Workplace Safety and Insurance
Appeals Tribunal
Tribunal d'appel de la sécurité professionnelle
et de l'assurance contre les accidents du travail

Common Conditions of the Hand and Wrist

Discussion paper prepared for

The Workplace Safety and Insurance Appeals Tribunal

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This Medical Discussion Paper will be useful to those seeking general information about the medical issues involved. It is intended to provide a broad and general overview of a medical topic that is frequently considered in Tribunal appeals.

Each medical discussion paper is written by a recognized expert in the field, who has been recommended by the Tribunal's Medical Counsellors. Each author is asked to present a balanced view of the current medical knowledge on the topic. Discussion papers are not peer reviewed. They are written to be understood by lay individuals.

Discussion papers do not necessarily represent the views of the Tribunal. A Vice-Chair or Panel may consider and rely on the medical information provided in the discussion paper, but the Tribunal is not bound by an opinion expressed in a discussion paper in any particular case. Every Tribunal decision must be based on the facts of the particular appeal. Tribunal adjudicators recognize that it is always open to the parties to an appeal to rely on or to distinguish a medical discussion paper, and to challenge it with alternative evidence. Please see *Kamara v. Ontario (Workplace Safety and Insurance Appeals Tribunal) [2009] O.J. No. 2080 (Ont. Div. Court)* for reference. For more information about these papers, please consult the *WSIAT Guide to Medical Information and Medical Assessors*.

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Introduction

The hand, including the wrist, is the most commonly injured part of the body accounting for 24% of Workplace Safety and Insurance Board (WSIB) lost time claims. The most common traumatic hand injuries in the workplace are lacerations, crush injuries, amputations, and fractures. Non-traumatic issues such as compressive neuropathies, progressive osteoarthritis, and overuse conditions are frequently attributed to the workplace, but have multifactorial etiologies. These are complex situations that require a detailed medical understanding.

Anatomy of the Hand and Wrist

A. Bones

The four **fingers** of the hand each consist of a **distal phalanx**, **middle phalanx**, and **proximal phalanx** (Fig. 1). The **thumb** only has a distal and a proximal phalanx. All five digits have a **metacarpal bone** within the palm of the hand. The metacarpals connect to the **wrist (carpus)**.

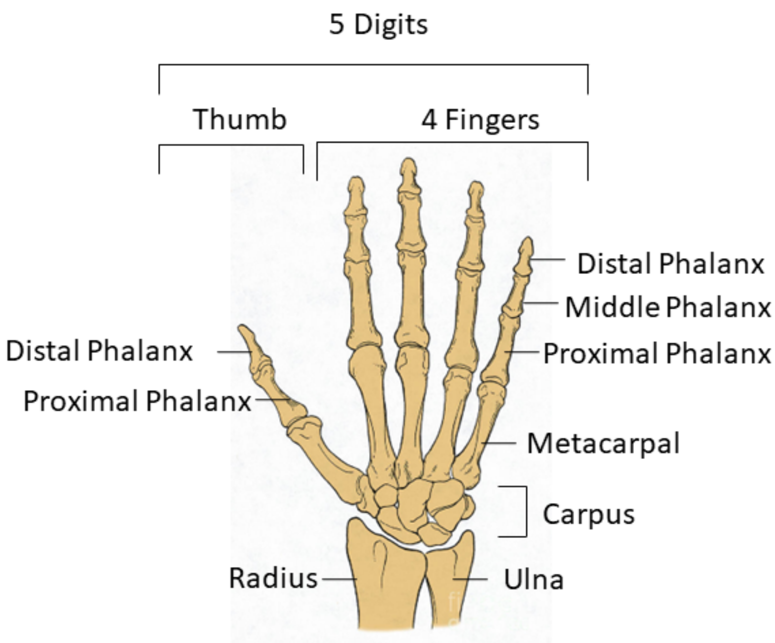

Figure 1. Hand bones. Image credit: Science Source

The **wrist (carpus)** is the most complicated joint in the body. It comprises eight **carpal bones** organized in two rows (Fig. 2). The proximal row consists of the **scaphoid**, **lunate**, and **triquetrum**. The scaphoid is the most commonly broken bone in the carpus. The **pisiform** bone is not a structural part of the row. The distal carpal row consists of the **trapezium**, **trapezoid**, **capitate**, and **hamate**. The wrist technically includes the distal portion of the two long bones of the forearm: the **radius** and the **ulna**.

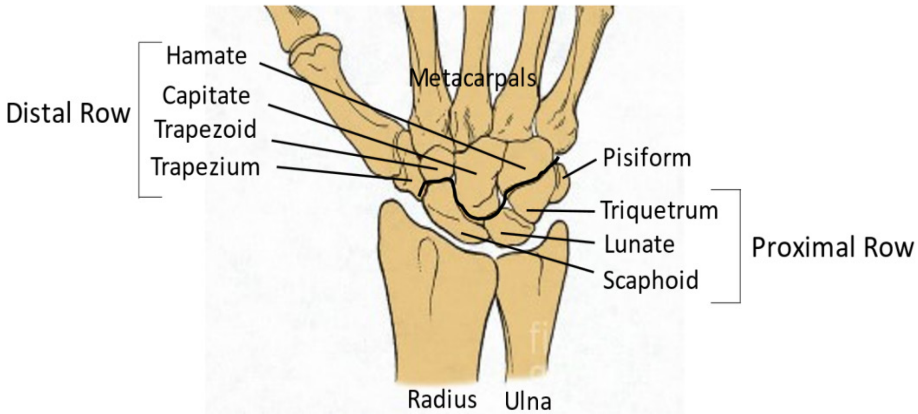

Figure 2. Wrist (carpal) bones. These are organized in 2 rows. Image credit: Science Source

B. Joints, Ligaments, and Capsules

The small joints of the fingers include the **distal interphalangeal (DIP) joint**, the **proximal interphalangeal (PIP) joint**, and the **metacarpophalangeal (MCP) joint** (Fig. 3). The thumb only has an **interphalangeal (IP) joint** and a MCP joint.

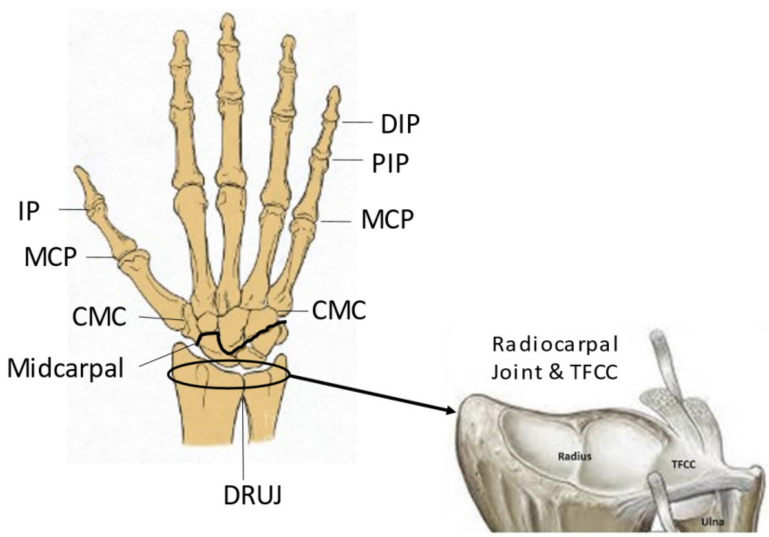

Figure 3. Hand and wrist joints. See text for abbreviations. Image credit: Science Source

All of these joints have **collateral ligaments** on either side of the joint referred as **radial** or **ulnar** ligaments, based on their position and named after the respective forearm bones (Fig. 4). The ulnar collateral ligament at the thumb MCP joint is the most commonly injured small joint ligament in the hand. All of the small joints have a **volar plate,**

composed of dense connective tissue that also stabilizes the **volar** (palm) side of each joint. All joints have **capsules** around them for added stability and to maintain a small amount of fluid in each joint. The fluid is made by the **synovium** that is the inner lining of the joint
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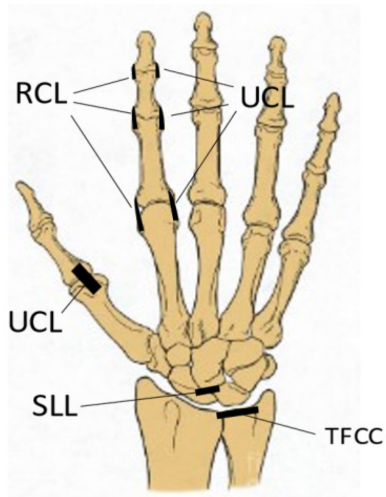

Figure 4. Hand and wrist ligaments. Each joint of each digit has a radial collateral ligament (RCL) and an ulnar collateral ligament (UCL). The scapholunate ligament (SLL) and the triangular fibrocartilage complex (TFCC) are vital to wrist stability. Image credit: Science Source

For all five digits, the metacarpal bones join a carpal bone at a **carpometacarpal (CMC) joint** (Fig. 3). The CMC joint at the base of the thumb (*aka* **basilar joint**) is highly mobile to allow a large arc of motion and, therefore, special function of the thumb. This joint is a common site of osteoarthritis. All CMC joints have thick capsules and ligaments.

The two carpal rows (Fig. 2) create a **ball-in-socket-*and*-ball-in-socket** design to allow for exceptional motion. The capitate and hamate bones of the distal row form a ball that articulates with a socket made primarily by the scaphoid and lunate of the proximal row. The entire proximal row articulates with the shallow socket of the distal radius. The socket of the distal radius is completed by the **triangular fibrocartilage complex** (**TFCC**; Fig. 3 & 4). The joint between the distal and proximal rows is the **midcarpal joint**.

