Chapter 4: Forearm
4.3 Forearm shaft fractures, transverse 
(12-D/4)
### Case title
Radial and ulnar shaft fractures, transverse (12-D/4)
ESIN radius retrograde, ulna antegrade

### Step title
Case presentation

An eight year old female fell from a tree and presented clinically with an angulated left forearm. Her x-rays demonstrated displaced and shortened transverse fractures of the radial and ulnar shafts at nearly the same level (Figs. 4.3-1, 4.3-2)

### FIGURES

**Fig. 4.3-1.**

- a.

**Fig. 4.3-2a-b.**

- a.
- b.
**Fig. 4.3-1. Clinical appearance.** On presentation, there was an obvious apex-dorsal angulation in the left forearm.

**Fig. 4.3-2. Injury x-rays.**

- **a.** AP and
- **b.** lateral x-rays taken at the initial evaluation. There are complete fractures of the distal shafts of both the radius and ulna with shortening and angulation.

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**Step title**

**Surgical approach**

**Text**

**Entrance sites and nail advancement**

*Separate sites* In surgically stabilizing the shafts of the radius and ulna, the standard entrance sites are separate and at each end of the forearm. The radius site is distal and the ulnar site is proximal.

**Distal dorsal radial nail insertion** A 2-3 cm transverse or longitudinal incision is made over the palpable *Tuberculum Radii of Lister* (*Fig. 4.3-3*). Next, the subcutaneous tissue is spread and the fascia is incised to expose the tubercle. After retracting the wound, the awl is placed directly on the tubercle adjacent to the third compartment containing the extensor tendons. Care is taken to avoid injury to the tendons. The awl is directed ventro-laterally as it is drilled to perforate the dorsal cortex (*Fig. 4.3-4*). At this point it is important to be careful not to perforate the opposite cortex. The nail is introduced and advanced proximally to the fracture site (*Figs. 4.3-5, 4.3-6*).

**Proximal ulnar insertion** The skin is incised 1.5-2 cm transversely over the proximal lateral aspect of the olecranon, 3 cm distal to the apophysis. The lateral cortex of the olecranon is perforated with the awl directed obliquely in a distal direction (*Fig. 4.3-7*). The nail is inserted and advanced distally to the fracture site (*Fig. 4.3-8*).
Fig. 4.3-6

Fig. 4.3-7
Fig. 4.3-8.

Captions
**Fig. 4.3-3. Radial incision.** Clinical illustration of the small transverse skin incision made over the dorsal aspect of *Tuberculum Radii of Lister*.

**Fig. 4.3-4. Radial entrance site.** The dorsal cortex of the radius is made with the awl first placed perpendicular to the dorsal cortex of the tubercle and then directed proximally as it enters the medullary canal.

**Fig. 4.3-5. Radial nail insertion.** The radial nail is inserted into the entrance site and advanced using the T-handled hand chuck.

**Fig. 4.3-6. Primary radial nail advancement.** Following its insertion, the radial nail advanced to just short of the fracture site.

**Fig. 4.3-7. Ulnar entrance site.** The ulnar site is made on the lateral surface of the olecranon by drilling with the awl first perpendicular to the cortex and then gradually angulating it distally until it enters the medullary canal.

**Fig. 4.3-8. Ulnar nail advancement.** Using the inserter, the ulnar nail is advanced to just short of the ulnar fracture site.
### Reduction and Fixation

#### Standard technique

**Radius**

*Single reduction*  Because it is often the more difficult, the radius should be reduced first. Attempt to bring the fracture planes in contact indirectly by percutaneously manipulating the proximal fragment. Rotate the radial nail carefully to line up the tip perfectly to the medullary canal of the proximal fragment and then advance the tip into the proximal fragment (Fig. 4.3-9). Once passage of the nail into the canal has been verified, the nail is advanced proximally to the level of the radial tuberosity. The tip should be directed towards the ulna (Fig. 4.3-10).

*Limited open reduction*  Failure to introduce the nail into the proximal fragment requires an open reduction. To do so, make a short incision at the level of the fracture to remove the obstructing soft tissue. Under direct vision, reduce the fracture with small Verbrügge clamps and then advance the tip of the nail into the proximal fragment (Fig. 4.3-11).

**Ulna**

*Single reduction*  Following reduction of the radius, the ulna usually reduces spontaneously. The ulnar nail is advanced distally to the distal ulnar metaphysis. It is then secured in the strong cancellous metaphyseal bone with the tip rotated towards the radius to produce the maximal spreading of the interosseous membrane (Fig. 4.3-12). On rare occasions the ulna may need an open reduction in the same manner as described for the radius.

*Simultaneous reduction*  If reduction of the radius and/or ulna is difficult, it may be helpful to advance initially only advance the radial nail to the fracture site. Then, proceed with the insertion of the ulnar nail. The reduction now can often be accomplished more easily because both nails can be manipulated simultaneously.

#### Final positions

The nails are cut and their ends placed deep in the subcutaneous tissue. The incisions are then closed with single sutures (Fig. 4.3-13). The end of the radial nail must be placed sufficiently outside the tendon compartment to prevent constant friction and tendon rupture.

#### Alternative techniques:

**Radius**  Many still prefer to insert the radial nail via a lateral approach on the distal radius. The incision here needs to be a little longer in order to identify and protect the superficial radial nerve. The awl must be carefully placed directly on the lateral cortex (Fig. 4.3-14).

**Ulna**  Insertion of the ulnar nail in its distal metaphysis is favored by many. An incision is placed over the distal medial ulnar metaphysis. The medullary canal is opened with the awl and the nail is introduced to be advanced retrograde (Fig. 4.3-15). Manipulation of both bones from the same end may be helpful in reducing the difficult fracture patterns.
FIGURES

Fig. 4.3-9.

