Assessment of hand injuries

Accurate assessment of the injured hand requires a good knowledge of its anatomy and function. The thumb contributes approximately 40% of hand function (Slocum and Pratt, 1946; Emerson et al, 1996). It is critical for pinch, grasp and fine manipulation, which are essential for daily activities. This article provides an overview of assessing the injured hand including general history and examination, with elaboration on common injuries by anatomical area.

History

Management will be guided by the timing and mechanism of injury. Other salient points in the history include age, hand dominance, occupation, and hobbies such as sports. Comorbidities and tobacco use may limit the reconstructive options. It is also important to assess the patient's ideas, concerns and expectations. For example, a digital injury in a manual labourer and one in a musician may be managed very differently. Patient outcomes also rely on good postoperative compliance.

Examination

Assess the patient using Advanced Trauma Life Support principles to identify and treat first life- and then limb-threatening conditions.

Mr Kai Yuen Wong is Plastic Surgery Registrar in the Department of Plastic and Reconstructive Surgery, Salisbury NHS Foundation Trust, Salisbury SP2 8BJ

Mr Jonathan Maw is Clinical Fellow in the Department of Urology, Cambridge University Hospitals NHS Foundation Trust, Cambridge

Mr Patrick Gillespie is Consultant Plastic and Hand Surgeon in the Department of Plastic and Reconstructive Surgery, Cambridge University Hospitals NHS Foundation Trust, Cambridge

Correspondence to: Mr KY Wong (kaiyuen.wong@cantab.net)

On inspecting the hand, assess the site, size, geometry and nature of any wounds. Look for signs of contamination, infection, swelling, scars and pulsatile bleeding. Has there been skin loss or degloving? What structures are visible? Thorough irrigation of wounds will allow better visualization. Deformities may suggest underlying fractures, dislocation or tendon injuries. Burns may be caused by thermal, chemical or electrical stimuli. Determine whether the burn is superficial, partial or full thickness (*Table 1*).

It is important to correlate the clinical examination with the mechanism of injury as seemingly innocuous wounds can lead to underestimation of tissue damage. For example, high pressure hand injuries can cause significant mechanical and chemical tissue damage. The injected substances can track proximally into the forearm. Furthermore, increased compartment pressures can lead to compartment syndrome and neurovascular compromise. Compartment syndrome is a surgical emergency. It typically presents with swelling and pain out of proportion to the injury, particularly with passive stretching of the fingers.

Before palpation, ensure the patient has adequate analgesia or a local anaesthetic block. However, it is important to assess motor and sensory function (*Figure 1*) before any block. Palpate the joints, soft tissues and flexor sheath to elicit tenderness and identify any swelling. Also assess the capillary refill time, temperature, joint stability and note any surface irregularities.

Table 1. Characteristics of burn depth

Depth	Colour	Blisters	Capillary refill	Sensation
Epidermal	Red	No	Present	Present
Superficial dermal	Pale pink	Yes	Present	Painful
Deep dermal	Blotchy red	Sometimes	Absent	Absent
Full thickness	White	No	Absent	Absent

Figure 1. Typical sensory nerve distribution of the hand.