All the carpal bones are connected by a complex series of ligaments. The most commonly injured ligament within the wrist is the **scapholunate ligament (SLL),** named after the respective bones that it binds together (Fig. 4). Failure of this ligament results in a break of the carpal row and a collapse of the distal row into the proximal row. The joint between the proximal carpal row, the radius, and the TFCC is called the **radiocarpal joint** (Fig. 3). The TFCC not only completes the joint, but also contains the ligaments between the radius and the ulna to stabilize the **distal radioulnar joint (DRUJ)** between the two long forearm bones (Fig. 3). The carpus and the DRUJ all have capsules for secondary stability, and for fluid production and containment.

C. Motion of the Hand and Wrist, Muscles, and Tendons

To make a full fist, the digits come into **flexion**, whereas straightening them is termed **extension** (Fig. 5 bottom left). For the fingers to spread apart is **abduction**, and to come together is **adduction**. The specialized motion of the thumb in which it rotates to meet the fingertips is **opposition**. Wrist motion is similarly termed flexion and extension when moved to the palm (**volar**) or back (**dorsal**) sides, respectively. Sideways motion of the wrist is **radial** or **ulnar deviation**; circular motions are **circumduction**. Forearm twisting is termed **supination** when the palm is turned up, and **pronation** when the palm is turned down (Fig. 5 top left). These motions occur between the radius and ulna at the DRUJ and proximal radioulnar joint.

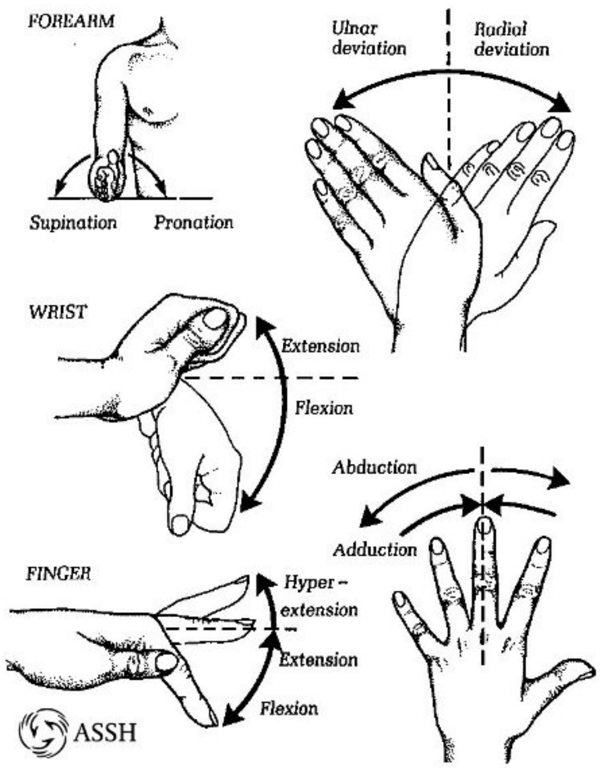

Figure 5. Motion of the forearm, wrist and digits
Image credit: Amercian Society for Surgery of the Hand

All active motions of the joints are controlled by muscles. The long **flexor muscles** originate at the **medial epicondyle** of the humerus (Fig. 6). The muscle mass is in the anterior forearm and each muscle has a long tendon to the wrist or digits. There are two flexor muscles for wrist flexion. There are two long flexor tendons to each finger and one long flexor tendon to the thumb. These nine tendons run through the carpal tunnel to their respective digits. The two long flexors to each finger control small joint flexion.

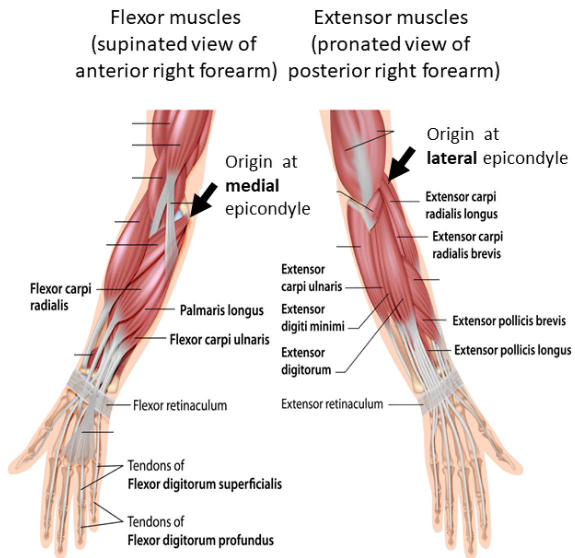

Figure 6. Long muscles of the fingers and wrist. Image credit: Alila Medical Media

The long **extensor muscles** originate at the **lateral epicondyle** of the humerus (Fig. 6). The muscle mass is in the posterior proximal forearm. There are three extensor muscles for wrist extension. There are multiple extensor muscles to the digits. Their tendons run through specialized numbered compartments on the back (dorsum) of the wrist and then form a tendinous expansion (**extensor aponeurosis**) on the dorsum of each digit to control the respective small joints.

The small muscles of the palm to each of the fingers are termed **intrinsic muscles** (Fig. 7). They have tendons to the sides of the proximal phalanges for abduction and adduction (Fig. 5) and also insert into the extensor aponeurosis. Based on the position of these tendons, their muscles actively flex the MCP joints, but extend the DIP and PIP joints. The corresponding intrinsic muscles to the thumb (Fig. 7) are responsible for adduction, flexion, and opposition. The thumb also receives tendons for abduction. Many of these tendons become inflamed with age and overuse to create such syndromes as de Quervain’s tendonitis or trigger fingers.

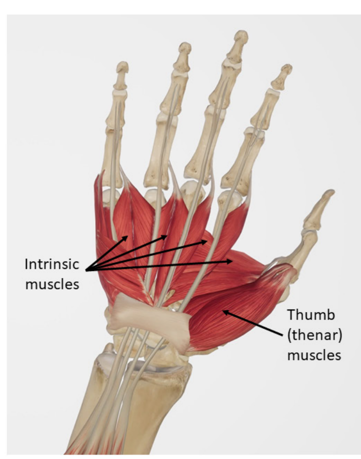

Figure 7. Intrinsic muscles of the hand. Image credit: Vesalii

D. Nerves

There are three major nerves to the hand for muscle activation and sensation (Fig. 8). Each nerve travels through tunnels where they can be compressed. The **median nerve** runs down the middle of the forearm through the **carpal tunnel**. It controls the small muscles of the thumb and provides sensation to the radial part of the palm and the digits, specifically the thumb, index, middle and ½ of the ring finger. The **ulnar nerve** travels down the ulnar side of the forearm. It controls most of the intrinsic muscles of the hand and provides sensation to the ulnar part of the hand including the small finger and ½ of the ring finger. The **radial nerve** runs on the dorsal to the radial side of the forearm and provides sensation to the dorsal radial 2/3 of the hand. It does not control any hand muscles but provides sensation to the back of the hand.

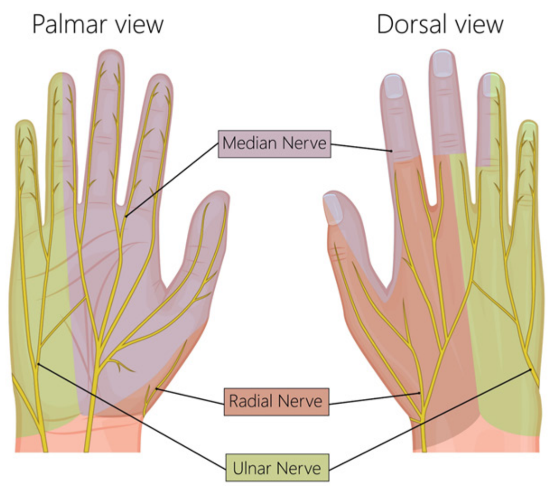

Figure 8. The three nerves of the hand and their sensory zones. Image credit: Aksanaku

Trauma

A. Wounds and Lacerations

Any **wound** or **laceration** (cut) of the hand stems from an injury that breaks the skin. Forty to 60% of hand injuries involve lacerations and two thirds of these injuries occur in men. There are countless ways in which these injuries occur. In the workplace, the highest risk is with cutting jobs and where there are contact hazards such as sharp edges, tools, and debris. A detailed understanding of the mechanism of injury and the environment in which they happen is important to understand potential injuries, risk of infection, and functional recovery. Simple wounds and lacerations are expected to heal without issues. Any wound or laceration may include a potential injury to the arteries, nerves, joints, and tendons that lie close to the skin. Complex wounds can heal with significant scarring, resulting in cosmetic concerns or contraction of joints. Wounds that involve any of the deeper structures may impact the use of the hands.

Examination requires specific testing of all nerves, tendons, and blood supply to the digits. Wounds are explored for contaminants and often washed out. X-rays are obtained to check for foreign material, intact bones, and aligned joints. Ultrasound may be useful to document intact tendons if the physical exam is inconclusive.

Lacerations are often glued or sutured, unless they are potentially contaminated, in which case they are left open. Surgery is generally required for repair of nerves, tendons, fractured bones, and arteries, if the blood supply to a digit is compromised. Tetanus (lock-jaw) immunization is checked, and prophylaxis is provided as needed. Routine antibiotics are not required unless the injuries are contaminated, or are associated with crush injuries, broken bones (fractures), exposed joints, animal or human bites, burns, or if they have been open for more than 12 hours. Antibiotics are also given to patients who have medical problems that may affect wound healing (i.e. diabetes, renal or peripheral vascular disease, immunocompromised). Any of these more complicated injuries or medical problems will likely affect future function. Despite surgical repair of a nerve, it is unlikely that sensation will return to normal. Poorer outcome is also affected by patient age and underlying osteoarthritis, as stiffness, persistent pain, and even cold intolerance all have a higher likelihood of occurring after these injuries.

