# 65 Hand injury

## 65.1 Introduction

Different people use their hands in very different ways. Some need nimble agile fingers, while others need a powerful grip. So, find out which functions you most need to preserve. Violinists and labourers have quite different expectations of their hands, and yet, provided their injuries are correctly treated, it is possible ultimately for each hardly to notice what might seem to have been a severe mutilation.

Hand injuries are often worse than they look, but there are many opportunities for disaster:
(1) You can easily miss cut nerves or tendons, so assume they are injured, until you have proved otherwise.
(2) If you neglect proper management especially about splinting, movement, and amputation (65.18), a patient may easily end up with a stiff hand, or a stiff useless finger.

*The outcome of a hand injury mostly depends on how you care for it during the 1st few days*. Injuries to the flexor tendons will cause difficulty. Most patients are unlikely to return for simple physiotherapy, so try to get the hand back into action as quickly as you can.

*Don't forget the general principles of wound care* (46.1). Grafting raw surfaces as soon as is practicable is particularly important, because this minimizes infection and the stiffness which otherwise follow.
Hand injuries are often multiple with several types of unjury in the same hand, so be prepared to modify the methods for single injuries described.

*N.B.* Hand operations are not easy, and only careful, dedicated, painstaking, delicate work is good enough! Although a hand injury may look minor, it is *never trivial*: a fractured phalanx can disable a patient and prevet work just as easily as a fractured femur!

Equipment:
*FINGER SPLINTS, aluminium, padded.* These are strips of aluminium with foam rubber on one side. Cut them and bend them to suit the need (65-9). If you cannot get them, try to make them.

**ASSUME NERVE & TENDON INJURIES IN A HAND WOUND UNTIL PROVED OTHERWISE**

**ELEVATING THE INJURED HAND**

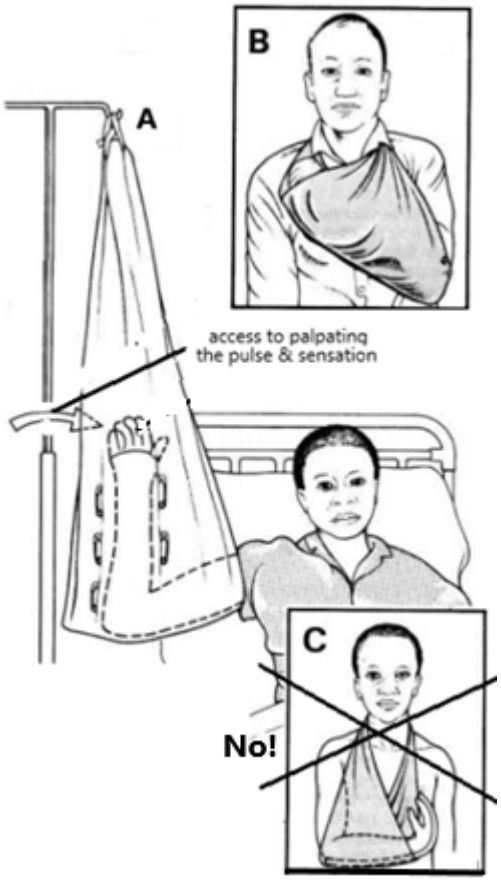


**Fig. 65-1 RAISING AN INJURED ARM AND HAND will reduce traumatic or infectious oedema and minimize stiffness. A, if the hand is injured or infected, pin it in a towel, & suspend it with the upper arm horizontal. B, for an ambulant patient, raise the hand in a St John's sling, C, *don't keep it horizontal.*** *Kindly contributed by Peter Bewes, Richard Batten & John Stewart.*

**HAND POSITIONS IN TENDON INJURIES**

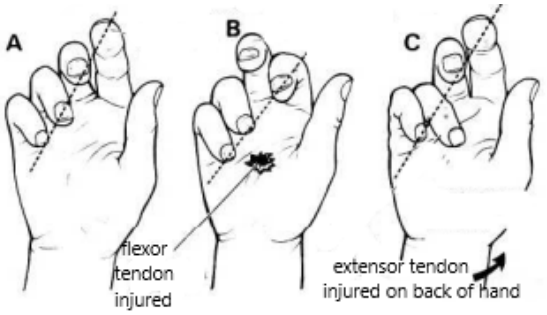


**Fig. 65-2 HAND POSITIONS IN TENDON INJURIES. A, in a normal hand the fingers are approximately in line. B, in a flexor tendon injury the injured finger is extended. C, in an extensor tendon injury it is flexed.** *Kindly contributed by Peter Bewes*

*N.B. There is a special position for flexor injuries* (65.16).

## HISTORY

Find out:
(1) the cause of injury: clean or dirty object *(e.g. a bite)*?
(2) the normal use of the hand? Left or right-handed?
(3) the injury mechanism: crushing, end-on force, injection, penetration, fire, heat, hyperextension, or angulation?

## EXAMINATION

Answer 5 questions:
(1) Is the hand or finger viable?
(2) Is the hand skeleton stable?
(3) Is there actual or impending skin loss?
(4) Are the nerves intact?
(5) Are the tendons intact?

Do your testing first on the uninjured hand. This allows you to be sure the patient understands what movements you want to test & also reassures him the testing won't hurt.

### LOOK

**If the fingers are not in their normal position of rest**, suspect a fracture, dislocation, or tendon injury because an unopposed uninjured tendon has pulled the injured finger into an abnormal position (65-2).

### FEEL

*CHECK THE CIRCULATION*

Test revascularization after pressure on the nailbeds & fingertip sensitivity.
Test the digital arteries: raise the hand, compress the digital arteries at the base of the injured finger until it becomes pale. Still compressing them, lower the hand. Release one artery. If the finger becomes pink, that artery is patent. Repeat the process with the other artery (modified Allen's test).
Perform the same test with radial & ulnar arteries to check the palmar arch (Allen's test).

*CHECK THE NERVES*

Test the motor & sensory functions of the median, ulnar, and radial nerves (65-3) *before you use any LA.*

**(a) Median nerve:**
(1) Test opposition.
(2) Test sensation at the index fingertip.
**(b) Ulnar nerve** (deep branch)**:**
(1) Lay the hand flat; test abduction of the index finger towards the thumb.
(2) Test sensation at the little fingertip.
**(c) Radial nerve** (distal):
(1) Test extension of the straight index with the wrist dorsiflexed. Or, keeping the palm flat on a table, test extension of the fingers.
**(d) Radial nerve** (proximal & distal)**:**
(2) Test the area on the dorsum outlined (65-3Dx)

**TESTING THE NERVES**

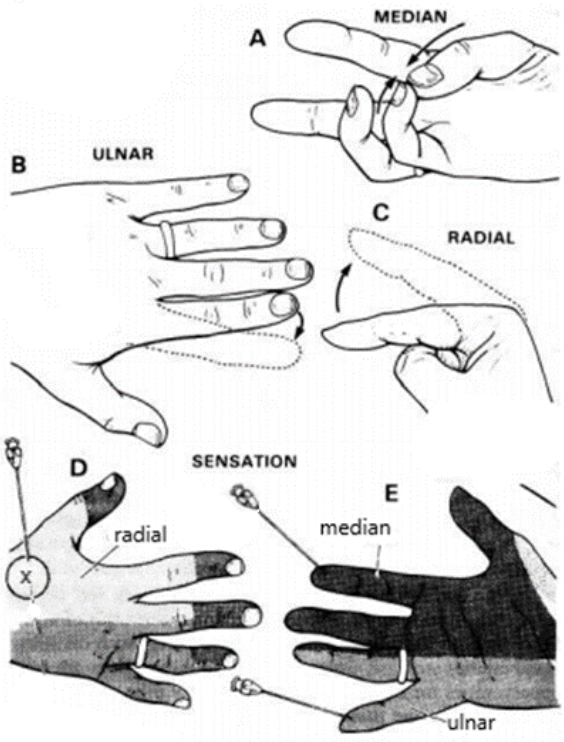


**Fig. 65-3 TESTING THE NERVES OF THE HAND. A, median nerve: check opposition of thumb & little finger. B, ulnar nerve: check abduction of the index towards the thumb. C, radial nerve: check extension of the straight index with the mcp joint flexed. D,E, check pin-point sensation over the palm & on a specific zone 'x' on the dorsum.**

### MOVE (CHECK TENDON FUNCTION)

Test the superficial, deep finger & wrist flexors, & the extensor tendons.
**(a) *Profundus* tendons:**
Test each finger in turn. Hold the proximal ip joint extended (65-4A): if flexion even to only 15° of the distal phalanx is possible, the tendon is intact.
**(b) *Superficialis* tendons:**
Hold all the fingers, except the one you are testing, fully extended (65-4B). If flexion of the proximal ip joint is possible, the tendon is intact.
**(c) Wrist flexors:**
Feel the tendons on the anterior of the wrist tightening with flexion against resistance (65-4C).
**(d) Extensor tendons:**
Test extension of the fingers against resistance (65-4D).

*CHECK STABILITY*

Look for swelling, and feel for tenderness over the injured joint; hold the bone proximal to the joint and move the bone distal from side to side. Check for laxity with an ip joint extended, and a mcp joint flexed. This is the position in which the ligaments are taut (65-8A).

**TESTING THE TENDONS**

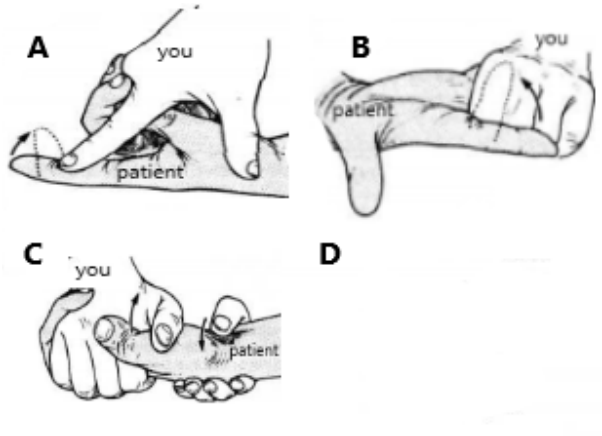


**Fig. 65-4 TESTING THE FLEXOR TENDONS. A, keeping the proximal ip joints extended, test flexion of the distal ip joints. B, keeping the fingers extended, except the one tested, test flexion of the proximal ip joint. C, feel wrist flexors at the wrist when acting against resistance.**

RADIOGRAPHS

If you suspect fractures or foreign bodies, including glass, take AP & lateral views. If you suspect an avulsion fracture at the base of a phalanx, make sure that the radiograph is centred correctly. To locate foreign bodies, cross 2 pieces of wire and put them over the entry hole, and a 3rd wire in a plane at 90°.

*CAUTION! Don't confuse a fracture* with:
(1) A nutrient artery which passes obliquely through the cortex of a phalanx, usually at the junction of its middle and distal ⅓.
(2) The shadow of soft tissues. These may look like fracture lines but pass across a bone and are not confined to it.
(3) Epiphyses.

IMMEDIATE TREATMENT

Bleeding is seldom severe. Pressure with gauze, and raising the injured hand, will usually stop the haemorrhage. If it persists, apply a tourniquet, identify the bleeding vessel & ligate it. *Don't use diathermy. Don't clamp blindly*.

TREATMENT FOR SEVERE HAND INJURIES (65.19)

Record which nerves and tendons have been damaged before you use anaesthesia! Peeking and poking in a wound will achieve little afterwards.

**LOCAL ANAESTHESIA FOR THE HAND**

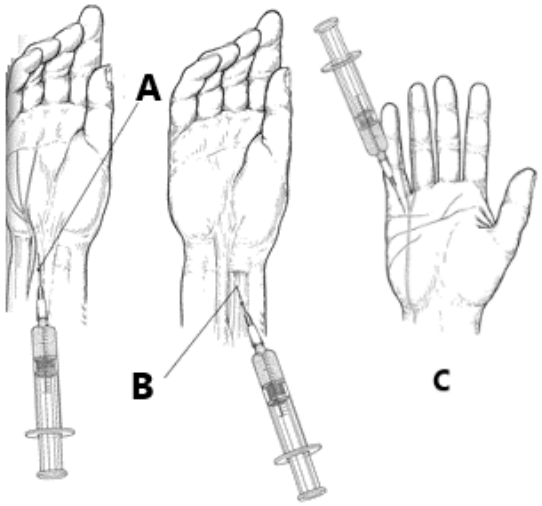


**Fig. 65-5 LA FOR HAND SURGERY. A, for an ulnar block, inject LA just lateral to the *flexor carpi ulnaris* tendon. B, for a median block, inject LA just lateral to the *flexor carpi radialis* tendon. C, for a digital block, inject LA between the metacarpal heads.** *After Champion HR, Robbs JV, Trunkey DD, Trauma Surgery Part 2, Butterworth, 4th ed 1989.*

Anaesthesia must be adequate, so that you are not fighting with a moving hand. Relaxation is unnecessary. There are several possibilities:
(1) Ketamine.
(2) An axillary block.
(3) An intravenous forearm block.
(4) Median, ulnar, or radial nerve blocks.
(5) Finger blocks (for the 2 distal segments only), or a combination of these.

*CAUTION! Never use adrenaline in an intravenous forearm block, or in any block in the fingers or hand.*

Admit all but the most minor injuries and operate on them in the main theatre. Put yourself in a comfortable position, seated with the patient's hand on a table in front of you.

