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Management of hand fractures

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Abstract

Hand fractures are the most common fractures of the upper extremity, with a reported incidence of 3.7 per 1000 per year for men and 1.3 per 1000 per year for women. Understanding the diagnosis and management of these injuries is vital for any clinician working in the emergency department, plastic or orthopaedic surgery or providing community care. This review identifies the most common presentations and outlines how to assess and manage such fractures appropriately, with an emphasis on clinical and radiographic examination. The majority of hand fractures are managed conservatively and operative management should be carefully considered on a case-by-case basis with analysis of patient and fracture-related factors, in order to achieve optimal hand function following treatment.

Key words: Fractures; Hand; Hand fracture; Metacarpal; Phalanx

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Introduction

Fractures of the metacarpals and phalanges are the most common fractures of the upper extremity, with a reported incidence of 3.7 per 1000 per year for men and 1.3 per 1000 per year for women, and the vast majority occurring between the ages of 11 and 45 years (Chung and Spilson, 2001; van Onselen et al, 2003; Anakwe et al, 2011). Most hand fractures (>80%) are stable and can be managed non-operatively with appropriate splinting and immobilisation, either before or after closed reduction (Anakwe et al, 2011). Operative management needs to be carefully considered, taking into account patient factors such as premorbid functional state, profession, motivation and medical comorbidities. Figure 1 demonstrates the bony anatomy of the hand, as represented in a plain radiograph in the anteroposterior view.

Figure 1. Overview of the bony anatomy of the hand. CMCJ = carpometacarpal joint; DIPJ = distal interphalangeal joint; MCPJ = metacarpophalangeal joint; PIPJ = proximal interphalangeal joint.

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Assessment

History

Table 1 illustrates specific questions to ask in a patient presenting with a hand injury, in conjunction with a generic medical and surgical history.

Clinical examination

Examine the injured and unaffected hands simultaneously. A good technique is to ask the patient to place both hands on a pillow and check for sites of pain before touching the patient. The authors use the look, feel, move principle as outlined in Table 2.

In the uninjured hand, the tips of the ring, index, middle and ring fingers should all converge towards the middle wrist crease when in flexion – this is the normal cascade of the hand. It is always important to compare the cascade with that of the unaffected contralateral hand, as individuals may have a degree of scissoring or rotational deformity naturally, which can be misleading. Any significant scissoring or rotation related to the injury can have a considerable impact on hand function and may indicate that surgical management is warranted.

Table 1. Important hand injury-specific features to ascertain on history
Detailed history of the injury to understand mechanism of action
Hand dominance
Profession and hobbies (such as does the patient play any sports or musical instruments)
Previous injury to the hand including any existing hand pathology, for example arthritides
Social history including home environment (will the patient cope at home if their hand has to remain immobilised)

Table 2. Examination of the injured hand with a suspected fracture				
Look	Swelling or bruising	Strongly suggestive of underlying soft or bony injury		
	Cuts or lacerations	May suggest open fracture and indicate patient needs admission		
	Deformity	Can suggest underlying fracture; look for the following:	Asymmetry	Compare with unaffected hand
			Angulation	Loss of normal contours in the hand
			Shortened finger	Compare with unaffected hand
			Sunken knuckle (metacarpophalangeal joint)	Suggests boxer's type fracture of metacarpal head
			Rotation	Fingernails should be in line along a single plane
	Cascade		Scissoring	Fingers cross over each other (Figure 2)
Feel	Pain or tenderness	Very important to ascertain this before touching the patient. Leave the painful sites to the end of this stage of the examination		
	Joint stability	Occurs with ligamentous injury or fracture involving a joint		
	Joint effusion	Can suggest underlying fracture		
	Crepitus	Can suggest underlying fracture		
	Numbness	Can suggest nerve damage		
	Vascular exam	Assess for circulation distal to injury		
Move	Range of motion	Use to indicate presence of bony or soft tissue injury; assess hand as a whole and then each digit individually		