B. Fingertip Injuries

The fingertip is the most frequently injured part of the hand. Most are lacerations or **crush injuries**. Injuries can involve the skin, pulp tissue, distal phalanx bone, and the nail and nail bed. In the workplace, gears, chains, and rollers are mechanical hazards capable of crushing and pinching. Basic principles of care are noted in the “Wounds and Lacerations” section above.

Very small injuries may require only dressing changes and can heal well. A **damaged nail bed** can sometimes be repaired surgically. **Exposed bone** may require local surgical skin coverage. Severe injuries can sometimes benefit from surgical amputation to a level that will heal better.

The cosmetic and functional outcome of a fingertip injury is, however, *not* predicted by the severity of the original injuries. Because there are many nerve endings at the fingertips, severe or **chronic pain** may occur even with minor cuts. Patients may stop using the digit entirely and can develop a generalized upper extremity **pain syndrome**. **Nail deformities** can cause psychological and functional issues. Any injury can result in intolerance to cold temperatures. Outcomes are improved by early motion and desensitization, and although outcomes are difficult to predict, they are worse in the elderly or when associated with diabetes, smoking, or chronic medical conditions.

C. Amputation of a Digit

Traumatic loss of a digit is called a **complete amputation** and can occur with deep cuts, by severe crush injuries, or **avulsions** (or a combination of these mechanisms). If a digit remains partially attached, this a termed a **partial** or **near-complete amputation**. Power saws are the most common mechanism of these injuries. Young males are the highest risk group based on the nature of their work.

Beyond first aid treatment, surgical treatment is required for these injuries. For a partial amputation of a thumb, attempts are usually made to repair or reconstruct the thumb, given its importance to overall hand function. The same logic applies to multiple partial finger amputations. However, for a single finger with a partial amputation, this injury is often surgically converted to a complete amputation and the skin of the amputated stump is closed. This is called a “revision” procedure and will often have a better functional outcome compared to a reconstructed finger that will usually be stiff and with poor sensation. Some patients recuperate well after a revision procedure with early return to daily work and leisure activities; however, many patients will have residual issues with a weaker hand or reduced or heightened sensitivity that may require permanent work restrictions.

For complete amputations of a thumb or multiple fingers, the digits can be surgically reattached (**replantation**). All key anatomical components (bone, tendons, nerves, blood vessels) are reattached using a microscope. Replantation is rarely done for crush and avulsion injuries because the tissue damage will result in poor functional outcome. Replants are also rarely done in adults for a single amputated finger since the hand can function well with one less finger. Replants would not be done for patients in poor health, especially if they have diabetes, or lung or heart disease that may lead to medical issues while they are recuperating. Smokers have a poorer outcome. Despite successful survival of a replanted digit (approximately 80% of cases), function will never be normal. With reconstructed or replanted digits, stiffness, poor sensation, and cold intolerance are universal issues. The entire hand will be weaker and there will be a permanent impairment. Custom and winter gloves may be helpful for cold intolerance. Most patients have nightmares and significantly psychosocial issues after an amputation. Some will use artificial silicone fingers (aesthetic prostheses) for social or sedentary work activities.

D. Fractures of the Hand

Any bone within the hand can be broken and each fracture can have a unique cause and treatment. Finger and metacarpal fractures are the most common sports-related fractures in adults. If not treated properly, finger fractures can have significant consequences, including poor function, chronic pain, stiffness, and deformity.

The subjective history of the injury should include mechanism of injury, timing and progression of symptoms, and any previous finger injury. As with all hand injuries, the physical examination is crucial. Common signs of injury are local swelling, erythema, pain, deformity, and tenderness to palpation. The assessment should also include finger alignment, ligament integrity, sensation, blood supply, and flexion and extension of the joints to determine if the tendons are intact. A systematic approach to the finger examination avoids missed diagnoses, potential complications, and poor outcomes. X-rays are required and a CT scan may be helpful to ascertain additional detail about a fracture, particularly if surgery is contemplated.

Distal Phalanx Fractures

A **tuft fracture** (Fig. 9) is the most common type of distal phalanx fracture. This fracture at the fingertip is usually from a crush injury. X-rays are required for the diagnosis and to follow the healing process. Distal phalanx fractures are usually stable and can be treated with simple splinting of only the tip of the finger. Splinting for two to four weeks should be followed by range of motion and strengthening. A longer splint on the finger or a longer duration of splinting can lead to excessive stiffness of the whole finger and delayed return to activities and work.

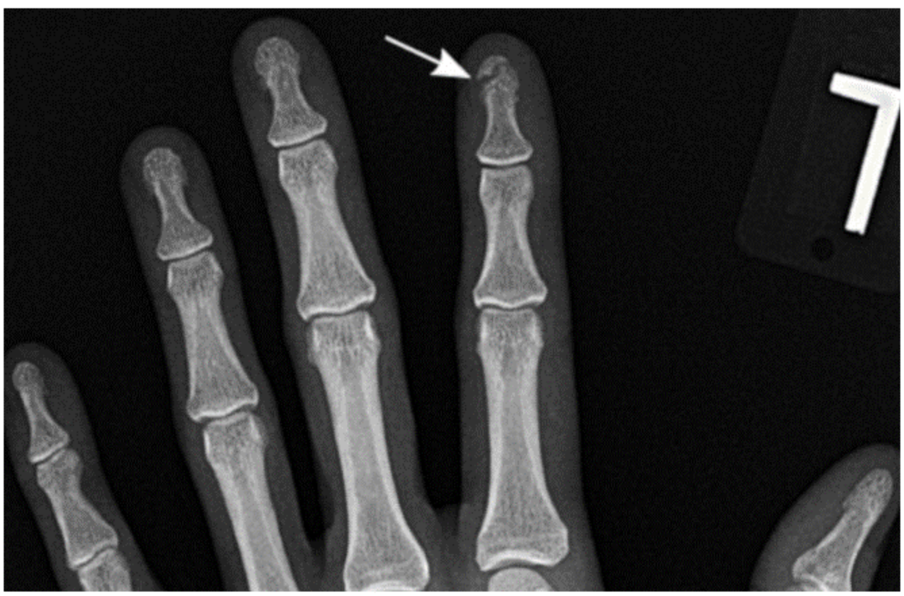

Figure 9. X-ray of a tuft fracture of distal phalanx. Reproduced with permission from Borchers, J.R.: Common Finger Fractures and Dislocations. *American Family Physician* 2012, vol. 85, no. 8: 805

Any soft tissue and nail bed injuries associated with these fractures must be recognized and treated. Patients should be informed that these fractures are often complicated by pain, increased sensitivity, or numbness for up to six months following the injury. If there are several small fracture fragments (**comminution**) or a fracture through the waist (narrowest part) of the distal phalanx, healing may be very slow (**delayed union**) or the fracture may never heal (**non-union**), resulting in ongoing pain and a rubbery feeling (instability) at the fingertip.

Mallet Fractures

A **mallet finger injury** occurs when the insertion of the extensor tendon into the distal phalanx is torn (avulsed) or broken off (Fig. 10). This occurs with or without a small fragment of bone and X-rays are therefore required. These injuries are caused by a force to the tip of the finger. In younger people, this is usually due to a sports injury from being hit by a ball. In older people, it can occur very easily with any impact, and is therefore seen in minor workplace injuries.

On exam, the finger is slightly flexed at the DIP joint (or the IP joint for the thumb). The patient is able to flex the joint but cannot fully extend it due to the disruption of the extensor mechanism. The PIP joint may be slightly extended and may be tender.

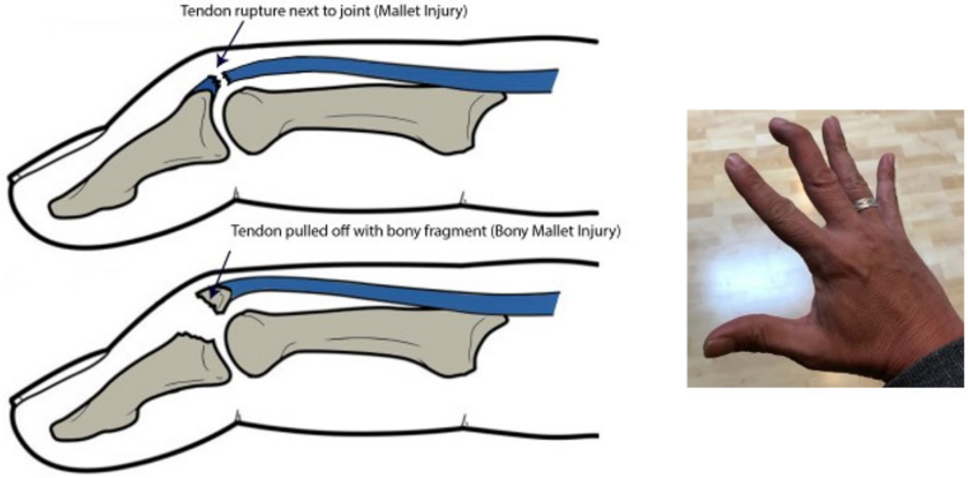

Figure 10. Mallet injuries. Left image reproduced with permission as adapted from OrthoInfo. © American Academy of Orthopaedic Surgeons. https://orthoinfo.org/, right image reproduced with permission from https://www.physio-pedia.com/Mallet_Finger

Treatment of a mallet fracture includes splinting the DIP joint straight in extension for eight weeks. It is imperative that extension is maintained at all times during treatment because any flexion at the joint can affect healing and may extend the treatment period. Outcomes are usually very good with a goal of return to full activities. Surgery may be required if the bone fragment is very large. Long-term issues include persistent flexion and an inability to extend the digit, as well as DIP joint stiffness. These patients often complain about difficulty putting on gloves and re-injuries to the finger.

