Fractures of the Hand in Children

Which are simple?
And
Which have pitfalls??

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I. Introduction
A. Most fractures involving the hand in children appear simple and they usually are able to be treated by simple means.
B. Some fractures have hidden pitfalls and need to be treated aggressively to prevent having an unacceptable outcome.
C. The purpose of this discussion is to differentiate those which can be treated simply from those which need a careful evaluation and aggressive treatment.
D. These fractures and other associated injuries will be discussed starting from the fingertips and progress to the bases of the metacarpals.

II. Fractures and Dislocations of the phalanges.
A. Fingertip injuries
1. Fingertip crush injuries
   a. These usually are manifest as stable linear fracture lines.
   b. The fractures usually heal without any sequelae even if there is interposed tissue.
   c. The focus need to be on management of the overlying soft tissue injuries
2. Finger tip avulsions
   a. Distal to the nail bed and DIP joint most of these can be left to heal by secondary closure (Fig.1).
   b. If available, the skin of the avulsed portion can be applied as a full thickness graft to provide temporary coverage.
   c. The complicated skin flaps usually are not necessary.
3. Mallet fingers
   a. These injuries usually are the result of a bending force at the physis of the proximal physis of the distal phalanx.
   b. The extensor tendon inserts on the dorsum of the epiphysis while the flexor tendon inserts on the proximal metaphysis (Fig.2)

Fig. 2. Mallet finger. a. X-ray of a minimally angulated fracture through the proximal physis of the distal phalanx. b. Muscle forces on the fragments with the extensor tendon acting on the epiphysis and the flexor tendon acting on the metaphysis.
c. **Usual Mallet pattern.**

1.) SH I. Seen in the younger patients <12yrs.
   - a.) Often presents as an open fracture with associated nail bed avulsion.
   - b. This combination termed a Seymour fracture **SE66**.
2.) SH III. Seen as a true avulsion of the dorsal aspect of the epiphysis.
3.) **Treatment**
   - a.) SH II injuries of the require open debridement of the fracture with associated reduction of the fracture.
   - b. Immobilization with splint with or with pin fixation.
   - c.) SH II injuries vary from closed reduction; to closed reduction plus percutaneous pin fixation; to open reduction depending upon the degree of comminution. and surgeon’s preference
4.) **Pitfall:** Failure to recognize these as an open fracture.

**d. Reverse Mallet pattern**

1.) Due to hyperextension injury where the avulsion fracture fragment comes off the palmar aspect of the epiphysis (Fig. 3).

![Fig. 3. Reverse mallet. a. Hyper-extension of this distal fragment resulted in avulsion of the palmar aspect of the epiphysis. b. AP view shows the fracture involves the epiphysis. c. The fragment reduces in flexion.](image)

2.) Not to be confused with the “Jersey finger” in which the flexor insertion pulls off a metaphyseal fragment
3.) These fractures reduce in flexion and are treated by flexing the fragment. May require pin fixation if there is severe swelling.
4.) True Jersey fractures require bony re-attachment of the flexor insertion. This bony attachment may be retracted proximally to lie palmar to the middle phalanx (Fig. 4.).

![Figure 4. Jersey finger. In the jersey finger the flexor tendon avulses of the phalanx with a piece of bone and is retracted proximally.](image)
B Fractures of the Phalangeal condyles

1. The fractures can involve one or both condyles (T or Y patterns) or transversely across the neck in which case they are called Supracondylar fractures.

2. These fractures are inherently unstable and can drift into an angular deformity (Fig. 5).

Fig. 5. Late angulation. Left. Supracondylar fracture which is well aligned in the injury x-ray. Right. Following conservative treatment the condylar fragment has angulated to produce an Apex radial deformity.

3. True supracondylar fractures can rotate dorsally due to the collateral attachments (Fig. 6). This rotation usually cannot be corrected and held by non-operative methods. If not corrected a flexion block may develop.

Unrecognized supracondylar fracture

Resulted in block to flexion

Fig. 6. Apex palmar angulation. Left. Supracondylar fracture which developed apex palmar angulation (dotted line and arrow) which was not corrected. Right. Following conservative treatment the condylar fragment remained angulated to producing a block to flexion.

4. Treatment These fractures almost always require surgical stabilization.
   a. Unicondylar fractures require pin or a small screw fixation.
   b. Supracondylar fractures require cross pin fixation placed either antegrade or retrograde.
   c. The adjacent joint may need to be extended with traction applied to correct and stabilize the fragment prior to pin fixation (Fig. 7).
      In this case, the pins are placed antegrade.
   d. In some cases the joint may need to be flexed to reduce and stabilize the fragment. In this case, the pins are placed retrograde.
5. Pitfalls
   a. Failure to stabilize the condylar fragment.
   b. Failure to correct the rotation or angulation.
   c. In small infants, the condyle may be unossified, in which the true nature of the fracture may be unrecognized.

