use of a punch: the forearm is pronated to allow forward shift of the radial nerve and thus protect it from injury. The punch is placed on the epiphysis, not on the radial neck, in order to avoid potential damage to the precarious vascularization (**a**). Clinical case: a 5-year-old girl with a Type IV fracture (**b**); (**c**) nail is pushed upwards while the radial head is reduced with the help of the punch; (**d**) nail enters the epiphysis and reduction is maintained with the punch; (**e**) result at 3 years follow-up

reduction maneuvers. Blunt-tipped nails may not penetrate the dense cancellous bone and instead push the fractured fragment. Nails with a tapered tip combine two advantages: sharpness for easy penetration of the epiphysis, and flatness for increased trabecular support and easier fracture reduction. Furthermore, stainless steel has a lower elastic modulus than titanium, which facilitates rotational maneuvers.

The most commonly used diameter is 2.0 mm, but it may vary from 1.5 to 2.5 mm depending on the age of the child.

If a straight nail is used, the tapered leading end must be slightly bent to anchor in the fractured fragment. Mild contouring is performed in the same plane and direction as the tip to match the natural curve of the radius at the end of the procedure.

15.2.7 Surgical Approach

The skin incision is made on the lateral aspect of the metaphysis of the distal radius, 10 mm distal to the anticipated entry point. This avoids the risk of skin impingement during oblique insertion of the nail (see Chap. 16).

Identification of the distal physis with fluoroscopy assists in accurately positioning the 15–20 mm longitudinal incision. Blunt scissors dissection is then performed. The radial vein and the sensory branch of the radial nerve are successively retracted posteriorly and protected with a mini retractor. Dissection continues anterior to the insertion of the brachioradialis tendon to avoid potential damage to the extensor pollicis brevis and abductor pollicis longus tendons, and is carried down to the bone (Fig. 15.4).

The entry hole is made with an awl in the same anterior posterior oblique direction, 10–15 mm above the distal physis. Care should be taken not to slip anteriorly to avoid injury to the radial artery. The chief advantage of this anterolateral approach to the distal radius is safety as there are no critical superficial neurovascular structures in the vicinity. Furthermore, if the

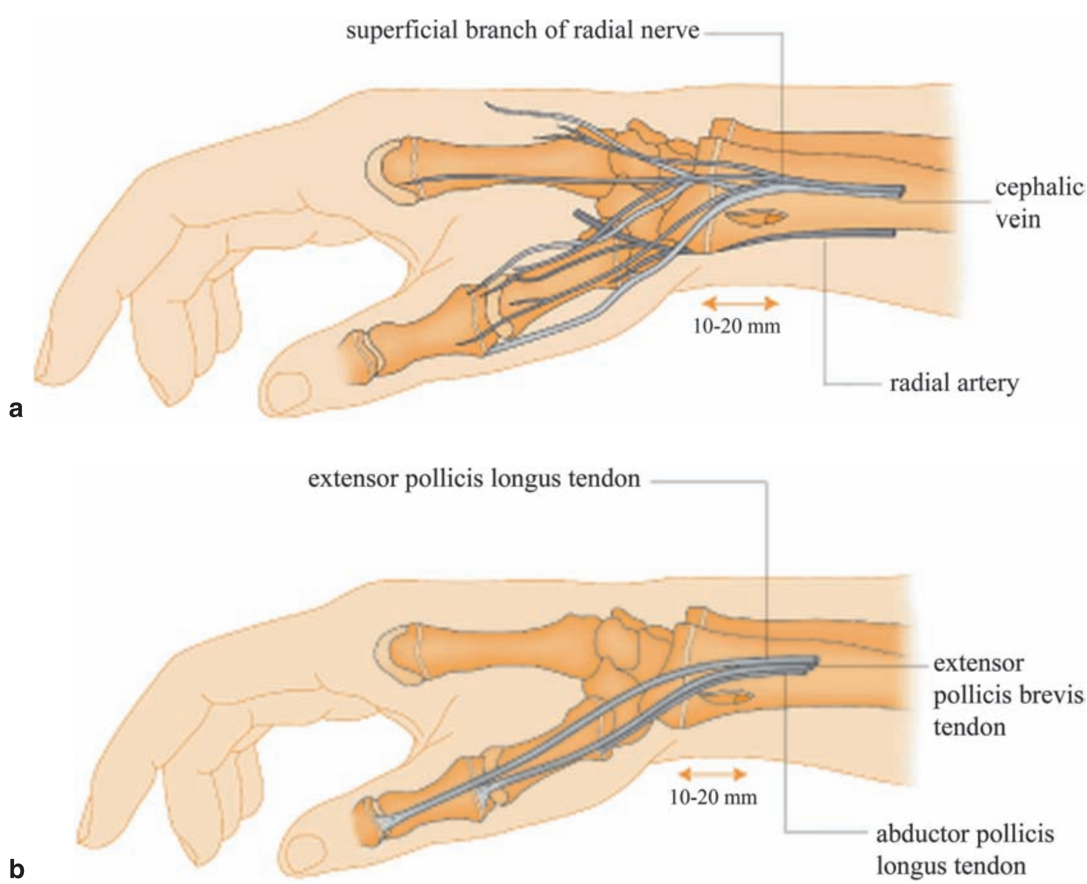


Fig. 15.4 Entry hole is created in the distal radial metaphysis. A 15–20 mm longitudinal incision is made anterior to the intermediate antebrachial vein and the sensory branch of the radial nerve. (**a**) The hole is made in an anterior-posterior direction to avoid injury to the radial artery; (**b**) position of the entry hole: 10–15 mm above physis, on the anterolateral aspect of the distal radius, anterior to insertion of the brachioradialis tendon and anterior to extensor pollicis tendons

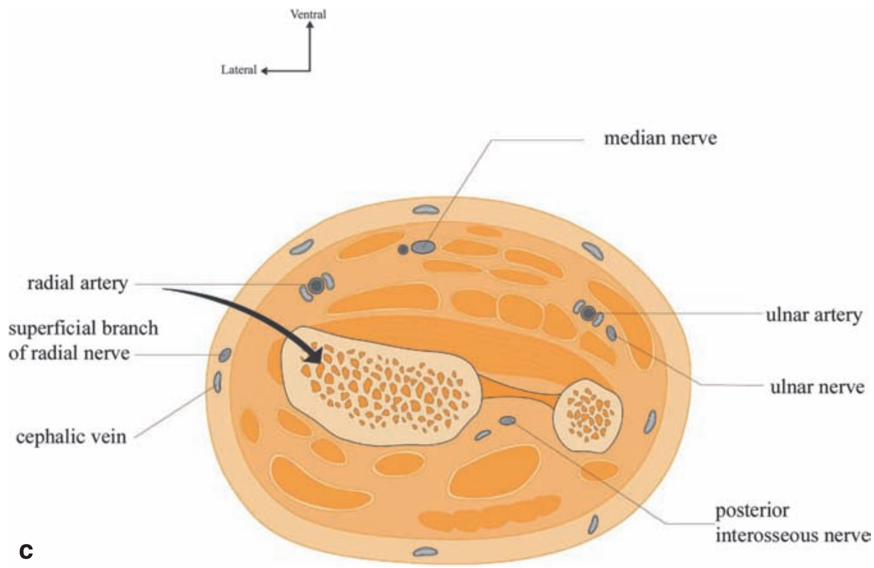


Fig. 15.4 (*cont.*) (**c**) Transverse section through incision

metaphysis is firmly held in mid-pronation with the thumb and index finger, the awl can be safely directed posteriorly, opposite the radial artery (Fig. 15.5).