Middle and Proximal Phalanx Fractures

Middle and **proximal phalanx fractures** are associated with trauma. Fractures may be **non-displaced** or **displaced**, depending on whether they are anatomically aligned or not. Stable non-displaced fractures can be treated conservatively with buddy taping and early range of motion, but need to be followed carefully to ensure stability and alignment. Outcomes can be expected to be very good.

Displaced, **oblique**, or **spiral fractures** are inherently unstable and may require surgery. If surgery is required, stiffness of the finger or of the whole hand is more likely.

If the fracture continues into one of the joints (termed **intra-articular**) it is often complicated and unstable and may need surgery. These fractures have a poorer outcome, and joint stiffness and secondary post-traumatic osteoarthritis can occur, leading to a permanent impairment.

Metacarpal Fractures

Boxer's Fractures

A **boxer's fracture** is a break of the neck of the 5^{th} metacarpal bone of the small finger near the knuckle (MCP joint; Fig. 11). It occurs in young men who punch an object or another person. If it occurs in the workplace, frustration, anger, or altercation are probable factors.

Symptoms of a boxer's fracture include pain, local swelling, and a depressed knuckle. A physical exam is important to assess rotation of the injured finger and the presence of any open wounds. The fracture is diagnosed by X-rays. The fractures are usually treated with a short-term partial cast or simply by taping the ring and small fingers together (buddy taping) and applying an elastic bandage. Early mobilization is useful to reduce stiffness. Patients must be warned that the profile of their knuckle will never be normal, but should be reassured that hand function should be normal, despite the angulation of the broken bone. If the injured finger is rotated, it will catch under the adjacent finger while making a fist (termed **scissoring**). This is a functional issue and must therefore be corrected either by **closed reduction** (manipulating the fracture) or **surgical reduction**. There are not specific guidelines for the amount of scissoring that can be accepted, this is purely a subjective complaint. A "**fight bite**" is an open wound from striking another individual in the mouth. These have a high risk of infection and require emergency irrigation and should not be closed with sutures.

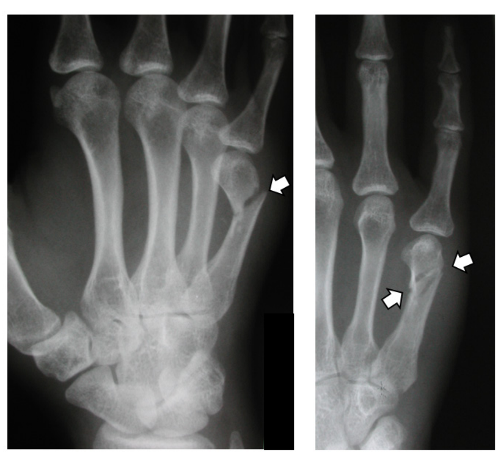

Figure 11. Boxer's fractures of 5^{th} metacarpal bone. Courtesy Dr. H. von Schroeder

Fractures of the Thumb

Fractures of the thumb at the base of the first metacarpal can affect the CMC joint where the thumb connects to the wrist, and may therefore have functional implications. There are two fracture patterns (Fig. 12). Fractures at the base of the thumb can be simple with a sizeable piece of bone broken off (**Bennett fracture**), or the bone is shattered into three or more pieces (**Rolando fracture**). Patients present with pain and swelling. X-rays confirm the fracture. The thumb can be displaced through the fracture and can be unstable. As such, there is a higher chance of surgery for these fractures compared to other hand fractures. Typically, a good functional outcome is expected.

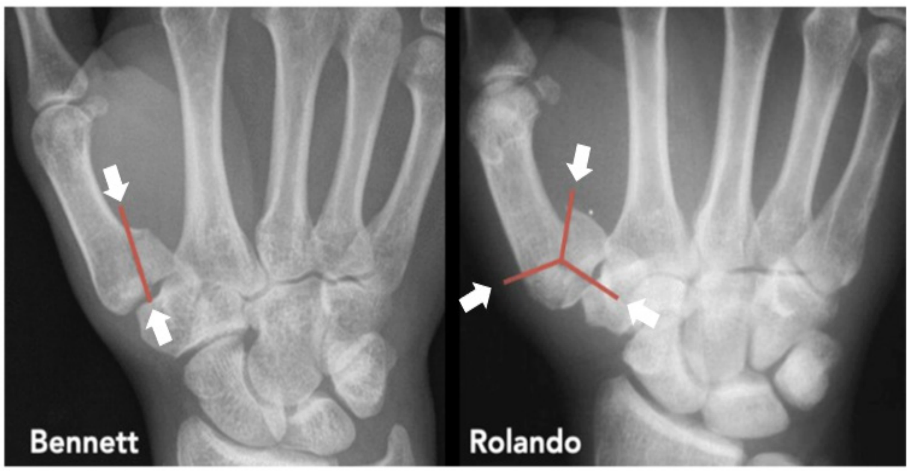

Figure 12. Base of thumb fractures. Image credit: https://litfl.com/bennett-fracture-eponymictionary

E. Wrist Fractures

Scaphoid Fractures

The **scaphoid bone** is the most frequently fractured bone within the wrist (Fig. 13). The fracture occurs most commonly in men in their 20's, usually from a higher energy fall from a height or during sports. Unlike other fractures, pain and swelling may be minimal and patients may therefore not seek medical care. When assessed, tenderness is located at the radial side of the wrist. X-rays, including special views of the scaphoid, are required. However, acute fractures may be missed on X-rays and follow-up X-rays, CT, or MRI scan are required to establish the presence of the fracture (or other injury). Most scaphoid fractures will heal with 8 weeks of cast immobilization, and patients can be expected to do well.

Figure 13. Scaphoid fracture. Image credit: Science Source

Fractures that are displaced or are slow to heal require surgery. Failure to diagnose or immobilize the fracture can result in a non-union (the fracture does not heal). This leads to a slowly progressive arthritis termed **scaphoid non-union advanced collapse** (**SNAC** – see below). With this, wrist motion is gradually lost, grip strength diminishes, and the wrist is prone to re-injury and functional loss.

Distal Radius Fractures

Distal radius fractures are the most common fractures in the body and account for 18% of all adult fractures (Fig. 14). They occur most frequently in women in their late 50's and 60's from **falling on an outstretched hand** (**FOOSH**) from a standing height. The number of WSIB claims for radius fractures has increased due to increasing numbers of older women entering the workforce. Men who sustain distal radius fractures are younger, generally in their 40s. In this group, the fracture is often a result of higher energy impact, generally falling from a height, such as from scaffolding, or in a car crash.

Symptoms, as with most fractures, include pain, swelling, and visible deformity. The physical exam includes assessment of the nerves and blood supply to the hand, as these can be compromised by the fracture. X-rays are required, and a CT scan can provide additional detail in some cases to assist with decision-making for surgery. An MRI scan or wrist arthroscopy are reserved for patients with ongoing symptoms after fracture healing.

There are several possible fracture patterns of the distal radius and many eponyms used to describe them (e.g. **Colles' fracture**). Most fractures occur only within the wide part of the bone and do not enter into the radiocarpal joint. These can be manually reduced (aligned or "set") by a physician. Careful follow-up is required, since a loss of reduction can result in **malunion** of the fracture and possible future pain and functional issues. Fractures that have many fracture fragments (**comminuted**) typically involve the radiocarpal joint. For this reason, and because of the higher energy of the injury with comminuted fractures, there is a higher risk of **post-traumatic arthritis**, hand stiffness, and other complications. Surgery is frequently indicated and usually involves applying a plate and screws to the broken bone (**open reduction and internal fixation, ORIF**).

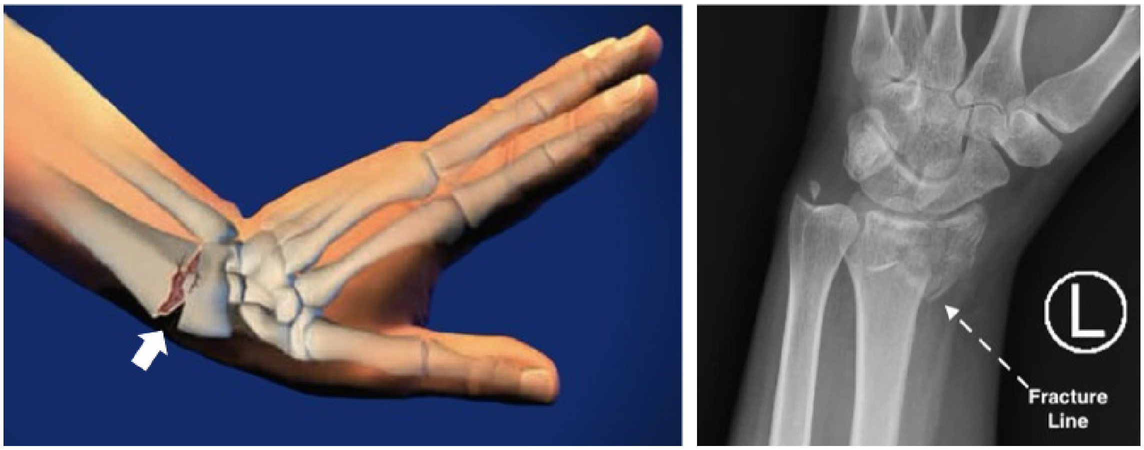

Figure 14. Distal radius fracture. Left image reproduced with permission from ViewMedica, right image reproduced with permission from Michigan Medicine – University of Michigan

Risk factors for radius fractures relate to: a) unsafe environments where falling is more likely, and b) **osteoporosis**. Although radius fractures generally heal quickly with or without surgery, maximal recuperation can take over a year after the injury. Complications are frequent. Pain on the ulnar side of the wrist is common and can be due to malunion of the radius fracture. In this scenario, the radius heals in a shortened position, leaving the ulna bone relatively long, which therefore abuts against the carpal bones. Grip strength remains poor, and surgery may be required to treat the malunion. Another reason for pain in this region is a fracture of the ulnar styloid or a TFCC tear that occurred concurrently with the radius fracture. The TFCC does not appear on X-rays and these injuries can therefore be missed without a proper physical exam. Since the TFCC and its attachment at the ulnar styloid are also responsible for stability between the radius and the ulna at the DRUJ (Fig. 3), this injury can result in a loose joint and may affect the twisting motion (pronation and supination) of the forearm.