A 'lead hand' which you can bend to hold the patient's fingers how you want is very useful. *Don't use the big instruments of a general set.*

Use fine forceps and needle holders. Cut the bones with a bone nibbler, a Gigli saw, or a fine finger saw. Remove as little bone as you can. *Don't use a big amputation saw.*

## INCISIONS FOR HAND EXPLORATION

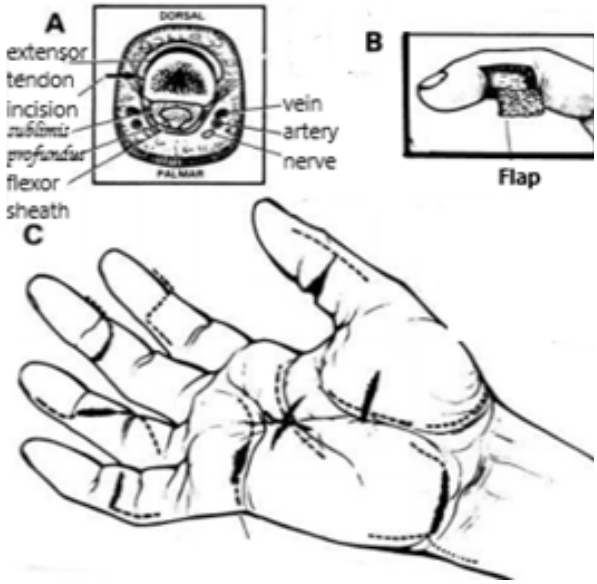


**Fig. 65-6 INCISIONS FOR EXPLORING HAND INJURIES. A, anatomy of the finger. B, base a flap towards the palmar surface. C, incise a finger in its mid-lateral line (Bunnell's incision); *avoid extending an incision across a flexor crease*. If this is inevitable, make a 'snake' the incision across the hand, or extend it each way from the ends of the wound in the form of a 'Z' (Bruner's incision).** *Kindly contributed by Peter Weston.*

*TRACTION is of little value.* It may be briefly necessary to reduce dislocations, or multiple displaced metacarpal fractures. Apply adhesive strapping along the sides of the fingers and watch the circulation in them carefully or use specially made finger traps if available. *Don't simply wrap strapping around them.*

### TOURNIQUETS

Start by exsanguinating the hand with an Esmarch bandage and place a tourniquet on the forearm (3.8). Then scrub up yourself and paint and drape the hand. For most wounds, leave the tourniquet on throughout the operation, *but don't exceed 1½h*. If there is much tissue damage, remove it to determine which tissue is non-viable.

*N.B. It is dangerous to wind a thin rubber round the base of a finger and hold it with a haemostat.*

*CAUTION!* Wherever you apply a tourniquet, record its time of application.

RINGS can seriously impede the circulation in an injured hand. So remove them either with soap and water. If this fails, wind a fine string closely round the finger from its tip towards the ring. Thread the string under the ring, and use it to help pull the ring off (65-7A-E). If this also fails, cut the ring off, protecting the finger.

## REMOVING A RING

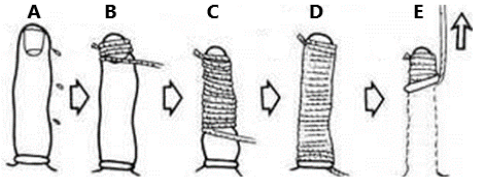


**Fig. 65-7 A-E, how to remove a ring by lubricating a finger with soap and then using a piece of string, or suture.** *Kindly contributed by Peter Bewes.*

### WOUND TOILET

Get patients to put their hands under running water. Wound toilet must be thorough (54.1). Use plenty of soap and water. The skin of the hand is very precious, so excise only what you have to. Remove any prolapsed fatty tissue from the palm of the hand. If a wound is badly contaminated, take time to extract all foreign material, remove necrotic tissue, and wash it thoroughly.

### INCISIONS

To extend a wound, use incisions along creases as much as possible (65-6). If a wound crosses a crease, make a 'Z'; if you need to extend an incision on a finger, cut on the side of the finger in the mid-axial line, obliquely across it, or along a crease line.

*CAUTION! Avoid cutting at right angles to a crease*, because a contracture may follow.

Reflect a flap on the side of a finger with its base on the palmar surface (65-5B).

### NERVE AND TENDON INJURIES

Do your utmost to repair cut nerves & tendons primarily (48.1).

### COVERING AN OPEN HAND INJURY

Wait until there it is clean before closing a wound. Useful solutions, if there is a defect, are skin grafts from the anterior forearm or an abdominal flap (46.5). For fingertip injuries, dressings are better than flaps or skin grafts (65.18).

### EXTERNAL OR INTERNAL FIXATION ?

In some fractures, and especially in severe hand injuries, external fixation is useful, but it isn't simple. Internal fixation with K-wires 0.8-1.2mm in diameter is usually better; it needs some basic skills and hygienic OT conditions (65.21). *We don't advise screws and plates!*

### CLOSING A HAND INJURY

Use monofilament sutures (4/0 or 5/0) on fine needles and *don't tie them too tight. Don't close wound edges unnecessarily.* Allow space for drainage. *Wounds along the creases don't need suturing.*

DELAYED PRIMARY SUTURE is always safer in all but the cleanest and most recent wounds, especially if the wounds overlie joints or fractures. It is also best in 'untidy', burst, or severely bruised wounds.

ANALGESICS are necessary because hand injuries are painful, so make sure the patient is given enough analgesics; opioids might be necessary.

ANTIBIOTICS are not nearly as important as a careful would toilet. Delayed primary suture gets better results than immediate primary suture & antibiotics.

TETANUS TOXOID: Don't forget this (46.7).

BANDAGES
**(a) Thumb.**
Ensure the thumb is held well anteriorly and in abduction. Place a roll of bandage between it & the palm, so that the thumb opposes the fingers and *does not lie in the plane of the palm*.
**(b) Severe Injuries** (65.19)

Try to obtain uniform, firm compression. Pack plenty of dry gauze around a severely injured hand. If adjacent fingers are injured, pack plenty of gauze between them to prevent them sticking together. *Don't bind them to one another.*
*CAUTION!* If possible, keep the fingertips showing, so that you can check their perfusion.

SPLINTS
When necessary, always splint the hand in the position of safety (65-8), except when the tendons are injured. Leave the splint on until the wound has healed. Splint ip joints extended. Splint mcp joints flexed, unless it is absolutely necessary to splint them extended, as in an extensor tendon injury. Splint the thumb in opposition.
*CAUTION! Don't forget to elevate the hand!*

For someone ambulatory, raise the arm across the chest with a St John's sling (65-1B).

POSTOPERATIVE CARE
Watch the circulation in the fingers, check the temperature, and palpate the regional lymph nodes. If there are no signs of infection, leave the dressing and the splint for 7days. Remove the sutures after 10days.

***NEVER IMMOBILIZE A mcp JOINT IN EXTENSION***

EXERCISES
In a serious injury, exercises are absolutely critical if normal use of the hand is to return! Start as soon as the traumatic oedema has subsided. Explain that exercises are essential to prevent the hand becoming stiff: *make sure this is understood!* Movements must begin even if painful. Demonstrate these movements, and then get the patient to do them, actively, or, gently, passively many times a day.

The range of movement should slowly increase until each joint has a full range. This means:
(1) Flexion and extension of all the fingers and the thumb.
(2) Adduction and abduction of all the fingers to and from the midline.
(3) Abduction, adduction, and circumduction of the thumb, and its opposition to each of the fingers.

Most adults can do these exercises on their own. Children usually recover so quickly that they hardly need them.
Provided patients do their exercises, they need not come for physiotherapy, but if they are reluctant, you need to persuade them somehow.
*CAUTION!* Explaining to a patient the value of exercises may be the most valuable thing you can do.

## 65.2 Stiffness in hand injury

Stiffness is *the* great enemy in hand injuries. The bones in an injured hand almost always unite, but in adults, the finger joints easily become stiff as the result of oedema, infection, and immobility.
Minimize stiffness by:
(1) Elevating an acutely injured hand (65-1B). A firm compression dressing with plenty of cotton wool will also help.
(2) Pay particular attention to the principles of wound management, and *never suture an injured hand or any of its fingers tightly*.
(3) *Never unnecessarily immobilize fingers*
(4) *Never immobilize >3wks*.
Then start exercises immediately, whatever the condition of the finger. If you break this rule, a stiff finger may remain forever.
*Many finger fractures don't need immobilisation*, and will unite better without.
(4) *Don't immobilize any neighbouring normal fingers*, because they too will become stiff.
(5) Dress an injured hand in the position of safety (65-8).

(6) Start movements early. From the very beginning, exercise all joints that have not been splinted, including the wrist, the elbow, and the shoulder. This will prevent the being left with a good hand, but a stiff shoulder.

***NEVER TRY TO BEND FINGERS FORCIBLY, OR TO STRETCH THEM PASSIVELY.***

Start active movements early, and if the injury is severe, make sure the patient has some occupational therapy. Encouraging doing or making something is better than merely encouraging movements.

**CONTROL TRAUMATIC OEDEMA BY ELEVATION**

## 65.3 Positions of safety & function

When the ligaments of a finger joint that is not being used lie slack, they shorten, and then the joint becomes stiff. The mcp joints stiffen if they are left in the extended position, and ip joints if they are left flexed. So leave injured fingers so that their ligaments are stretched. This is the position of safety (65-8). It is the position from which a patient is most easily rehabilitated.

**THE POSITION OF SAFETY**

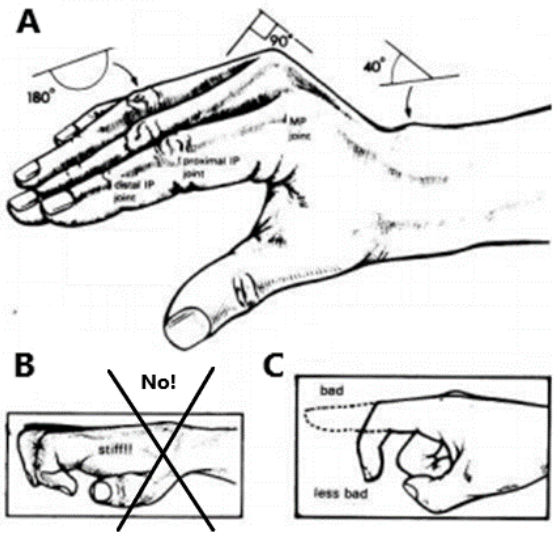


**Fig. 65-8 THE (JAMES) POSITION OF SAFETY A, note that the mcp joints of the fingers are flexed, as near 90° as possible, but that the ip joints are in full extension. Both the joints of the thumb are extended, and the thumb is forward of the palm. B, the results of malpositioning: the mcp joints will extend, and the ip joints will flex. C, the least unsatisfactory position for a stiff finger.** *Kindly contributed by Peter Bewes.*

**(a) The position of safety** in the fingers *is not easy to maintain*.
*Always splint an injured hand in the position of safety* (65-8):
(1) Flex the finger mcp joints 70-90°, or as near to 90° as possible.
(2) Keep the finger ip joints in full extension.
(3) Keep the thumb mcp & ip joint extended, abducted and opposed (well forward of the plane of the palm, so that it can be used for grasping). *A stiff thumb in the plane of the palm will be useless.*
(4) Dorsiflex (extend) the wrist to 30-40°.
*The only exceptions are nerve and tendon injuries in which the positions for relaxing injured tendons take precedence over the position of safety.*

Adapt whatever method you choose to the needs of the injury. *The only part which needs to be in the position of safety is the injured part.* The rest of the hand can be in any position provided it is allowed to move.
The wrist is the key. Keep it moderately dorsiflexed with a plaster cock-up splint (58-4), and the rest of the hand will fall into the position of safety.

**(b) The position of function** is the most useful position for a finger or hand that will not move, and *is different from the position of safety*. *The worst position for a permanently stiff or ankylosed finger is full extension.* It will be much less of a nuisance if it is partly flexed. It may be even less of a nuisance if it is amputated (65.24). If several fingers are stiff, they should be partly flexed, as if the hand were grasping something.

SPLINTS FOR FINGER INJURIES

Bend the aluminium splint to 90°, and strap it to the palm with its angle just proximal to the proximal transverse palmar crease for the index and middle finger, or the distal palmar crease for the ring and little fingers. These are the positions of the mcp joints: (compare them with your own by looking at your own hand from the side).

After reduction of a fracture, lay the finger on the splint so that the mcp joint is flexed to 90°, and the ip joints are extended. The splint need not cross the wrist. *Don't double it back over the dorsum of the finger.*

## FINGER SPLINTS

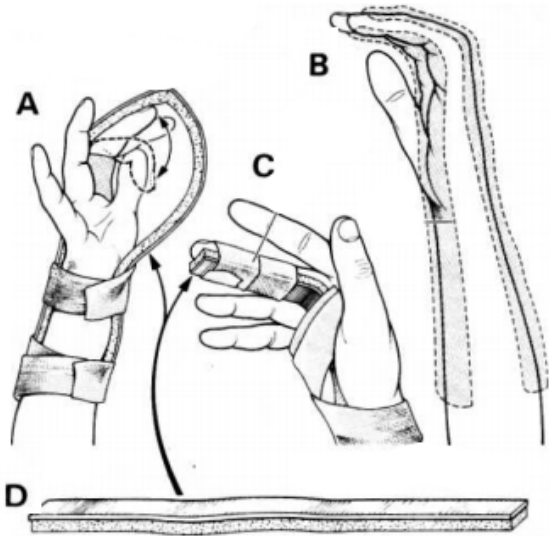


**Fig. 65-9 SPLINTING AN INJURED HAND. A, a splint for a fracture of the anterior tip of the middle phalanx: it will allow the pip joint to flex but not extend. B, dorsal and palmar plaster cast in the position of function. C, a finger correctly splinted with its mcp joint flexed and its ip joint extended. D, you can use padded aluminium splints for many purposes** *Partly after Watson-Jones R. Fractures & Joint Injuries, Churchill Livingstone 5th ed, 1974 with kind permission.*

*CAUTION!* Examine the fingertip to check for rotation, and warn the patient not to meddle with its position, or take it off. If this is a real problem, a plaster cast will be wiser.
If the injury is stable, you can usually use a garter splint (or "buddy tape". If the finger is still rotated (scissoring), fixation may be indicated.

As soon as the immediate swelling is reduced, bind the patient's injured finger to one of its neighbours with adhesive strapping (65-10). If there is the choice of 2 adjacent fingers, strap it to the finger which best corrects any deformity.

A garter splint is more comfortable if you put a little padding between the two fingers. If more than one phalanx is fractured, you may be able to apply more than one garter splint.

(1) *Make sure you correct any rotational deformity*.
(2) Be careful how tightly you apply a garter splint during the acute phase, or the strapping may obstruct the circulation of the injured finger.
(3) *Don't let the strapping cross a joint*.

*Remove a garter splint at 3wks*, except for fractures of the middle phalanx, for which you may need to leave it on longer. Rely on clinical union, and *don't wait for radiological union*.