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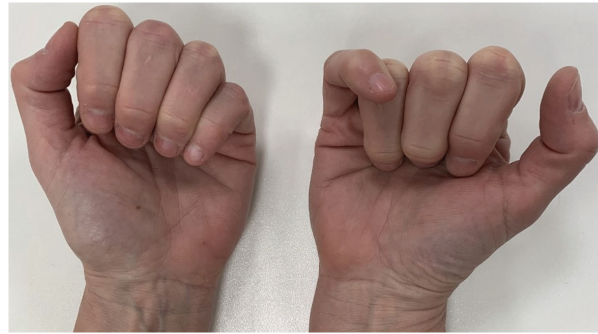

Figure 2. Comparison of cascade with contralateral hand, demonstrating right fifth metacarpal neck fractures with significant scissoring.

Scissoring describes the overlap of an injured digit with an adjacent digit and is best assessed by asking the patient to slowly flex and extend their fingers (asking the patient to 'slowly make a fist') and observe for any differences within the cascade. Rotation can be assessed by looking at the orientation of the nailplates when the hand is in full flexion.

Investigations

Radiograph imaging with posteroanterior, oblique and lateral views is imperative when considering a hand fracture, but the importance of clinical examination to assess functional deficit cannot be understated in the decision-making process.

Management

Following assessment, it is important to immobilise the fracture in an appropriate splint (see below for different options) to prevent any displacement of fragments, and to maintain patient comfort. This applies regardless of whether a decision has been made for operative or non-operative management.

Selection of the optimal surgical treatment depends on many factors, including fracture location (articular vs extra-articular), geometry (transverse, spiral or oblique, comminuted) (Figure 3), deformity (angulation, rotation, shortening), whether the fracture is open or closed, and intrinsic fracture stability (Day and Stern, 2011). Figure 4 illustrates incision markings for open surgical approaches to reduction and fixation of the metacarpal and the proximal phalanx.

Table 3 outlines situations where operative management is indicated. Open fractures are an emergency and should be admitted, closed fractures can usually be managed in the outpatient setting, coming in for a day case procedure if the decision to operate has been made. The management plans for open, phalangeal and metacarpal fractures are briefly outlined below.

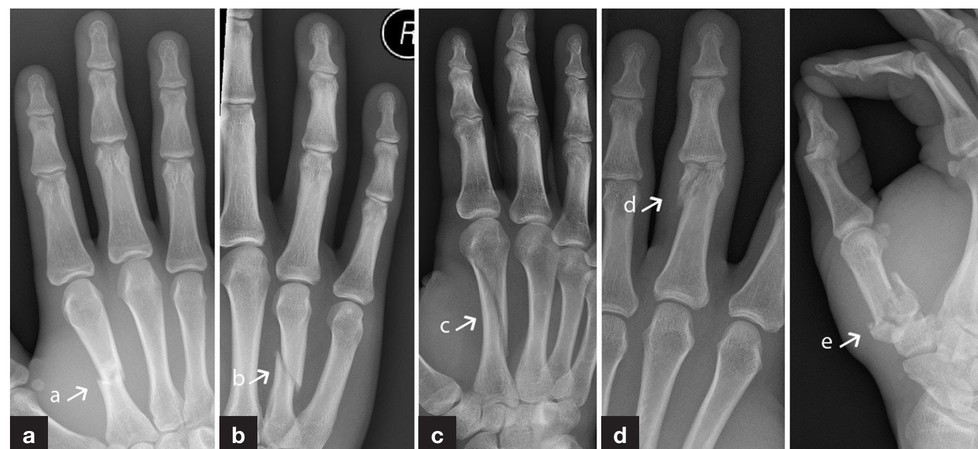

Figure 3. Common fracture patterns: (a) transverse, (b) short oblique, (c) long oblique, (d) intra-articular, (e) comminuted.

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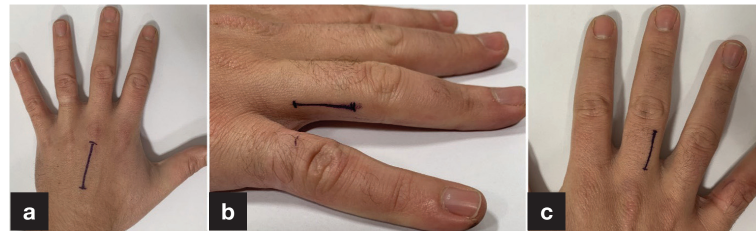

Figure 4. Surgical approaches to open reduction and internal fixation of (a) metacarpal, (b) proximal phalanx lateral incision, (c) proximal phalanx dorsal incision.