Hand stiffness after a radius fracture may be due to tight casts, excessive swelling, or underlying osteoarthritis of the small joints of the hand that are susceptible to stiffness. **Complex regional pain syndrome** (**CRPS**, aka. **reflex sympathetic dystrophy**) is also known to occur after radius fractures. This diagnosis should be based on the formal **Budapest criteria** and has a very bad prognosis for return to work; however, this diagnosis is often misapplied based only on prolonged swelling and pain.

F. Dislocations, Sprains and Ligament Injuries

A **dislocation** of joint is defined when the bones are completely out of alignment, whereas the term **subluxation** refers to a partial dislocation. For these injuries to occur, the soft tissues around the joint, including the ligaments, capsule, and volar plates (at the small joints) are stretched (**attenuated**), partially torn, or completely torn. The term **sprain** is generically applied to the pain and damage around injured joints. Whether joints are completely or partially dislocated, they can spring back to their normal position or be **reduced** (put back into place) before they are medically assessed. The injuries are therefore sometimes missed or underestimated.

History, examination, and need for X-rays for joint injuries are the same as for hand fractures (above). Assessing **joint stability** is necessary for appropriate management of dislocated joints.

The PIP joint is the most commonly dislocated finger joint. Injuries to the MCP joint often occur in the thumb. Dislocations of DIP joints are commonly traumatic and often complicated by fracture and soft tissue injury.

PIP Joint Injury

The PIP joints are stabilized by their soft tissue structures, including the collateral ligaments and volar plates. Dislocations are described as **dorsal** (Fig. 15), **volar**, or **lateral**, depending on the direction of the middle phalanx to the proximal phalanx.

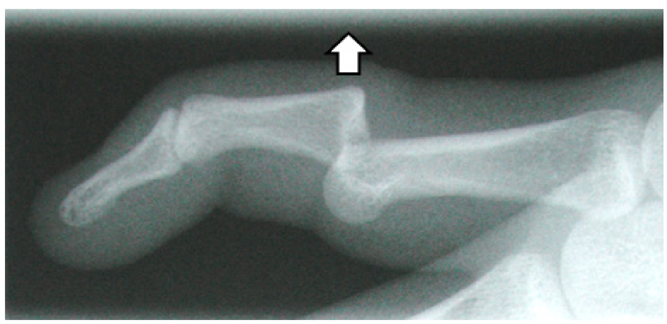

Figure 15. PIP joint injury with dorsal dislocation and tear of volar plate. Courtesy Dr. H. von Schroeder

A **dorsal PIP dislocation** is the most common type of finger dislocation. The injury occurs when the finger is bent backwards into extension. It occurs most commonly in young adults during sports or in the workplace when a finger is caught in machinery or during a manual task. With **hyperextension**, the volar plate tear can be seen as an **avulsion fracture** on a lateral X-ray of the joint. The PIP dislocation leads to obvious deformity of the middle phalanx and volar plate tenderness. The joint is reduced (realigned back into place) manually and early motion is preferred. Long-term splinting can result in severe stiffness of the joint. Despite treatment, the joint can remain swollen and tender for many months. Failure to treat PIP dislocations can lead to chronic pain, degenerative changes, and functional loss. If the joint is unstable after reduction, or it is associated with fractures, specialty care is required, and outcomes are less predictable.

Dislocation of the PIP joint in other directions can damage the insertion of the extensor tendon (**central slip**) or the collateral ligaments. These injuries require longer periods of immobilization. Because the PIP joints are crucial for grasping, careful follow-up is needed to prevent permanent impairment.

Ulnar Collateral Ligament Injury of the Thumb

Skier's thumb is an injury to the **ulnar collateral ligament** (**UCL**) of the thumb MCP joint (Fig. 16). It is the most common ligament injury in the hand and has a risk of disabling chronic instability if it is not treated properly. The injury occurs when falling onto a hand that is gripping a ski pole or a tool. This causes the thumb to bend outwards and thereby tear the ligament. The region is painful and swollen. Physical examination includes determining partial or complete ligament damage by stability testing and comparing to the opposite side. Complete tears and instability of the UCL are more frequent in men. X-rays are assessed for joint alignment and the presence of an avulsion fragment. The torn ligament or the avulsed bone-ligament can be very displaced and can sometimes be felt while examining the injury (**Stenar lesion**) or seen on ultrasound. A cast or splint is used to treat stable, undisplaced avulsion fractures and incomplete UCL injuries. However, surgery is necessary for displaced bony avulsion fractures, or complete UCL ruptures.

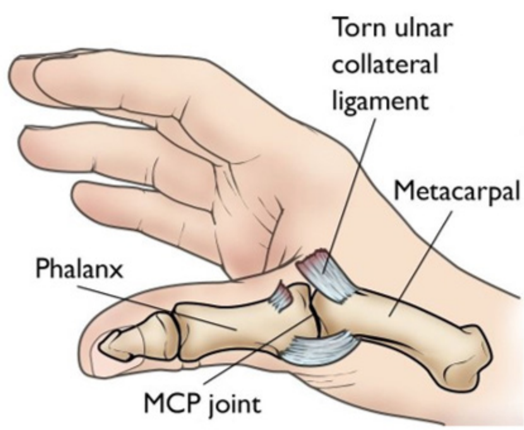

Figure 16. Skier's thumb – UCL tear. Reproduced with permission from OrthoInfo. ©American Academy of Orthopaedic Surgeons. https://orthoinfo.org/

The chronic version of an UCL injury is called a **gamekeeper's thumb**. This occurs with missed or untreated acute injuries, or from chronic attenuation of the joint. Chronic overuse is usually from decades of using a specific tool and is usually a work-related injury in this context. The term gamekeeper's thumb was originally used to describe weak thumbs in gamekeepers (keepers of rabbit and game hen). The injury occurred as the gamekeepers sacrificed the animals by manually breaking their necks. The condition is most common in elderly men. The physical examination findings are an unstable MCP joint (again, compared to the other side), but also a chronically enlarged joint due to arthritic changes that develop from years of instability. X-rays show malalignment of the joint and arthritic changes. Braces are commonly prescribed, but if these are not sufficient, **surgical reconstruction** or **joint fusion** are very successful, including return-to-work. Differential diagnosis of a gamekeeper's thumb includes **primary osteoarthritis** of the joint (without ligament tear), **radial collateral ligament injury**, or a **trigger thumb** (below). Pain and hyperextension deformity of the joint without a tear are often in conjunction with advanced arthritis at the base of the thumb (CMC joint).

Scapholunate Ligament and Perilunate Injuries

The **scapholunate ligament** (**SLL**) is named after the two bones (scaphoid and lunate) that it connects in the proximal carpal row (Fig. 4). It is the most injured ligament within the wrist. This injury occurs from falls or sudden twists when holding power tools. It occurs most commonly in young men and symptoms may be shrugged off as simply being a minor sprain and are therefore underdiagnosed and undertreated. The history and presentation are very similar to a scaphoid fracture (above). Examination identifies tenderness between the two bones on the back of the wrist and a specific finding of instability known as a positive **Watson shift test** in which the scaphoid can be subluxed, resulting in a clunk and pain. X-rays may show a gap between the scaphoid and lunate bones (Fig. 17), but the X-rays may be normal. X-rays done while the patient is actively gripping an object may make the gap more obvious, but an MRI or wrist arthroscopy may be required to confirm the diagnosis. Partial tears can be treated with cast immobilization. Full tears may require surgical reconstruction. If untreated, an SLL tear can progress to a specific pattern of osteoarthritis known as **scapholunate advanced collapse** (**SLAC** – see below) resulting in stiffness, excessive joint fluid production and hand weakness.

Figure 17. Scapholunate ligament tear of the wrist. The two bones splay apart on the right X-ray (arrow). Image credit:Samir Benoudina, Radiopaedia.org; rID: 51849

Higher energy injuries, such as a fall from a height, will tear not only the SLL, but the injury can continue through the wrist, resulting in a greater degree of damage. The disruption occurs around the lunate bone and these injuries are therefore called

perilunate injuries. These are severe injuries that require emergency assessment, X-rays, CT scan and surgical reduction and stabilization, or reconstruction. Many of these patients will have numbness of the hand, due to injury to the **median nerve** or swelling in the carpal tunnel requiring urgent **carpal tunnel release surgery**. Only half of workers with a perilunate injury will return to manual labour due to chronic pain, stiffness, and weakness.

Triangular Fibrocartilage Complex Tears (Fig. 18)

The **triangular fibrocartilage complex** (**TFCC**) has two functions on the ulnar side of the wrist. Together with the radius, the TFCC forms the socket and cushion for the carpal bones. The 'fibro' or ligament part of the TFCC stabilizes this side of the wrist, including the DRUJ.

The TFCC is at risk for either **acute injury (Type 1)** or **chronic degenerative (Type 2)** injury. Acute injuries occur in younger people from a fall onto the hand (with or without an associated radius fracture), or from a twisting injury (e.g. a power tool catching and twisting the wrist).

The second type of TFCC tear is due to natural wear. These occur proportionally with advancing age, and are more common that the acute type.

Figure 18. The TFCC (arrow) between radius and ulna supports the joint between the two bones and cushions the carpus. Image credit: SciePro

Patients at higher risk for TFCC injuries are those who have an ulna bone that is longer than the radius at the wrist (**positive ulnar variance**). This occurs normally in about 10% of the population. With the longer ulna, there is less space between it and the lunate bone, such that the TFCC is thinner and more likely to tear.