## A GARTER SPLINT FOR FINGER INJURIES

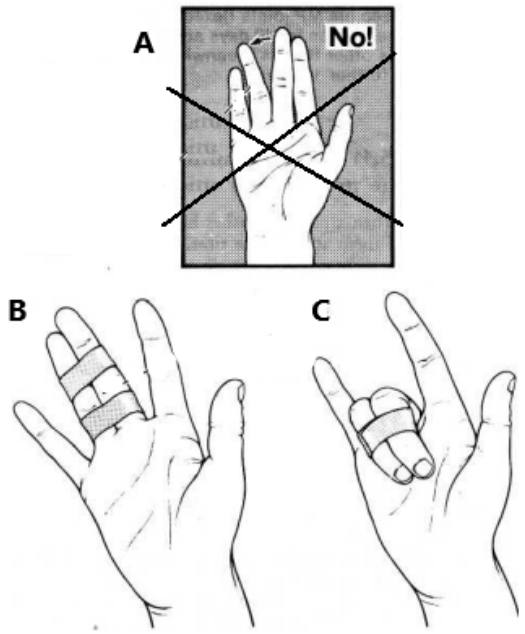


**Fig. 65-10 A GARTER ("BUDDY") SPLINT. A, its great advantage is that it keeps an injured finger moving, and simultaneously corrects rotation. B, *never put strapping across a joint.* C, the splint is designed to achieve stability *with* movement.** *Kindly contributed by Peter Bewes.*

**If a garter splint fails to achieve good reduction of an oblique fracture**, fixation is probably necessary.

## CORRECT ANY ROTATIONAL DEFORMITY IN AN INJURED FINGER

PLASTER SPLINTING INDICATIONS
(1) Fractures of single fingers in uncooperative, uneducated patients who might interfere with an aluminium finger splint.
(2) Multiple fractures.
(3) Some fractures of the thumb.
(4) If necessary, you can use a volar slab for almost any fracture or wound of the hand.
(5) Burns (50.14).
(6) Infections involving joints or tendons.

Apply a volar slab with the wrist dorsiflexed, the mcp joints flexed, and the IP joints extended, as when using an aluminium splint. When the volar slab has set, add a dorsal one to maintain the position of the fingers against the volar slab. If necessary, add longitudinal ridges to the volar slab to give it greater strength.

*CAUTION!* (1) If possible, leave the thumb free. If you have to include it, bring it forward of the palm. (2) A hand which has been properly immobilized is bulky. *Don't try to make a tidy parcel out of it.* (3) *Don't immobilize normal fingers*: keep them moving.

DIFFICULTIES WITH SPLINTS FOR THE HAND

**If you are in doubt as to when to remove a splint**, err on the side of removing it a little too soon, especially if a finger is not in a position of safety. Remove all splints at 3 weeks or earlier (the mallet splint is an exception (65.7).

## 65.4 Nail injury

Considerable discomfort and disability may result from loss of the nail (not just in guitar players!).

### ANATOMY OF THE NAILBED

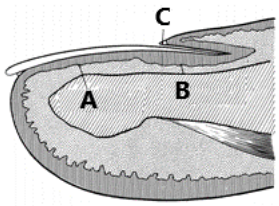


**Fig. 65-11 DISTAL FINGER ANATOMY. A, the nail bed is a 'sterile' matrix. B, the germinal matrix (from which the nail grows) is more proximal. C, the eponychium is not attached to the nail, and leaves an opening where infection can enter.** *After Champion HR, Robbs JV, Trunkey DD, Trauma Surgery Part 2, Butterworths, 4th ed 1989.*

**(a) Severely lacerated nailbed & avulsed nail,** usually with an underlying distal phalanx fracture, remove any foreign material & all loose bony fragments. Close nail bed lacerations with 6/0 absorbable so it is smooth enough to make a new nail adhere to it (65-12B).

### NAILBED INJURIES

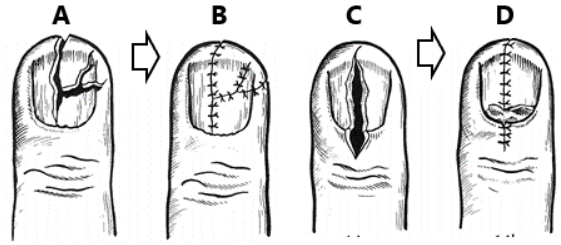


**Fig. 65-12 NAILBED INJURIES. A, burst nailbed, usually associated with a distal phalanx fracture. B, sutured carefully to create a smooth surface. C, nailbed & eponychium laceration. D, separated closure.** *After Champion HR, Robbs JV, Trunkey DD, Trauma Surgery Part 2, Butterworths, 4th ed 1989.*

A more severe injury to the fingertip may remove the nail, completely or partly. Clean the wound, remove the base of the nail, and replace the nail or the nail bed under the nail fold. Hold the nail in place with a mattress suture, and administer antibiotic prophylaxis.

### SUBUNGUAL HAEMATOMA

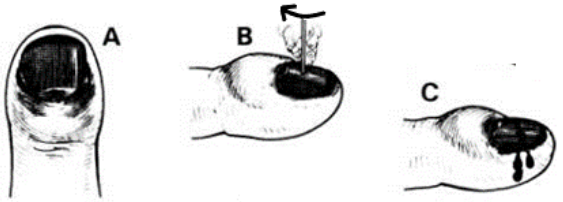


**Fig. 65-13 NAIL INJURIES. A-C, trephining a subungual haematoma with a blunt needle.** *Partly after Rutherford WH, Nelson PG, Weston PAM, Wilson DH. Accident and Emergency Medicine. Pitman 1980 with kind permission*

**(b) Subungual haematoma.** A blow on the end of a finger may cause blood to collect under the nail. You can easily relieve the severe pain that this causes. Use a large hypodermic needle, and twist this through the nail over the haematoma (65-13B). *This doesn't need LA.* Dress the wound to keep the finger dry for 24h.

### REMOVING A SPLINTER UNDER THE NAIL

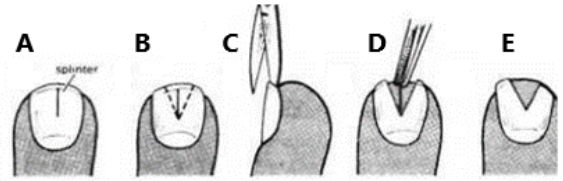


**Fig.65-14 REMOVING A SUBUNGUAL SPLINTER. A-E Cutting the fingernail around the splinter to release it. You need a regional LA block to do this.** *Partly after Rutherford WH, Nelson PG, Weston PAM, Wilson DH.Accident and Emergency Medicine. Pitman 1980. with kind permission*

**(c) Splinters below the nail.** If you cannot remove a splinter with forceps, use scissors to excise a V-shaped area of the nail under a LA ring block (65-14D-H), and then extract the foreign body.

## 65.5 Finger fracture

There are many possible fractures in the hand, seeing there are 23 bones in it. Some fractures, such as those entering joints, are serious, while others, such as undisplaced fractures of the phalanges need only exercises.

## FINGER FRACTURE TYPES

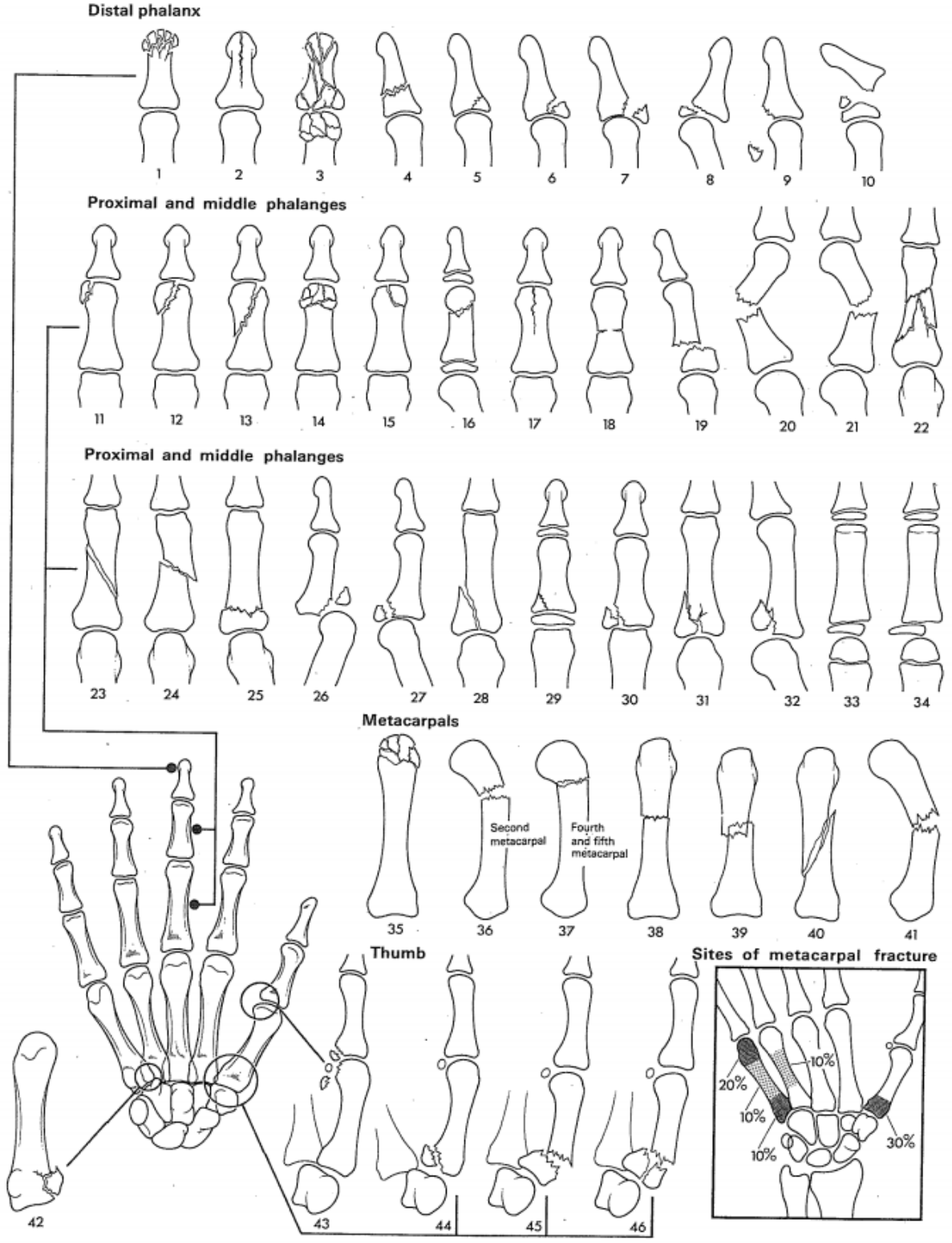


**Fig. 65-15 FINGER FRACTURE TYPES. Treat conservatively, if appropriate, with a garter splint: 1-5, 11, 15, 17, 18, 22, 29, 31, 35, 37, 40, 42, 44, 45. Treat with a Mallet splint: 6,7. Reduce & splint: 10, 19-21, 23-25, 32-34, 36-41. Treat by fixation if possible: 12-14, 16. Try to obtain early surgery for: 8, 9, 26-28, 30, 43. Note the relative frequency of metacarpal fractures.** *Adapted from Watson-Jones R. Fractures & Joint Injuries, Churchill Livingstone 5th ed, 1974 with kind permission.*

Appropriate treatment includes:
(1) Active movements.
(2) A garter splint (65-17).
(3) An aluminium splint.
(4) K-wire fixation
(5) Internal fixation
(6) External fixation.

*By all means avoid stiffness!* An unnecessary splint is much worse than no treatment! You can disregard many fractures; concentrate on helping the patient to regain movement.

A common error is to overtreat hand fractures; but phalangeal fragments often angulate, and any fracture which needs reduction also needs splinting, preferably with an aluminium splint.

*Avoid rotation in finger fractures*, because this will make an injured finger overlap its neighbour (65-15D). Prevent this serious disability by making sure that all fingers always point to the point (65-15Ax), which is slightly lateral to the wrist crease.

Fortunately, most fractures unite readily, so there is no point in checking for radiological union. If after 3wks, there is clinical union, you can assume that a fracture has united.

**AVOID ROTATION IN FINGER FRACTURES**

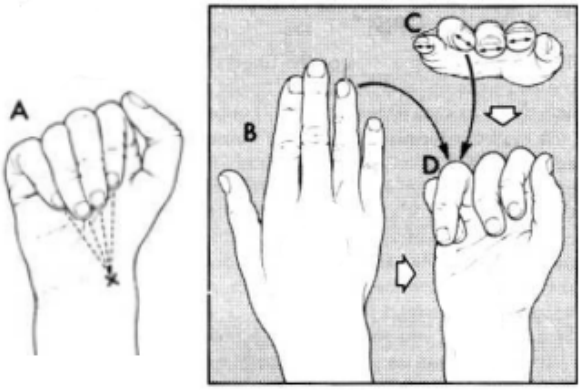


**Fig. 65-16 THE PROBLEM OF MALROTATION. A, all fingers should point to 'x'. B, you can easily miss a rotation deformity. C, check the alignment of the nails by looking at them end on. D, look at the effect of malrotation with the fingers flexed.**

## 65.6 Distal phalanx & ip joint injury

The tips of the 3 longest fingers are often crushed in a door, or hit with a hammer. Their distal phalanges may be small bones, but they are particularly important, especially for a typist or a guitarist.

In most injuries to a distal phalanx, ignore injuries to the bone and the nail, and treat the soft tissue injuries alone.

A combined angulating and crushing injury, such as crushing in a door (65-17A), can cause a mallet finger. Take a lateral radiograph to distinguish this from extensor tendon rupture, which is rare.

**(a) Crush fracture** (65-16:1,2).
*Don't suture the wound*. Mould the fragments together, apply a paraffin dressing, gauze & plenty of cotton wool, and a firm bandage round the distal phalanx only.
*Don't include the terminal ip joint in the bandage.* Keep it moving & flexing. *Don't splint the finger.*
Warn that the finger will remain tender for 6wks, but may continue to improve its shape over the next 6months.

Drain a subungual haematoma if present and painful (65-11B). Leave the nail in place, and dress it with Vaseline gauze. If it is loose, reconstitute the nail bed with a mattress suture which will draw it under the nail fold. It may regrow normally.