The nail is attached to a T-handle and inserted into the medullary canal. Advancement of a tapered implant through such a narrow path may be somewhat difficult, and slight pronation movements or even light hammer blows may be necessary. Following the natural curve of the radius facilitates initial advancement of the nail.

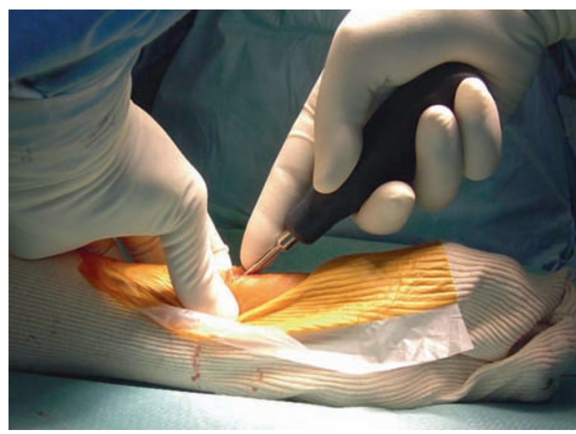


Fig. 15.5 Surgeon firmly holds the distal metaphysis in mid-pronation with the *thumb* and *index finger* while directing the awl in a slightly oblique posterior direction

15.2.8 Crossing the Fracture Site

Once the nail has reached the fracture site, it must be rotated so that its tip is positioned right in front of the radial head, in the plane of maximal displacement. The nail is firmly impacted into the radial head under fluoroscopic guidance using heavy hammer blows. Then, reduction of translation and tilt is obtained by rotating the nail 180° anteriorly. In fact, direction of the rotation depends on the position of the radial head, but as the radial head is most often translated postero-laterally, rotation is performed in an anteromedial direction. Therefore, with the surgeon facing the distal end of the radius, rotational movement will be clock-wise in a right elbow and counterclockwise in a left elbow (as for testicular reduction in testicular torsion repair). Gentle rotation is mandatory, otherwise the tip of the nail may cut out into the epiphysis. It is also recommended to combine rotation of the nail and pronation of the forearm. In fractures with grade 4 displacement, it may be necessary to use a punch as previously described to gently move the radial head toward the nail until it is positioned right in front of the nail tip (Fig. 15.6).

15.2.9 Final Reduction

Once closed reduction is completed, the tip of the nail should be directed medially and follow the natural curve of the radius. This means that after reduction and stabilization have been achieved, further manipulation will result in secondary displacement (Fig. 15.7).

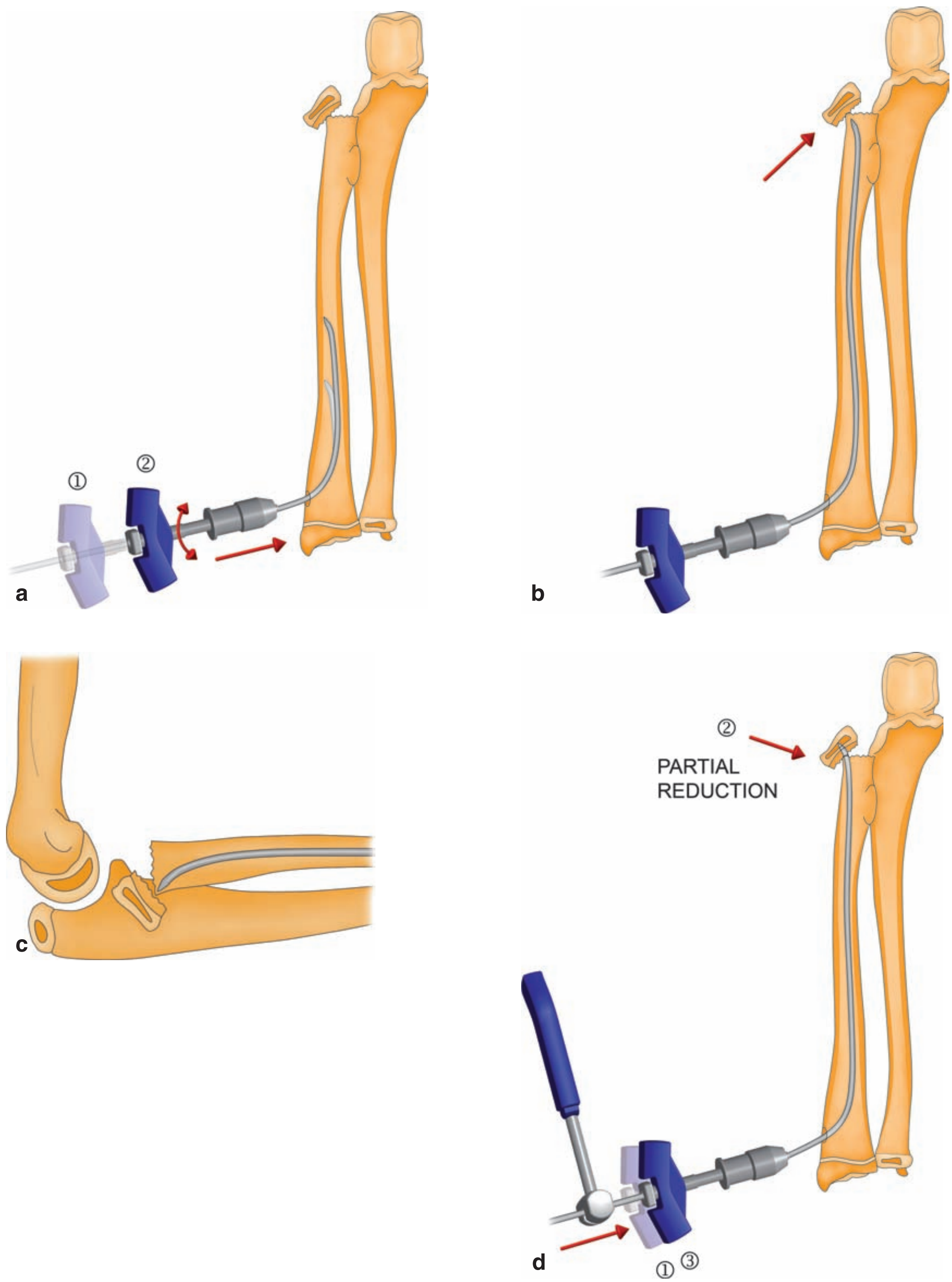


Fig. 15.6 Flexible intramedullary nailing (FIN) for radial neck fracture: (**a**) intramedullary nail is slowly advanced with the aid of slight rotatory movements (clockwise and counterclockwise) of the T-handle. Tip of the nail reaches the fracture site laterally (**b**) and posteriorly (**c**). During this time, the surgeon tries to reduce the radial head as much as possible by applying digital pressure; (**d**) then, the nail is impacted into the radial epiphysis using a slotted hammer

