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# Common Musculoskeletal Problems of the Limbs in Accident and Medical Practices

## 1. The Wrist and Hands

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**Issues this article will address**

- Anatomy of the wrist and hands
- Diagnosis and management of common wrist and hand injuries

## Salient Points

- Understanding the anatomy of wrist and hand is important for diagnosing wrist and hand injuries.
- Wrist and hand injuries can be divided into bony and non-bony types.
- Non-bony types of wrist and hand injuries include sprains, rupture of ligaments and tendons, tenosynovitis, nerve damage, and cartilage tear.
- Bony types include fractures of the distal radius and ulna, and carpal, metacarpal and phalangeal bones.
- Wrist and hand pain can result from inflammatory processes of joints such as gout and rheumatoid arthritis.

**Key words:** Musculoskeletal disorders • Wrist injuries • Hand injuries • Fractures • Ligament rupture • Nerve damage

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## Introduction

Doctors working in Accident and Medical practice commonly encounter acute and chronic musculoskeletal conditions. In this the first of a series of articles dealing with common conditions that practitioners may face, musculoskeletal conditions of the wrist and hands are reviewed. The second article will deal with conditions related to the forearm and elbow, while the third will deal with musculoskeletal conditions commonly seen in the shoulder. Subsequent articles will look at conditions related to the hip, knee, ankle and foot, respectively.

Wrist and hand injuries are commonly seen in Accident and Medical clinics as these parts of the body are extensively utilised in any type of work, and they are usually the parts that take the impact of a fall or catching an object. Understanding the anatomy of the wrists and hands is essential because of its link to the biomechanical and pathological process involved in the injury.

## Anatomy of the Wrist

The wrist connects the hand to forearm. It provides mobility and stability to the hand for delicate functions, as well as forceful grasping. Its bony structure consists of eight carpal bones that are arranged in two rows. From the radial to ulnar side, these bones are the scaphoid, lunate, triquetrum, and pisiform in the proximal row, and the trapezium, trapezoid, capitate, and hamate in the distal row. They articulate with each other, the distal end of the radius in the forearm, and the metacarpals of the hand (Figs 1 and 2).

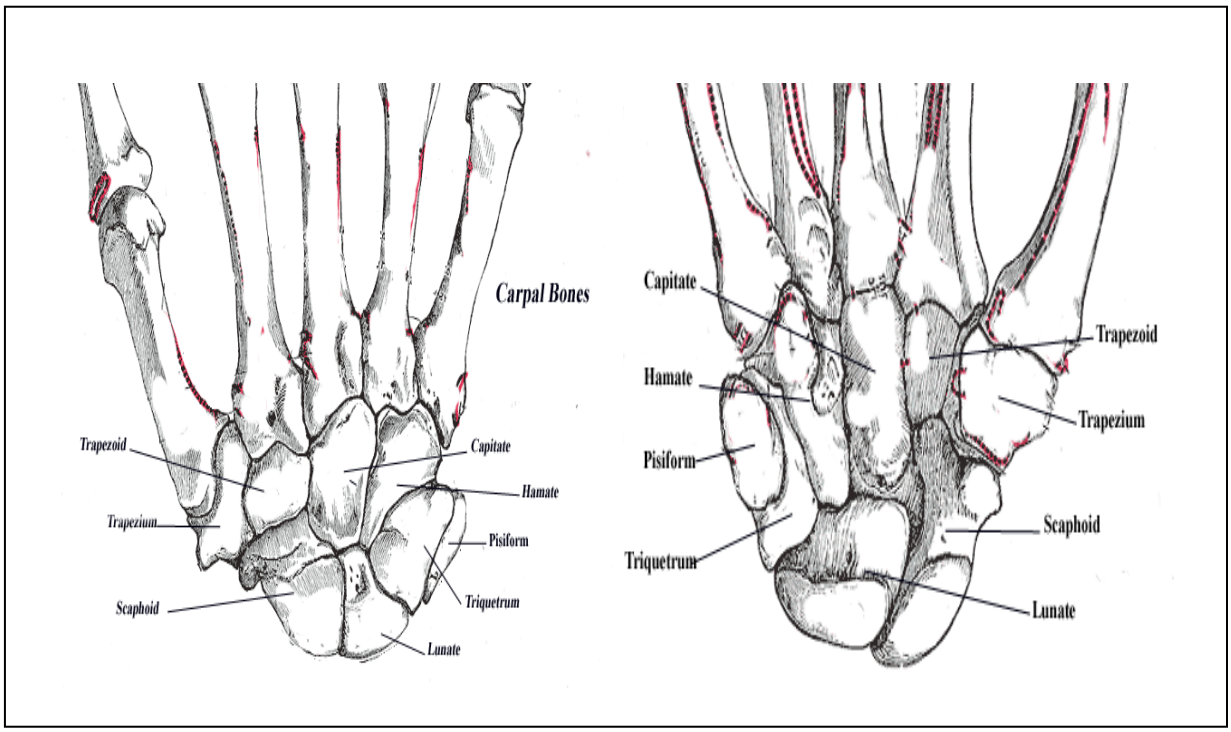


**Fig. 1** (left). Wrist and hand bones – dorsal aspect.
**Fig. 2** (right). Wrist and hand bones – volar aspect.
(Modified from Gray's Anatomy of the Human Body, 20th ed.[1]).