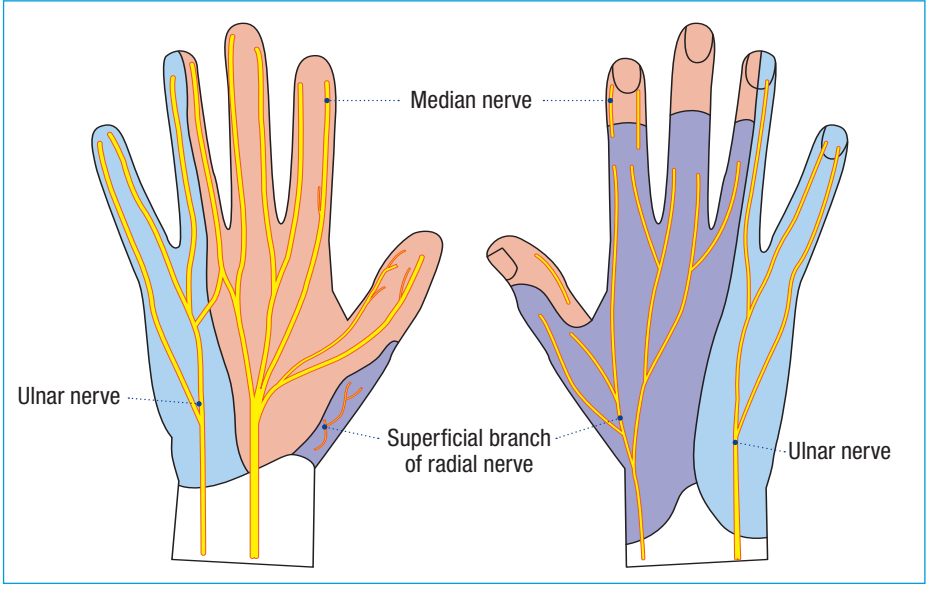


Figure 2. Allen's classification of fingertip injuries showing the division of injuries into zones.

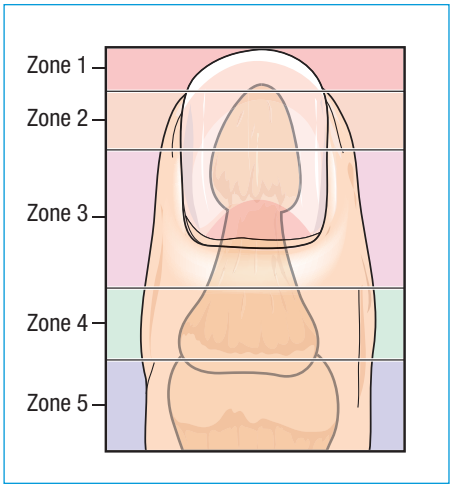


Figure 3. Geometry of fingertip amputations. **a.** Volar oblique, **(b)** dorsal oblique and **(c)** transverse amputations.

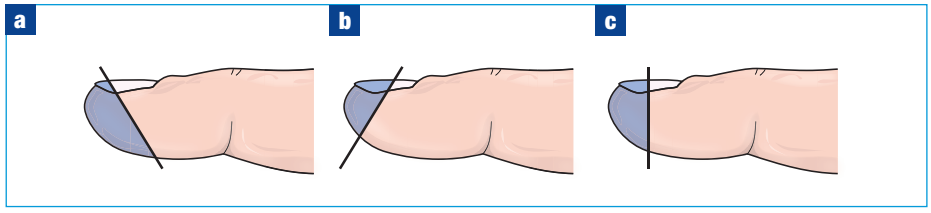
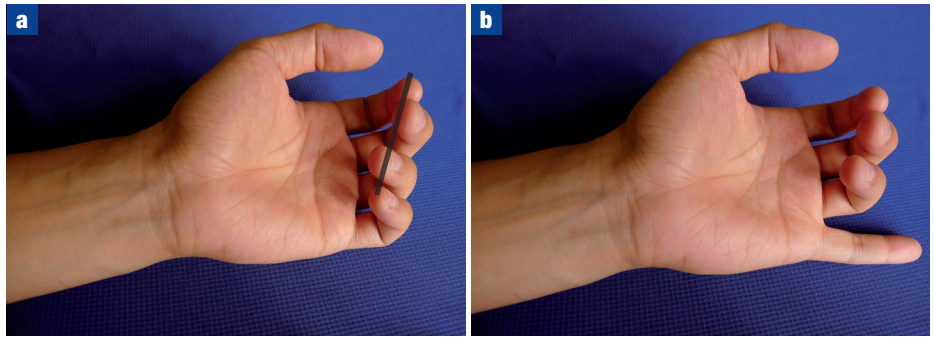


Figure 4. **a.** Normal cascade of digits at rest and **(b)** abnormal cascade suggesting avulsion of little finger profundus tendon.



Compare both hands to evaluate passive and active movements. Assess range of movement and any rotational deformity. Unless there are obvious muscle injuries, the purpose of testing specific muscle groups is to evaluate potential nerve or tendon injuries.

It is important to assess the rest of the upper limb as guided by the clinical history and examination findings. This should include X-rays to exclude foreign bodies or fractures where appropriate.