Table 3. Indications for operative management
Failure of closed reduction
Significant rotational deformity
Articular fractures
Subcapital fractures (phalangeal)
Open fractures
Segmental bone loss
Multiple hand or wrist fractures
Associated soft tissue injury (vessel, tendon, nerve, skin)

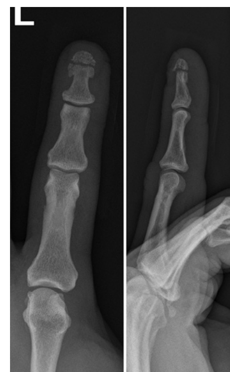

Figure 5. Distal phalanx tuft fracture.

Open fractures

Open fractures are those associated with a full-thickness injury to the overlying skin, meaning the fracture is exposed to the external environment, even though a bone fragment may not be directly protruding or visible through the site of injury. This particular type of hand fracture requires irrigation within the emergency department, after which a non-adherent dressing should be placed, followed by splinting as per closed fracture management. Patients should be admitted into an appropriate ward and intravenous antibiotic therapy should be commenced, awaiting urgent surgery (typically within 24–48 hours of presentation) to fix the fracture and treat any soft tissue injuries.

Distal phalanx

The most common injuries of the distal phalanx are crush injuries, often resulting in damage to the nailbed. Sometimes these are associated with a 'tuft' fracture (Figure 5), which can be comminuted, and usually only limited to the distal half of the distal phalanx. Tuft fractures do not require fixation and can be managed with just a protective splint. Associated soft tissue injuries (that is a nailbed or pulp laceration) require washout and repair to reduce the risk of infection and optimise conditions for healing, and tuft fractures can be simultaneously reduced with careful approximation of soft tissues (Day and Stern, 2011).

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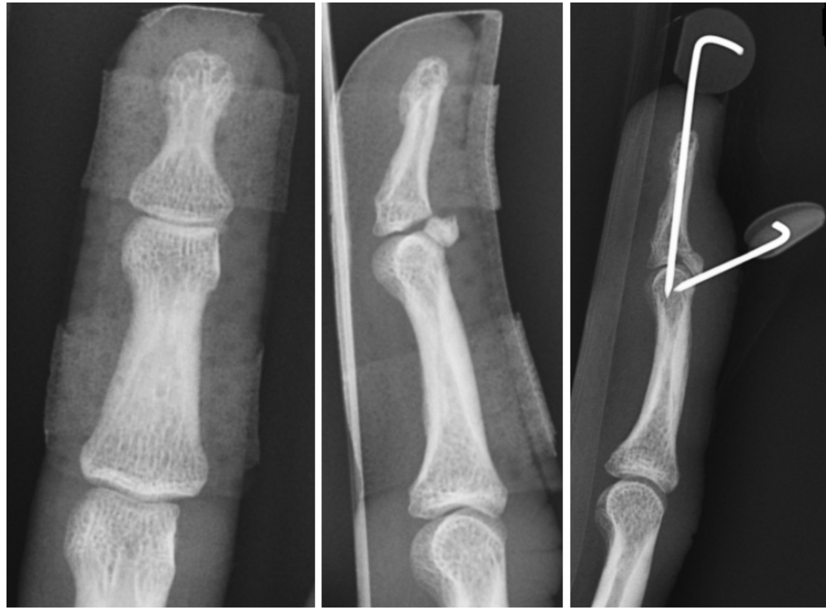

Figure 6. Mallet fracture treated with extension pinning.

Transverse fractures of the distal phalanx affecting the proximal half can be managed non-operatively if they are only minimally displaced, with the soft tissues around them providing adequate splinting. If significant displacement is apparent, an axial or longitudinal Kirschner wire (k-wire) can be percutaneously inserted under local anaesthetic with radiographic guidance. Often, k-wire fixation will require immobilisation of the distal interphalangeal joint, with the wire extending into the middle phalanx, to ensure good stability of the fracture.