The carpal bones are bound tightly together by intrinsic and extrinsic ligaments in a complex arrangement. Basically, these ligaments run on both sides of the carpal bones from radio-proximal to ulnar-distal in an oblique fashion. This arrangement provides mechanical stability during rotational movement of the wrist. In terms of clinical relevance, the important structures

to consider are the scaphoid-lunate ligament and ulnocarpal complex (which includes the radiotriquetral ligament and the triangular fibrocartilage), the ulnolunate ligament, the ulnar collateral ligament, and the dorsal and palmar radioulnar ligaments (Figs 3 and 4).[2-4]

The mid-carpal joint is the joint between the proximal and distal rows of the carpal bones, while the scaphoid bone crosses both rows. The significance of this positioning of the scaphoid bone is transmission of force though the scaphoid when the wrist is subjected to forced extension, with radial deviation during a fall onto an outstretched hand or a heavy object landing on an outstretched hand. This is the common mechanism of scaphoid fractures.[5]

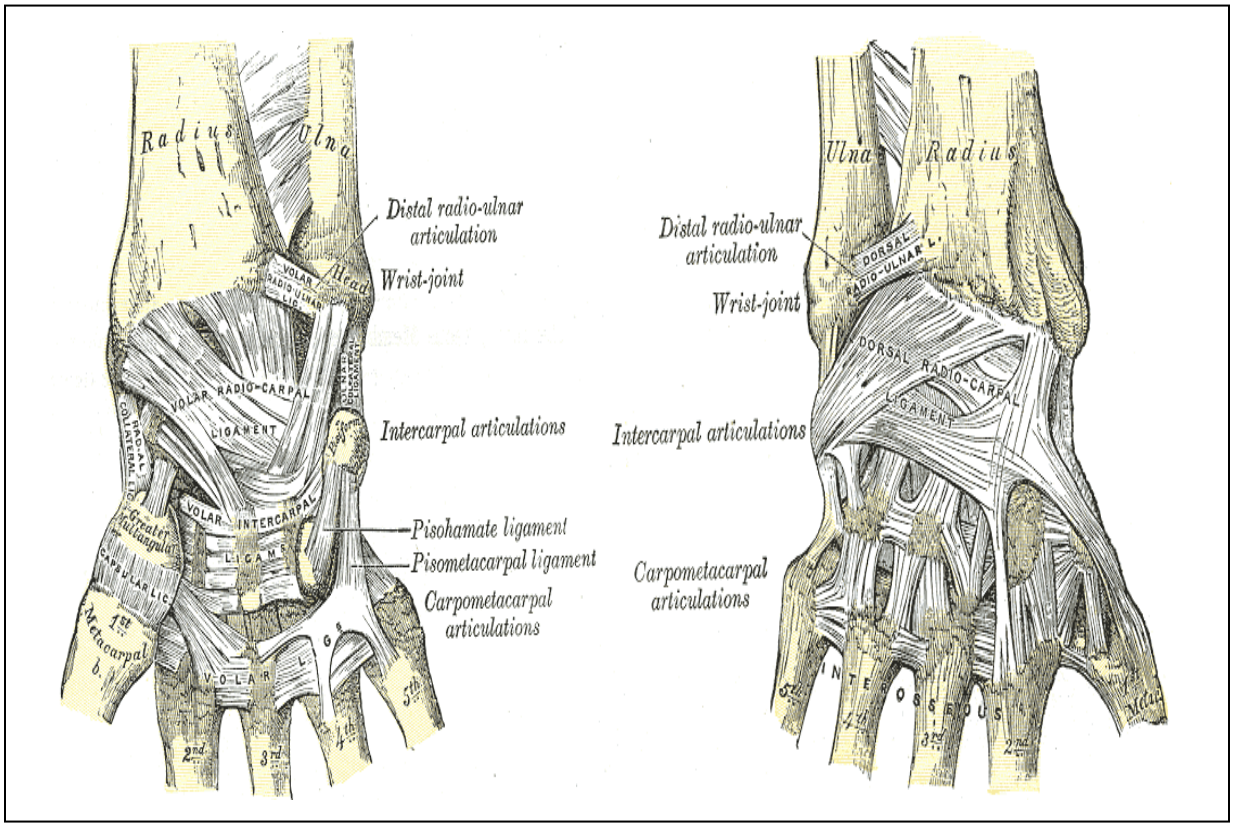


**Fig. 3** (left). Wrist ligaments – volar aspect.
**Fig. 4** (right). Wrist ligaments – dorsal aspect.
(Modified from Gray's Anatomy of the Human Body, 20th ed. ed.[1]).

The carpal tunnel forms at the volar aspect of the carpus with the flexor retinaculum running from the scaphoid tubercle to the hook of the hamate. Ten structures traverse through the

carpal tunnel – the median nerve is immediately under the flexor retinaculum, the four flexor digitorum superficialis tendons run deep to the nerve, while the four flexor digitorum profundus tendons and the flexor pollicis longus run deep to the superficialis (Fig. 5).

Guyon's canal is located medially and superficially to the carpal tunnel. It is formed between the pisiform, the hook of the hamate, and the pisohamate ligament which is a fibrous expansion from the flexor carpi ulnaris inserting into the pisiform (Fig. 3). The ulnar nerve and artery pass through this canal.

The extensor tendons run at the dorsum of the carpus and they are held in position by the extensor retinaculum. The compartment which is formed by extensor retinaculum is divided into six areas. The various compartments contain, from the radial to ulnar aspect, the abductor pollicis longus and extensor pollicis brevis (the site of De Quervein's tenosynovitis), the extensor carpi radialis and longus, the extensor pollicis longus, the common extensor tendons, the extensor digiti minimi, and the extensor carpi ulnaris (Fig. 5).

