FIN Without Image Intensification

6

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Flexible intramedullary nailing (FIN) is performed using closed reduction whenever possible. The Healing process mainly relies on formation of external callus and endosteal callus, which is clearly enhanced by the presence of the intramedullary nails (see Chap. 2).

Our experience shows that open fractures and/or fractures treated by open reduction following unsuccessful external maneuvers have delayed healing. Still, no nonunions have been reported (Fig. 6.1), and postoperative course is hardly affected, since the nails provide effective protection against refracture caused by low-energy trauma.

As early as 1977, in Nancy, both-bone forearm fractures were treated by open reduction and internal fixation using Flexible Intramedullary Nails.

During the development phase of FIN, many young surgeons have visited us from Africa, South America, and Asia. They were all very impressed. When they left, they were eager to use it and popularize it in their own countries. But the BIG question was "how can we manage without image intensification?"

We prompted them to start using FIN without the help of the image intensifier using a direct approach to the fracture site.

6.1 Surgical Techniques (Fig. 6.2)

The patient is positioned supine on the operating table, whatever the bone segment to be treated. FIN is performed under general anesthesia. Initial insertion is the same as for a closed reduction technique, with the nails advanced into the medullary canal as far as the fracture site. Then, a direct approach is used for anatomic reduction and engagement of the opposite fragment under visual control.

Depending on the anatomic location of the fracture, length of the skin incision may range (in adolescents of the same age) from 40 mm for a forearm fracture to 60 mm for a femoral fracture. The fracture site is exposed using a direct approach carried along the intermuscular septa between the anatomic compartments, at some distance from critical neurovascular structures.

- Femoral fractures are best managed from a lateral approach. The iliotibial band is incised longitudinally, and the vastus lateralis is retracted anteriorly to afford access to the femoral shaft.
- In forearm fractures, the radius is approached anterolaterally between the ventral compartment and the lateral compartment. In distal-third fractures, the incision is preferably located on the ventral aspect of the bone. In proximal-third fractures, due to the deep position of the radius, the bone must also be approached between the ventral compartment and the lateral compartment to avoid injury to the radial nerve. Ulna is much easier to approach: directly from its posteromedial aspect, between the flexor and the extensor carpi ulnaris.
- For the tibia, the surgeon is free to use the approach he is most familiar with: anterior, medial, or anterolateral approach.
- Caution must be exercised when approaching the humerus laterally, due to the presence of the radial nerve, which courses around the posterolateral border in the middle shaft of the humerus. Depending on the location of the fracture site, a medial approach may be safer.

With a direct approach to the fracture site, the hematoma is evacuated during local debridement. Bone fragments are identified, and the medullary canal is located. Periosteal stripping is not desirable since periosteum has already been severely distorted during the injury.

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Fig. 6.1 A 14-year-old boy with an open fracture of both bones of the distal third of the forearm (**a**). Following debridement, combined antegrade/retrograde flexible intramedullary nailing (FIN) (retrograde posteromedial for the radius, antegrade for the ulna) was performed using two 2 mm diameter nails (**b**). Delayed healing of both bones was noted at 3 months (**c**); 4 months (**d**); and 5 months (**e**). Bone union was eventually achieved at 8 months (**f**)

One nail or two nails are advanced until they appear at the fracture site. Then, the leading ends of the nails are properly oriented so that they easily engage the opposite fragment. Some nails have a marker line, which greatly facilitates orientation of the nail tip. At this stage, the length X of the opposite fragment is measured from the metaphysis opposite the entry site to the fracture site, using reliable anatomic landmarks for reference. This measurement is transferred to the free end of the nail, and a mark is made for later reference.

Reduction is then performed using two reduction clamps. The nails can serve as tools to move the bone