Mallet fractures of the distal phalanx are those affecting the dorsal aspect of the distal interphalangeal joint, associated with insertion of the terminal extensor tendon into the distal phalanx. There are four types of mallet injuries, of which only type 4 is a true 'mallet fracture' (Doyle, 1999). If the fracture fragment is not significantly displaced, and remains directly adjacent to the remaining bone, it is likely that non-operative treatment, with an extension splint for 6–8 weeks, can lead to good outcomes. Either splint treatment or extension block pinning (Figure 6) are acceptable treatment methods based on the current literature for mallet fractures, including fractures with volar subluxation (Day and Stern, 2011).

Middle phalanx

Subcapital fractures

These are generally quite unstable and fixation with a single axial k-wire can be a straightforward approach to ensure a good stable reduction (Figure 7). This requires immobilisation of the

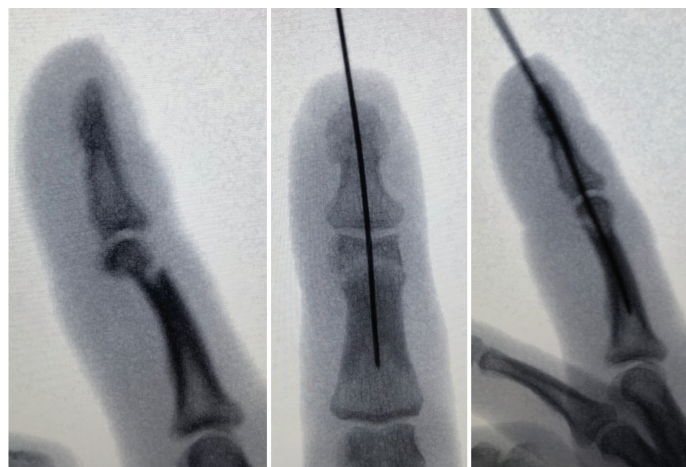

Figure 7. Middle phalanx subcapital fracture fixed with axial k-wire.

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distal interphalangeal joint, so it is crucial that patients treated in this manner are seen in hand therapy postoperatively to optimise range of movement and overall outcomes.

Volar plate injuries

Small avulsion fractures at the base of the middle phalanx on the volar surface are likely the result of a volar plate injury. This is an extremely common injury, usually caused by hyperextension of the proximal interphalangeal joint during sporting activities, and can be managed non-operatively in the majority of cases with a dorsal blocking splint and hand therapy. Common radiographic findings associated with volar plate injuries are illustrated in Figure 8.

The proximal interphalangeal joint is an extremely important joint for overall hand function, and fractures at the base of the middle phalanx can disrupt this joint, leading to permanent stiffness if not adequately treated. The aim should be to restore joint space congruity and maintain fracture fragment reduction until clinical bone healing can occur. Figure 9 demonstrates an external distraction frame, used to achieve this while avoiding direct disruption of the joint surfaces.

There are various tools and a number of described techniques that can be used to create an external distraction device for the proximal interphalangeal joint, and these can be selected depending on resource availability and surgeon experience (Suzuki et al, 1994; Hynes and Giddins, 2001; Ruland et al, 2008; Liodaki et al, 2015). The 'Giddins' frame' technique uses two parallel k-wires to achieve a distraction frame that can be applied under local anaesthetic. The first wire is bent into shape (Figure 9) to form a hook which keeps the distal wire under traction, holding the fracture out to length, and restoring joint-line congruity (Hynes and Giddins, 2001).