*Don't amputate exposed bone of the terminal phalanx*, *or remove any possibly viable bone*, because much of the fingertip may still be alive.

*N.B.* **If you remove the distal fragment**, *a useless floppy fingertip will remain*.
The distal phalanx has great capacity for repair.

**(b) Crush fracture including the distal ip joint** (65-16:3).
Amputate through the middle phalanx, leaving enough of its shaft to include the attachment of the *flexor superficialis* tendons.

**(c) Transverse & basal distal phalanx fracture** (65-15:4,5).
An undisplaced transverse or basal fracture needs no special treatment.

**(d) Dorsally displaced basal distal phalanx fracture** (65-15:6,7)
Treat this as a mallet finger (65.7) if it is displaced.

**(e) Anteriorly displaced basal distal phalanx fracture** (65-15:8,9)**.**
This needs early surgery. Suture or fix the bone fragment in place with a pull out suture (65-29).

**(f) Anteriorly displaced distal phalanx fracture** (65-15:10).
The distal fragment is forced out through the nail bed; reduce it & insert the proximal end of the nail into the nail fold where it will act as a splint. Splint the distal ip joint in extension (as a mallet finger) for 2wks. A mallet deformity often follows.

## 65.7 Mallet finger

The extensor mechanism of the fingers is liable to two similar injuries: the distal ip joint to a 'mallet finger' (65-17D), and the proximal ip joint to the 'boutonnière injury' (65.18).

A mallet deformity is the distal ip joint which cannot be fully extended. One of the extensor tendons tears away from the base of the distal phalanx. In doing so it may remove a small fragment of bone. The distal phalanx cannot be extended actively, so that it remains permanently bent. If you apply a cast in the first fortnight, you may succeed in preventing a mallet deformity. However, if the cast is too tight, it will cause a pressure sore, and if it is too loose, it will be useless, so try to get it just right.

*N.B.* Check the fit after 3days when the swelling decreases.

If a patient has a mallet finger, disregard it if employed as a labourer, and encourage active movements. Many patients will accept the mild disability of a slightly bent fingertip. But, if a patient does fine work, apply a mallet splint or cast, especially if the index finger is involved

**If a chip of bone is displaced and does not reduce with extension,** fixation is needed. If this is impractical, do nothing, because a mallet cast will make things worse.

**If there is no bony fragment,** or there is one but it is not displaced (5), apply a special mallet splint (65-17E).

A MALLET CAST
Use it very sparingly, because the pip joint tends strongly to stiffen in the flexed position! The patient should keep moving the pip joint. Keep the splint or cast in place for 6wks for a non-bony injury.

**TERMINAL PHALANX INJURIES**

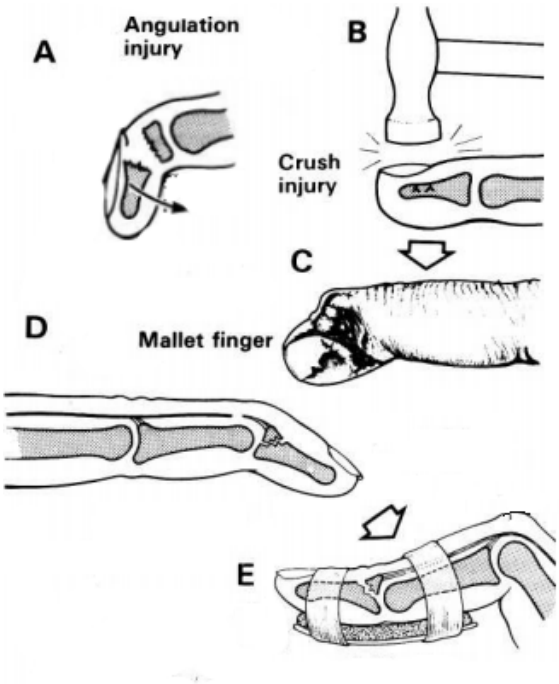


**Fig. 65-17 DISTAL PHALANX INJURIES. A, an angulation injury fractures an adult's terminal phalanx, or displaces a child's epiphysis. B, a crush injury. C, results in D, the typical deformity of a mallet finger. E, correct splinting held with an aluminium splint.** *Partly after Rutherford WH, Nelson PG, Weston PAM, Wilson DH. Accident and Emergency Medicine. Pitman 1980 with kind permission.*

## 65.8 Injuries common to middle & proximal phalanx

**(a) Injury of the head or condyle of the proximal & middle phalanx**
Stable injuries (65-15:11,15) need only a garter splint (65-17) but unstable injuries (with ruptures collateral ligaments or displaced fragments (65-15:12-14) need surgery. *The danger is a permanently swollen bent dip joint.*
**In a comminuted or T-shaped fracture** (65-15:14), the future function of the finger is likely to be poor. You may well get a better functional result with a distal phalangeal amputation.

**(b) Phalangeal neck fracture** (65-15:16).
Especially if the distal fragment is rotated, this needs fixation.

**(c) Phalangeal shaft fracture.**
An undisplaced fracture (65-15:17,18,22,23) needs only a garter splint.

Reduce displaced fractures (65-15:19-21,24) by pulling on the distal part, and correct any rotation especially for the spiral fracture (65-15:23).
Hold these in a garter splint but if they remain unstable, an aluminium splint or even K-wire fixation may be necessary.

**(d) Phalangeal basal fracture** (65-15:25-32).
The transverse basal fracture of a proximal phalanx (65-15:25), usually in an elderly patient, may well have marked angulation, which you may mistake it for hyperextension of the mcp joint. *Make sure the other fingers don't obscure it on a radiograph.* Reduce the angulation and splint the finger for 3wks in the position of safety 65-7).

Try to reduce dorsal (65-15:26,30), anterior (65-15:27) or lateral (65-15:28,31) fragments, pushing the fragment into alignment with the joint, and reducing any luxation. Hold these, as before, in a garter splint but if they remain unstable, an aluminium splint or even fixation may be necessary, but will not be feasible if the fracture is comminuted (65-15:31,32).

**(e) Angulated phalangeal fractures**
This is a common type of finger injury in which a transverse fracture angulates, either in a palmar (65-15:20) or dorsal (65-15:21) direction, pressing on the flexor or extensor tendons respectively. *If you don't correct this displacement, particularly in a fracture of the proximal phalanx, the tendons cannot function normally.*

Easy to reduce, this fracture readily displaces again, unless you hold the mcp joint firmly flexed until the fragments have united. This is fortunately also the position of safety (65-7) for this joint. *Be sure to correct any rotation*. Although closed methods are not perfect, *you are likely to get better results than with K-wiring.* A practical closed method to hold the position is to strap the fractured finger over a firm roll of bandage in the palm (65-18).

After traction, disimpact & reduce the fracture, making sure the injured finger points to the point 'x' (65-16A). Hold it there with adhesive strapping for 10days, *but not longer*. Finally, protect it for another 10days with a garter or aluminium splint.

Treat the fracture with dorsal angulation similarly; keep the mcp joints flexed, and the ip joints extended. Hold the position with aluminium splints both dorsally & on the palmar side of the finger.

**ANGULATED PHALANGEAL FRACTURES**

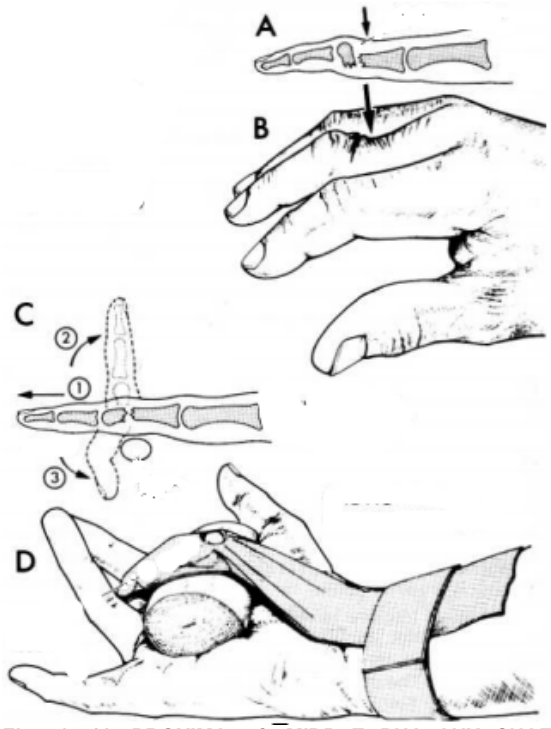


**Fig. 65-18 PROXIMAL & MIDDLE PHALANX SHAFT FRACTURE WITH PALMAR ANGULATION. A, radiograph. B, appearance of a fractured proximal phalanx with palmar angulation. C, traction for disimpaction (1), posterior angulation for reduction (2), & flexion for holding (3). D, the completed splint with the finger flexed forwards in the palm over a roll of bandage.**

## 65.9 Open proximal or middle phalanx fracture

A serious injury usually crushes several fingers at the same time. Both flexor (65.16) and extensor (65.15) tendons may be badly bruised.

**If only 1 finger is severely injured**, an amputation may be best to regain function quickly (65.24). But *preserve even a stump of an injured thumb.* Toilet the wound carefully. Remove detached fragments and any dead fatty tissue. Trim any grossly contaminated bone ends.

**If the skin edges come together easily**, suture them immediately with the minimum number of fine sutures. The hand is very vascular, so immediate primary closure is usually worth the risk. If the skin edges do not come together easily, or the wound is not clean, leave the wound open for delayed primary suture, or apply a split skin graft.

**If the fracture is stable (**65-15:22**) and the next finger is normal,** put it in a garter splint. If there are no adjacent normal fingers, find the position that best holds the fragments reduced, close the wound, and then devise an aluminium or plaster splint that will hold this position. Leave the normal fingers unsplinted and encourage movements. Elevate the hand.

**If a severe open injury is unstable,** you need some sort of fixation (65-32).

## 65.10 Metacarpal fracture

These common fractures usually follow a blow to the jaw in which the assailant breaks one or more metacarpals, usually the base of the 1st, the neck of the 5th, or the mid-shafts of the others. The fracture lines run either spirally, or transversely across the shafts or necks. If a fracture is transverse, the fragments are usually angulated dorsally; if it is spiral, fragments may overlap.

Typically, the back of the hand is painful and swollen. On clenching the fist, the normal contour of the knuckles is lost. *Radiographs are not essential,* and may fail to show the fractures, unless you take several views.

Reduction in the anteroposterior plane is much less important than with fractures of the phalanges. The bowing of a transverse fracture and the overlap of a spiral fracture usually cause little disability.

**HOLDING REDUCTION OF A TRANSVERSE METACARPAL SHAFT FRACTURE**

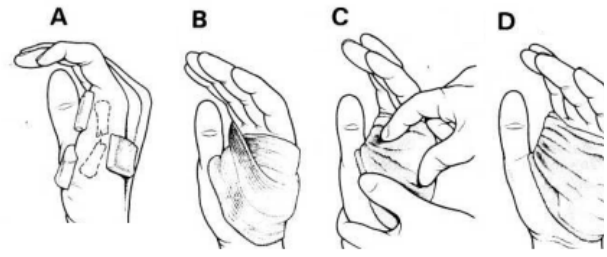


**Fig. 65-19 MAINTAINING REDUCTION OF A TRANSVERSE FRACTURE OF A METACARPAL SHAFT. *Don't use this for fractures of the neck.* A, apply padding (preferably orthopaedic felt) ready for 3-point pressure. B, apply adhesive strapping to the hand. C, apply an 8cm plaster bandage to the hand and mould it by firm pressure to provide 3-point fixation. D, the completed cast.** *After Watson-Jones R. Fractures & Joint Injuries, Churchill Livingstone 5th ed, 1974 with kind permission.*

You can leave many of these fractures unreduced. There may be no need to splint them, except temporarily for comfort. *The main danger is a stiff hand, so early movement is more important than accurate reduction of the fragments.*

**EARLY RETURN OF FUNCTION TAKES PRECEDENCE OVER ACCURATE REDUCTION OF METACARPAL FRAGMENTS**

**(a) Metacarpal head fracture** (65-15:35).

Ignore this and treat by active movements; if a twisting injury has torn a small chip off the metacarpal head, apply a garter splint for 3wks.

**(b) Metacarpal neck fracture**
Where the 2nd metarcapal neck is fractured (65-15:36), the head tends to angle palmarwards, reduce it by pushing the proximal fragment forwards. You may need to maintain reduction by fixation with a K-wire. Treat 3rd, 4th, 5th, metacarpal neck fractures, often from boxing injuries (65-15:37) conservatively.

*CAUTION! Don't try to disimpact and splint these fractures* because stiffness will result.

**(c) Metacarpal shaft fractures**
Treat undisplaced fractures (65-16:38) by rest and elevation for 10-14 days, with or without a protective bandage. Follow this with active finger and wrist movements.

Use of the hand should be fairly comfortable within 1wk. There may be crepitus for some days and a lump on the back of the hand permanently. A transverse fracture takes 5wks to unite, and a spiral fracture only 3wks.

A displaced fracture (65-15:39) needs traction and pressure to reduce it. Correct any rotational deformity. Apply a plaster cockup splint and mould it to the palm so as to maintain the metacarpal arch. Bandage the hand to the splint and leave the fingers free.

For a spiral fracture (65-15:40), correct any rotational deformity by manipulation, and apply a garter splint so that the correction is maintained.

A fracture of the 5th metacarpal shaft may displace dorsally (65-15:41); you can accept an angulaton <40°. Greater than this, reduction & fixation is advisable or apply 3-point fixation (65-19).

**(d) Metacarpal base fracture**

Posterior displacement of the bases of the 2nd, 3rd, 2nd & 4th metacarpals causes the line of the knuckles will be flat instead of tracing a normal curve. This is a rare, unstable and disabling injury, because dorsiflexion of the wrist becomes impossible, and so use of the fingers will be impaired. Reduce the fracture by asking an assistant to exert traction on the fingers. Press firmly with your thenar eminence on the back of the hand, while exerting counter-pressure on the front of the carpus.

A fracture of the base of the 5th metacarpal (65-15:42) is the equivalent to that of the 1st on the other side of the hand.