Fingertip injuries

The fingertip includes all structures distal to the flexor and extensor insertions on the distal phalanx. It is the most commonly injured part of the hand yet it is often underappreciated that these injuries can lead to significant morbidity.

Nail bed injuries may present as subungual haematomas, lacerations, crush injuries or amputations. Crush injuries are commonly associated with distal phalanx fractures.

Fingertip amputations may be partial or complete. Classify the affected tissue into skin, pulp, bone and nail bed. Allen's classification is sometimes used to describe these injuries (*Figure 2*). The geometry of the injury is crucial in determining the potential reconstructive options (*Figure 3*).

Neurovascular injuries

Test sensation distal to the injury. Note there is considerable variation in the median and ulnar nerve cutaneous innervation to the hand. The 'ten test' is a useful tool to evaluate sensibility (Strauch et al, 1997), particularly for assessing ulnar and radial digital nerve injuries. A reference body part with comparable innervation is first established such as the patient's uninjured hand or cheek. This area that the patient feels is normal is given a score of 10 on a scale of 1 to 10. Using light touches or strokes, the patient is asked to compare the part tested with the comparatively normal area. A low score in any area suggests the need for further investigation.

Two-point discrimination can also be used to assess overall sensory function with comparison to uninjured areas. A value of less than 6 mm in the finger pulp is taken as normal although there is variation within the normal spectrum based on nerve and gender (Dellon, 1981; Louis et al, 1984).

Seddon (1942) classified nerve injuries into neurapraxia, axonotmesis and neurotmesis. Neurapraxia is a physiological conduction block with no anatomical nerve disturbance. Axonotmesis occurs when an axon is served and with neurotmesis there is complete lack of anatomical nerve continuity. Neurapraxia is unlikely if there is complete nerve palsy, sympathetic paralysis or wounds over the nerve course.

Any loss of sensation on both sides of a digit should alert the examiner to potential vascular compromise as the palmar digital arteries are just dorsal to the proper palmar digital nerves. Conversely, proximal to the metacarpal neck the common palmar digital arteries are usually palmar to their associated common digital nerves.

Check radial and ulnar pulses. They may still be present with forearm vascular injuries as a result of the palmar vascular arches. Allen's test can help test ulnar and radial artery flow. Blood is exsanguinated from the hand by elevation and making a fist. With both radial and ulnar arteries compressed, the hand is opened and should appear blanched. Release of pressure over the ulnar artery should allow the hand to fill with blood. Return of colour demonstrates flow and a positive test. The radial artery is tested by changing the order of these manoeuvres.

Tendon injuries

In the absence of fractures or dislocations, disruption of the normal cascade of digits may suggest a tendon or nerve injury (*Figure 4*). An injured digit may assume an extended position, which is refractory to the tenodesis effect. The latter is the normal increase in flexor tone at the interphalangeal and metacarpophalangeal joints with passive wrist extension.

The tendons of each finger should be individually tested. The flexor digitorum superficialis is tested by holding adjacent digits in full extension and asking the patient to flex the finger at the proximal interphalangeal joint. To evaluate the flexor digitorum profundus, position the finger

in full extension, immobilize the middle phalanx against the examining surface, and ask the patient to actively flex the distal interphalangeal joint.

The extrinsic extensor tendons are exclusively responsible for metacarpophalangeal joint extension and also extend the proximal interphalangeal joints provided metacarpophalangeal joint hyperextension is blocked. However, extension of the proximal interphalangeal joints is primarily a function of the intrinsic interossei and lumbrical muscles. Juncturae tendinum provide intertendinous connections between extensor tendons on the dorsum of the hand. Thus, extension may be preserved with lacerations of the extensor digitorum communis tendon proximal to the juncturae tendinum.

The extensor indicis proprius and extensor digiti minimi allow independent extension of the index and small fingers. They can therefore be tested by asking the patient to make a fist and extend the index or small finger.