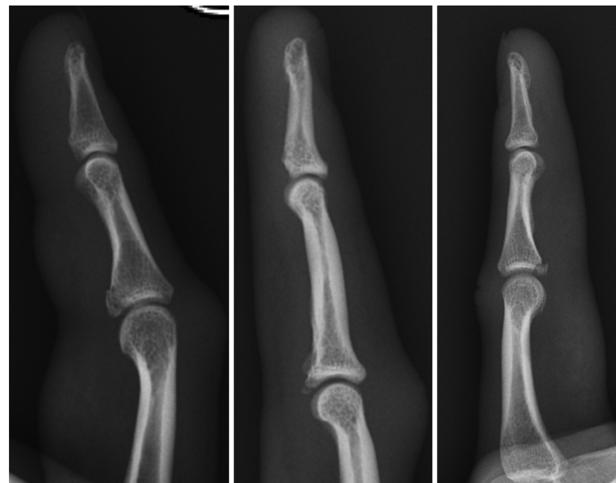

Figure 8. Three examples of volar plate injuries affecting the proximal interphalangeal joint.

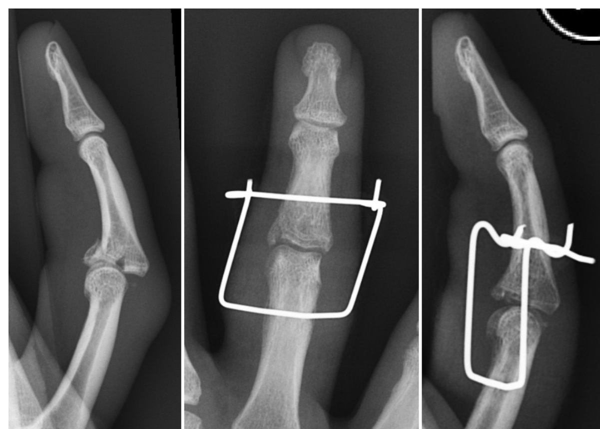

Figure 9. Middle phalanx fixed with external distraction frame.

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Proximal phalanx

Unicondylar fractures

These are almost always unstable and one should err on the side of operative management (Day and Stern, 2011). Fixation with either screws (Figure 10) or k-wires (Figure 11) is generally feasible, following open or closed reduction respectively.

Phalangeal shaft

For operative management of displaced phalangeal shaft fractures, similar techniques to metacarpal shaft fractures can be used, as described below. A dorsal approach with longitudinal split of the extensor tendon (which is subsequently repaired) is typically used. Owing to the inevitable tendon splitting and higher risk of scar formation and adhesions associated with the extensor mechanism, a closed approach with k-wire fixation is often preferred when feasible.

Metacarpal neck

Fractures of the metacarpal neck are very common, most often in the fourth and fifth metacarpals, and typically result from axial force applied through the closed fist. These are erroneously referred to as 'boxer's fractures' in reference to the punch-like mechanism of injury, but a professional boxer is most likely to injure the index or middle finger metacarpals. The direct impact of the punch causes comminution of the volar cortex and dorsal angulation of the fracture as a result of the pull of the intrinsic muscles. The degree of angulation, as demonstrated in Figure 12, is an important factor in deciding whether these fractures require closed reduction, as numerous authors have demonstrated good results and functional outcomes without any attempts at reduction, even with angulation as high as 40–60° (Statius Muller et al, 2003; Day and Stern, 2011). The fifth metacarpal is the most forgiving in terms of angulation tolerated, following by the fourth and so on.

For fractures with a higher degree of angulation, closed reduction is often possible, which can often be fixed with the insertion of two retrograde crossed k-wires from the

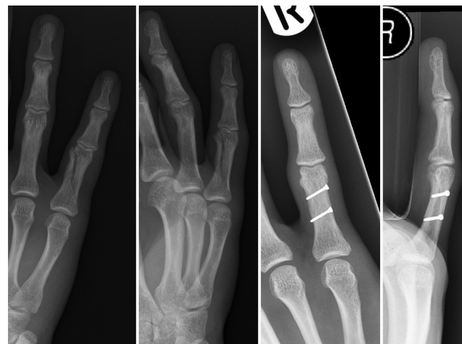

Figure 10. Proximal phalanx fixed with lag screws.