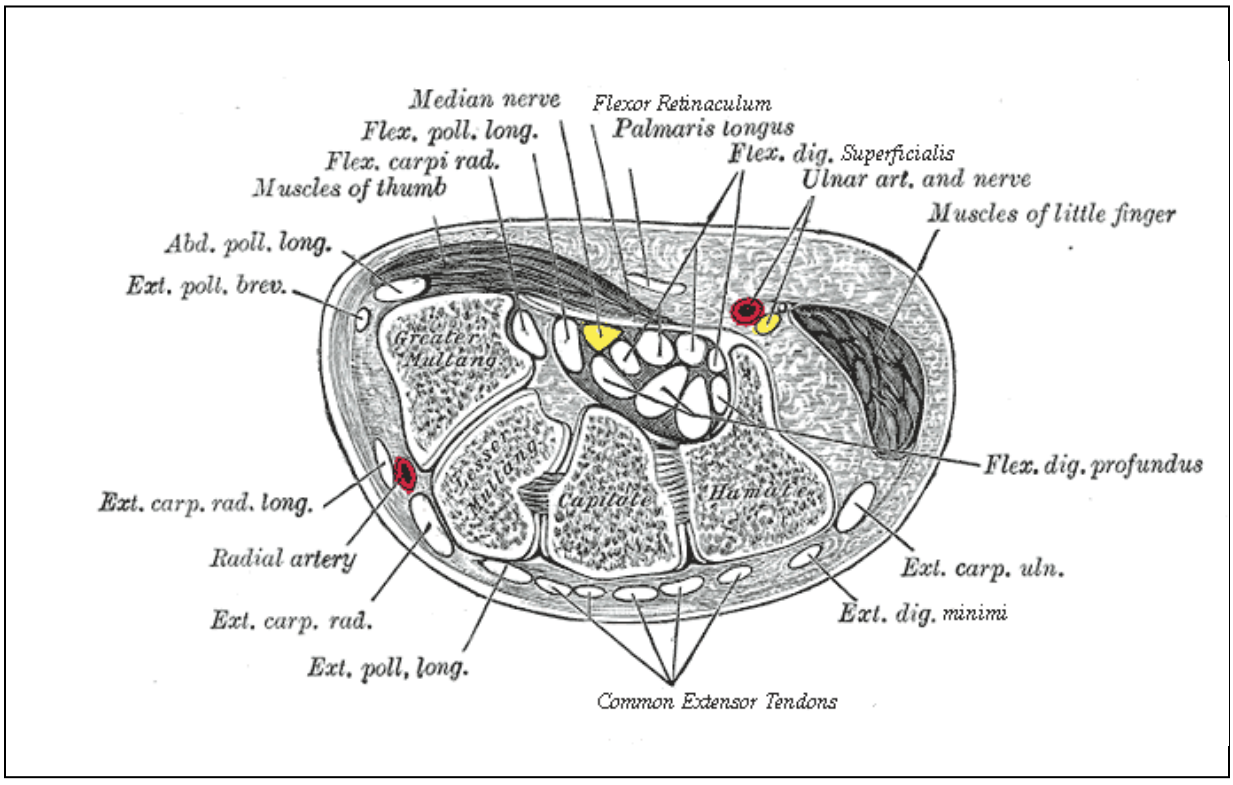


**Fig. 5.** The wrist – transverse cross sectional view (modified from Gray's Anatomy of the Human Body 20th ed.[1]).

## Anatomy of the Hand

Anatomically, the hand consists of three parts: the carpus, the hand proper, and the digits. The carpus has already been discussed (above). The hand proper consists of 5 metacarpal bones with their tendons, muscles, ligaments, blood vessels and nerves. An interesting aspect of the metacarpal bones is that the transverse diameters of their heads is larger at the volar aspect and, as a result, when the metacarpo-phalangeal (MCP) joints are flexed, there is an increase in tension along the collateral ligaments holding them. There is also deviation of the metacarpal heads towards the third metacarpal bone and this helps grasping. The bases of the metacarpals articulate not only with the carpal bones but also with each other. The carpometacarpal joints are most mobile in the thumb and least mobile in the index and middle metacarpals.[2-4]

The digits consist of three phalanges for each of the fingers, and two phalanges for the thumb. The phalanges articulate with each other via the interphalangeal joints and the proximal phalanges articulate with the metacarpals via the MCP joints. Each of these joints is stabilised by collateral ligaments and by a thickening at the anterior part of the capsule in the joints, which is known as the volar plate.

Movements of the fingers are conducted through the coordinated actions of the extrinsic and intrinsic systems. The extrinsic system consists of the long flexors and extensors of the digits. The intrinsic system consists of the thenar, hypothenar, lumbricalis and interossei muscles.

The blood supply to the long flexor tendons comes through the mesotendons and these are modified in the flexor sheath as vinculae. The nerve supply to the hand can be divided into the motor and sensory supplies. The motor innervation comes from the median, ulnar and radial nerves. The intrinsic muscles in the hand are exclusively supplied by the median and ulnar nerves. The median nerve innervates the thenar muscles and the lateral two lumbricals. The ulnar nerve supplies the rest of the intrinsic muscles, i.e. the medial two lumbricals, hypothenar and interossei muscles. The ulnar nerve also supplies the thenar muscles to a variable degree. The main extrinsic long flexor is the flexor digitorum profundus (FDP), and this has a similar innervation as the hand in that the lateral half is innervated by the anterior interosseous branch of the medial nerve and the medial half by the ulnar nerve.

The sensory supply to the hand starts from the C6 – C8 nerve roots at the neck. The dermatomes of the hand are distributed from C6 to C8 and from the radial to the ulnar side, with the middle finger in the C7 dermatome (Fig. 6). The sensory fibres reach the hand via the median, ulnar and radial nerves (Fig. 7). The median nerve supplies the sensory innervation to the lateral 3½ fingers and corresponding metacarpals at the palmar aspect. The ulnar nerve provides the sensation over the medial 1½ fingers and corresponding metacarpals at the palmar side. The radial nerve supplies the sensation to the posterior aspect of the hand proper.