The extensor pollicis longus can be tested by resisted thumb interphalangeal joint extension with pressure over the dorsal distal phalanx. Alternatively the patient can be asked to place his/her palm down on a table and lift the thumb off the surface while keeping the thumb adducted. The extensor pollicis longus tendon is palpable in the radiodorsal aspect of the wrist. The extensor pollicis brevis can be tested by resisted thumb extension with the thumb interphalangeal joint in slight flexion and applying force against the dorsal proximal phalanx.

Elson's test is useful for assessing acute central slip extensor tendon injuries (Elson, 1986). Passively flex the proximal interphalangeal joint to 90° over a table top and test resisted proximal interphalangeal joint extension. With acute ruptures of the central slip, proximal interphalangeal extension will be weak but the distal interphalangeal joint will be rigid in extension. Normally the distal interphalangeal joint remains floppy in this position as there is slack in the lateral bands as a result of the taut and intact central slip pulling the entire extensor apparatus distally when the proximal interphalangeal joint is flexed.

The site of tendon injury can be split into flexor (*Figure 5*) and extensor zones (*Figure 6*) as originally described by Verdan (Verdan, 1960; Kleinert and Verdan, 1983). These zones are clinically relevant when considering surgical treatment. Flexor zone II is often referred to as 'no-man's land' as a result of the multiple pulleys and relative proximity of the flexor digitorum superficialis and flexor digitorum profundus within the narrow fibro-osseous sheath. Repair of tendons in this zone is associated with increased risk of adhesions, poor tendon glide and potential for flexion contractures. The extensor zones are easy to recall by noting that the joints are odd numbered.

Figure 5. Flexor zones of the hand and wrist.

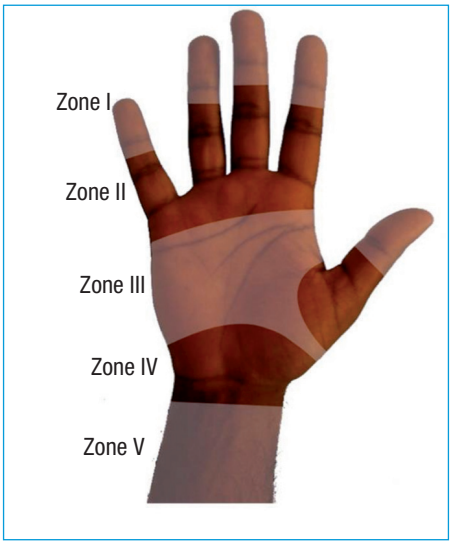


Figure 6. Extensor zones of the hand, wrist and forearm.

Fractures

Fractures should be confirmed with postero-anterior (PA), lateral and oblique view X-rays. Optimal treatment largely depends on whether the fracture is reducible and if this can be maintained (stable or unstable). Assess fracture location (diaphysed *vs* metaphysed), geometry (transverse, spiral, oblique, comminuted), deformity (angular, rotational, shortening), joint involvement (intra-articular, extra-articular), whether it is closed or open and if there is associated soft tissue injury.

The majority of metacarpal and phalangeal fractures can be treated non-operatively. The scaphoid is the most commonly fractured carpal bone. Such fractures typically occur from a fall onto the outstretched hand with wrist hyperextension and axial compression. Patients may present with pain and swelling in the anatomical snuffbox. X-rays are the standard primary investigation with four views for a suspected scaphoid fracture including PA, lateral, semi-pronated oblique and PA with ulnar deviation. It is important to note that 16% of these cases are not identified on initial X-rays (Hunter et al, 1997) and may take up to 1–2 weeks to become evident on plain film (Tiel-van Buul et al, 1992). With positive X-rays, computed tomography is the best modality to assess fracture morphology for subsequent surgical management. Magnetic resonance imaging is the best modality to detect occult scaphoid fractures and associated soft tissue injuries. It has an excellent reported sensitivity (100%) and specificity (95–100%) for assessing acute fractures (Gaebler et al, 1996; Breitenseher et al, 1997; Hunter et al, 1997).

Infections

Paronychia is the most common infection in the hand. It is an infection of the perionychium. Pressure necrosis can lead to death of the nail fold. Pus may track under the nail plate and also into the pulp. Felons are closed space subcutaneous infections of the pulp, which may be complicated by osteomyelitis of the distal phalanx or less commonly flexor sheath infections.