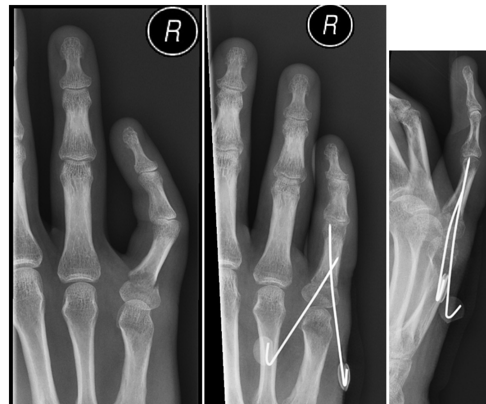

Figure 11. Proximal phalanx fixed with k-wires.

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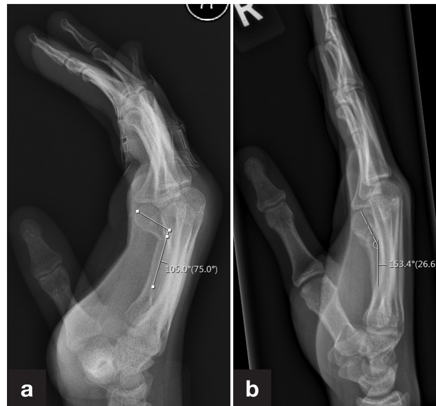

Figure 12. Right fifth metacarpal neck fractures: (a) significant angulation, (b) mild angulation.

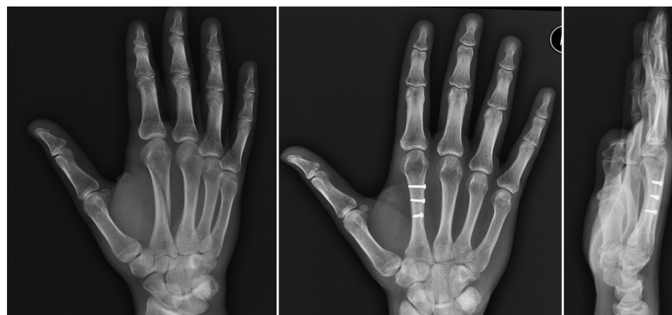

Figure 13. Right second metacarpal open reduction and internal fixation with three lag screws.

lateral or dorsal (non-articular) portion of the metacarpal head into the shaft, and exiting through the dorsal metacarpal shaft.

The fracture with the larger degree of angulation is more likely to need surgical management, but in both cases, clinical examination of the hand is necessary to ascertain any functional loss or deformity in order to guide the optimal treatment option.

Metacarpal shaft

Open reduction and internal fixation offers the more stable repair of metacarpal shaft fractures compared to k-wire fixation, and allows early active mobilisation. Many methods can be applied depending on the geometry of the fracture (Day and Stern, 2011).

Interfragmentary compression screws (or 'lag screws') can be used as a method of fixing long oblique or spiral fractures, and the technique is classically described as being suited in cases where the fracture length is at least twice the bone diameter (Figure 13). For short oblique or transverse fractures, lag screw fixation is unsuitable. Similarly, if the fracture is multi-fragmentary and individual fragments do not contain enough cortical substance to tolerate screw fixation, a compression or bridging plate may be used (Figure 14).

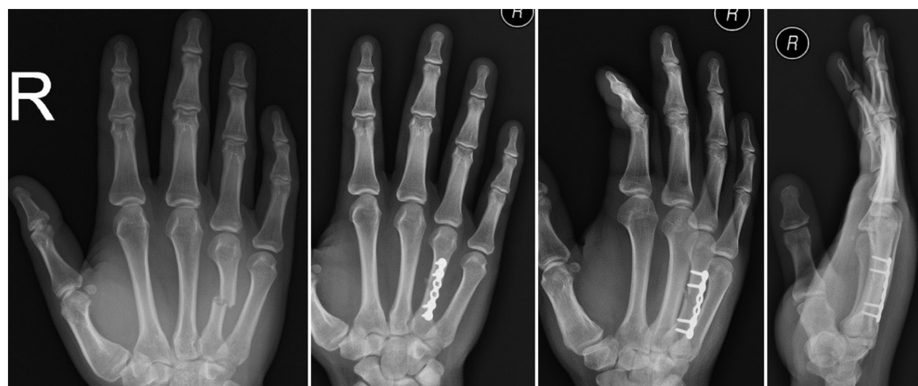

Figure 14. Right fourth metacarpal open reduction and internal fixation with 6-hole plate

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Base

Undisplaced fractures at the metacarpal base are generally stable and can be managed non-operatively. Caution should be taken to assess for fractures of the carpal bones and specialist orthopaedic input as well as imaging with computed tomography should be considered, as simple X-ray radiography may be inadequate in visualising such fractures.