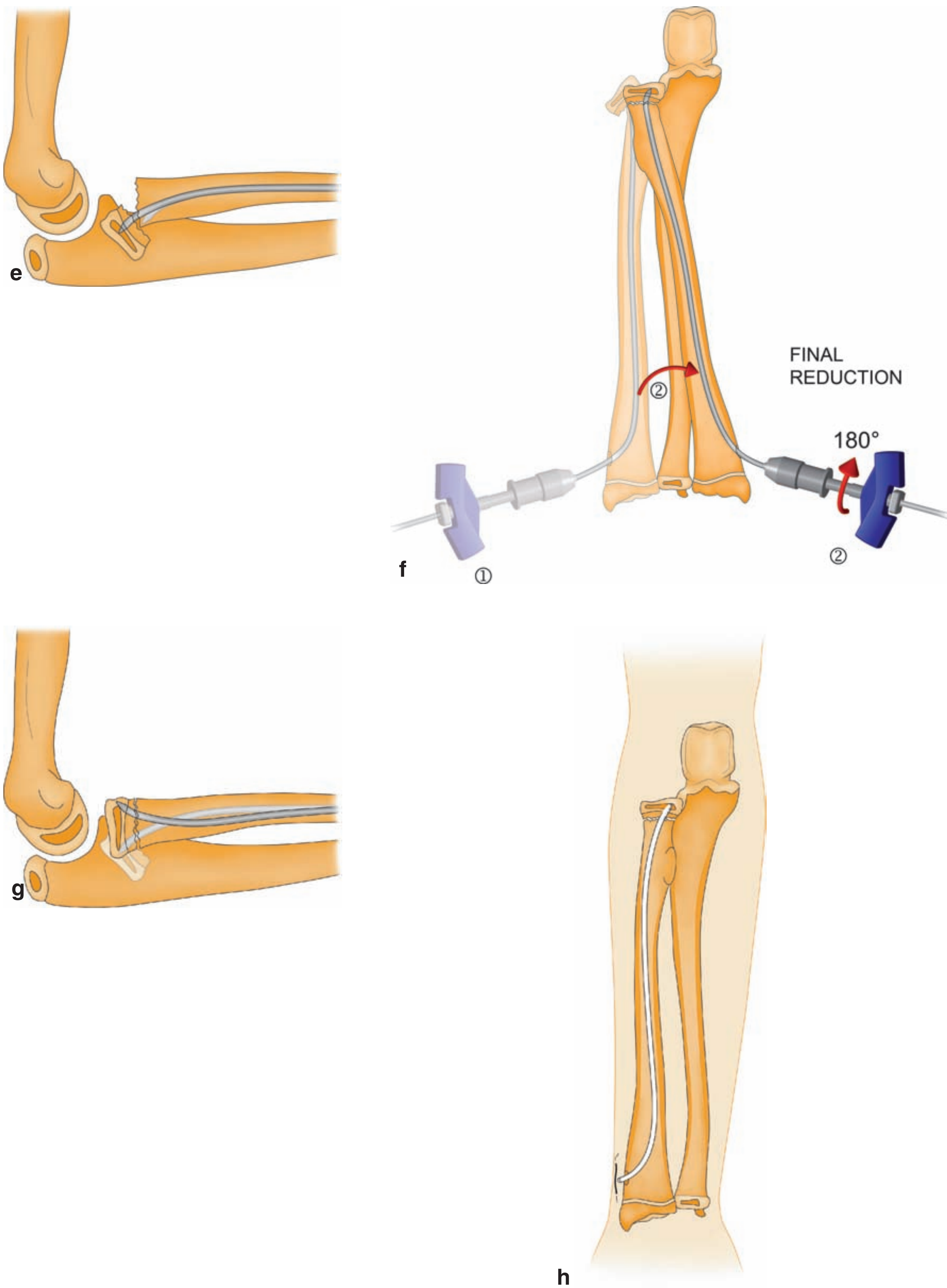


Fig. 15.6 (*cont.*) (**e**) Then, the nail is impacted into the radial epiphysis using a slotted hammer; (**f, g**) finally, reduction is performed by combining rotation of the T-handle and pronation of the forearm; (**h**) reduction and stabilization are now achieved

Owing to the remodeling capacity of the radial neck and depending on the child's age at the time of surgery, under reduction (lateral tilt) of up to 20° and even 30° is acceptable [9]. Therefore, we think that one should not try at all costs to achieve a perfect reduction at the risk of damaging the lateral periosteum or making multiple perforations in the radial head.

15.2.10 Wound Closure

At the end of the procedure, the trailing ends of the nails are slightly bent to keep them at a distance from the bone, and carefully trimmed using cutting pliers to make a clean cut that will not cause injury to the subcutaneous tissues. Only 3–5 mm should protrude out of the bone to facilitate later removal. In case of excessive protrusion, the use of an impactor may be necessary to recess the nail ends. The wound is closed without drainage and a compressive dressing is applied (Chap. 16, Fig. 16.7).

Alternatively, the distal end can be left unbent, and just cut using its elastic properties. Once trimmed, it will spring back and lie flush against the metaphysis, thus avoiding impingement upon critical structures.

Then, the wound is closed in two layers without drainage.

15.2.11 Types of Radial Neck Fractures

15.2.11.1 Type IV

These fractures cannot be managed straight away with FIN as the severe radial head tilt precludes impaction of the nail. The first technical option is to use a punch to partially reduce the radial head and allow insertion of the nail [8].

The second option is to perform a step-by-step reduction: first, the nail is impacted into the radial head and reduction is attempted by rotating the nail. If reduction is insufficient, the nail is freed by applying a firm hammer blow to avoid the risk of secondary displacement, and the impaction/rotation procedure is repeated to complete the reduction (Fig. 15.8).