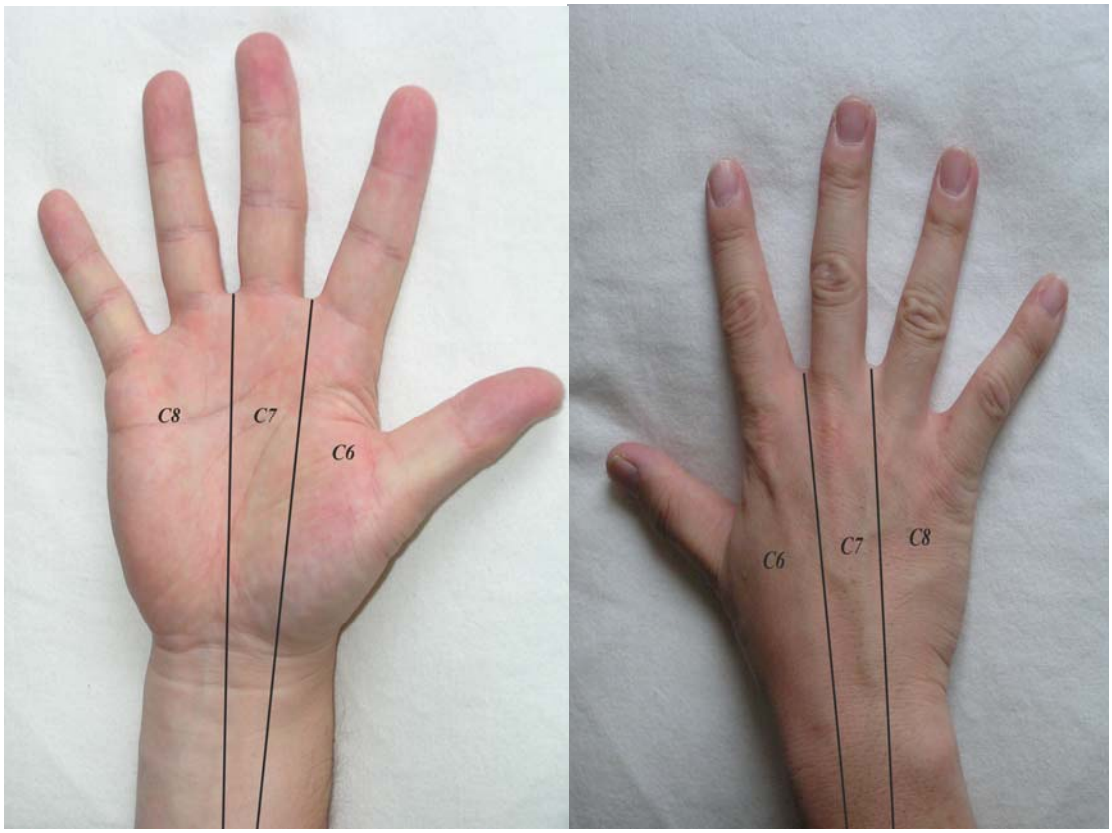


**Fig. 6.** The dermatomes of the hand.

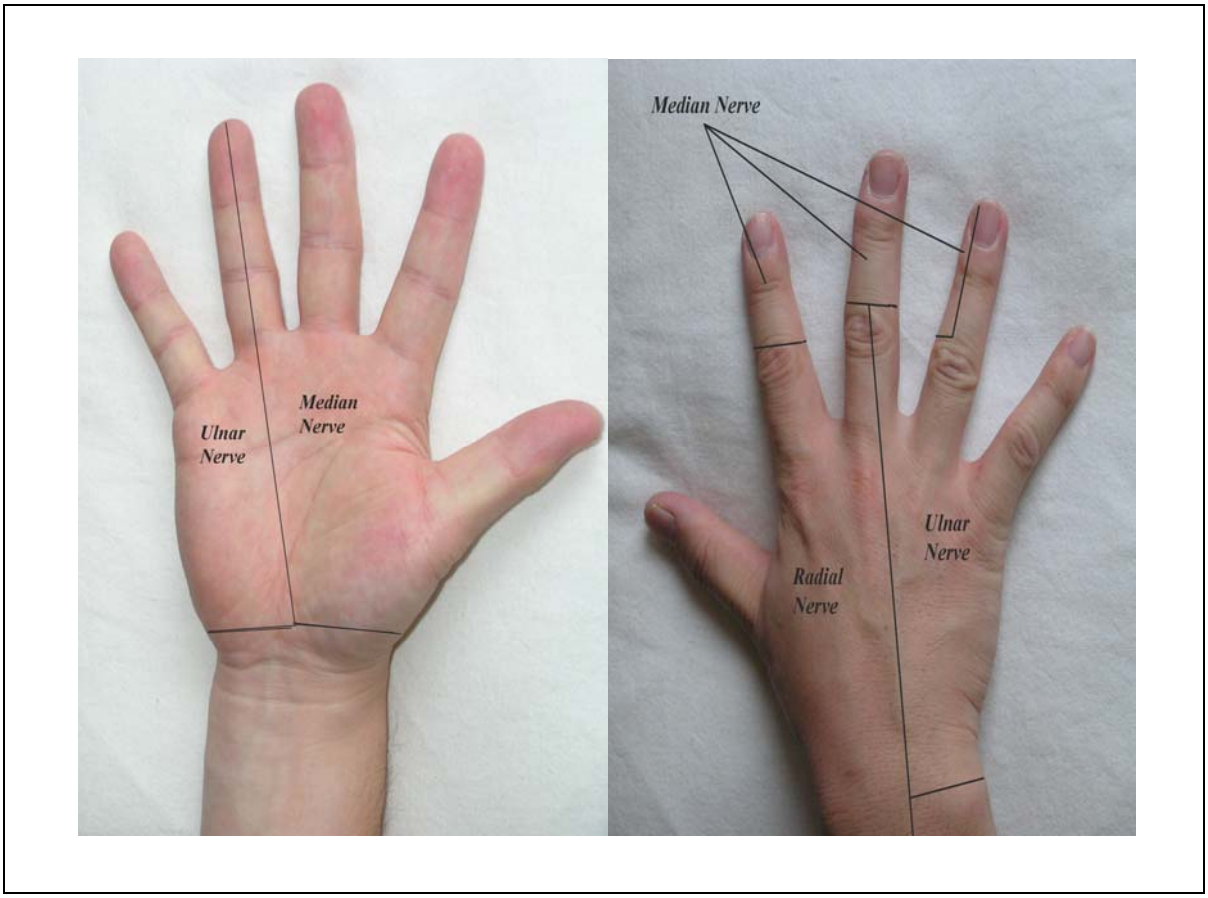


**Fig. 7.** Peripheral nerves of the hand.

## Wrist Injuries

### *Sprains and Other Painful Wrist Conditions*

Wrist sprain refers to a ligament injury of the wrist joint. This most often happens when a person falls onto the outstretched hand. The injury mostly heals well with conservative treatment, but a significant injury (including a complete rupture) to the intrinsic ligaments, particularly over the scaphoid and lunate area, can result in prolonged pain with weakness and a reduced range of movement. A complete rupture of the scaphoid lunate ligament presents with either diffuse swelling and tenderness over the carpus, or localised tenderness over the scaphoid lunate joint. The diagnosis can be made via the x-ray appearance of a widened gap between the scaphoid and lunate. Treatment involves operative repair of the ligament, preferably within 3 weeks, but delayed repair can be done up to 6 months after the injury.[6]

When there is persisting pain over the wrist with localised tenderness over the scaphoid lunate joint and the x-ray scaphoid views of the wrist have a normal appearance, it is important to consider dynamic scapholunate instability. This is the most common cause of wrist pain and instability in adolescents and young adults.[7] Watson's provocative test is a useful way to check on the stability of this joint. The test involves pressuring the scaphoid tuberosity from the palmar side with the examiner's thumb while the wrist is ulnar deviated. As the wrist is brought into the radial side from the ulnar side, the subluxed scaphoid is reduced with a clunk sensation and pain over the wrist. This indicates a positive test for scapholunate instability. Operative repair is the treatment of choice.[7]

Pain over the ulnar aspect of the wrist can be caused by injuries involving underlying structures such as a fracture of the hook of the hamate or the ulnar styloid, or a TFCC (triangular fibrous cartilage complex) tear. Clinical examination will localise the injured areas. A fracture of the hook of the hamate or non-union has a focal point of tenderness over the proximal hypothenar area about 1 cm distal to the flexor crease at the wrist, while tenderness due to a fracture of the ulnar styloid tends to localise to the site of the injury. A TFCC injury causes tenderness over the gap between the ulnar styloid and the pisiform.[8]

Specific tests such as a lunotriquetral shear test and supination lift test can be supportive of specific diagnoses when they are positive. The lunotriquetral shear test involves providing dorsal and palmar forces to the triquetrum and lunate, respectively. A positive sign is a painful click which is indicative of possible tear of the lunotriquetral ligament.[8] The supination lift test involves requesting the patient to lift a desk with his palm flat underneath it. A positive sign is marked pain with weakness which is suggestive of possible injury to the TFCC.[8]