Pyogenic flexor tenosynovitis is an infection of the flexor sheath and is a surgical emergency. Early treatment is important as it can lead to tendon necrosis, permanent finger stiffness and spread of infection to the deep fascial spaces. Kanavel (1939) described the four cardinal signs of flexor sheath infection including:

1. Fusiform swelling of the digit
2. Partial flexion of the digit at rest
3. Pain along the flexor sheath on passive digit extension
4. Tenderness along the entire flexor sheath.

KEY POINTS

- Hand injuries are common. Accurate assessment requires a good knowledge of hand anatomy and function.
- The thumb contributes approximately 40% of hand function.
- Manage all patients using Advanced Trauma Life Support principles to identify and treat life- and then limb-threatening conditions.
- Patient expectations need to be clearly explored and managed in a timely manner to ensure optimal outcome.

Joint infections are a surgical emergency as they can result in articular cartilage destruction. They present as hot, swollen and tender joints with limited range of motion. The metacarpophalangeal joint is commonly injured and wounds in this area should be treated as a human bite following a punch to the mouth until proven otherwise.

Conclusions

It is often underappreciated that hand injuries can lead to significant morbidity. Timely diagnosis, referral and appropriate management are crucial to avoid long term complications. **BJHM**

Conflict of interest: none.

Breitenseher MJ, Metz VM, Gilula LA et al (1997) Radiographically occult scaphoid fractures: value of MR imaging in detection. *Radiology* **203**(1): 245–50 (doi: 10.1148/radiology.203.1.9122402)

Dellon AL (1981) *Evaluation of sensibility, re-education of sensation in the hand.* Lippincott Williams and Wilkins, Baltimore

Elson RA (1986) Rupture of the central slip of the extensor hood of the finger. A test for early diagnosis. *J Bone Joint Surg Br* **68**(2): 229–31

Emerson ET, Krizek TJ, Greenwald DP (1996) Anatomy, physiology, and functional restoration of the thumb. *Ann Plast Surg* **36**(2): 180–91

Gaebler C, Kukla C, Breitenseher M, Trattnig S, Mittlboeck M, Vecsei V (1996) Magnetic resonance imaging of occult scaphoid fractures. *J Trauma* **41**(1): 73–6

Hunter JC, Escobedo EM, Wilson AJ, Hanel DP, Zink-Brody GC, Mann FA (1997) MR imaging of clinically suspected scaphoid fractures. *AJR Am J Roentgenol* **168**(5): 1287–93 (doi: 10.2214/ajr.168.5.9129428)

Kanavel AB (1939) *Infections of the Hand. A Guide to the Surgical Treatment of Acute and Chronic Suppurative Processes in the Fingers, Hand and Forearm.* 7th edn. Lea and Feibiger, Philadelphia

Kleinert HE, Verdan C (1983) Report of the Committee on Tendon Injuries (International Federation of Societies for Surgery of the Hand). *J Hand Surg Am* **8**(5 Pt 2): 794–8

Louis DS, Greene TL, Jacobson KE, Rasmussen C, Kolowich P, Goldstein SA (1984) Evaluation of normal values for stationary and moving two-point discrimination in the hand. *J Hand Surg Am* **9**(4): 552–5 (doi: 10.1016/S0363-5023(84)80109-4)

Seddon HJ (1942) A classification of nerve injuries. *Br Med J* **ii**(4260): 237–9

Slocum DB, Pratt DR (1946) Disability evaluation for the hand. *J Bone Joint Surg* **28**: 491–5

Strauch B, Lang A, Ferder M, Keyes-Ford M, Freeman K, Newstein D (1997) The ten test. *Plast Reconstr Surg* **99**(4): 1074–8

Tiel-van Buul MM, van Beek EJ, Broekhuizen AH, Nooitgedacht EA, Davids PH, Bakker AJ (1992) Diagnosing scaphoid fractures: radiographs cannot be used as a gold standard! *Injury* **23**(2): 77–9 (doi: 10.1016/0020-1383(92)90035-Q)

Verdan CE (1960) Primary repair of flexor tendons. *J Bone Joint Surg Am* **42**: 647–57