Now, a third option is available, which consists of inserting a provisional nail to both partially reduce and stabilize the fracture. Then, a second nail is inserted in the same way, which will anchor in the partially reduced epiphysis. The provisional nail can then be removed, and reduction is completed using the second nail. The main drawback of this method is the creation of two distal holes, and its major limitation is the small diameter of the medullary canal, which may not accommodate both nails [6].

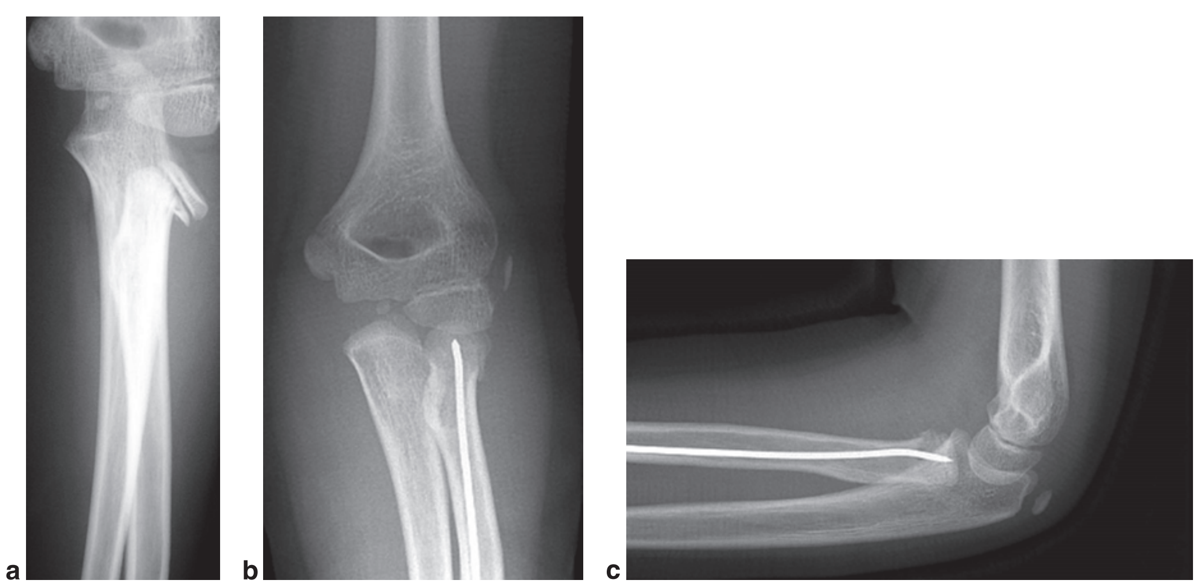


Fig. 15.7 A 9-year-old girl with a Type III epiphyseal separation of the radial neck: AP view (**a**). Immediate postoperative result of retrograde FIN performed with a 1.5 mm nail (**b, c**)

Fig. 15.8 An 11-year-old girl with a Type IV radial neck fracture (**a, b**). Retrograde FIN with a 1.5 mm tapered nail and anatomical reduction (**c, d**)

15.2.11.2 Radial Head Dislocation

Dislocation of the radial head anterior to the capitulum is not a contraindication to the FIN technique, which can still be used, but with extreme caution. The main hazard is misdirection of the nail, which may cause injury to the anterior structures. We strongly advise surgeons against the use of a punch in anterior dislocation cases because of the high risk of injury to the radial nerve. The main difficulty lies in evaluation of the plane of maximal displacement to correctly perform the reduction maneuvers.

Dislocation of the radial head posterior to the capitulum is a contraindication to percutaneous reduction because of the risk of 180° rotation of the radial head, which would result in avulsion of the periosteal flap (if present) and, as a consequence, in necrosis of the epiphysis (Case 1).

A posterolateral approach is used between the extensor carpi radialis, anteriorly, and the extensor digitorum, posteriorly. A technical trick from Métaizeau's personal technique consists in using a lateral approach through a superolateral arthrotomy, which will afford access to the radial head from above, and will reduce the potential risk of injury to an already weakened periosteal flap. Caution must be exercised when mobilizing the radial head, in order to preserve integrity of the few blood vessels that remain. Once reduction has been achieved, stabilization is provided by intramedullary nailing as previously described, or sometimes sutures are placed through capsuloperiosteal tissue [10].

15.2.12 Postoperative Care

At the end of the procedure, range of motion is carefully evaluated in pronation-supination. Image intensification is used to assess stability of the fixation.

A dry dressing is applied to the distal wound, and the upper extremity is immobilized in a long-arm cast (traditional plaster or more often resin) in slight pronation for 3 weeks.

Postoperative X-rays (AP and lateral) are taken with the cast on.

Postoperative monitoring is essential. It is focused on detection of compartment syndrome (one case in our series), and sensitiveness in the radial territory, particularly the dorsal aspect of the thumb and the first web space.

Pain killers and NSAIDs are prescribed for a few days.

The child is allowed to get out of bed on Day 1 and should wear a protective sling during the whole immobilization period.

15.2.13 Resumption of Activities

The child is usually discharged from hospital 1–2 days after surgery and is encouraged to return to school as soon as he/she is back home. He/she should be excused from sports and physical education for 2 months. At the third postoperative week, the child returns to hospital for removal of cast and X-ray control.

Self-rehabilitation is the rule for the next 4–6 weeks, that is, until the next follow-up visit. During this second visit, range of motion is evaluated, and the surgeon decides whether self-rehabilitation should be continued or rehabilitation should be performed by a physical therapist, knowing that massages and forceful passive ROM are proscribed as they may lead to the development of periarticular ossification.

15.2.14 Implant Removal

The nail is always removed. Although there is no "ideal" time to remove the implant, it is advisable to wait until full range of motion has been recovered. Better not run the risk of reoperating during the rehabilitation period (whether it is self-rehabilitation or rehabilitation performed by a physiotherapist). The appropriate time is around the second or third postoperative month.

Implant removal is usually performed on a day-patient basis using the initial approach. Extra caution is required during dissection of subcutaneous tissue as the presence of surgical adhesions may make it difficult to identify the sensory branch of the radial nerve. Therefore, we think it preferable to use a tourniquet.

Return to sports is allowed as soon as skin healing is complete.

15.2.15 Postoperative Follow-up

Periodical clinical and radiological follow-up for 2 to 3 years is mandatory as growth disturbances are not uncommon, and elbow function may deteriorate even after several years.

However, if after 2–3 years follow-up the morphology of the child's elbow is normal with full range of motion, longer follow-up is unnecessary.

15.3 Complications

15.3.1 Local and Regional Complications

Local and regional complications, whether preoperative or postoperative, are those of any other bone fracture.

However, radial neck fractures are seldom associated with preoperative complications. Protrusion of the fractured end of the bone is most often seen in associated fractures of the radial neck and olecranon, and vascular lesions are hardly ever seen. But, injury to the radial nerve should be systematically sought because of its close location, whether it be at presentation or during reduction, particularly when a punch is used.