Patients with a TFCC injury have pain on the ulnar side of the wrist. Clicking or popping can occur with motion. Some patients will describe a prominent ulnar head and problems with twisting the forearm or carrying weight in certain positions. Careful physical examination is required to sort out the issues, since there are many causes of ulnar wrist pain due to other ligament injuries or arthritis. An X-ray is used to look for positive ulnar variance and previous radius fractures, or fractures of the ulnar styloid where the TFCC anchors. An MRI scan is useful as a preliminary diagnostic tool. However, given that the incidence of TFCC tears increase with age, false positive scans are common. About 50% of people in their 50s will have a TFCC tear, and this number increases by 10% per decade of life. Treatment includes strapping or bracing the wrist, use of **non-steroidal anti-inflammatory drugs** (**NSAIDs**), **corticosteroid injections**, and surgery, including **arthroscopic surgery**. **Arthroscopy** is the diagnostic gold standard, since the TFCC can be directly visualized and tested, and often treated. In cases of positive ulnar variance, the ulna bone can be shortened surgically (**ulnar shortening osteotomy**), or the radius can be lengthened if there was a previous fracture and malunion of the bone.

G. Mutilating Hand Injuries

Severe injuries that cause damage to multiple tissues of the hand has devastating effects on an individual's life. In the workplace, these are usually from heavy machinery. There are unlimited permutations and combinations of the severity, extent, and the number of tissues involved. Surgical treatment plans are aimed towards functional recovery; however, the effects of the original injury, repeated surgeries (and failures), possible infections, and scar formation may often lead to poor outcomes with stiffness and chronic pain of the hand. Psychological recovery is difficult and underscores the need for **multidisciplinary care** for these patients. Factors reported to predict psychological sequelae of hand injuries include injury severity, pain, limb dysfunction, negative perceptions of injured limbs, suboptimal coping mechanisms, and limited social support.

Aging and Osteoarthritis

A. Primary and Secondary Osteoarthritis

Primary osteoarthritis (OA) is the most common form of arthritis, affecting millions of people worldwide. It occurs when the protective cartilage within the joints thins over time. It is a degenerative and progressive condition. In the hand, the two most common sites of OA are the **base of the thumb** and the **small joints of the fingers**, particularly the **DIP joints**. Symptoms include aching and pain of the involved joints, stiffness in the morning and after activity, joint tenderness, loss of motion and flexibility, and a grating or crackling sensation.

An OA joint will slowly increase in size for several reasons: there is an increase in fluid within the joint, and chronic swelling; the soft tissues thicken and bone spurs develop around the joint making the joint appear 'knobby'; and the joint may sublux and lose normal alignment and appear crooked. Although there is a degree of inflammation in and around an OA joint, and the joint may go through phases of redness and more tenderness, OA is not classified within the inflammatory arthritis group of joint conditions that includes **rheumatoid** and **psoriatic arthritis**. General risk factors for OA include female sex, increased age, obesity, genetics, and certain metabolic disease (e.g. diabetes, hemochromatosis).

Secondary OA develops after an injury or infection to a joint. Typically, a fracture that has extended into the joint can disrupt the smooth cartilage surface. Damage to a ligament can result in loss of joint stability and excessive pressure or motion on the cartilage. Bone deformities can also change the mechanical load across a joint, resulting in OA changes.

B. Osteoarthritis at the Base of the Thumb

The **carpometacarpal (CMC) joint** at the base of the thumb is one of the most common sites of OA in the body (Fig. 19). The incidence of arthritis is almost ubiquitous, with women having symptoms as early as in their fifth decade and men later in life. **Hypermobility** or **joint ligament laxity**, which is more common in women, may be a contributing factor for the earlier onset in women. Genetics play a role as well.

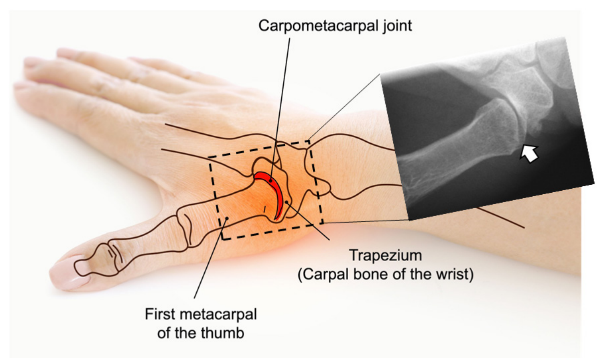

Figure 19. Osteoarthritis at the base of the right thumb CMC joint. X-ray of boxed area shows sclerotic and narrow arthritic joint (white arrow).Image credits left to right: Mikael Häggström, M.D., SrideeStudio

For the CMC joint, the OA changes result in the thumb metacarpal subluxing out of the joint and bone spurs (**osteophytes**) cause the joint to appear more prominent. Tenderness develops and pain is worse with use. The arthritis is usually present in both hands, but rarely does it begin at the same time. OA here is progressive. This is seen on X-rays and clinically, with increasing deformity. However, a patient’s pain and complaints are not proportional to X-ray progression and can be episodic.

Diagnosis is by physical exam and routine x-rays. Treatments include anti-inflammatory medications, analgesics, splints, corticosteroid injections, and surgery. OA at the base of the thumb is associated with osteoarthritis in other small joints of the hand, with **carpal tunnel syndrome**, and with **de Quervain’s tenosynovitis**.

Controversy exists between OA and work. OA develops with age and a combination of hereditary, and constitutional causes listed above, but the list does not include occupational risks unless there is a clear history of work-related trauma, resulting in secondary OA. Complicating matters is the wide range of decisions that are made regarding work-relatedness to OA diagnoses. OA joints are painful during activities, and hence, work activities are indiscriminately blamed for creating the condition that is commonly referred to as ‘wear and tear’. Awkward postures, extreme movements, and minor injuries can trigger symptoms that have been gradually developing with few or no symptoms for many years, or these events can make existing symptoms worse in workers who already have established OA. As with all conditions that have a multifactorial cause, a rational decision regarding the relative contribution of work activities towards the disability must be based on a careful analysis of the forces on the hand in the workplace, and the duration of those activities measured in years.

C. Osteoarthritis of the Wrist (SNAC, SLAC)

A broken scaphoid bone (above) may not heal because the young men with the injury may not seek medical attention, or the fracture is simply missed on routine x-rays. The fracture that has not healed is termed a **non-union** or **pseudarthrosis** (false joint at the fracture). The unhealed bone can remain symptom-free for several years or decades, but the chronic broken bone changes the mechanics of the wrist, resulting in a predictable pattern of osteoarthritis in the wrist termed **Scaphoid Non-union Advanced Collapse (SNAC) arthritis**.

Similarly, a tear of the scapholunate ligament between the respective bones may not heal. The ligament may also wear out (**attrition**) over several years and may be related to a specific calcium deposition. Whether an acute tear or attrition, the wrist slowly becomes arthritic over years or decades due to the abnormal mechanics of the wrist (Fig. 20). This predictable pattern of osteoarthritis is termed **Scapho-Lunate Advanced Collapse (SLAC) arthritis.**

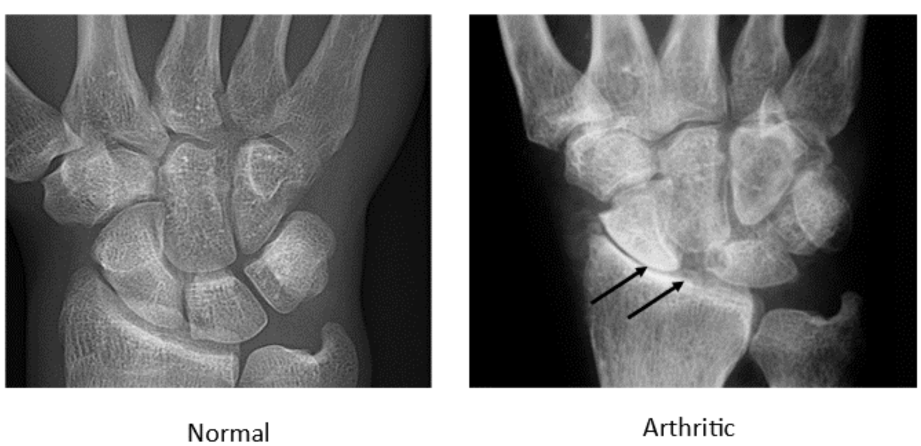

Figure 20. SLAC osteoarthritis. Image credits left to right: Mikael Häggström, M.D,Samir Benoudina, Radiopaedia.org; rID: 51849

Both SNAC and SLAC arthritis are forms of osteoarthritis. They are progressive, but the symptoms may remain relatively quiescent for many years or decades. However, pain and dysfunction following relatively minor trauma frequently occurs later in life. This **secondary trauma** triggers an increase in symptoms for which the patient seeks medical advice. The minor trauma may be, for example, forcibly extending the hand while pushing open a door, or a sudden twist of the wrist. These secondary traumas occur in common situations, including the workplace, and for this reason, the work-related event is identified as creating the condition despite x-rays showing that the arthritis had been developing for years. When assigning causation, “thin skull” principles may apply, with work being assigned as an aggravating factor, particularly if a worker has a long history of work and sports without any symptoms. Regardless, the symptoms would have eventually occurred with work or non-work events.

Abnormalities Without Trauma

A. Compressive Neuropathies – Tunnel Syndromes

The three major nerves to the hand, the **median**, **ulnar** and **radial nerves** can be compressed at several sites along their path from the neck (cervical spine) to the hand, to cause symptoms. Major causes are described below, but several important concepts must be considered when treating or assigning causation. These include aging, demographics, medical factors, posture, **double crush** (compression at more than one site), and association with other **repetitive strain** issues.