***Other Wrist Fractures***

Other fractures of the wrist mostly involve the distal radius and the scaphoid. In a Colles' fracture, there are dorsal angulation and displacement of the distal part of the radius. A Smith's fracture is a 'reverse Colles' with volar angulation of the distal fragment. Barton's fracture is a form of Smith's fracture but involves only the anterior portion of the distal radius.[9] Most of these fractures will need manipulation or open reduction and internal fixation to restore anatomical alignment.

Fractures involving the articular surface of the distal radius require careful assessment of the joint surface as there is an increased risk of arthritis with loss of congruity of the surface. Except for totally undisplaced intra-articular fractures of the distal radius, most intra-articular fractures in the distal radius require open reduction and fixation when the joint congruity cannot be established by manipulation.

Greenstick fractures of the distal radius and sometimes of both the distal radius and ulna are common in children. Depending on the age of the child, a certain amount of dorsal or volar angulation of the distal fragment can be accepted without the need to correct this deformity because of the great remodelling power of children's bones. As the bones of children are still growing, it is not uncommon for the growth plate to get injured when there are bony injuries. Most of the growth plate injuries in the distal radius belong to the Salter Harris type I and II classification which have a good prognosis.[10] A study by Lee et al. found that the incidence of significant growth disturbance was approximately 7% in their study population which had distal radius fracture.[11]

Scaphoid fractures are commonly seen in young males who have high energy impact on the dorsi-flexed wrist. This mechanism results in forceful impingement of the scaphoid into the dorsal lip of the radius, which may result in a waist fracture of the scaphoid. Clinically, the involved wrist shows swelling and pain with movement, particularly when the wrist is forcefully deviated radially. The classic sign of snuffbox tenderness on palpation is present. The accuracy of the diagnosis can be improved by utilising other signs. Scaphoid tubercle tenderness and pain over the scaphoid with longitudinal compression of the extended and mid-abducted thumb towards the scaphoid are additional signs that can be used to increase the accuracy of the diagnosis.[12] The undisplaced scaphoid waist fracture can be effectively managed by plaster immobilisation, but for any displacement at a waist >1 mm, the proximal fracture or vertical oblique fracture of the scaphoid may need open reduction and internal fixation for a favourable outcome.[5] Because of retrograde blood flow to the scaphoid, there is an increased risk of avascular necrosis at the proximal scaphoid with the fracture.