Early postoperative complications are those of any surgically treated fracture, including: compartment syndrome, early infection, secondary displacement [11].

15.3.2 Complications Associated with Radial Neck Fractures

A close correlation has been noted between the amount of initial displacement, treatment method, and quality of the functional and radiographic outcome. Open reduction of the radial head often leads to poor results and should be avoided, except in the rare cases of posterior dislocation. The best results are obtained with closed manipulation, but only mildly displaced fractures are amenable to nonoperative treatment. Intramedullary nailing yields similar results to nonoperative treatment; the only factors that may adversely affect the outcome are the amount of initial displacement and the presence of associated bone lesions. Most of these complications result in joint stiffness (more or less severe), most often in pronation-supination, rarely in flexion-extension.

15.3.2.1 Growth Disturbances

Hypertrophic radial head is a frequent complication (involving between 20 and 40% of the cases). We have personally had two cases in a series of 95 fractures managed with FIN. It is due to the hypervascularization, which follows injury. Its clinical impact varies according to the degree of hypertrophy, ranging from normal function to moderate restriction of pronation-supination. There is no appropriate solution to this problem.

Conversely, epiphysiodesis of the proximal radial physis may occur. We have had two cases in our own series. Causes are numerous and include: epiphyseal separation (rare), aggressive reduction maneuvers, repeated nail insertions, multiple perforations with the punch. However, it does not significantly affect function as the resulting shortening is very limited,which is attributed to two reasons: the first one is that the proximal radial physis contributes only 20% of the total growth of the radius, and the second one is the mean advanced age of the involved children.

15.3.2.2 Malunion

Malunion may result either from secondary displacement, or from a large postreduction fracture gap that was not filled during the bone remodeling process. Malunion is more frequently seen after manipulative reduction, but it may also occur after intramedullary nailing if the limb has not been immobilized after the procedure. Malunion produces a cam effect, which restricts ROM mainly in pronation-supination, and which is responsible for cubitus varus deformity. The potential for bone remodeling depends on the child's age. It is generally held that where residual tilt is greater than 30° there is incomplete bone remodeling [3]. Treatment will vary according to the degree of discomfort.

15.3.2.3 Anarchic Ossifications

Intra- or periarticular ossifications may develop and even create a radioulnar synostosis. In most cases, the cause is related to the surgical approach, but it may also be an ossification of the periosteal flap, particularly where there are associated bone lesions, as is the case in high-energy fractures. The three cases that we have had were radial neck fractures with an associated bone lesion (elbow dislocation in two cases, olecranon fracture in one) (Case 2). The degree of functional impairment they may cause depends on their volume and location. Resection may be necessary if ROM is severely restricted, which will require an appropriate postoperative rehabilitation protocol.

15.3.2.4 Necrosis of the Epiphysis

Fortunately, extensive epiphyseal necrosis is a rare occurrence. It is related either to an extended approach or to dislocation of the radial head (Case 3), particularly posterior dislocation (four cases (4.5%) of complete necrosis in our series). It should be pointed out that it is almost systematically associated with a poor functional outcome. Actually, there are many types of partial necrosis, but their rate is likely underestimated as revascularization takes place during the remodeling process so that necrosis goes undetected. These types of necrosis hardly affect function.

15.3.2.5 Nonunion of the Radial Neck

Nonunion of the radial neck also is a rarely reported complication [12]. Still, we have had three in our series of 95 FIN cases (Case 4). Its mechanism is very similar to that of necrosis. A major factor is precarious vascularization, which can be compromised in severely displaced fractures, posterior dislocation and open reduction. At issue is the question of whether this condition should be treated or not as it is generally well tolerated.

15.3.3 Complications Associated with this Technique

15.3.3.1 Vascular Complications

Although we have not personally experienced any vascular complications so far, they cannot be ignored. The most critical step is the creation of the distal hole as anterior misdirection of the awl can place the radial artery at risk. It is recommended to firmly hold the radius in mid-pronation with the thumb and index finger, and direct the awl slightly posteriorly.

15.3.3.2 Implant-related Problems

Implant-related problems are a common subject of complaint. Only in rare instances does it require surgical revision as hardware removal is normally a straightforward procedure.

However, the nail may occasionally irritate the sensory branch of the radial nerve and even extensor pollicis tendons. At worst, skin erosion may occur and should be treated as soon as possible to avoid the potential risk of sepsis. This is why we wish to insist on the importance of a slightly anterior approach and careful trimming of the nail at the end of the procedure. Both will reduce the risk of irritation of the nearby tendons and nerves and skin irritation at the entry point (which is often increased by muscle wasting).

15.4 Indications

Among all the treatment options that are currently available for radial neck fractures, intramedullary nailing is the "gold standard," whether alone or in association with punching. The reason is that reduction is performed by closed means and preserves vascularization of the radial head, which is known to be a strong predictor of good prognosis [13].

Nonoperative treatment is indicated in Type I fractures, which can be successfully managed with immobilization without reduction (long-arm cast with the forearm slightly pronated for 3–4 weeks). It is also indicated in Type II fractures after manipulative reduction, if adequate stability is achieved.

But, in cases where reduction is insufficient or unstable and in Type III fractures, intramedullary nailing is the treatment of choice as it provides both reduction and stabilization of the fracture. However, immobilization in a plaster cast for 3 weeks is highly recommended for protection purposes (Case 5).

In Type IV fractures, reduction can be achieved with FIN and reduction maneuvers (as described above), alone or in association with punching, or else using an open technique which, however, should be avoided as much as possible. Stabilization is provided by an intramedullary nail and cast immobilization. There are no indications for radiocapitular pin fixation.

Any associated bone lesions should be treated in the same procedure and are not a contraindication to FIN (Case 2).

15.5 Contraindications and Limitations

In cases of radial head dislocation, particularly posterior dislocation, no manipulative reduction should be attempted to avoid the risk of rotating the epiphyseal fragment 180°, which would result in necrosis. Direct nailing is also contraindicated. Open reduction is required, and an intramedullary nail provides stabilization. Some will advocate suturing of the peripheral periosteal structures.

15.6 Case Reports

15.6.1 Case 1

An 8-year-old child fell on her elbow. Initial X-rays, and more particularly the lateral view, showed a Jeffery Type II radial head fracture (a, b). It was treated by closed reduction and FIN. On the fluoroscopic image, note the 180° rotation of the radial head (c). Open surgery was necessary to perform reduction and FIN (again) using a 1.5 mm nail (d, e). The implant was removed during the fourth postoperative month. At 10-month follow-up, function was excellent with full range of motion, but the X-ray showed significant remodeling of the radial head (f). Still, viability of the epiphysis was confirmed by MRI (Fig. 15.9).

