

SELF ASSESSMENT EXERCISES

Self Assessment Exercises in Hand Trauma

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Introduction

Hand injuries are a common cause of morbidity and functional disability, often as a result of suboptimal immediate management. The following questions illustrate the kind of problem you may encounter in everyday practice, and the discussions attempt to give guidelines as to the accepted best practice.

Questions

You are a Medical Officer working in a medical centre, with a district general hospital within a few miles. The hospital has a plastic surgery and burns unit on site. The following patients may present to you during your working day.

1. A 23 year old right handed army chef presents to you having sustained a laceration to his left hand. Earlier that day he had been separating frozen burgers using a sharp knife. The knife slipped, and went into his left palm.

He is otherwise well, on no medication, has no known allergies, and is up to date with tetanus immunisations. Examination reveals a 1cm laceration in the centre of the palm, about 3cm proximal to the index/middle finger web space, which appears superficial. There is no active bleeding. Neurovascular examination reveals altered sensation over the radial side of the index finger compared to the other hand, but otherwise normal sensation, perfusion and a full active range of motion of all digits.

- What is the likely diagnosis?
- What should be your emergency treatment?
- What definitive treatment does he need?
- Is there a time limit after which this treatment is ineffective?

2. A 42 year old right handed Warrant Officer presents to you with a painful left hand. He gives a history of sustaining a small cut of the end of his index finger while gardening about a week ago, then a 2 day history of increasing pain in the index finger and hand, made worse on movement of that finger.

He feels systemically well, has no past history of note, and has no known allergies.

On examination, he has some symmetrical

swelling and redness of the index finger, with extreme tenderness over the palmar side of the digit. The finger is painful on movement generally.

- What diagnosis are you concerned about?
- What should the treatment be?

3. A young Welsh Guardsman presents having sustained an injury to his right hand. The previous evening he had been out for a few drinks, and got involved in a disagreement, which resulted in him punching a mirror.

Examination reveals ragged lacerations of his middle, ring and little fingers, each 1 to 2cm long over the extensor aspect of the proximal phalanges.

- How would you examine for functional deficit?

As you examine the hand, he demonstrates weakness of extension of the little finger MCP joint.

- How would you treat this injury?
- Is any further investigation indicated at this stage?
- What definitive procedure does he require? Within how long must this be done?
- How long should the hand be immobilised after this procedure?

4. A 21 year old bombardier presents to you with a right ring finger injury. He had been playing rugby yesterday afternoon and felt his finger 'go' when grabbing hold of another player's jersey. He thought nothing more of it, went out for 'a few beers' and has only attended now because he cannot move the tip of his ring finger.

Examination reveals some bruising of the finger and mild tenderness over the DIP joint. There is no evidence of open injury. He is unable to *flex* the finger at the DIP joint.

- What is the likely diagnosis?
- What investigation should you organise?
- What is the treatment?
- What advice should you give the patient?
- How long will the treatment last?

5. It is 1000 hrs. An 18 year old junior technician is rushed into your medical centre by his instructor. At about 0930, he lifted the

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Fig 1.

guard on a metal cutting press to clear some debris, and the blade came down, cleanly amputating his right (dominant) index and middle fingers through the proximal phalanges (Figure 1). First aid has been applied in the workshop and bleeding has slowed through a large field dressing. The instructor has brought the fingers with him packed in ice.

- a. What are your first actions?
- b. Should it be possible to save the fingers?
- c. If so, in what will you place the fingers to transport them to the plastic surgery unit?
- d. Within what time period should the surgery be performed?
- e. How will you transport the patient to the plastic surgery unit?

Answers to self-assessment questions

1.
 - a. Division of the radial digital nerve of the index finger.
 - b. The wound should be washed out with normal saline or Hartmann's solution. If there is likely to be delay in referral for more than 24-48 hours, the wound should be closed with a monofilament suture. A moist, iodine-soaked dressing should be applied, and the hand elevated in collar-and-cuff or high arm sling.
 - c. The patient requires formal wound exploration and primary microsurgical nerve repair under tourniquet control.
 - d. No.

Discussion

This patient has injured the radial digital nerve to his index finger. In injuries caused by stabbing with a knife, and in all injuries caused by glass, the size and position of the skin laceration may have no bearing on the structures injured within the hand, and all palmar injuries must be explored. The radial digital nerve of the index finger and the ulnar digital nerve of the little finger have a much more mid-axial course within the palm than might be expected (Figure 2). In diagnosing nerve injury, static two-point discrimination measured, for example using a twisted paper clip, has the highest and most reproducible predictive value of tests readily available at a primary care level (2). Comparison with the same digit of the uninjured hand must be performed.