***Neural Injuries***

Entrapment or compression of a nerve is characterised by sensory and motor changes of the nerve distal to the site of compression. The most common compression problem over the wrist is carpal tunnel syndrome, which involves median nerve compression over the wrist. The symptoms and signs of carpal tunnel syndrome can vary widely from vague ache of the arm to specific sensory changes over the median distribution, with thenar muscle wasting and weakness of the hand. A positive Tinel's sign and Phalen's test can be helpful in making the diagnosis but are not diagnostic. Tinel's test involves tapping of the median nerve over the volar aspect at the wrist. A positive sign produces a tingling sensation in the median nerve distribution over the affected hand. Phalen's test involves forced palmar flexion of the hand, opposite to a prayer position, creating an angle close to 90 degrees over the wrist. A positive sign produces numbness and a tingling sensation over the median nerve distribution of the hand when it is held in position for about 30 seconds.

Injection of a corticosteroid into the carpal tunnel can be diagnostic and therapeutic at the same time, but care is needed not to inject the corticosteroid into the median nerve during this procedure, as the long-term consequences are significant. Nerve conduction studies are helpful in cases of uncertain diagnoses of carpal tunnel syndrome.

The ulnar nerve may be entrapped in Guyon's canal at the medial aspect of the wrist. This results in sensory changes of the ulnar nerve distribution with weakness of abduction of the fingers. Treatment of this compression neuropathy includes the use of night splints for temporary immobilisation, avoidance of provoking activities to reduce repetitive stress to the area of compression, corticosteroid injections to reduce local inflammation and swelling, and surgical decompression to relieve structural compression.

***Tendon and Tendon Sheath Injuries***

It is not uncommon to encounter entheses or tendonitis in Accident and Medical practice when manual workers present with increasing pain in the hand, wrist or forearm. De Quervain's tenosynovitis involves the inflammation of the tendon sheath covering the extensor pollicis brevis and abductor pollicis longus. It usually has diffuse tenderness and swelling over the radial side at the distal radius. A positive Finkelstein's sign is marked pain over the wrist when the

flinched fist with the thumb under the fingers is deviated medially. Treatment includes temporary immobilisation with thumb/wrist splints, avoidance of repetitive movement involving the wrist and hand, analgesia, and physiotherapy.[13,14] Corticosteroid injections should be reserved for those who have failed to respond to the above treatment. A De Quervain's tenosynovitis refractory to corticosteroid injections may need surgical intervention with division of the involved tendon sheath.[13]

### *Inflammatory Conditions*

Inflammatory conditions that can affect the wrist include rheumatoid arthritis and gout. It is important to consider rheumatoid arthritis for any persisting and ongoing pain with swelling, particularly over the distal radioulnar joint.[14] Gout may present with diffuse swelling and warmth over the wrist, with reduction in the range of motion due to pain. An elevated serum uric acid level is a useful investigation for making a diagnosis of gout. However, it may not be consistently elevated during acute attacks of gout.

### *Chronic Wrist Pain*

Chronic wrist pain is a difficult problem to deal with in Accident and Medical practice. However, there are investigations that can be performed to illuminate this problem. A bone scan is a valuable tool to determine whether the chronic wrist pain requires further evaluation or not. An increased uptake of radioactive tracer indicates possible pathologies such as occult fracture, localised inflammation from inflammatory or degenerative diseases, ligamentous injuries, and others. This is an effective screening tool for separating those who need further evaluation because of possible pathology from those who do not have any obvious pathology.[15] Ultrasound is helpful in making a diagnosis of occult ganglia for chronic wrist pain and other mass-like lesions, as well as tendon-related injuries. The best available investigation for chronic pain in the wrist is magnetic resonance imaging (MRI). However, this is not readily available to Accident and Medical practitioners or primary care providers.

## Hand Injuries

Phalangeal and metacarpal fractures are common injuries in this part of the body. Like any fracture, there may be angulation, displacement and rotation at the fracture sites. The most

important deformity to be aware of is rotational deformity. If this is not corrected properly at the onset of injury, there may be significant interference with hand function later.

***Metacarpal Fractures***

Fifth metacarpal fractures are common. Those involving the neck usually result from punching with a closed fist. Angulation of the neck fracture may result in cosmetic deformity over the knuckle in the fifth MCP area, but there is little functional problem once it is healed as long as rotational deformity is not present or corrected. Up to 40 to 45 degrees of angulation at the neck of the fifth metacarpal can be accepted with no functional problem of the affected hand.[9]

Bennett's fracture is a well-known fracture at the base of the first metacarpal extending into the carpometacarpal (C-MC) joint. This fracture is inherently unstable because of the position of the fracture and the anatomical arrangement of the C-MC joint and attachment of muscles in the region. The distal fragment is pulled proximally due to the attachment of many muscles and the proximal fragment is triangular in shape with an attachment to the trapezium. Any obliquity of the fracture line does not help the stability of this fracture. Treatment should involve reduction and immobilisation in plaster, usually with a percutaneous pin.

Multiple metacarpal fractures with displacement require operative intervention with restoration of the metacarpal alignment, as the distortion of the metacarpal arch can significantly interfere with finger function.