## 65.11 Thumb sprain

Although the 1st metacarpal is more mobile and more like a phalanx than the other metacarpals, stability is also important. Try to keep an injured thumb mobile and to maintain palmar abduction, and radial abduction, though the latter is less important. *Try, especially, to avoid a contracture in adduction.*

A violent lateral movement tears the medial mcp ligament, or pulls a bony fragment from the base of the proximal phalanx (65-15:43, 65-20). Hold the 1st metacarpal steady, and try to move the thumb from side to side. Compare the movement with that on the contralateral side.

Examine the radiograph carefully.
*N.B.* There is a sesamoid bone opposite the metacarpal head!
If you are in doubt about the diagnosis, inject LA into the site of the fracture and repeat the clinical examination by comparing with the contralateral thumb. If there is abnormal movement, assume rupture of the ligament.
Unless this injury is successfully treated, pinch grip is lost, and so will writing or opening a door.

**If a fragment of bone is visible** and can be reduced, the thumb may be successfully managed in a thumb spica cast (65-20).

**If the ligament is fully torn and there is no piece of bone**, the ligament must be repaired with sutures pulled through the bone or a specialized suture anchor. This type of procedure should only be done by a specialized hand surgeon.

**SPRAINED THUMB**

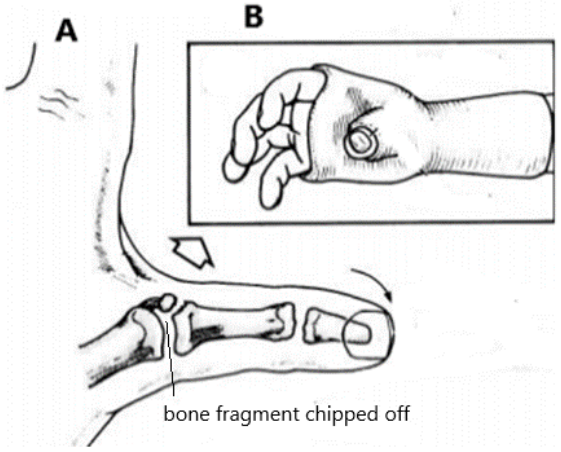


**Fig. 65-20 SPRAINED THUMB. A, forceful abduction tears the medial ligament & may chip off a piece of bone. B, fit this cast from mid-forearm including the thumb ip joint. Just before it sets, try to move the shaft of the proximal phalanx into the reduced position. Keep the fingers free.**

## 65.12 Thumb injury

CRUSH INJURIES
**If the thumb has been crushed**, immobilize it with a dorsal aluminium splint, or scaphoid cast (64-11), which leaves the fingers free and brings the thumb forward into a position in which it opposes the other fingers.

METACARPAL BASE FRACTURE
The base of the first metacarpal is often injured. If there is no abnormal movement between the thumb and the carpus, there is a sprain or an undisplaced fracture. Fit a cast as described below.

**If there is abnormal movement**, the base of the 1st metacarpal has broken in one of 3 ways (65-21).

**(a) Bennett's fracture** (65-15:44, 65-21C).
An oblique fracture line runs proximally into the joint from the ulnar border of the shaft of the 1st metacarpal, c. 1cm from its base. The proximal fragment remains attached to the trapezium, and the long distal fragment displaces radially and dorsally. The thumb looks shortened.

## 1ST METACARPAL BASE FRACTURES

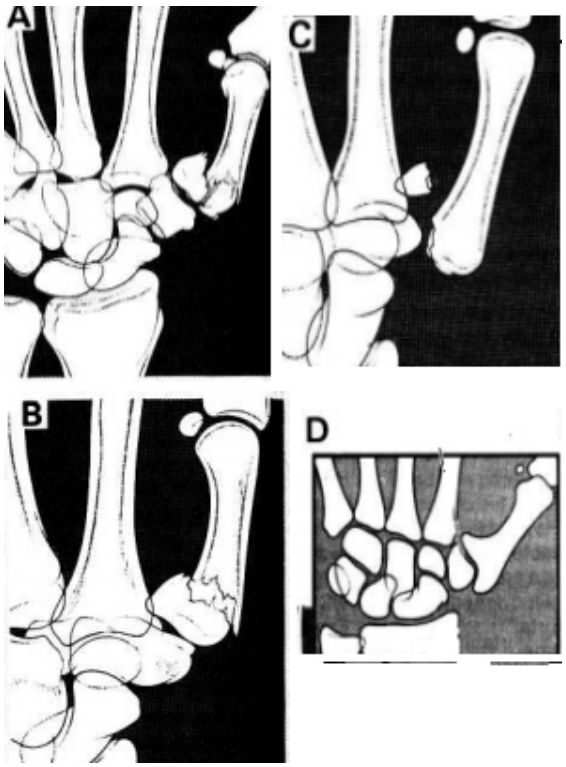


**Fig. 65-21 1ST METACARPAL BASE FRACTURES. A, a T- or Y-shaped fracture. B, a transverse fracture. C, Bennett's fracture. If you don't treat this, it causes a characteristic deformity, D, which may, however, cause few symptoms.** *Kindly contributed by Peter Bewes.*

The base of the thumb swells; moving it is painful, and the swelling obscures the displacement. This is one of the few fractures where you should examine for crepitus, so pull the thumb gently, if necessary under LA. It will elongate, and you will feel the two fragments grating together, after which the thumb will spring back. This distinguishes Bennett's fracture both from a dislocation (65.23), and from an impacted transverse fracture (65-15:38).

Reducing it is easy, but holding it reduced needs careful attention to detail. With LA in the fracture haematoma, extend the thumb while applying pressure to the palmar aspect of the 1st metacarpal head *(not the phalanx)*, and simultaneously pressing on the dorsal surface of the metacarpal base. *Don't exert traction & don't extend the thumb too much* which will force it out of joint. You should first be able to *see* the base of the 1st metacarpal slipping in & out of the carpo-metacarpal joint, & then feel it.

*N.B.* Now place felt or wool over the joint and rehearse the sensation of dislocation & reduction, so that you can place the thumb in its correct position in the cast.

## BENNETT'S FRACTURE

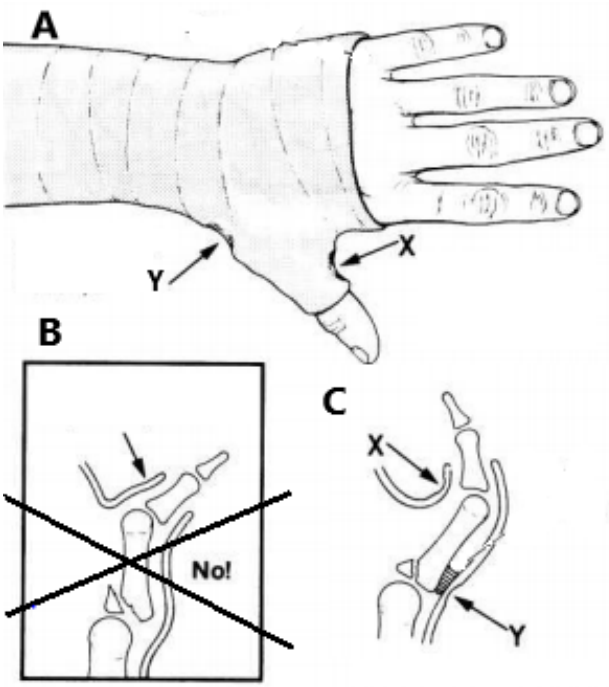


**Fig. 65-22 BENNETT'S FRACTURE. A, pad the 1st metacarpal. While the cast is setting, apply pressure to its head ('X') and base ('Y'). Apply the cast with care so as to avoid a pressure *sore.* B, *don't press on the ip joint & extend the thumb, and not extend the mcp joint.* C, points X,Y shown radiologically.** *After Charnley J, The Closed Treatment of Common Fractures. E&S Livingstone, Edinburgh 3rd ed.1961 with permission.*

Apply a complete wet plaster from just below the elbow to half-way up the proximal phalanx of the thumb. Feel again for the sensation of reduction that you have already rehearsed. Recognize this through the wet plaster, and hold it while the plaster sets at points X,Y (65-22C), so that your finger pressure marks remain visible on the plaster. *You don't need much pressure*, just ensure extension at the carpo-metacarpal joint.

Immediately obtain a post-reduction radiograph to check the position. If this is unsatisfactory, try once more. If once again, you fail, the options are either fixation or encouraging early active motion. Leave the cast on for 4wks.

**If the patient complains of severe pain,** remove the cast. There may be a pressure sore on the skin, which can erode down to tendon.

**If the reduction slips,** remove the cast and start active motion. After 2yrs, most movement will have returned, despite the characteristic radiographic deformity (65-21D).

**(b) Transverse & T- or Y-shaped fractures of the 1st metacarpal base** (65-15:45,46)
The latter fracture line enters the joint, but treat all 3 types of fractures by early active motion, and warn that a lump will remain. Neglect of motion will result in a stiff hand.

## 65.13 Finger & thumb dislocation

These injuries are usually the result of severe hyperextension of the finger or thumb. The base of the dislocated phalanx comes to lie dorsal to the head of the bone proximal to it. Dislocations of ip joints are more common and more easily reduced than dislocated mcp joints.

**REDUCTION OF AN MCP DISLOCATION**

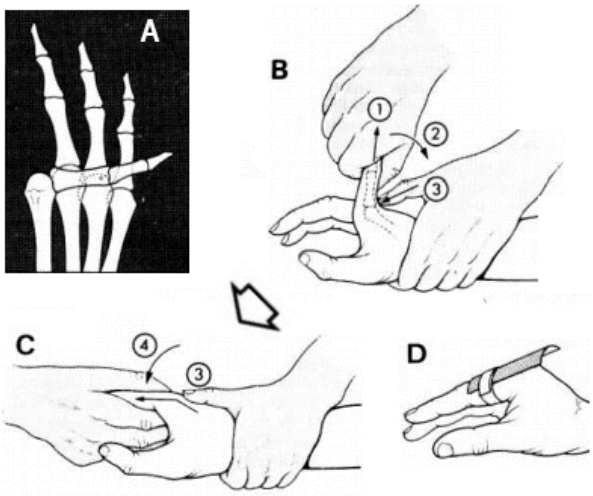


**Fig. 65-23 REDUCING A DISLOCATED MCP JOINT. A, reduce dislocations of the ip joint in the same way. B, exert traction on the finger (1) & disimpact the dislocation by hyperextension (2), while sliding the base of the phalanx forward on the metacarpal (3). C, then flex the finger into a straight position. D, if the finger is unstable after reduction, fit a guard.** *After de Palma AF, Management of Fractures and Dislocations, An Atlas.WB Saunders, 2nd ed. 1970 with kind permission.*

(1) Pull in the long axis of the dislocated phalanx (65-23B:1), *not the metacarpal,*
(2) Hyperextend an mcp joint first (65-23B:2), because this is the position in which the collateral ligaments are slack,
(3) Push the base of the dislocated phalanx forwards into place.
(4) Finally, flex the mcp joint and the finger will snap into position.
(5) Treat the injury as an acute emergency; the longer a finger is dislocated, the more difficult will it be to reduce.
After 4days, reduction may be impossible.

**DISLOCATED FINGERS AND THUMBS ARE ACUTE EMERGENCIES**

**USING LONG GAUZE FOR REDUCTION**

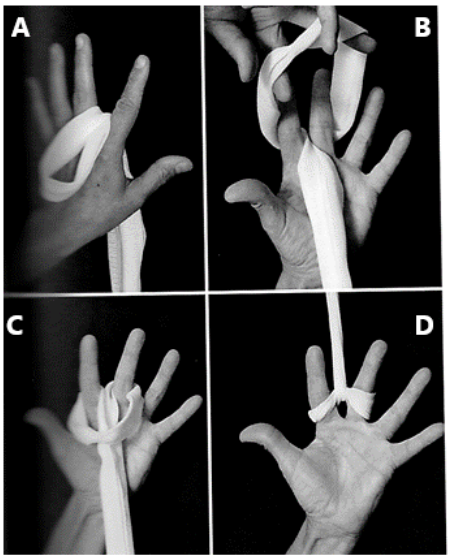


**Fig. 65-24 USING A LONG GAUZE FOR REDUCTION. A, pass the looped bandage between 2 fingers. B,C slip the loop back from the dorsal to the palmar side. D, then hook the bandage upwards, so it pulls the loop tight.** *After Gosselin RA, Spiegel DA, Foltz M. Global Orthopaedics. Springer 2nd ed 2019*

Test the finger for stability with the ip joint extended and the mcp joint flexed. Hold the proximal bone of the joint steady, and move the distal bone from side to side.

**If the reduction is stable,** flex the injured finger over a roll of crepe bandage for 7days (65-18), then apply a garter splint (65-10) & start exercises.

**If reduction is unstable,** immobilize the finger in the position of safety with a splint (65-9).

Reduction may fail if:
(1) the anterior ligament has detached and entered the joint.
(2) the phalangeal head has buttonholed through the anterior capsule, which becomes tighter the more you pull.
(3) there is an avulsion fracture of the phalangeal base.

*N.B. Don't make >2 attempts at reduction*, because you may damage the capsule and the collateral ligaments. Torn ligaments will cause the finger to deviate to one side and result in much disability.

*N.B.* In a severe extension injury, the fibrocartilaginous volar plate over the palmar surface of mcp & ip joints may tear. This may pull & avulse a chip of bone (65-15:27).
Immobilize the finger in flexion for 5days, then start active movements. The swelling may take weeks to resolve. A flexion contracture, or a hyperextension deformity sometimes follows.

## 65.14 Collateral ligament injury

A violent sideways movement may tear the collateral ligaments of the fingers. The ip joints have less sideways 'give' in them than the mcp joints. Examine the injured finger carefully to distinguish a strain from a tear.

Take a careful history to decide how force was applied to the finger: end-on, laterally, in crushing. Localize the tenderness and swelling exactly.
Check joint movements through their full ranges, from full flexion to full extension. If there is impairment, expect a significant injury.
Stress the collateral ligaments by holding the proximal bone still and angulating the distal bone.

If stressing the joint is merely painful, but there is no abnormal mobility, it is only sprained. If there is abnormal mobility compared with the normal side, but there is still a good end-point there is a partial tear. If the movement has no good end-point, however, it is completely torn. If you are in doubt, introduce a ring LA block and repeat the test.