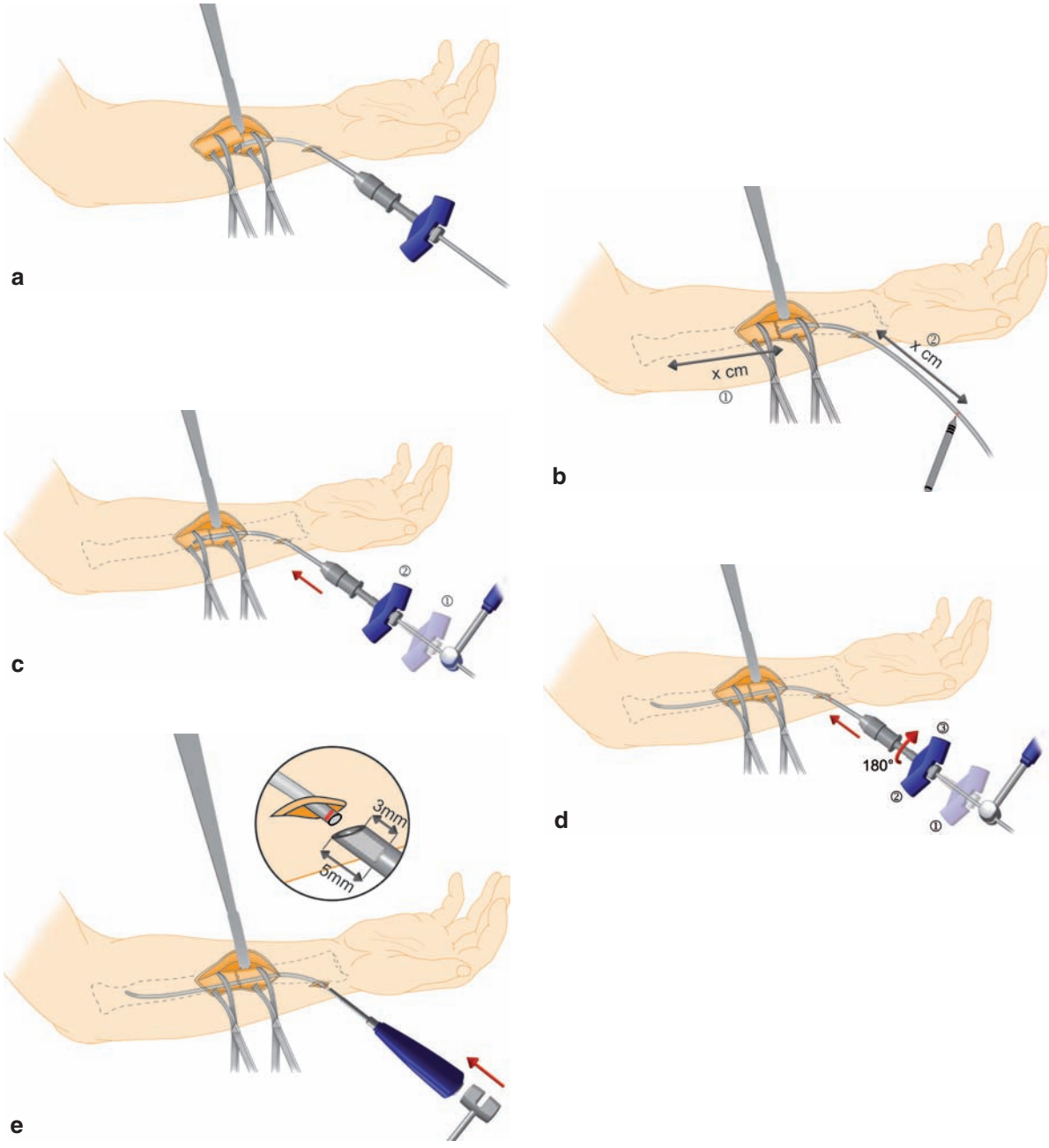

Fig. 6.2 Open FIN. Example of a radial fracture treated by retrograde FIN: one nail is inserted and advanced as far as the fracture site, and fracture site is opened (**a**). Reduction is performed using two reduction clamps. The length "X" of the proximal segment is measured *(1)* and measurement is transferred to the free end of the nail *(2)* (**b**). After the nail tip has been properly oriented, the nail is pushed across the fracture site with the help of a slotted hammer (**c**). The nail is advanced up the proximal fragment to the previously determined insertion depth "X" (**d**). If necessary, the nail is rotated to achieve optimal alignment of the fracture. The free end is then trimmed and recessed using the impactor (**e**)

fragment in which they lie. Then, the nails are pushed across the fracture site with the help of the slotted hammer, and advanced further until they reach the metaphysis. The mark previously made on the nail indicates proper insertion depth. Next, using the T-handle or the dedicated inserter, each nail is rotated so that it points to the right direction (with its concave side properly oriented), that is, the direction that allows alignment of the fracture. The reduction clamps are removed to check the quality and stability of reduction. Any residual angulation can be corrected by rotating the nails until stable, anatomic reduction is achieved. The free ends of the nails may be bent before trimming. Final impaction is performed as described in Chap. 5. Again, stability of the fracture site is assessed, and wounds are closed. It is up to the surgeon to decide whether drainage of the main wound (i.e., fracture site) is necessary.

In certain situations, the surgeon may select to leave the implants in situ. But this needs to be planned, as in this case, the trailing ends are simply recessed into the bone and buried to avoid irritation of the subcutaneous and cutaneous tissue.

6.2 Postoperative Care

Postoperative management does not differ from that described in each Chapter of this book, for each fracture location. Delayed healing that may be noted at the 3-month radiographic follow-up is only due to periosteal disruption and evacuation of the fracture hematoma. Subsequent radiographic assessments will confirm good healing of the fracture. At the most, the nails will be removed a few months later than recommended for closed FIN.

6.3 Conclusion

FIN can be safely performed without using intraoperative fluoroscopy. Furthermore, the free ends of the nails may be recessed and buried in bone for permanent implantation, if necessary.