Median Nerve

Carpal Tunnel Syndrome

The most common compressive peripheral neuropathy caused by compression of the **median nerve** at the carpal tunnel of the wrist. Please refer to the WSIAT Carpal Tunnel Syndrome Medical Discussion Paper (2022).

Pronator Syndrome and Lacertus Fibrosus Syndrome

These three syndromes are neuropathies of the **median nerve** at the elbow region (Fig. 21). They are due to compression by different local anatomical structures. Discomfort develops in the proximal anterior forearm and worsens with activity. Nerve entrapment in this region causes **paresthesia** (tingling) and **dysesthesia** (abnormal sensation) of the thumb, index, middle, and half of the ring finger. This is the same pattern of numbness and tingling as with **carpal tunnel syndrome**, but the patient’s physical examination differs with symptoms and provocative testing that is localized at the anterior elbow region. A careful physical exam is therefore required. **Neurodiagnostic testing** is often non-contributory. Splinting, activity modification, and surgery are the main treatment options. As with carpal tunnel syndrome, these syndromes are often attributed to work activities. A case for causation could be made for jobs that require excessive pronation of the forearm (e.g., using a screwdriver) since both the **pronator muscle** and the **lacertus fibrosus** tighten with this activity resulting in direct compression of the nerve.

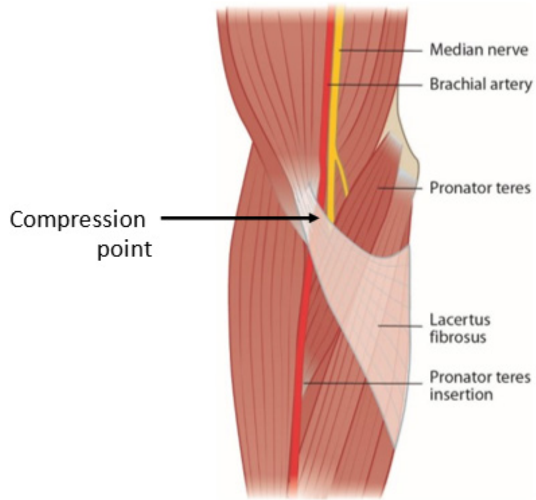

Figure 21. Median nerve compression at the elbow.
Image credit: https://www.mdpi.com/2077-0383/11/14/3988

Ulnar Nerve

Cubital tunnel syndrome (CUTS)

This is an entrapment neuropathy of the **ulnar nerve** at the elbow. There are several anatomic structures that can compress the nerve in this region. Patients report numbness and tingling in their small fingers and half of their ring fingers. They may notice weakness of the hand and trouble with dexterity. Muscle wasting of the hand occurs with advanced cases. CUTS is exceptionally common after middle age, regardless of work status. In workers, it is attributed to repetitive or sustained activities that involve flexion of the elbow (e.g., holding a phone). Sleep posture with flexed elbows is a cause and aggravating factor.

Physical findings are a positive **Tinel's sign** at the **cubital tunnel**, resulting in **paresthesia** (tingling) to the small finger and to the ulnar half of the ring finger. Tinel's testing will result in stronger paresthesia on the affected side, but the condition can be bilateral in many patients. Clinical examination also includes an **elbow flexion test** in which the elbow is maintained in a flexed (bent) position in an attempt to induce the symptoms. Less commonly, the nerve can slide or sublux out of the cubital tunnel. CUTS can be associated with **medial epicondylitis (golfer's elbow)**. Surprisingly, patients with CUTS are often erroneously diagnosed with carpal tunnel syndrome although the findings are quite different.

Workplace causation is assigned if a worker has a job that requires sustained elbow flexion or repeated forceful flexion. The treatment for CUTS is **activity modification** to prevent elbow flexion (day and night) or **surgical release** with or without **transposition of the nerve** in front of the flexion point at the medial epicondyle.

Guyon's Canal — Ulnar Tunnel Syndrome

The **ulnar nerve** is vulnerable in its groove in the palm of the hand between the pisiform and hook of the hamate bone. Nerve function may be interfered with by constriction or by recurrent friction. The disease occurs among labouring occupations. Symptoms of ulnar tunnel syndrome are numbness and tingling on the ulnar side of the hand (small and half of the ring finger), similar to CUTS. The difference is that CUTS includes numbness on the dorsal side of the hand. With **Ulnar Tunnel Syndrome**, weakness and wasting of the ulnar-innervated muscles of the hand can occur. Causal factors include severe and repeated pressure at **Guyon's canal**. Imaging (ultrasound or MRI) is indicated to rule out a mass, such as a **ganglion**, in the canal.

Radial Nerve

Radial Tunnel Syndrome

This syndrome is due to entrapment of the **deep branch of the radial nerve** in the proximal forearm. Patients have deep, aching pain in the forearm. Many cases are misdiagnosed and mistakenly treated for **lateral epicondylitis**, although the two conditions are distinct on physical examination and can co-exist. The pain localizes to the proximal forearm distal to the origin of the extensor muscles. It commonly radiates proximally and distally along the dorsolateral aspect of the forearm. There are no sensory disturbances. It may be associated with activities involving excessive forearm twisting, but most cases are idiopathic. This condition is infrequent and controversial.

B. Tendonitis and Tenosynovitis

Tendonitis and **tenosynovitis** are terms that are used to define pain along tendons and their compartments (**sheaths**), respectively. An enthesopathy refers to pain along a tendon as it inserts into bone. They represent injury or inflammation. These conditions frequently arise around the wrist, and they can be one of the most common issues found in factory or assembly line workers. The etiology may be associated with exposure to new or unusual work, such as returning to work after absence or sudden strain or increasing the intensity or speed of a task. It can occur after localized blunt trauma. Symptoms may include constant pain, aching or shooting pains up the arm, swelling, creaking tendons (**crepitus**) and restriction of movements. The pain results in restricted motion and weak grip strength.

Tendon inflammation can be **acute**, **subacute**, or **chronic**. For **acute tenosynovitis**, the onset is recent, for example, immediately following a weekend of heavy gardening or a sudden change in work activities. Symptoms are mild redness of the area over the affected tendon, warmness of the affected area, severe pain, painfulness of the tendon when moved and possibly palpable and audible crepitus. For **subacute tenosynovitis**, the physical findings are less severe. Symptoms include a dull ache over the tendon, discomfort with specific activities and some tenderness over the tendon and possible adjacent tendons. With **chronic tenosynovitis**, pain is persistent, and tenderness is mild. Motion is limited and likely related to the reactive fibrous tissue in the tendon sheath. Strength is reduced.

Risk factors include peri-menopausal or post-partum women, medical conditions such as diabetes, and perceived overuse.

De Quervain's Tenosynovitis

De Quervain's tenosynovitis (a.k.a. **stenosing tenosynovitis**, **tenovaginitis** or **tendonitis**) is a common and well-recognised inflammation, typified by a very localized swelling at the radial side of the wrist and thickening of the **fibrous sheath** (Fig 22). Pain is located over the radial styloid region along the **abductor pollicis longus** and **extensor pollicis brevis** tendons. The exact cause is unknown. Excessive friction from overuse may be a factor, because it tends to occur after repetitive actions. It is also common in women in the post-partum period. Some cases are without an identifiable cause, while others are due to trauma. The diagnosis is based on the localization of pain at the radial aspect of the wrist plus a positive **Finkelstein's test**. Osteoarthritis at the base of the thumb is commonly associated with de Quervain's tenosynovitis or may be an alternative cause for pain in the region.

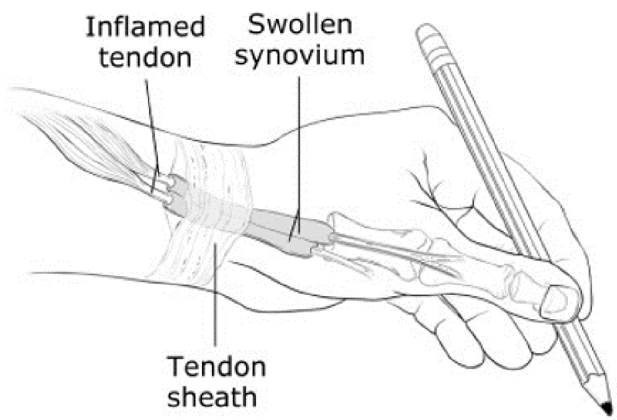

Figure 22. De Quervain's tenosynovitis. Reproduced with permission from Griffin LY (ed): Essentials of Musculoskeletal Care, 3rd Edition. Rosemont, IL. American Academy of Orthopaedic Surgeons, 2005

Trigger Digit (Stenosing Tenosynovitis)

A **trigger finger** or **trigger thumb** is characterized by clicking, locking, limited motion, and pain at the base of a digit in the palm (Fig. 23). It is due to impingement of the **flexor tendons** as they glide through the **first tendon sheath** (the **A1 pulley**.) The exact etiology is yet to be identified, but has been associated with swelling or fraying of a flexor tendon and inflammation of the **tenosynovium**. The A1 pulley may thicken (**hypertrophy**) and tighten with age and overuse. A **nodule** may be felt at the pulley as the patient attempts to move the digit. It occurs in about 3% of the population. The condition is age-related, especially in the fifth and sixth decades of life. It is more common in women, in patients with diabetes mellitus (10% of diabetics), and with osteoarthritis of the small joints of the hand. It has been associated with carpal tunnel syndrome and has a slightly higher incidence after carpal tunnel release surgery. It is attributed to repetitive work or heavy gripping, including in sports, but occurs with similar frequency in non-workers. Diagnosis is made with physical examination. Differential diagnosis includes Dupuytren's contracture, a genetic thickening within the palm resulting in static finger flexion deformity.