Displaced fractures of the metacarpal base can be well treated with closed reduction and, depending on the level of instability, k-wire fixation may or may not be required.

Thumb metacarpal

Fractures of the first metacarpal base can be classified into different types depending on the exact fracture geometry (**Figure 15**). Each requires a nuanced approach to management.

A Bennett fracture occurs when the thumb metacarpal is axially loaded and partially flexed, and is really a fracture-subluxation, which can often be managed with closed reduction and k-wire fixation.

Three-part Rolando fractures can be managed with open reduction and internal fixation, using either a plate (eg T-plate) or screws, but it is extremely important to carefully judge the true level of comminution before proceeding with surgery, and computed tomography scanning may prove useful. A higher degree of intra-articular comminution may be treated better with an external fixation device or multiple k-wires, and anatomical reduction may not always be possible.

Splinting and immobilisation

The three stages of bone healing are: inflammation, which starts immediately following injury and lasts several days; repair, which begins at <24 hours and peaks at 2–3 weeks; and remodelling, which includes resorption of callus and can last months to years depending on the bone and fracture (Day and Stern, 2011).

Clinical bony union takes an average of 4–8 weeks, and a fracture generally needs to be held in a stable reduced position for a period of 4 weeks before mobilisation of adjacent joints. This can be achieved by a number of splinting methods that can often be used in conjunction with one another. These include plaster casts, thermoplastic splints and a

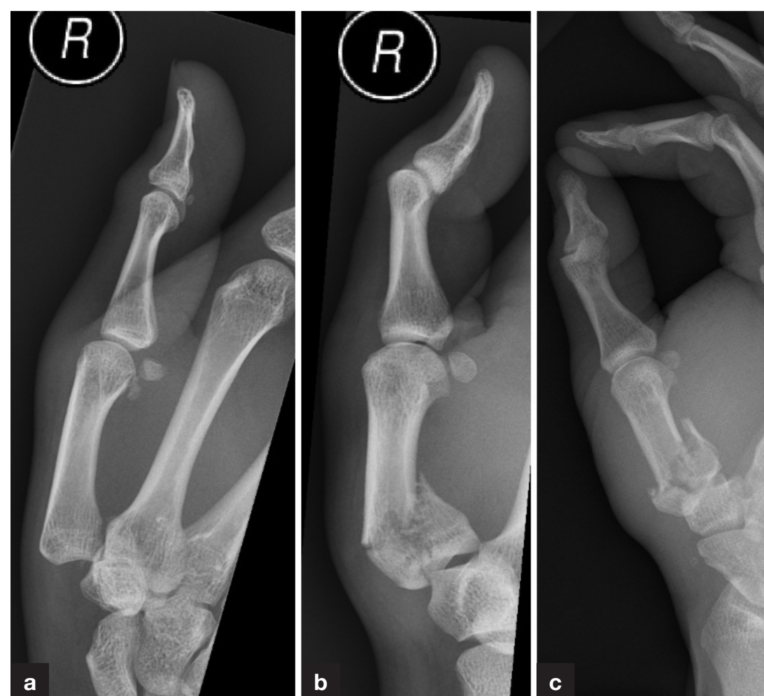

Figure 15. Fracture patterns of the first metacarpal base: (a) Bennett: intra-articular fracture with a volar-ulnar fragment, (b) Rolando: Y- or T-shaped complete intra-articular fracture, (c) severely comminuted intra-articular fracture.