***Gamekeeper's or Poacher's Thumb***

This refers to rupture of the ulnar collateral ligament of the thumb over the MCP joint. The injury can involve either pure rupture of the ligament or avulsion of the bone from the base of the proximal phalanx. Treatment depends on the presence or absence of a Stener lesion, which refers to the interposition of the adductor aponeurosis to the base of the proximal phalanx where the ulnar collateral ligament is ruptured. This interferes with appropriate healing of the ligament. A Stener lesion is likely to be present if there is complete rupture of the ulnar collateral ligament.[16] A complete rupture of the ligament is likely if there is radiological evidence of widening of the first MCP joint when the joint is stressed in a radial direction in both 30 degrees

of flexion and full extension. If there is radiological evidence of the first MCP joint widening only in 30 degrees of flexion, this may indicate that the accessory collateral ligament is intact.[16]

The presence of Stener lesions requires operative intervention to repair the ulnar collateral ligament. This is also indicated in displaced avulsion fracture at the base of the proximal phalanx. The absence of Stener lesions or an undisplaced fracture at the base of the proximal phalanx with no Stener lesions can be treated with plaster immobilisation for 4 weeks followed by a removable thumb splint with gradual mobilisation exercise.[17]

***Phalangeal Injuries***

For phalangeal fractures, the most important aspect of management is to allow the joints in the fingers to mobilise as early as possible once the fracture deformities (including angulation and rotation) are corrected. Fractures of the phalanges that are extra-articular and a minor deformity in terms of alignment and displacement require only simple immobilisation with the adjacent phalanx by use of strapping. The fingers should then be mobilised at the earliest possible time, usually within 2 weeks, as pain is tolerated.

***Volar Plate Injury***

Volar plate injury with an avulsion fracture over the interphalangeal joints occurs during hyperextension of the finger joints. This injury can be deceptive in that x-ray of the joints may show only a minor avulsion type of fracture at the volar aspect over the base of phalanges, but recovery may be prolonged with stiff and swollen joints. This happens because of scarring and fibrosis at the anterior aspect of the joints where avulsion injury has occurred.

Any volar plate injury involving more than one-third of the articular surface should be referred to a hand team for operative repair. If the injury is less than one-third of the articular surface, temporary immobilisation in flexion of the involved joint is recommended with supervised mobilisation. According to ACC management guidelines for this injury, an extension block splint in 30 degrees of flexion is recommended with review in 7 to 10 days.[18] For a small avulsion type of volar plate injury, there is no consensus as to whether early mobilisation with or without buddy strapping is superior to immobilisation in varying degrees of flexion/extension.[19] It is

worthwhile informing patients about prolonged courses of recovery with residual swelling and stiffness over the joint.

### *Interphalangeal Joint Dislocations*

Most dislocated interphalangeal joints can be easily reduced by steady traction on the affected joint under digital block, but at times, the head of the phalanx can slip through the defect in the capsule and reduction becomes difficult unless an open procedure is undertaken. A reduced interphalangeal joint can be treated by strapping it to the adjacent digit for up to 2 weeks with early gradual mobilisation. Any displaced intra-articular fracture involving the interphalangeal joints will need operative repair if the fracture involves more than one-third of the articular surface.

### *Boutonniere Deformity*

A Boutonniere deformity refers to flexion deformity over the proximal interphalangeal joint due to rupture of the central slip of the extensor mechanism, which results in falling of lateral slips to sideways. This allows the proximal interphalangeal joint to protrude through the extensor mechanism. A Boutonniere deformity may result from mechanical trauma involving axial loading into the extended proximal interphalangeal (PIP) joint or laceration over the dorsum at the PIP joint. A full thickness burn over the affected joint can also result in this deformity if the central slip of the extensor is disrupted.[20] Other causes for Boutonniere deformity include rheumatoid arthritis and other inflammatory conditions that can affect the joint. Chronic synovial inflammation of the joint in rheumatoid arthritis results in forced flexion of the joint with elongation of the central slip and eventual rupture.[20]

An examination shows swelling and tenderness over the dorsum of the PIP joint with lagging in full extension during the acute phase of the injury. An x-ray can at times show an avulsion fracture from the middle phalanx. There is a clinical test that can assist in recognising acute injuries to the central slip and extensor mechanism. This involves a loss of 15-20 degrees or more in active extension of the PIP joint of an affected finger with the wrist and metaphalangeal joint fully flexed.[20]

Treatment involves either temporary immobilisation of the involved finger at the PIP joint while allowing the distal interphalangeal (DIP) joint of the involved finger to mobilise, or operative repair. There is a specific test known as the Haines-Zancolli test which may be helpful in terms of choosing between splinting and surgery.[21] The test is positive if flexion of the DIP joint is not possible with an extended PIP joint. It is negative if passive flexion of the DIP joint is possible while the PIP joint is kept in an extended position. It has been suggested that a positive test predicts less success with conservative treatment involving splints.[20] Conservative treatment using a splint may require up to 6 to 8 weeks or until the patient achieves a pain-free full range of movement of the finger.[13]

***Swan Neck Deformity***

This type of deformity refers to flexion of the DIP joint with concurrent hyperextension of the PIP joint. Although it may be associated with rheumatoid arthritis, not all swan neck deformities are due to rheumatoid arthritis. It is important to achieve an appropriate diagnosis early as the deformity can be treated more effectively when a proper intervention is instituted early. The diagnosis is helped by measuring serum rheumatoid factor, C-reactive protein (CRP), and the erythrocyte sedimentation rate (ESR), along with x-ray of involved joints. Rheumatoid factor is present in 80% of patients with rheumatoid arthritis,[22] and CRP and ESR are elevated in most patients with rheumatoid arthritis. These are good markers for monitoring disease activity and responses to treatment. X-ray of the affected joints may show no abnormality except for some soft tissue changes such as joint effusion or fusiform swelling at an early stage of the disease. The progression of the disease becomes evident with juxta-articular osteoporosis and erosion of the cartilage and underlying bone structure with narrowing in the affected joints.