SPRAINS
Apply a garter splint. Pain may persist for 6months and swelling for 2yrs.

TEARS
Reduce any displacement and get a radiograph, apply a garter splint for 6wks.
If reduction failed, the joint needs to be explored and any interposed soft tissues extracted.
Although complete ligament tears of the ip joints do recover with conservative treatment, tears of the mcp joints often remain unstable, especially the ulnar collateral ligament of the thumb.

## 65.15 Extensor tendon injury

Follow guidance on tendon repair in general (47.1)
Injuries to extensor tendons are easier to treat than those to the flexors because the extensor tendons have only short sheaths, so that adhesion to them is not the problem that it is with flexor tendons, and they are joined to one another so that their cut ends do not retract. Any suture method which will bring their cut ends securely together is likely to be adequate.

The boutonnière deformity is the result of a wound on the dorsum of the pip joint which destroys the central slip of the extensor tendon, so extension of the joint actively through its last 30° is no longer possible, although there is still a full range of passive movement. Such a wound may look minor, and the skin over it may only be bruised, but it is potentially serious. If you don't treat this adequately, the serious deformity of 65-26 may follow. The proximal ip joint is acutely flexed, and the distal ip extended.

The tear in the central slip of the extensor expansion prevents extension of the middle phalanx & enables the combined tendons of the *lumbricals* and *interossei* to slip forwards and flex the proximal ip joint, instead of extending it in the normal way.

**EXTENSOR TENDON INJURIES**

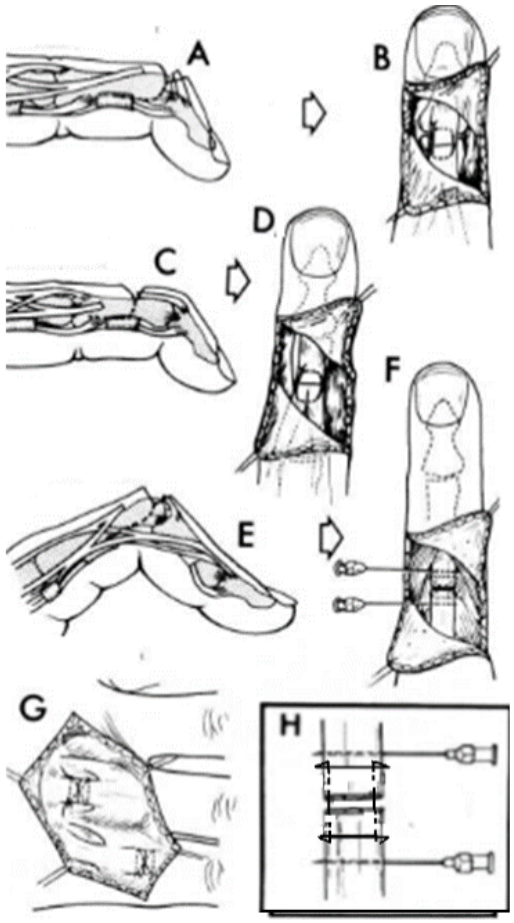


**Fig. 65-25 EXTENSOR TENDON INJURIES. A, B, a tendon cut over the dip joint. The flaps to repair this injury have been cut along the extensor creases, *not across them*. C, D, a similar injury, this time over the middle phalanx. E,F, an injury over the proximal ip joint held with needles to make it easier to suture. It is often more convenient for these needles to go in through the skin on one side and out on the other. G, cut extensor tendons over the back of the hand. H, tendon fixed for suturing** *From Heim U, Baltensweiler J. Checkliste Traumatologie, Thieme 1984, with kind permission.*

Treat a boutonnière injury like any other injury of the extensor tendons, but the results will not be as predictable.

INDICATIONS FOR PRIMARY SUTURE
(1) The injury occurred <24h before.
(2) There is no crushed or dead tissue.
(3) The wound is not badly contaminated.
In all other cases delayed primary suture of the skin and secondary repair is wiser.
If there is severe loss of the skin of the back of the hand, consider the flap coverage.

REPAIR
Apply a tourniquet and irrigate & debride the wound. Splint the hand and wrist in hyperextension while you operate. Clean the wound (54.1), excise the skin edges, and extend the wound if necessary to expose the tendon ends. Trim them.

Draw the proximal and the distal ends into the wound and hold them in place with needles which pass through the skin, the tendon, and then the skin again.

Hyperextend the finger to bring the distal tendon into view. Suture the flat ends with 3/0 or 4/0 non-absorbable monofilament suture (48.4). Splint the hand for 3wks with the wrist hyperextended (if possible), the mcp joints flexed 15°, and the ip joints extended.

*CAUTION! Don't allow flexion of the injured hand until the period of splinting is complete.*

**THE BOUTONNIERE (BUTTON-HOLE) DEFORMITY**

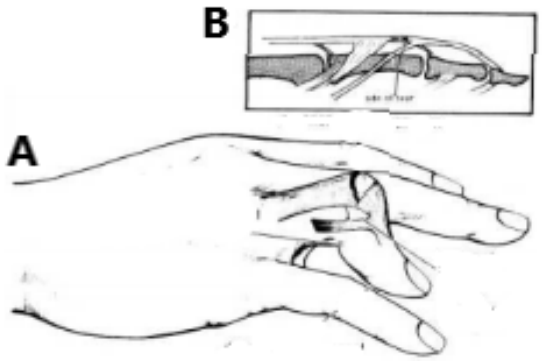


**Fig. 65-26 THE BOUTONNIERE (BUTTON-HOLE) INJURY is a tear in the extensor expansion of the pip joint in which the combined tendon of the *lumbricals* & *interossei* slips forwards anterior to the axis of the joint, so that they flex the middle phalanx instead of extending it, as they do normally. The dip joint is extended. If not treated correctly, a disabling flexor deformity will result.**

If after repair of a boutonnière injury, extension of the proximal ip joint is impossible when you take off the splint, you need to make a further attempt at open repair.

## 65.16 Flexor tendon injury

Flexor tendon lacerations are difficult injuries. On the volar (anterior) surface of the wrist there are 14 tendons, 2 main nerves, and 2 arteries, all of which can be cut. Exposing and finding them is not easy, thus repairing them takes a long time. Diagnosing that a flexor tendon is injured is usually easy.
However, if one of the fingers lies extended out of line with the others, it has probably been pulled by the unopposed action of its extensor tendon. This enables you to decide which of the flexor tendons is cut (65-2).

**ANTERIOR WRIST STRUCTURES**

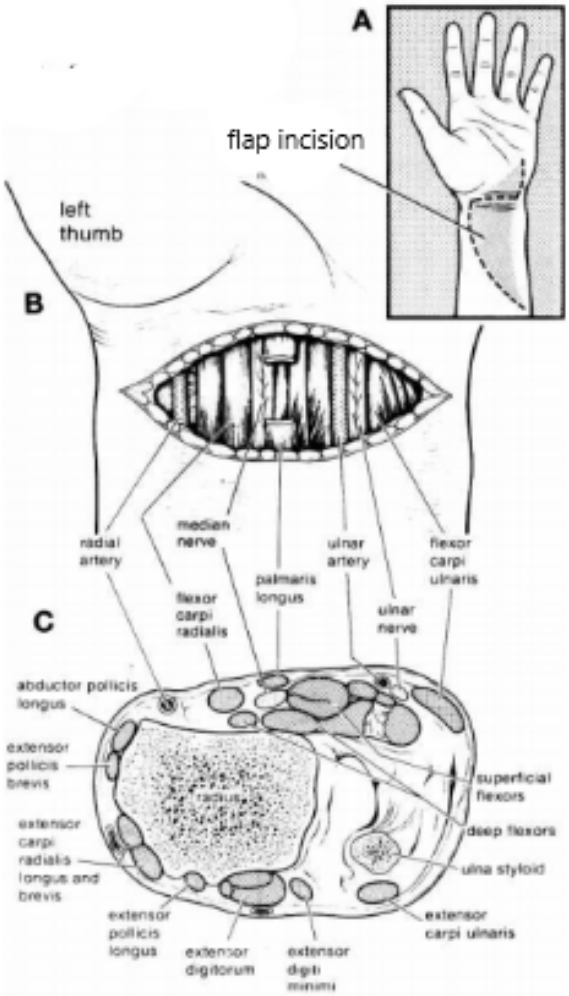


**Fig. 65-27 STRUCTURES ON THE ANTERIOR WRIST SURFACE. A, cut flaps like this. B, the structures exposed through an incision in the flexor crease of the wrist. C, a cross-section of the wrist. Note the median nerve is under the *palmaris longus* tendon, between the *flexor carpi radialis* & the deep flexors.**

One of the dangers in any flexor injury is that on clenching the fist, the proximal ends of the flexor tendons are pulled too far proximally in their sheaths, especially in Zones 1 & 2. If this happens, the blood vessels on the *vinculae* which nourish the sheath's cut end will be torn, and it becomes ischaemic, producing dense adhesions. The first principle in caring for such an injury is to keep the wrist flexed.

For repairing flexor tendon injuries, there are 5 zones:
**Zone 1, distal to the pip crease** and the insertion of the *superficialis* tendon, where repair is easier, because there is only the *profundus* tendon to be sutured. One difficulty is that the *profundus* tendon usually retracts. A flail dip joint is a nuisance, but a stiff dip joint after a repair is only a minor handicap.

**Zone 2, an intermediate zone between the distal palmar crease and just distal to the pip crease,** where repair is very difficult because the superficial and deep flexor tendons are so closely packed and run in the same sheath. This is a 'no man's land': even experienced surgeons have problems here.

## ZONES FOR FLEXOR TENDON REPAIR

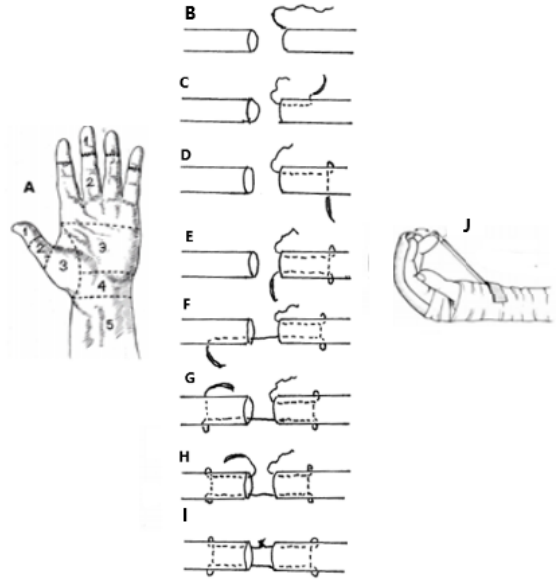


**Fig. 65-28 ZONES FOR FLEXOR TENDON INJURIES. A, Flexor injuries in Zone 5, at the wrist, are not too difficult. Zones 4 & 3 are fairly difficult. Zone 2 is a *'no man's land' that even experts find difficult*. Zone 1 is is about as difficult as Zones 4 & 3.**
**B, the rough ends of a cut tendon. *In real life injured tendons never look as tidy as this!* Anchor the tendon with needles & trim its ends. B, oppose the clean ends. C-H, insert the needle as shown to bring the ends together. I, tie the suture ends together to bring the tendon ends into apposition. J, on completion, use a plaster backslab and curve it as shown. Pass a suture through the nail and tie a rubber band to a piece of strapping fixed proximally on the wrist.**

For the unskilled, and the moderately skilled, the concept of 'no man's land' is still very relevant, because damage to normal fingers & their neurovasculature is a real risk.

*So don't try!* Instead, perform debridement and irrigation of the wound, and close the skin.
Also, *flexor pollicis longus* is difficult to repair with good results, even if it is the only flexor tendon.
**Zone 3** extends from the end of the carpal tunnel to the A1 pulley.

**Zone 4** is within the carpal tunnel.
Zones 3 & 4 include the palm between the wrist and the distal palmar crease where repair is not too difficult. If you are moderately skilled, try to repair the *profundus* tendon(s) and disregard or remove *superficialis*.

**Zone 5** extends from the musculo-tendinous junction of the forearm to the tendons at the wrist at the entrance to the carpal tunnel. In this zone, repair the tendons immediately because they retract and scar rapidly.

## DISTAL FLEXION TENDON INJURIES

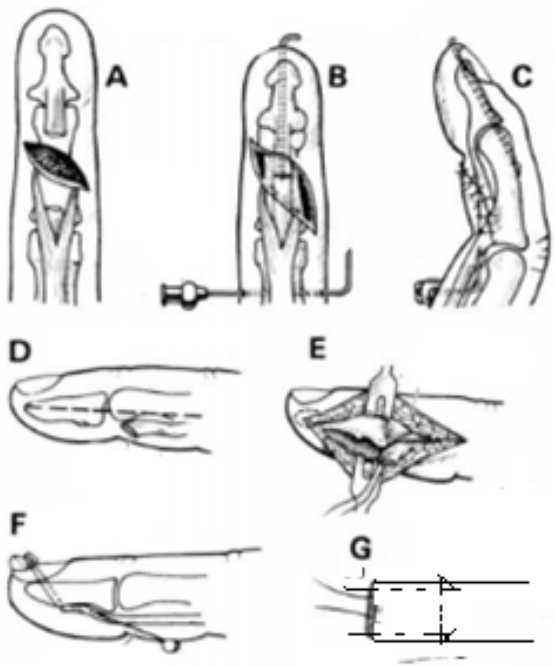


**Fig. 65-29 FLEXOR TENDON INJURIES IN ZONE ONE. A, an injury over the middle phalanx. B, the terminal phalanx anchored with K-wire, and the *profundus* tendon brought into the wound and anchored with a needle. C, repair is complete. D, avulsion of the flexor tendon off the distal phalanx. E, open the finger from the side and place a suture in the end of the deep flexor tendon. F, with a withdrawal suture in place, anchor the tendon with sutures round the nail. G, how the withdrawal suture is anchored.** *After Heim U, Baltensweiler J. Checkliste Traumatologie, Thieme 1984, with kind permission.*

EMERGENCY TREATMENT
Irrigate and debride the wound. Put the arm in a sling, with the wrist and fingers flexed so that they form a 'C' (65-1). This will keep the cut tendons in their sheaths with their blood supply intact. Clean the wound, suture the skin only.