This is a sharp, clean injury and as such the wound is unlikely to be markedly contaminated. Washing out the wound (using for example a 20ml syringe and 23G needle), however, will reduce any particulate and bacterial contamination that does exist and will lower the chances of wound infection. Although saline is readily available, Hartmann's solution is probably a better choice. Furthermore, as with all wounds, bacterial colonisation will increase with time, and wounds with greater than 10^5 organisms per gram of tissue will not heal primarily (3). This figure should be viewed in the context that clinical evidence of pus only appears at greater than 10^8 organisms per gram. If definitive treatment and primary closure are likely to be carried out within 48 hours, then

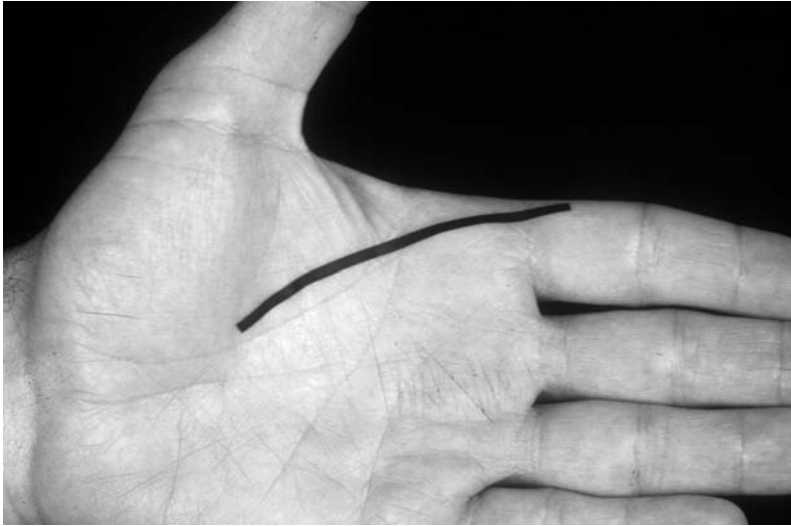


Fig 2. Course of the radial digital nerve to the index finger. The radial digital nerve to the index finger lies in a more mid-axial position within the palm than might be expected, and can be palpated where it lies over the metacarpal head.

a simple dressing with a topical antimicrobial such as iodine will suffice in the interim. The best treatment, however, is to close the wound after irrigation. Evidence for the use of prophylactic antibiotics is scanty, and this decision should be made based on the wound itself and on the degree of surrounding skin contamination.

Functional recovery of untreated or very severely injured nerves is unpredictable and usually poor (4). Whilst a seemingly trivial area of sensory loss may exist in the hand, the functional disability can be severe. Hand surgeons use the concept of 'leading' and 'trailing' edges of the digits and hand to determine clinical priority - thus the radial digital nerve of the index, and the ulnar digital nerves of the thumb and little fingers are of utmost functional importance.

Optimum management requires early, direct microsurgical nerve repair or grafting. Techniques to repair transected peripheral nerves continue to evolve. Despite best efforts and the use of microsurgical technique, peripheral nerve function after a repair never returns to normal, and sensory recovery after digital nerve repair varies widely between reports. In a review of the literature in 1988, MacKinnon and Dellon found that approximately 60% of patients eventually achieved complete, or near complete recovery (5), but authors report varying outcomes (6,7). Of perhaps equal importance, repair will prevent the formation of painful neuromas.

Nerve repair that is performed within the first 24 hours after injury is termed *primary repair*. Those that are carried out within 1 week of injury are referred to as *delayed primary repairs*. When repair is delayed by more than 1 week after injury, it is termed *secondary repair*. A number of studies have examined the effect of timing on outcome (8-10). Primary or delayed primary nerve repair usually gives the most favourable results, provided the nerve is sharply transected,

optimum wound conditions exist, and there are no associated injuries. If ideal conditions are absent, secondary repair may be considered. In nerves that are only partially divided, primary repair should always be carried out, as it becomes almost impossible to separate intact from scarred fascicles at a later date.

2. a. Flexor sheath infection (acute suppurative flexor tenosynovitis).
- b. Surgical drainage and washout.

Discussion

Flexor tenosynovitis is most commonly seen in the index, middle, or ring fingers and is usually caused by a penetrating injury, especially over the flexor creases where the skin and flexor tendon sheath are in close approximation (11). Kanavel (12) described the four cardinal signs of suppurative tenosynovitis:

- The involved finger is held in a flexed position,
- There is fusiform or symmetrical swelling of the entire finger,
- There is exquisite tenderness that affects the entire flexor sheath and is limited to the sheath, and
- Intense pain is experienced with passive extension of the sheath, most marked at the proximal end.