Treatment of swan neck deformity requires early referral to a specialist. The best outcome can be achieved by combing medical therapy with surgical management. Early stages of swan neck deformity can be treated with a custom-made splint by a hand therapist which allows active flexion of the PIP joint but prevents hyperextension of the joint. With further progression of the disease, surgical intervention is required to limit tightness in the joint and correct the deformity.[23]

***Mallet Finger***

Mallet finger refers to loss of extension at the DIP joint due to either forcible stretching of the extensor tendon or avulsion from the distal phalanx. The mechanism of injury usually involves an impact on the tip of the finger while it is held in extension. This can result from being hit by a ball. Other mechanisms involve sudden flexion of the DIP joint, which can happen when pushing in or pulling out a sheet or cover with extended fingers.[24] The clinical features show flexion deformity over the DIP joint with loss of active extension. There may be some swelling or tenderness with palpation over the affected area. However, pain is not the main symptom. In most cases, the first thing a patient notices is the flexed finger at the DIP joint. X-ray of the affected joint is useful to exclude a fracture at the base of the distal phalanx where the extensor tendon is inserted.

Treatment involves use of a mallet finger splint in most cases. However, open reduction and internal fixation with k-wire is indicated for those injuries that involve a large bony fragment with displacement at the articular surface and subluxation of the distal phalanx. Controversy exists regarding operative repair of these injuries.[25] It is still worthwhile to refer them to hand surgeons for a second opinion. When using a splint for treating mallet finger, it is important to make sure it does not fit too tightly. A pressure ulcer can result over the dorsum of the DIP joint with a tightly fitting mallet finger splint. If there is difficulty in finding a suitable size mallet finger splint, consider referring the patient to a hand therapist. A custom-made thermoplastic mallet finger splint is an excellent and comfortable alternative to a pre-made and tightly fitting plastic splint.

## References


1. Gray H, Anatomy of the human body, 20th ed. (Fig. 219-220, Fig. 334–335, Fig. 422). Available from: www.bartleby.com.
2. Nordin M, Frankel VH. Basic biomechanics of the musculoskeletal system, 2nd ed. Philadelphia: Lippincott Williams & Wilkins, 1989; pp. 261-73.
3. Lister G. The hand, 4th ed. Edinburgh: Churchill Livingstone, 2002: pp. 271-88, 295-302, 323-6, 382-91.
4. Dandy DJ. Essential orthopaedics and trauma, 2nd ed. Edinburgh: Churchill Livingstone, 1993; pp. 201-13, 221-4.

5. Haisman JM, Rohde RS, Weiland AJ. Acute fractures of the scaphoid. *J Bone Joint Surg Am* 2006;88:2750-8.
6. Gelberman RH, Cooney WP 3rd, Szabo RM, Carpal instability. *J Bone Joint Surg Am* 2000;82:578.
7. Wintman BI, Gelberman RH, Katz JN, Dynamic scapholunate instability: results of operative treatment with dorsal capsulodesis. *J Hand Surg [Am]* 1995;20(6):971-9.
8. Forman TA, Forman SK, Rose NE. A clinical approach to diagnosing wrist pain. *Am Fam Physician* 2005;72:1753-8.
9. McRae R. Practical fracture management, 3rd ed. Edinburgh: Churchill Livingstone, 1994; pp.169-208..
10. Mehlman CT, Koepplinger ME. Growth plate (physeal) fractures; last updated Jul 20, 2004. Emedicine. Available from: www.emedicine.com/orthoped/topic627.htm
11. Lee BS, Esterhai JL Jr, Das M. Fracture of the distal radial epiphysis. Characteristics and surgical treatment of premature, post-traumatic epiphyseal closure*. Clin Orthop Relat Res* 1984;(185):90-6.
12. Parvizi J, Wayman J, Kelly P, Morgan CG. Combining the clinical signs improves diagnosis of scaphoid fractures. A prospective study with follow-up. *J Hand Surg [Br]* 1998;23(3):324-7.
13. Brukner P, Khan K. Clinical sports medicine, 2nd ed. Clinical Sports Medicine, Australia: McGraw-Hill, 2001; pp. 292-320.
14. Palmer KT. Regional musculoskeletal conditions: pain in the forearm, wrist and hand. *Best Pract Res Clin Rheumatol* 2003;17(1):113-35.
15. Pin PG, Semenkovich JW, Young VL, Bartell T, Crandall RE, Gilula LA, et al. Role of radionuclide imaging in the evaluation of wrist pain. *J Hand Surg [Am]* 1988;13(6):810-4.
16. Heyman P, Gelberman RH, Duncan K, Hipp JA. Injuries of the ulnar collateral ligament of the thumb metacarpophalangeal joint. Biomechanical and prospective clinical studies on the usefulness of valgus stress testing. *Clin Orthop Relat Res* 1993;(292):165-71.
17. Morgan WJ, Slowman LS. Acute hand and wrist injuries in athletes: evaluation and management. *J Am Acad Orthop Surg* 2001;9:389-400.
18. ACC Treatment Profiles. Sprain finger. Wellington: Accident Compensation Corporation, 2001.
19. Cooper S. Volar plate avulsion fractures. *Journal of the Accident and Medical Practitioners Association (JAMPA)* 2006;3(1):1-8.
20. Coons MS, Green SM. Boutonniere deformity. *Hand Clin* 1995;11(3):387-402.

21. Likes RL, Ghidella SD. Boutonniere deformity; last updated Jun 1, 2005. Emedicine. Available from: www.emedicine.com/orthoped/topic24.htm.
22. Sandoval R. Swan neck deformity; last updated Jul 6, 2006. Emedicine. Available from: www.emedicine.com/orthoped/topic562.htm.
23. Kiefhaber TR, Strickland JW. Soft tissue reconstruction for rheumatoid swan-neck and Boutonniere deformities: long-term results. *J Hand Surg [Am]* 1993;18(6):984-9.
24. Harrison BP, Hilliard MW. Emergency department evaluation and treatment of hand injuries. *Emerg Med Clin North Am* 1999;17(4):793-822.
25. Meals RA. Mallet finger; last updated Feb 28, 2006. Emedicine. Available from: www.emedicine.com/orthoped/topic413.htm.