AMPUTATION
Even when the flexor tendons to a single finger have been cut and you cannot refer the patient, there are good arguments for you to attempt a repair.

REPAIR
Indications & method are as for extensor tendons (65.15)
Retrieve the distal tendon stumps by flexing the digit. Bring the proximal tendon end down by flexing the wrist and by proximal-to-distal milking.

If this does not bring the cut end out, try *(only once)* to grasp it very gently using a fine haemostat and bring into the wound.
*N.B. Repeated blind attempts to retrieve the tendon with a clamp will damage the surrounding sheath and lead to excessive scarring.*

If these manoeuvres fail, extend the incision proximally to find the proximal end or make a separate incision just proximal to the A1 pulley in the palm. Once you find the proximal cut end, deliver the tendon end to the injury site through the flexor sheath using a fine PVC tube or silicone catheter. Then hold the tendon in place with a 25-G needle and repair it (65-21).

**If you are not sure which finger a tendon belongs to**, put a suture through the tendon and pull on this to see which finger moves.

**If the *profundus* tendon is cut over the middle phalanx,** repair it beyond the fibrous flexor sheath. Squeeze it to a button near the distal end of the finger. This will prevent the strong pull on the tendon tearing the repair apart.

**If the *profundus* tendon becomes detached from its terminal phalanx, perhaps with a fragment of bone** (65-15:8,9) this is the palmar equivalent of a mallet injury (65.7). Open the finger from the side (65-29E), and pass a suture through the torn end of the tendon. Pass the suture round the terminal phalanx and tie it, leaving a segment outside to allow its removal.

**If the thumb tendons are injured,** attempt primary repair.

POSTOPERATIVE CARE (ALL ZONES)

Immobilize the wrist in a splint in flexion for 3wks (65-28). This allows an injured tendon to move in its sheath, and in doing so to minimize adhesions. It also allows limited active extension, while the rubber band keeps the flexion without straining the suture.

The critical period for rupture of the suture line is immediately after removing the splint, so start movements gradually, and try to devise some form of check strap to prevent sudden movements which may rupture the repair. The hand will be stiff and painful after the injury, but with perseverance, it should improve steadily over several months.

**If you are able to perform a 4- or 6-strand intra-tendinous repair**, early movements are possible, starting from the 1st day with strictly passive movements of the injured fingers in flexion. Then from 2wks, passively placing the fingers into flexion and then trying to and actively hold the finger in place.
From 3wks advise active movements in stepwise fashion without loading or resistance over the next 8wks.

## 65.17 Repair of a digital nerve

Follow guidance on nerve repairs in general (48.1)
A finger with sensation will be much more useful than without, and since secondary suture is unsatisfactory, attempt a primary repair if you can. The digital nerves are quite large and are entirely sensory, so they recover well. Beyond the dip joint, the nerve is too small for repair.

After repair, immobilize the finger round a roll of bandage in the palm for 3wks. Injuries in the distal part of the hand will take 4months to recover, and those proximal to the wrist c.1yr.

## 65.18 Accidental amputation

The treatment of a pulp amputation depends on the completeness & the size of the piece lost. Treatment also depends on how clean the cut is: a butcher's knife and a power saw cause very different injuries.

**DISTAL PHALANX INJURIES**

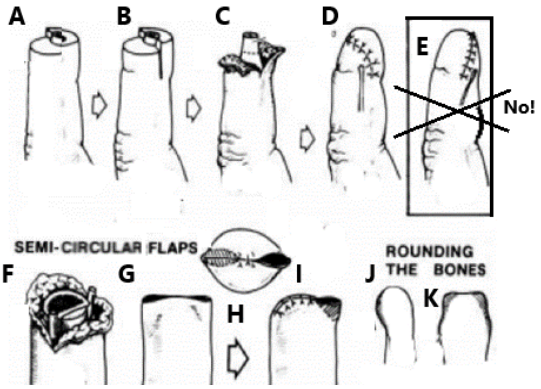


**Fig. 65-30 DISTAL PHALANX INJURIES. A-D, transverse amputation of the distal phalanx (*rarely in reality as neat as this).* E, prepare unequal flaps, shorter on the dorsal side. F, trim the protruding bone, prepare the flaps. G, ensure the suture line is on the dorsum. H, *avoid a palmar scar & a neuroma.***

**If there is some soft tissue covering the bone**, even some periosteum, the finger can be left to granulate in with good result although this may take several weeks. However, in this case, the tip will be sensate and thus more functional. Skin grafting almost always results in an insensate tip, albeit with faster healing. *Don't perform a V-Y plasty except in cases of amputation at the ip joint:* this also results in an insensate tip & maybe scarring.

**If the partly detached slice is still bleeding,** showing that it is still alive, debride & suture it back on, even if it is quite large. Apply the minimum of dressings and elevate the hand.

**If the partly detached piece is not bleeding,** or if its tendons or nerves have been cut, it is probably better amputated completely.

**If the piece is <1cm$^2$,** it is not worth grafting. Apply vaseline gauze and let it granulate. This is possible in most of the cases with injuries in the finger tip!

**If the piece is >1cm$^2$**, shorten the bone so as to cover the stump with a good flap of palmar skin, either as fish mouth flaps (65-30D-G) or semicircular flaps (65-30J-L). A shortened finger is often best, so patients often say.

CHANG (36). an amateur guitarist, amputated the index finger through its middle phalanx, and severely injured the middle, ring, and little fingers in a machine at work. They were hanging on only by some crushed soft tissue and were cold and without sensation or movement. The possibility of microsurgery and the many months of rehabilitation it would require was discussed. He wished to be back at work quickly because there was much unemployment, so he opted for amputation. After intensive physiotherapy involving heavy metalwork, he was soon back at work, and still plays the guitar, but with a plectrum to pluck the strings.

KALIM (39) the wood chopper in Fig. 75-29, degloved the index, middle finger, and thumb in a machine at work. The ring and little fingers were less severely injured. But he could still move them all normally; their tendons were undamaged. The possibility of burying them in an abdominal skin pouch was discussed, but it was not considered practical to restore sensation with a neurovascular island transfer, since this would have required months of physiotherapy. He was in danger of losing his job, so he chose to have the thumb, index, and middle fingers amputated. A few weeks of physiotherapy restored movement to the ring and little fingers and he was soon back at work; he can even do up his own buttons. LESSONS (1) All the surviving parts of the hand were covered with good skin. (2) It was possible to preserve the whole of the 1st metacarpal. (3) Active physiotherapy started almost immediately. (4) Early amputation can leave a very functional hand.

**CONSIDER THE NEEDS OF EACH PATIENT**

## 65.19 Severely injured hand

Multiple injuries demand measures that may be quite different from single finger injuries. The soft tissues are likely to be severely injured, causing much swelling and stiffness. There may be other even more serious injuries elsewhere. One stiff finger is manageable, but a stiff hand is a serious disability. It is often difficult to know whether to splint or mobilize an injured hand.

METHOD

Carefully irrigate and debride the hand (65.1). *Don't suture the skin*. Apply a wet dressing with plenty of cotton wool. The hand will swell severely, so elevate it. Keep it in the position of safety with a plantar plaster cast. Administer an antibiotic and analgesics.

First find the median or ulnar nerves (48.1); it is seldom that both are involved. Then find the injured tendons: beware, *the median nerve looks very much like a tendon*! Suture the nerves (48.1) and tendons (47.1). If one artery is cut, repair it if possible, but *don't waste time on it*. If both arteries have been cut, the collateral circulation may be enough to keep the hand alive, but repair at least one artery (49.5), especially if the patient is old. Try to suture all tendons, *except palmaris longus*. If you have difficulty, the deep flexors are the most important.

**If there are fractures of the middle and ring fingers,** strap them to their normal neighbours. If this is impractical, support the injured fingers with aluminium splints.

**If there are multiple phalangeal fractures,** early active movements are likely to produce good function, though *not if the metacarpals are fractured*. Here K-wire fixation is more effective (65.20).

**If a single finger is badly damaged,** consider amputating it, especially if the other fingers are normal.

**If several metacarpals are fractured and severely deviated,** apply K-wire fixation (65-32). If convenient, incorporate it in a cast which is immobilizing the wrist.

**If several of the fingers are badly damaged,** conserve as much function based on the examples described below.

**SOME SEVERE HAND INJURIES TREATED**

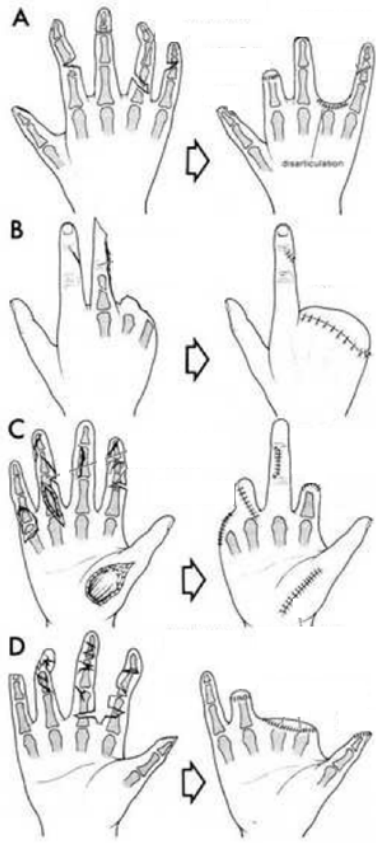


**Fig. 65-31 SOME SEVERE HAND INJURIES. You may have to cope with any of these. One of your most difficult decisions will be whether to splint an injured hand or to mobilize it.** *After London PS. Practical Guide to the care of the injured. E & S Livingstone 1967 with kind permission.*

**Hand 65-31A.** The tendons and the neurovascular bundles of the index and ring finger are so severely injured that amputation is the only reasonable option. Close the end of the index finger with a palmar flap, and the ring finger by removing the stump of its proximal phalanx.

Close the middle finger with a fish mouth flap (36.14), so as to save as much length as you can. The ulnar neurovascular bundle of the little finger is intact, so fix its middle phalanx. Graft the wound on the tip of the thumb with skin taken from the amputated tip of the index finger.

**Hand 62-30B.** Half the middle finger is intact, so fillet it by removing the bone to make a flap that will cover the stumps of the amputated 4th & 5th fingers. *Take care not to damage its blood supply, including its dorsal veins*. Remove the injured phalanges, pull the flexor and extensor tendons distally, cut them off cleanly, and allow them to retract.
Cut back the digital nerves of the amputated fingers so that their cut ends lie deep in the palm. Leave all the fat in the flap, suture it in place without tension, and evert the suture line. If there is any excess skin, remove it from the dorsal aspect rather than the palmar aspect of the flap, but *don't make it too narrow*.

**Hand 65-31C.** There is a soft tissue wound round the base of the thumb. Close it without tension by slightly increasing its length. Both the neurovascular bundles in the index finger are cut, so amputate it just proximal to the ip joint.
Suture the small flap on the middle finger into place. The ring finger is so severely injured that you can only save its proximal phalanx. The little finger is also severely damaged, so amputate it through the head of its metacarpal. A grip between thumb and index finger will still be possible, so there will still be a useful hand.

**Hand 65-31D.** Repair the thumb by simple suture. Both the index and the middle fingers are so severely damaged that amputation through the mcp joints is necessary. More of the index finger remains, so you can amputate it through its proximal ip joint, and turn up a flap. A powerful grip will remain.

**A GROSSLY INJURED HAND**

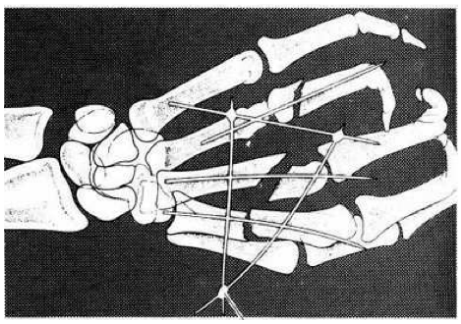

**Fig. 65-32 THE 'KEBAB METHOD' FOR A GROSSLY INJURED HAND. This is the patient 'Yvonne' in the text, who was later able to return to typing, despite the severity of her injury.** *Kindly contributed by Peter Bewes.*

**Hand 65-32**
**If the hand is so severely injured that you cannot save any of the fingers**, try to save as much of the metacarpals as you can. If the thumb remains, this will give something to grip against. Mould what remains of the hand into the best position (65.8). If necessary, insert K-wires longitudinally down the fractured bones and transversely across the hand to stabilize the metacarpals. Hold the ends of the rods or wires together with epoxy resin, plaster, or string. Leave the wound open for the first few days. Close it by secondary suture, or with skin grafts as appropriate. Remove all K-wires after 14-21 days.

YVONNE (26) and her husband had been driving all night when he veered into the fast lane on the motorway. She sustained multiple open dislocations of the mcp joints of the right hand, its dorsum was degloved, and several of its metacarpals and proximal phalanges were fractured, as in (65-32). Amputation was considered, but the circulation and sensation in her fingers was good, and she was, moreover, a typist. A tourniquet was applied and the wound was irrigated and debrided under GA. The metacarpals were repaired by threading K-wire down their marrow cavities, and further stabilized with transverse wires held with epoxy resin.
The wound was covered with split skin (fortunately most of the extensor tendons were still covered with paratenon), and the hand was bandaged in the position of safety (65-7). She later returned to typing.

## 65.20 External & internal fixation

INTRODUCTION
Open reduction and internal fixation (ORIF) by plating or screwing demands high standards of hygiene and resources. Therefore, where resources are limited, *it is usually impossible to perform and usually contra-indicated.*

**FINGER FIXATION USING PLASTIC**

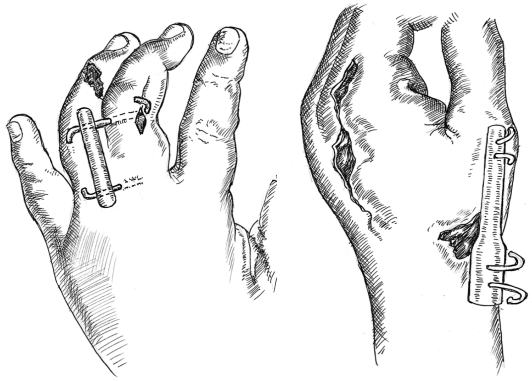

**Fig.65-33 EXTERNAL FIXATION WITH A PLASTIC CANNULA SHEATH. Don't put it over the midline & avoid the extensor mechanism.**

External fixation is a good option for the treatment of complex trauma of the wrist.