All four signs may not be present initially and pain on passive extension is the most reliable finding. An early infection without all four Kanavel's signs may be treated with elevation, splinting and intravenous antibiotics, such as co-amoxiclav. If the patient fails to improve after 24 hours, surgical drainage and flexor sheath irrigation is required. Established pyogenic tenosynovitis is a surgical emergency and Medical Officers should have a very low threshold for referral if the diagnosis or results of conservative treatment are in doubt.

Surgical treatment involves exploration and drainage, and early surgery will avoid adhesion formation and tendon necrosis. If the tendon is intact, 'closed' drainage and irrigation through distal finger and proximal palmar incisions may be performed (13). Where there is established tendon necrosis, resection of the involved tendon is required, and the wounds are left open to drain and heal by secondary intention. Delayed tendon reconstruction is carried out when all infection has disappeared, though results are often poor.

3. a. The patient should be examined for loss of extension of the fingers at the MCP joints and for potential central slip injury. A digital neurovascular examination should also be carried

- out, and as with all punch injuries, metacarpal fractures may be present.
- b. Emergency treatment should be simple pressure and elevation to stop any bleeding, followed by wound washout. Wounds should be dressed or approximated by suture as in question 1b.
 - c. No further investigation is required at this stage. X-rays will be necessary to exclude metacarpal or phalangeal fractures and to look for shards of glass within the digits, but these may be carried out at the plastic surgery unit and do not need to be done before referral.
 - d. The patient requires formal wound exploration and extensor tendon repair. There are no rigid time limits within which this must be carried out.
 - e. Injuries to the extensor tendon at this level are usually managed post-operatively with 6 weeks of splinting, followed by progressive active and passive mobilisation.

Discussion

The patient is most likely to have divided both extensor tendons to the little finger. However, he may have divided the central slip or lateral bands, and glass shards may have caused injury to the digital neurovascular bundles. Placing the patient's palm on the edge of a table and asking him to actively extend all fingers may show some weakness of extension, extensor lag, or loss of resistance to gentle pressure on the extended finger. It should be remembered that PIP joint extension is primarily a function of *intrinsic muscles* within the hand, acting via the lateral bands, and *Extensor Digitorum Communis* (EDC) is the prime extensor of the MCP joints only. Furthermore, the index and little fingers have additional extensors (*Extensor Indicis* and *Extensor Digiti Minimi* respectively). This complex arrangement means that meaningful conclusions from examination are difficult to reach. Indeed, division of the extensors over the proximal phalanx may produce no postural change and little if any functional loss.

Some injuries may be accompanied by loss of, or damage to the overlying skin, and this can be problematic. Wounds should be washed out as described in 1b. Simple lacerations should be closed if delay is expected, but if skin flaps are present, these should be laid down with tapes (eg *Steri-Strips*TM) and not sutured. Elevation in a collar-and-cuff or high arm sling is required.

The lack of definitive diagnosis from examination of the injuries means that all such lacerations require surgical exploration.

There are no rigid time limits within which repair must be carried out, and primary treatment aims to provide optimum conditions for wound and tendon healing. Early repair is preferable, but if there is skin loss, or non-viable skin flaps are present, the soft tissue defect will usually need to be addressed first.

Extensor tendon injuries are not as 'benign' as is often taught, and in our opinion, those distal to the MCP joint should always be referred to a trained hand surgeon. In a 1990 report, Newport, Blair, and Steyers (14) looked at the results of extensor tendon repair in 62 patients with 101 injured tendons, where all repairs were carried out by trained hand surgeons. Overall, fewer than 50% of fingers had a good to excellent result, whereas more proximal injuries had good to excellent results in 63% to 83% of cases. 60% of this series had associated injuries, including fractures, dislocations and joint capsule or flexor tendon injuries. In a 1995 study, Evans *et al* (15) looked at the results of 46 extensor tendon repairs in 42 patients. All repairs were carried out by junior A&E staff under local anaesthetic. Four patients (9.5%) had associated injuries. Using the same grading system, only 17% of patients with injury in the finger had a good or excellent result, whereas 83% of those patients with injury at or proximal to the MCP joint had good to excellent results. The majority of injuries in this region are treated with 6 weeks of static post-operative splinting. Splints support the MCP joints, whilst encouraging movement at the inter-phalangeal joints. It may be that controlled early active mobilisation regimes are superior, but we could find no studies to support this claim and further work is required.

4.
 - a. Closed avulsion of the *flexor digitorum profundus* (FDP) tendon.
 - b. Lateral X-ray of the digit.
 - c. Early repair.
 - d. Function will not return without surgery. Treatment will require his commitment to rehabilitation following repair, and the best results are from early surgical intervention
 - e. Usually 4 weeks of immobilisation followed by active and passive exercises, though this will depend on the class of avulsion.