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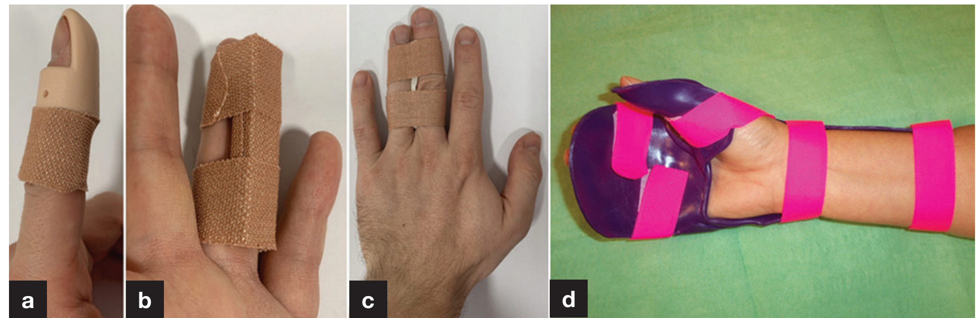

Figure 16. a. Mallet splint. b. Zimmer splint. c. Buddy taping. d. Thermoplastic splint.

variety of plastic or metal splints suited to immobilising digits (Figure 16). Additionally, 'buddy taping' a finger to adjacent digits can also be used to stabilise minor injuries or to correct mild rotational deformities.

In postoperative cases where pinning with k-wires was used to fix the fracture, the wires can be removed in the outpatient clinic typically after 4 weeks. This is well tolerated by the majority of patients without anaesthetic.

In case of an extremely stable fixation, as for example that which can be achieved by open reduction and internal fixation with a plate and screws, the hand can be mobilised sooner, and a timeframe of 1 week postoperatively is recommended. This helps to avoid joint stiffness and formation of soft tissue adhesions, which are inevitable with prolonged immobilisation.

Hand therapists play an integral role in the operative and non-operative management of patients with hand fractures. They are skilled in fabricating thermoplastic splints, fitted to the patient's hand and designed to only immobilise the relevant joints to protect a fracture during healing, while allowing other joints to move freely. Therapists also take the lead in designing and supervising therapeutic modalities, and structuring an exercise programme that contributes to improved outcomes.

Anaesthetic options

When considering the appropriate anaesthetic modality for hand fracture fixation, the surgeon must consider the estimated total operative time and the anatomical location of the fracture.

Fracture fixation of the distal phalanx (and often middle phalanx), which is expected to have a relatively short operative time, can often be performed using local anaesthetic. These fractures are distal enough that a simple 'digital ring block' can offer adequate analgesia for the patient to tolerate the procedure. A ring tourniquet can be used safely in shorter procedures (<60 minutes), and is usually well-tolerated by patients under digital anaesthesia (Wapler et al, 2016). Metacarpal fractures and most fractures of the proximal phalanx require at least a regional anaesthetic to ensure adequate patient comfort throughout the procedure.

Brachial blocks are extremely useful in hand fracture fixation and reduce the burden of general anaesthetic for procedures with a relatively short operative time (<2 hours) by enabling the use of an arm tourniquet. Without a regional block, patients find arm tourniquets extremely uncomfortable, and generally intolerable within 10–15 minutes (Chin and Handoll, 2011; Chandrasoma et al, 2018).

For procedures where the operative time is expected to be longer than 2 hours, it is recommended that a general anaesthetic be used. This is often the case in patients with multiple hand fractures.

Conclusions

Hand fractures should be thoroughly assessed by clinical examination and radiographic imaging. Operative management should be carefully considered on a case-by-case basis with analysis of patient and fracture-related factors, in order to achieve optimal hand function following treatment. Numerous open and closed approaches to surgery exist, and many of the techniques described can be used in conjunction for the management of complex fractures. Hand therapy is integral in the rehabilitation and overall outcome following hand injuries.

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Key points

- Radiographs and clinical examination must be used in conjunction during assessment of hand fractures.
- Patient factors must be taken into consideration when deciding on optimal management.
- Most hand fractures can be managed non-operatively.
- Unstable fractures usually require surgical fixation.
- Closed or open approaches to hand fracture fixation can be used.

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Conflicts of interest

The authors declare no conflicts of interest.

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