Note: this unusual fracture needs to be known better.

Fig. 15.9 Case 1

15.6.2 Case 2

An 11-year-old child presented with a Type IV radial neck fracture associated with an olecranon fracture (a, b). Treatment consisted in reduction of the radial head fracture with a punch and FIN using a 2 mm nail, and open reduction and fixation of the olecranon fracture with K-wires. At 45 days posttreatment, range of motion had not yet been restored: there was a flexion and extension lag, and a loss of pronation-supination of about 40° in each range (c, d). The implant was removed, but at 1-year follow-up, no improvement was noted. CT showed small calcifications, particularly along the medial border of the radial head that might explain this loss of motion (e). Eighteen months after the initial treatment, arthrolysis was performed and calcifications removed, and an intensive rehabilitation program was initiated. At the 3-year follow-up, the X-ray showed remodeling of the radial head and medial epicondylar groove. There was a loss of 5° both in flexion and extension as compared to the contralateral side, full supination, and a loss of 30° in pronation (as compared to the contralateral elbow) (f, g) (Fig. 15.10).

Note: the severity of this case is attributable to the associated lesions.

Fig. 15.10 Case 2

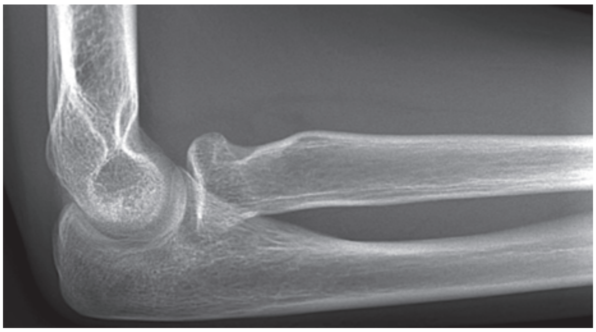
f  g 

Fig. 15.10 (*cont.*) Case 2

15.6.3 Case 3

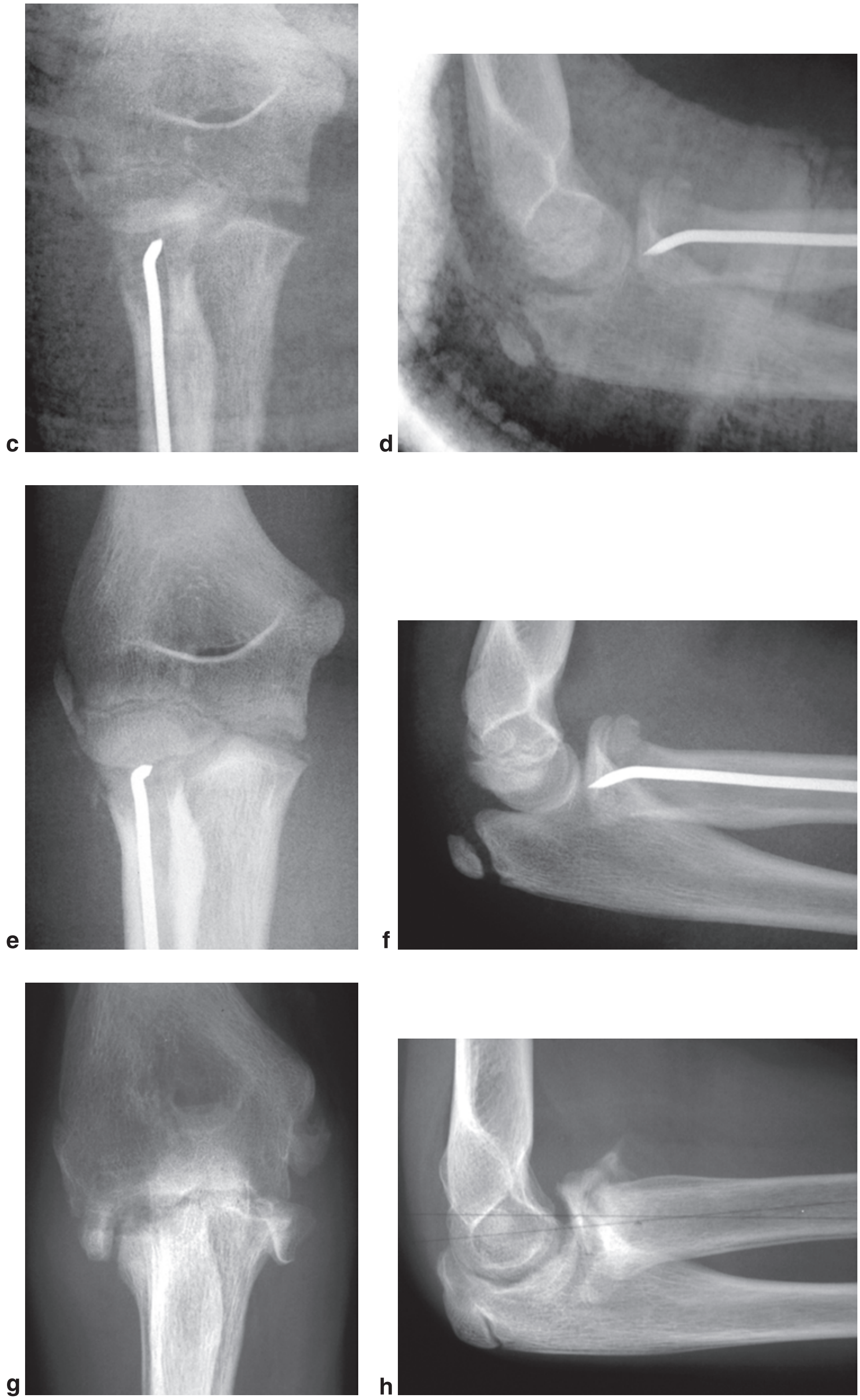
An 11-year-old girl was treated for a Type IV fracture of the radial head associated with dislocation of the elbow joint. Dislocation was reduced by closed means (a, b) and radial head fracture by manipulation, prior to performing FIN with a 2 mm nail (c, d). At 3 months, the radiographic result was quite good (e, f). However, necrosis of the radial head gradually developed, leading to a poor functional outcome. Extension lag was 25° but the child had recovered full flexion. Loss of pronation-supination was about 60° in each range (g, h) (Fig. 15.11).

Note: necrosis of the radial head may occur when nonoperative treatment is used.

a  b 

Fig. 15.11 Case 3

Fig. 15.11 (*cont.*)
Case 3



15.6.4 Case 4

An 11-year-old boy operated on for a Type IV fracture. Treatment consisted in punching and FIN using a 2 mm nail (c, d), followed by immobilization in a splint for 3 weeks. Healing was delayed and at the 6-month follow-up, the X-ray showed nonunion of the radial neck (e, f). MRI not only confirmed the presence of fibrous nonunion but also good viability of the radial head (g). As the child complained of functional discomfort, surgical revision was performed 1 year after the initial injury: all fibrous tissue was removed and iliac crest graft was used. Six months later, bone union seemed to be achieved. Function was satisfactory, with a mild residual flexion contracture of 10° and a loss of supination of 40°: flexion- extension = 130°-10°-0°, pronation-supination = 90°-0°-40° (h) (Fig. 15.12).