Discussion

Avulsion of the FDP tendon from its insertion into the base of the distal phalanx is the second most common flexor tendon injury after lacerations (1). Many of these injuries occur in rugby, when, in grasping the jersey of a player who is pulling away, the finger is forcibly extended while the FDP is



Fig 3. FDP avulsion. Lateral X-ray of digit. A flake of bone has been avulsed with the FDP tendon and can be seen caught opposite the PIP joint, at the A3 pulley. This is a Leddy and Packer type II avulsion.

maximally contracting. 75% or more occur in the ring finger (16). Often these patients present late, on average 2 months after injury (20). Furthermore, the diagnosis may be missed and the patient is told he has a 'stuck finger'. Unfortunately delay in diagnosis and treatment can severely affect functional outcome. FDP avulsion injuries are classified into 3 types, according to position of the avulsed FDP tendon and thus remaining tendon blood supply:

- Type I: The tendon retracts into the palm, having torn both long and short vincula, structures that transmit blood supply to the tendon.
- Type II: The most common type. The

tendon retracts to the level of the PIP joint, leaving the long vinculum intact and thus partially maintaining blood supply. A small bony fragment may be taken with the tendon.

- Type III: There is a large bony fragment, which catches in the distal end of the flexor tendon sheath, saving both vincula.

Lateral X-rays may thus show a bony fragment or fleck of bone (Figure 3). Frequently, however, in both types I and II, there is no fragment, and X-rays will appear normal. In these cases ultrasound of the digit may be helpful in locating the end of the avulsed FDP.

Unlike closed extensor tendon rupture (mallet finger), early diagnosis and prompt re-insertion of the avulsed flexor tendon is the treatment of choice. Patients should be referred to the next available outpatient clinic. Late presentations may warrant secondary tendon reconstruction or DIP joint arthrodesis to maintain grip strength.

Rugby players are seldom keen to allow an injury to prevent them from completing the season. The degree of disability arising from loss of FDP function and the fact that late reconstruction yields much inferior results should be emphasised.

5.
 - a. Full assessment of the patient should be carried out in accordance with ATLS guidelines (22). He may have suffered significant blood loss and should be resuscitated, given supplemental O₂ and cannulated. He should be assessed for other injuries. No attempt should be made to remove the field dressing and additional dressings and elevation should be used to stem any further bleeding. Under no circumstances should either a tourniquet be used or the digital vessels sought out and tied off or clipped. Digital blocks must be avoided.
 - b. Yes.
 - c. The amputated fingers should be removed from direct contact with ice. They should be wrapped in sterile dressings moistened, *but not soaked*, with saline or Hartmann's solution, and placed in a clean 'zip-lock' bag, such as a specimen bag. The bag should be placed in iced water for transport with the patient.
 - d. The sooner the fingers are revascularised, the better the outcome. Whilst a figure of 6 hours is quoted by many, tissues within digits have a very low metabolic demand, and digits that have remained cold have been replanted as many as 48 hours after amputation.
 - e. By emergency ambulance.

Discussion

The patient has suffered a significant injury and may have lost a large quantity of their blood volume. Transected arteries, however, will retract and contract, slowing any blood loss. The ends will eventually become plugged by thrombus. Any attempt to tie off these vessels may preclude replantation of these important fingers, or at the very least will reduce the chances of successful revascularisation. Performing a digital block may damage vessels proximal to the injury and may interfere with blood flow across the microsurgical repair.

The advent of microsurgical vessel repair has allowed digital replantation and revascularisation since early reports in the 1960s. Replantation of digits is now carried out almost routinely at plastic surgery units (Figures 4&5). Patient motivation and intelligence are among the major factors that influence functional outcome after replantation (21). Single-digit replantation remains a controversial issue, but the treatment will depend very much on the informed decision of the patient. In contrast, the thumb should be replanted whenever possible. Multiple-digit amputations are nearly always attempted unless the patient does not want the operation, or there are medical contraindications. The patient described in this scenario is a young fit man, training in a technical trade. He has suffered



Fig 4 & 5. Complex single digit replant.

This patient amputated the index and middle fingers of his dominant hand with a circular saw. X-rays of the hand and amputated fingers show destruction of the head of the index finger metacarpal and base of the middle finger proximal phalanx. A ray amputation of the index finger metacarpal was performed. The middle finger was discarded and the index finger was replanted onto the middle finger metacarpal, creating a new MCP joint. Functional recovery was excellent.

clean 'guillotine' amputations of two digits on his dominant hand, and would be the perfect case for replantation, should he wish it.

The goal of transport medium is to avoid freezing the amputated part, whilst keeping it cold to avoid the negative effects of warm ischaemia.

Following a telephone call to the Plastic Surgery Registrar on call, arrangements should be made to transport the patient and his fingers to the unit as quickly as possible. Helicopter transport is seldom required because the patient can arrive faster by ground.

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