Fig. 4.3-10
Fig. 4.3-11.

Fig. 4.3-12.
Elastic stable intramedullary nailing (ESIN)
CAPTIONS

Fig. 4.3-9. Radial reduction. Once a reduction of the radius has been achieved, the radial nail is passed into the proximal fragment (arrow).

Fig. 4.3-10. Radial positioning. This nail is advanced proximally to the level of the radial tuberosity. The tip is directed toward the ulna (arrow).

Fig. 4.3-11. Open reduction. Failure to achieve a closed reduction may require exposure of the fracture site through a small incision to visualize passage of the tip into the proximal fragment (arrow).

Fig. 4.3-12. Ulnar positioning. The ulnar nail is advanced distally to seat the tip in the metaphysis. The tip should be directed toward the radius (arrow).

Fig. 4.3-13. Final positioning. Following cutting the nails to the proper length, the ends are buried under the subcutaneous tissues. Notice the spreading effect on the interosseous membrane produced by central pointing of the tips (double arrow).

Fig. 4.3-14. Lateral radial incision. Alternatively, the distal radial entrance site can be placed in the lateral cortex. It is important to be sure that the incision is long enough to visualize and retract the superficial radial nerve.

Fig. 4.3-15. Distal ulnar entrance site.

a. The tip of the nail is inserted through the entrance site in the distal metaphysis of the ulna and advanced retrograde towards the fracture site.

b,c. Two views of the injury x-rays of a 9 year old male who sustained a Grade I open fracture of his ulnar shaft (arrow) and a closed fracture of the distal radial shaft.

d,e. Two views of the post-operative x-rays demonstrating ESIN stabilization. Following debridement of the ulna, it was stabilized via retrograde passage of the nail. Note the tips of the nails face each other to reestablish the spread of the interosseous membrane.

Notes

Step title
Post-operative care
Text

Early motion allowed
The postoperative x-ray of the patient shown in Figure 4.3-2 demonstrates a satisfactory final alignment (Fig. 4.3-16). Because no post-operative immobilization is required, active motion can commence as tolerated (Fig. 4.3-17). X-rays 4 weeks later demonstrate sufficient callus formation (Fig. 4.3-18) to permit participation in sports. At 3 months post injury, the x-ray demonstrates sufficient consolidation and remodeling to schedule nail removal (Fig. 4.3-19). In most cases, there is a full functional recovery (Fig. 4.3-20). If significant restriction of pronation or supination continues for more than 3 months following nail removal, physical therapy should be initiated with close supervision until full functional recovery has been achieved (Fig. 4.3-21).
FIGURES

Fig. 4.3-16.a-b.

Fig. 4.3-17.
Fig. 4.3-18a-b.

a.  

b.  

Fig. 4.3-19a-b.a.

a.  

b.  

Fig. 4.3-20a-b.
Fig. 4.3-21a-b.
<table>
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| **Fig. 4.3-16.** Post-operative X-rays.  
  a. AP and  
  b. lateral x-rays taken immediately following ESIN stabilization. |
| **Fig. 4.3-17.** Early recovery.  
  Two young patients who demonstrate almost full recovery of elbow motion 5 days following ESIN stabilization of their radial and ulnar shafts. |
| **Fig. 4.3-18.** X-rays at 4 weeks.  
  a. AP and  
  b. lateral x-rays with early callous at 4 weeks. |
| **Fig. 4.3-19.** Final healing.  
  a. AP and  
  b. lateral x-rays taken 3 months later prior to removal of the nails demonstrating almost complete remodeling of the fracture site. |
| **Fig. 4.3-20.** Full recovery.  
  This young girl has recovered full (a) supination and (b) pronation. |
| **Fig. 4.3-21.** Limitation persists.  
  This patient still demonstrates limitation of (a) supination and (b) pronation (notice the compensation by the shoulder). At this point, physical therapy may need to be initiated. |
### Pitfalls -

**Approach**

- **a.** Avoid performing the dorsal radial approach totally percutaneously (without a surgical incision) as this may injure one of the extensor tendons.

- **b.** Take great care not to perforate the opposite cortex when inserting the awl. Perforating the cortex will produce an abnormal passageway that will guide the nail into the vital anterior or medial soft tissues which can then become injured.

- **c.** Always be sure that the cut end of the nail lies outside the tendon compartment. A secondary tendon injury could arise from the constant rubbing against the sharp end of nail (Fig. 4.3-22).

- **d.** Avoid implantation of the ulnar nail directly through the olecranon apophysis. The cut end of the nail will lie very superficial which would allow it to easily perforate the skin.

- **e.** Descending antegrade radial nailing using a proximal insertion carries with it a high risk of injury to the deep branch of the radial nerve.

### Pearls +

**Approach**

- **a.** Incising the skin sufficiently and retracting it with small hooks to allow placement of the awl under direct view will prevent this complication.

- **b.** Accentuation of the curve of the nail tips will facilitate their gliding off the inner surface of the opposite metaphyseal cortex. This will guide the tip into the medullary canal.

- **c.** The dorsally implanted radial nail should be long enough to lie outside the extensor tendon compartment in the subcutaneous tissue.

- **d.** Insert the ulnar nail through the lateral cortex of the olecranon a few centimeters distal to its tip.

- **e.** This approach and technique should never be used!!!
FIGURES

Fig. 4.3-22. Tendon rupture. This female's *Extensor Pollicis Longus* tendon was ruptured by rubbing against the sharp edge of the short radial nail.

Fig. 4.3-23. Fracture blow-out. Forcing a nail through the narrow diaphyseal canal using a hammer can produce a blow-out fragment. The nail should be advanced by rotating the tip.

CAPTIONS

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