C. Phalangeal shaft fractures
   1. Two main fracture patterns.
      a. Oblique
         1.) Can both shorten and rotate. (Fig. 8).

Fig. 7. Supracondylar rotation reduced.
   a. The distal fragment was rotated (dotted line).
   b. Traction was applied to the distal fragment to stabilize it for pin fixation.

Fig. 8. Complications of oblique shaft fractures.
   a. The fracture fragments may shorten.
   b. In addition to shortening, there may also be rotational malalignment.

   2.) Treatment
      May require percutaneous pin stabilization.
      b. Transverse
         1.) The force of the lateral band may angulate the fragment. (Fig. 9).
2.) **Treatment**

a.) If treated non-operatively MP and IP joints need to be flexed to neutralize the effects of the lateral bands

b.) May require percutaneous pin stabilization.

### 2. Beware the complex fracture patterns!!

a. There may be a combination of ipsilateral shaft and condylar fractures in the same digit (Fig. 10).

### D. Proximal Phalangeal fractures.

1. In the pediatric age group the area affected is most commonly the metaphysis or physis (Fig. 11).
2. These fractures most commonly involve the little finger (The Extra Octave Fracture).
3. Structurally, there are two components (Figure 12).
   a. Angulation. This is usually apparent on the initial clinical examination.
   b. Rotation. Unless looked for carefully, this may be overlooked.

4. Treatment
   a. Almost all can be treated non-operatively.
   b. Both the angulation and rotation need to be addresses.
   c The Campbell Technique (Figure 14).
      1.) The MP and IP joints are first flexed which usually corrects the apex angular deformity.
      2.) The rotation is then corrected by applying a rotational force to the hyper flexed digit.
d. Operative indications.
   1.) Rare
   2.) Open fractures.
   3.) Multiple unstable open fractures (Fig. 15a).
   4.) Interposed tissues (Fig.15b).

5. Pitfalls:
   a. Failure to adequately treat the fracture with residual deformity which can result in a loss of MP motion.

II. Fractures of the Metacarpals
   A. Fracture patterns. Four areas involved. (Fig.16).

Fig. 14 The Campbell technique. This technique consists of the above two steps. (Courtesy of Dr Robert M. Campbell).

Fig. 15a-b. Operative indications. a. This patient had multiple unstable fractures that required surgical stabilization. b. The flexor tendon was interposed between the fragments of the proximal phalanx of the ring finger.

Fig. 16a-d. Metacarpal fracture patterns. a. Head. b. Neck. c. Shaft. d. Proximal metaphysis.
1. Fractures of the metacarpal head
   a. Usually Physeal-Epiphyseal Involvement (Fig.17.).
   b. If displaced, usually requires surgical intervention

2. Fractures of the metacarpal neck.
   a. Usually result of pugilistic encounters.
   b. Effects more cosmetic rather than functional.
   c. Loss of the prominence of the metacarpal head.
   d. Prominence of the angulation of the metacarpal neck.
   e. Treatment
      1.) Up to 60° of angulation, splint for comfort.
      2.) >60° manipulate to satisfactory alignment.
      3.) Closed reductions difficult to hold with a cast.
      4.) Operative indications.
         a.) Open Fractures
         b.) Closed reduction plus percutaneous cross pin fixation.
         c.) Closed reduction and Intramedullary nail fixation (Fig.18).

Fig. 17a-c. Metacarpal head fracture patterns. a. Salter-Harris II. b. Salter-Harris III. c. X-ray of comminuted Salter-Harris II-III fracture pattern d. Following open reduction.

Fig. 18a-b. Metacarpal head IM Fixation. a. Injury image demonstrating 68 degrees of angulation of the metacarpal neck. b. Following a closed reduction, the fracture was stabilized with a small flexible nail.
3. Fractures of the metacarpal shaft
   a. These are usually green stick apex dorsal.
   b. The intrinsic muscles cause the fracture to angulate dorsally.
   c. Following a closed reduction, a cast is applied with wrist dorsiflexed and the MP joints flexed to relax the intrinsics (Fig. 19).

d. Operative indications
   1. Open fractures
   2. Unstable fractures
   3. Severe swelling
e. Specific fractures that usually require surgical management.
   1. Shaft fractures
      a. Can Stabilize with
      
      ![Fig. 19a-b. Metacarpal shaft closed reduction. a. Injury image demonstrating apex dorsal angulation. b. Following a closed reduction, the fracture was stabilized with a cast with the wrist dorsiflexed (white arrow) and molding applied proximally and distally (black arrows).](image)

      Percutaneous pins

      Intramedullary pins
f. Thumb metacarpal fractures

1. Proximal Physeal Fractures Thumb metacarpal

2. Closed reduction and cast application may be difficult to apply and manage

3. These fractures are usually best stabilized with pins placed either percutaneously or via an open reduction.

REFERENCES