Note: the intra-articular position of the radial neck may promote nonunion.

Fig. 15.12 Case 4

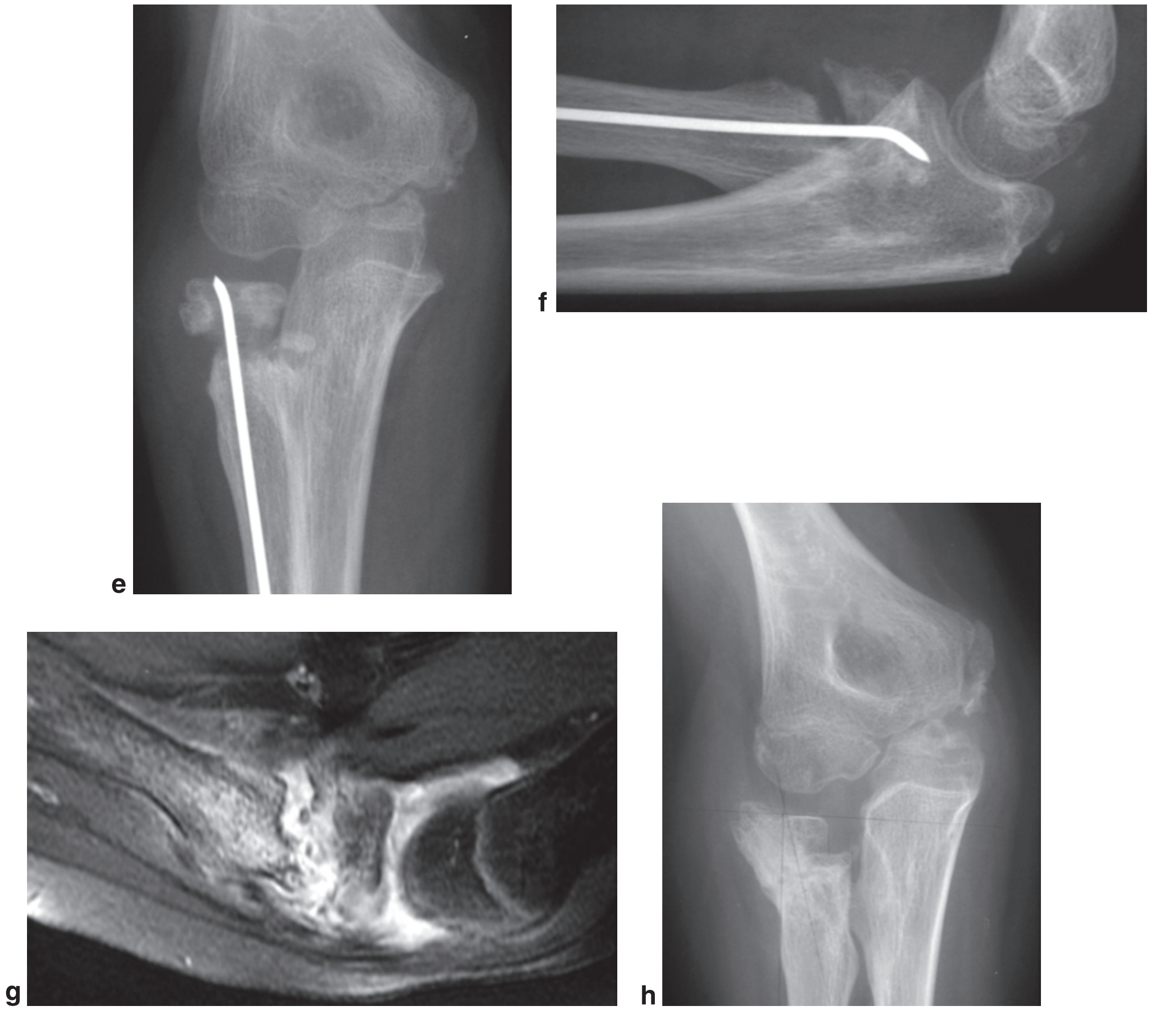


Fig. 15.12 (*cont.*) Case 4

15.6.5 Case 5

An 8-year-old child with a radial head fracture initially treated by closed means. The control X-ray taken with the cast on showed secondary displacement with tilt greater than 30° (a, b), which was confirmed by CT reconstructions (c, d). FIN was performed using a 1.8 mm tapered nail, with a good radiographic and functional outcome at 3 months postoperatively (e, f). The child had recovered full range of motion (ROM was equal in both elbows) (g, h) (Fig. 15.13).

Note: in children, residual tilt (if any) of the radial head should not exceed 20°.