Bridging external fixation of the wrist *via* the radius and the 2nd metacarpal row is very helpful in dislocated wrist trauma with or without severe skin and soft tissue trauma.

Use external fiaxation for finger fractures severely comminuted or open & grossly contaminated (*e.g.* in gunshot injuries). You can use the plastic sheaths of cannulae as crossbars and needles or K-wires as pins. Reduce the fracture and measure the length of plastic you need. Avoid the extensor mechanism & the midline when placing the pins; make them diverge slightly to add to stability of the fixation.

K-wiring is however better and less complicated for simpler fractures. K-wiring can combine various aspects of external and internal fixation in severely injured fingers. It offers bone stabilization without further bone exposure, thereby protects skin and soft tissue, and can be easily removed. Bone infection due to K-wiring is very rare. So, even in the hands of the less experienced surgeon, it is a good option.
Use it in complicated finger and metacarpal, as well as in open fractures.

INDICATIONS:
(1) Displaced fractures of phalangeal shafts, where closed reduction has failed and there is a rotational deformity (scissoring).
(2) Displaced fractures close to or involving a joint.
(3) Major unstable injuries.

**FIXING FRACTURES WITH K-WIRE**

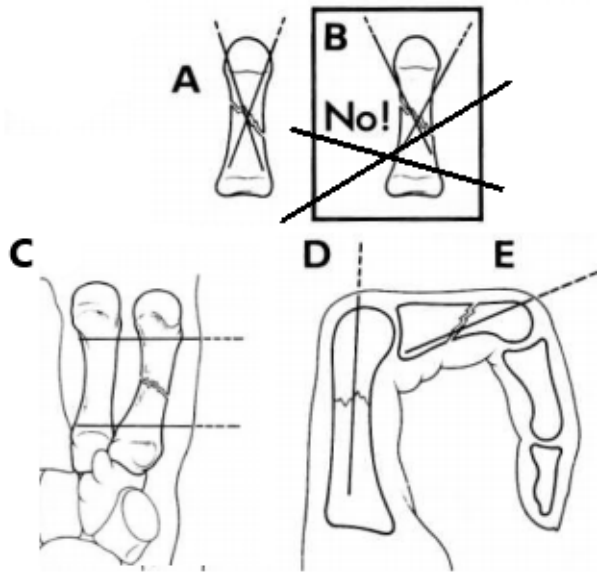


**Fig. 65-34 FIXING FINGERS WITH K-WIRE. A, drill the wires through the sides of a condyle. B, *not through the side of the neck*. C, fixing the shaft of the 5th metacarpal with K-wire. D, longitudinal fixation of a metacarpal. E, is the same injury as in A, but viewed from the side.** *Kindly contributed by James Cairns.*

A useful way of fixing some unstable fractures is to use K-wires. Insert 2 wires to cross one another in order to immobilize a fracture very satisfactorily (65-34).

EQUIPMENT
A bone drill,
A K-wire plier cutter,
Some 8 cm lengths of 0.75-1.2mm K-wire.

**If you don't have a drill**, you may be able to put the wire in with a Steinmann pin introducer, but this is technically very difficult.

K-wires are usually supplied with sharp points; to sharpen a cut end, do so with a wire cutter. If possible, use wire with a beveled end slightly wider than the rest of the wire.
This will overdrill the bone through which it passes and avoid distraction of the fragments.

METHOD (GRADE 2.3)
Drill the wire in with a hand drill or power drill. Cut the wires short just under the skin. Leave the wires in for 12-21days, or until the bone has united.
Bend the wire protruding outside the skin and cut it, so it makes a small hook c. 0.5cm long.

*Make sure the cut end doesn't press into the skin.* This can then easily be removed in clinic without LA.
Otherwise a buried wire needs a cut in the skin under LA to extract it with pliers, which may not be readily available.

**For the shaft of a phalanx,** enter the lateral aspect of a condyle, and drill through the shaft, into *but not through its base*. Drill from the dorsal aspect of the condyle, towards the volar aspect of the base. Going through the sides of a condyle will be easier than trying to go through the sides of the neck of the shaft. The bone is harder here and it is difficult for the drill to enter the bone obliquely.

**For fractures of the neck of a metacarpal,** enter the condyle in a similar manner.
*N.B. Many of these fractures don't need K-wire* (65.11).

**For unstable open finger fractures**, apply K-wires in the position of safety. Drill the wire through the head of a phalanx to one side of the midline (65-10A). Pass it down to, *but not through,* the base of the phalanx. Cut it off under the skin over the proximal ip joint. Supplement this with an external splint to protect the pins.

**To hold the position of a metacarpal base & neck fracture** (65.10) apply K-wire fixation if necessary.

## 65.21 Difficulties with finger injury

**If the finger is degloved,** the skin is stripped off the finger, by a ring, a rope or high-pressure liquid. An alternative to amputating the degloved finger is to cover it with an abdominal flap (46.5). *This is a method for the careful, caring operator.* It is easy to start this procedure, but difficult to see it through to a successful result. Too often the result is a stiff hand.

**If there is a severe injury of the back of the hand**, perhaps involving the extensor tendons, management will depend on whether or not the tendons still have a thin filmy pink sheath of *paratenon* over them. If they do, primary repair of the tendons and primary split thickness skin grafting is the best and allows you to put the hand into the position of safety (65-7). If there is no *paratenon* over the extensor tendons, a flap is needed.

**THERE IS NO SUCH THING**
**AS A TRIVIAL HAND WOUND**

**If the thenar muscles are severely crushed,** pressure builds up within the firm thenar fascia causing severe pain and paralysis. Pain on passively stretching the muscles is a sign of impending ischaemic contracture, so make an urgent surgical decompression (49.6). Make an incision over the thenar eminence parallel to the skin crease at its base or obliquely. Cut the underlying fascia *taking care not to go too far medially or proximally*, or else you will injure the recurrent branch of the median nerve which supplies the thenar muscles.
*N.B.* If there is pressure on the median nerve with numbness, a carpal tunnel release is necessary as well.

**If the hand has been bitten,** the risk of infection, particularly after a human bite, is great. Osteomyelitis may follow. So, irrigate and debride the wound thoroughly and leave it open. Elevate the hand in a roller towel. Administer a broad spectrum antibiotic. *Don't forget anti-tetanus toxoid!*
*N.B. Beware the bite injury of the knuckles:* a seemingly innocuous wound easily results in spreading infection along the extensor tendons!

## 65.22 High pressure injection injury

Sticky liquid mixed with air from an industrial spray gun can penetrate very deep in the hand and spread along synovial sheaths to the bursae in the palm, or even the forearm. You may only see a small puncture wound initially, from which an oily frothy liquid exudes.

Where the substance has been injected may be grossly swollen. Such a wound needs radical debridement. A radiograph will show how far thick oil has extended into the tissues (65-35).

**If an industrial gun or pump has injected grease, diesel oil, paint, compressed air, or abrasives into the hand,** these materials enter the tissue planes of the hand under high pressure, and may reach even up into the forearm. *Although the skin wound may be small and the initial injury almost painless, the tissues underneath are grossly injured*. Soon the hand starts to swell and becomes very painful. This is an acute surgical emergency and an extensive wound debridement is essential. *Neglect may lead to amputation.*

**HIGH PRESSURE GUN HAND INJURY**

**Fig.65-35 HIGH PRESSURE GUN INJURY TO THE HAND. Extensive spread of oil in the index finger. Explore the wound after applying a tourniquet; remove all foreign material, loose fragments of bone, & dead tissue. Note damage to nerves & tendons for later repair. N.B. You may need to release the tourniquet to see which tissue is viable.** *After Verhoeven N, Hierner R, High pressureinjection injury of the hand. Strategies Trauma Limb Reconstr.* 2008; 3(1): 27–33.

MANAGEMENT (GRADE 2.4)
Elevate the hand for 5-10mins. Explore the injury under GA and a tourniquet. Consult an anatomy book to show you where the important structures are. Incisions recommended are not exactly the same as for sepsis (8-4B,6B).

*Don't use an Esmarch bandage* as this may spread the oil further.

Note damage to nerves, arteries, and tendons. *Leaving foreign material in the tissues is more dangerous than opening up the hand fully.*

When you have removed all the foreign material, apply a firm dressing and take the tourniquet off. After 5-10mins, remove the dressing and control bleeding.
Then dress the wound without suturing it. Finally, leave the hand in the position of safety, inspect it daily, and remove more foreign material if necessary. The hand will be stiff, but if you don't treat this radically an amputation will be inevitable. This is an acute surgical emergency and an extensive wound debridement is essential.

**(a) Index, middle & ring fingers**
Injection into the index, middle & ring fingers does not extend to the palm. If there is gross swelling, amputate the finger at the mcp joint. Otherwise make a radial or zigzag incision (8-6B) and clean out the oil conscientiously (65-36). You may well end up amputating the finger later because of stiffness.

**EXPOSURE OF A FINGER**

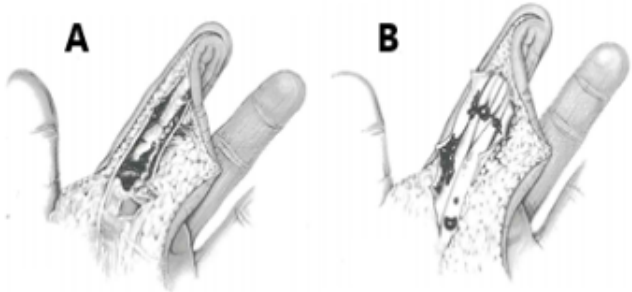


**Fig. 65-36 EXPLORING A FINGER FOR INJECTION INJURY. A, initially the oil penetrates along the line of fire, B, but then reaches the transverse metacarpal ligament and spreads laterally.** *After Champion HR, Robbs JV, Trunkey DD, Trauma Surgery Part 2, Butterworths, 4th ed 1989.*

**(b) Little finger**
Make a zigzag incision on the palmar surface and inspect the synovial sheath. If oil has penetrated this, open it fully proximally with a further zigzag, taking care not to damage nerves & vessels, clean the tissues and rinse out the bursa (65-37).

**EXPOSURE OF THE LITTLE FINGER**

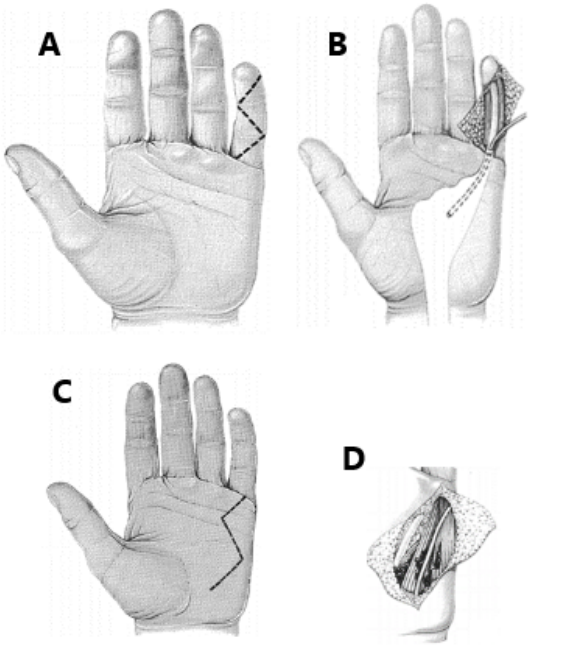


**Fig. 65-37 EXPLORING THE LITTLE FINGER. A, make a zigzag incision to explore the little finger. B, extend this to open the ulnar bursa.** *After Champion HR, Robbs JV, Trunkey DD, Trauma Surgery Part 2, Butterworths, 4th ed 1989.*

### (c) Thumb & thenar eminence

Decompress the thumb itself by a zigzag incision, and if the oil has spread proximally, open the thenar eminence also (65-38) to explore the radial *bursa*.

**EXPOSURE OF THE THUMB**

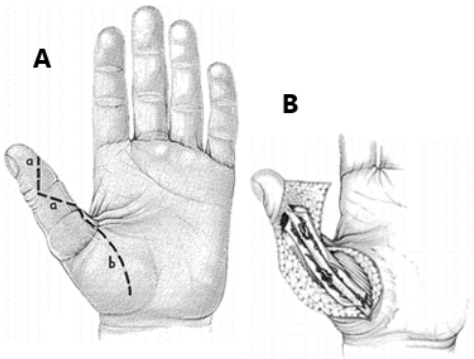


**Fig. 65-38 EXPLORING THE THUMB. A, make a zigzag incision to explore the thumb. B, extend this to open the radial bursa.** *After Champion HR, Robbs JV, Trunkey DD, Trauma Surgery Part 2, Butterworths, 4th ed 1989.*

### (d) Mid-palm

Make an angular incision and undermine a large palmar V-flap with its fat. Remove the superficial palmar aponeurosis and clean the area superficial to the flexor tendons very carefully, taking care not to damage nerves & vessels. You may need to go deeper towards the septum attached to the 3rd metacarpal which divides off the thenar space (65-39).

**EXPOSURE OF THE MID-PALM**

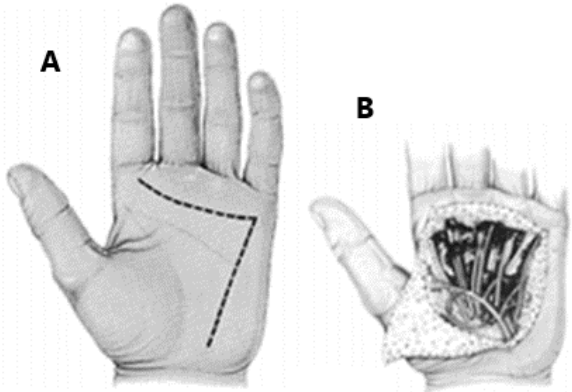


**Fig. 65-39 EXPLORING THE MID-PALM. A, make an angular incision reflecting a V-flap with its fat. B, after removing the palmar aponeurosis, carefully remove the oil with saline & pledgets.** *After Champion HR, Robbs JV, Trunkey DD, Trauma Surgery Part 2, Butterworths, 4th ed 1989.*