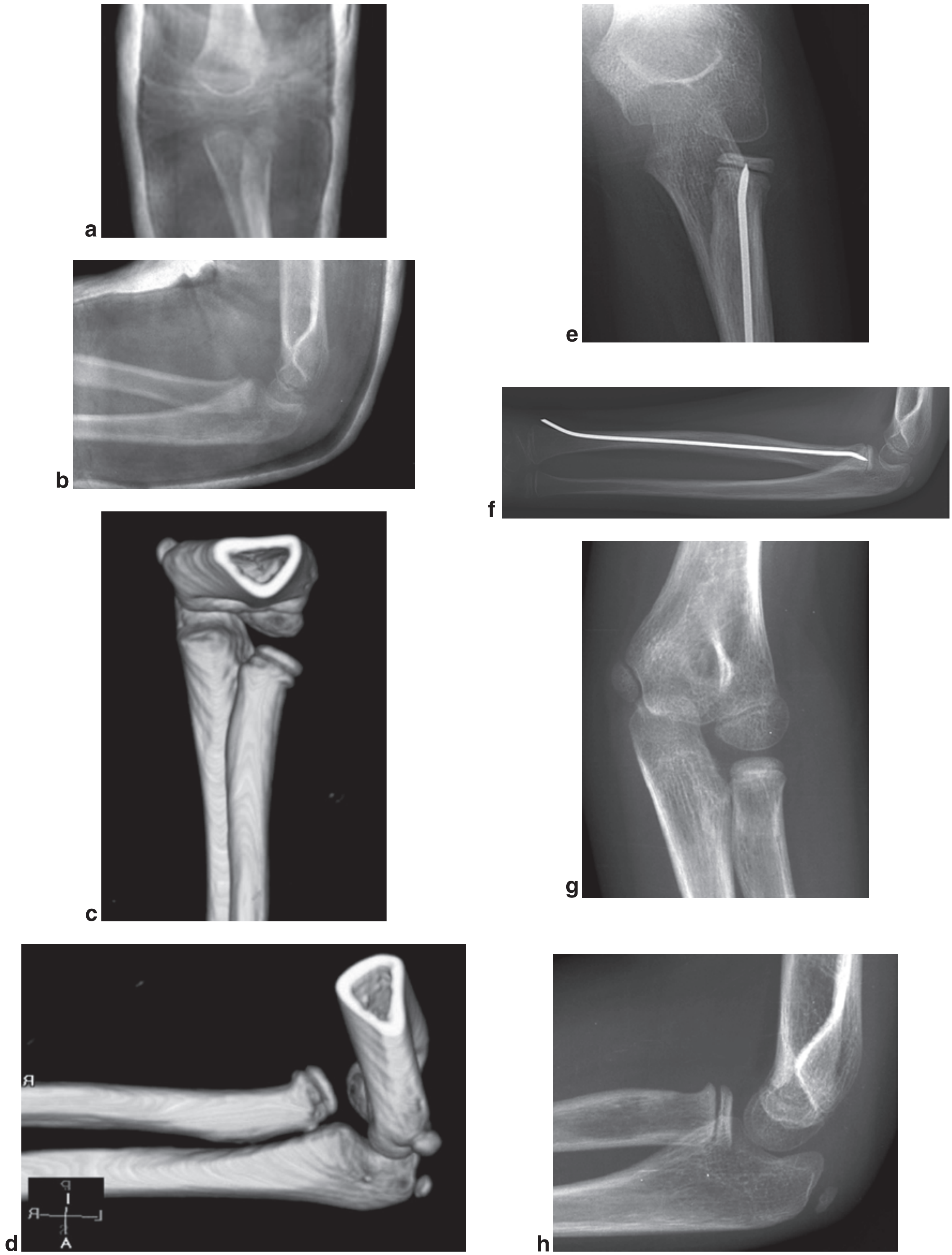


Fig. 15.13 Case 5

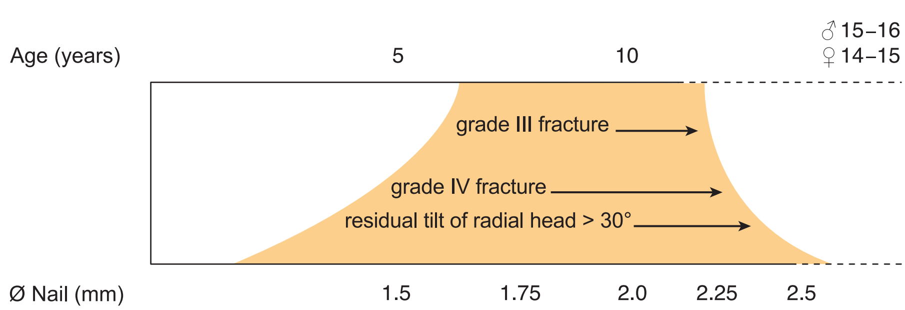
15.7 FIN and Radial Neck Fracture: Postoperative Management in the Absence of Complications

Day 0	• Long-arm plaster cast • AP and lateral radiographs • Continuous monitoring • Operated arm is elevated • Pain killers ± antiinflammatories
Day 2	• Discharge with instructions • Early return to school
Three weeks postop.	• Cast removed; AP and lateral radiographs. • Self-rehabilitation
Two months postop.	• Clinical and radiological (AP and lateral) follow-up • Nail removal is considered • Return to sports
Twelve to twenty-four months postop.	• Clinical and radiological (AP and lateral) follow-up

15.8 Six Key Points

- Whenever possible, reduction should be achieved by closed means, using a punch if necessary.
- A 1.5–2.5 mm nail with a tapered end (for dense epiphyseal bone) is advanced up to the proximal metaphysis.
- Image intensification (AP and lateral views) should be used to make sure that the tip of the nail is positioned right in front of the epiphysis.
- The nail should be impacted into the epiphysis using a slotted hammer (one single try).
- Fracture must be reduced by gentle rotation of the nail combined with appropriate maneuvers.
- Immobilization in a long-arm plaster cast for 3 weeks.

15.9 FIN Indications: Radial Neck Fracture



References

1. Chambers HG, Wilkins KE. Fractures of the proximal radius and ulna. In: Rockwood CA, Wilkins KE, King RE, éds. Fractures in children. Vol. 3. 4e éd. Philadelphie: Lippincott-Raven; 1996. p. 586–613
2. Jeffery CC (1950) Fractures of the head of the radius in children. J Bone Joint Surg. 32B:314–24
3. Newman JH (1977) Displaced radial neck fractures in children. Injury. 9:114–21
4. Métaizeau JP, Lascombes P, Lemelle JL, Finlayson D, Prévot J (1993) Reduction and fixation of displaced radial neck by closed intramedullary pinning. J Pediatr Orthop. 13:355–60
5. Lascombes P. Radial head and neck fractures in children. In: Surgical techniques in orthopaedics and traumatology. Emcycl Méd Chir (Elsevier SAS, Paris), 55-240-C-10, 2000, 4p
6. Métaizeau JP, Prévot J, Schmitt M (1980) Réduction et fixation des fractures et décollements épiphysaires de la tête radiale par broche centromédullaire. Rev Chir Orthop. 66:47–9
7. Pontailler JR. Fracture du col et de la tête radiale. In: Damsin JP, Langlais J, éds. Traumatologie du coude de l'enfant. Cahier d'enseignement de la SOFCOT n° 72. Paris: Elsevier; 2000. p. 128–45
8. Kohler R, James J, Brigound T, Michel CR. Traitement des fractures du radius chez l'enfant par poinçonnage percutané (19 cas). Rev Chir Orthop. 1991;77 Suppl 1:140
9. Radomisli TE, Rosen AL (1998) Controversies regarding radial neck fractures in children. Clin Orthop. 353:30–9
10. Chotel F, Vallese P, Parot R, Laville JM, Hodgkinson I, Muller C et al (2004) Complete dislocation of the radial

head following fracture of the radial neck in children: the Jeffery type II lesion. J Pediatr Orthop. 13:268–74
11. Peters CL, Scott SM (1995) Compartment syndrome in the forearm following fractures of the radial head or neck in children. J Bone Joint Surg. 77A:1070–4
12. Waters PM, Stewart SL (2001) Radial neck fracture nonunion in children. J Pediatr Orthop. 21:570–6
13. Schmittenbecher P, Haevernick B, Herold A, Knorr P, Schmid E (2005) Treatment decision, method of osteosynthesis, and outcome in radial neck fractures in children: a multicenter study. J Pediatr Orthop. 25:45–50