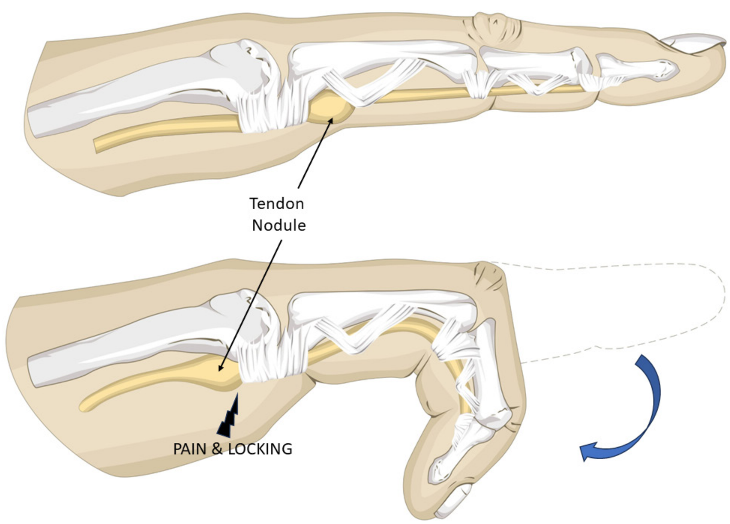

Figure 23. Trigger finger. Image credit: Akora Illustrator

C. Repetitive Strain Injuries and Overuse

This is a heterogeneous group of musculoskeletal problems commonly attributed to doing repetitive tasks or constantly using the hands and arms. These disorders are exceptionally common with a prevalence of about 6% in the Canadian population and are commonly seen in workers, athletes, and musicians. They are known by terms such as **repetitive strain injury (RSI)**, **overuse syndrome (OS)**, **cumulative trauma disorder (CTD)**, and **work-related upper limb disorders (WRULD)**. The terms are often used interchangeably. They are challenging in terms of management and adjudication.

Overuse conditions are characterised by pain, but can also include joint stiffness or decreased motion, tingling or numbness, cramping, or swelling. These issues can affect any part, or several regions of the upper limb (including the shoulder and neck), or even the opposite side. They can result in fatigue, a decline in work performance and years of impairment. Because they are associated with tenderness along nerves, tendons, joints, and muscles, they may incorporate the more specific diagnoses such as carpal tunnel syndrome or tendinitis.

Pathophysiology

A medical model for these conditions remains the prominent assumption. The terms Repetitive Strain *Injury* and Cumulative *Trauma* Disorder imply an etiological mechanism of "injury" or "trauma," but acute trauma is uncommon as an initiating event, and there is rarely any definable tissue damage. Proposed concepts of musculoskeletal micro-tears, muscle fatigue, muscle over-contraction, and low oxygen in the tissues are likewise unsatisfactory to account for the chronicity and severity of symptoms.

Within the medical model, an inflammatory process is often used to rationalize the injury or chronicity. It follows that strategies to reduce the inflammation (i.e. rest, splints, and anti-inflammatory medications, including corticosteroids) are helpful in treatment, but frank signs of inflammation are also uncommon, and these treatments are rarely effective in long-term symptom control.

Causation and Workplace Etiology

Demographically, these conditions are more common in women in the perimenopausal age group. There is a higher predisposition in patients with certain medical conditions, such as diabetes and obesity. Hypermobility, previous injury, pregnancy, sleeping postures, and general health (including inactivity, and smoking) are all factors associated with the development of these conditions. Studies have shown that **psychosocial factors** are also risk factors. These include depression, catastrophizing, negative attitudes towards employers, and monotonous work. Finally, recreational activities (sports, hobbies, musical instruments) and work itself are co-factors and are often blamed as the root of origin for the conditions regardless of whether or not they actually are.

Despite being multifactorial, the various possible contributory components are often not investigated. Instead, the functional loss is commonly attributed to repeated movement, heavy or unaccustomed "overuse" in the workplace. Assembly line work, keyboard use, and repetitive heavy work are commonly blamed as a cause for overuse syndromes. However, they occur with any type of work and have a variable onset.

Clinical Picture

Symptoms may be acute and localized, or they can be characterised by chronic and generalized (**diffuse**) pain. When acute, they can be triggered by a sudden increase in workload or force, work duration, changing work tools or instruments, or less commonly being struck by a blunt object. Alternatively, they can arise gradually and stay subclinical with few, if any, symptoms, and then be precipitated or aggravated by relatively minor trauma, repetition, lack of rest breaks, poor posture or positioning, or shiftwork.

Natural History

For early and mild cases of an overuse syndrome, these symptoms have the shortest duration and best prognosis. In these cases, the pain is at one anatomical site of a patient's upper extremity and can be associated with specific activities. The pain is described as an ache or tiredness that improves when avoiding certain activities or with rest.

It more advanced cases, the prognosis is poorer. The pain is at multiple sites with varying severity and can be associated with all work and non-work activities. Loss of strength is universal and poor coordination for fine tasks is typical. Pain can progress and be present at rest and at night, thus affecting sleep. Swelling is sometimes present. Work modifications may be set for prolonged periods or decided to be a permanent requirement. Absences from work are common, and termination may occur.

Although rare, an overuse syndrome can progress to severe chronic pain, hypersensitivity, cold intolerance, profound weakness, and progressive joint contractures. When this occurs, symptoms generally involve most of an upper extremity. Rarely is there a clear etiology, or minor trauma may have occurred early in the evolution of this disorder, but the condition is thought to have both physical and psychological causes. It is often viewed with suspicion because of the severity of the symptoms with few physical signs, and the poor outcomes with any treatments. It differs from Complex Regional Pain Syndrome (*a.k.a*. Reflex Sympathetic Dystrophy) that follows a definable acute injury.

Diagnosis of Overuse Syndromes

The diagnosis of RSI is based on identifying an activity that may be responsible for the condition, such as repetitive work, over-training for a sport, or over-use of a musical instrument. At first, the physical findings can be vague or unimpressive; they typically include weakness and general tenderness.

Despite being common, the diagnostic criteria are poorly or inconsistently defined in medical textbooks and in the lay press, and remain controversial. Even amongst medical experts, there are differences of opinion concerning the diagnoses of these conditions. For example, up to half of the doctors who write expert reports do not consider that RSI is a genuine disease entity.

Diagnostic dilemmas, changing symptoms, inadequate or ineffective treatments, or the chronic nature of many of these issues, can further lead to confusion. This can add to progression to chronic pain, possible mistreatment, and denial of claims.

Overuse conditions are associated with many other conditions including **tendinitis** (e.g. de Quervain's), **nerve compression syndromes** (e.g. carpal tunnel syndrome), **ganglion cysts**, **trigger digits**, and **epicondylitis** (tennis elbow, golfer's elbow). They are also associated with **osteoarthritis** but do not lead to osteoarthritis. As these associated conditions are treated, the overuse issues can persist, primarily seen as prolonged or chronic pain issues. This results in ongoing difficulties towards helping patients and establishing return to work or other activities.

Investigations

There are no gold-standard tests that can diagnose an overuse syndrome. Although many investigations such as x-rays, MRIs, ultrasounds, and neurodiagnostic tests are performed, they are often negative and add to the nebulous nature of the overuse conditions and the costs of managing them. Investigations are justified by the possibility that they may lead to finding a treatable source of pain, but they only rarely identify specific causes and have high false positive and false negative rates.

Treatments

Patients can be using anti-inflammatory medications, analgesics including narcotic medications, and may self-medicate with alcohol, marijuana, or illicit drugs. Patients often immobilize the area of injury in splints, braces, straps, wraps and/or slings. They may be applying ice or heat, or both. **Physiotherapy** or **occupational therapy** are commonly recommended. Therapy can focus on posture correction, stretching, strengthening, pain-control strategies, and education about the condition. Activity modification, including work restrictions, are typically recommended. Corticosteroid injections and surgery (rarely) are offered as attempts to control the regions of maximal pain. Multimodal approaches and **cognitive behavioural therapy** have shown some success, but overall, the wide array of treatments illustrate that overuse problems are difficult problems to resolve.

Controversy

Although quantifiable aspects of work (e.g. frequency of repetitions, weight of loads, duration of shifts or rest periods) are used to assign cause, there are no clear thresholds at which there is higher risk of developing an overuse issue. There are no types of work that have not been implicated in creating these conditions, including low force and low motion work. Further, changing the work or workplace, or attempts to prevent these conditions, is often ineffective.

Workers, their physicians, and family members often advocate within a medical model. However, opposing views claim that patients experience pain in the absence of organic disease. Workers are often blamed for laziness, poor motivation, or falsifying their symptoms, but full malingering is rare. Symptom exaggeration is common and is spurred by many factors including discontent with the nature and conditions of work.

Because of the varying types of work associated with the overuse syndromes, and because there is an incomplete understanding of the development of chronic musculoskeletal ill-health, these conditions are sometimes denied as work-related diseases. Judgement is therefore frequently required when ruling on causation.

However, in judgments that include a discussion of causation, there is rarely a clear indication as to whether or not the injury was solely due to the intensity of the work, or some combination of the many potential factors attributed to causation. A rational approach is therefore required.

Decision-making in determining the probability of a meaningful contribution of any aspects of the work towards the condition requires a clear understanding of the specific circumstances, covariates, and confounders contributing to the condition. When possible, it is helpful to know the statistics behind risk exposure, and the frequency or load of the tasks presumed to be responsible. This can add to a formal causal analysis (e.g., **Bradford Hill Criteria**) to establish a reasonable link leading to injury. In part, a detailed analysis will also include the elements of a temporal relationship, plausibility, and dose-response.

D. Ganglion

A **ganglion** is a benign fluid-filled cyst arising from a joint, ligament, or tendon sheath. These cysts are most common on the dorsal side of the wrist (Fig. 24) in young women and may be associated with **hypermobile** joints. If occurring at the small joints of the hand, they are called **mucous cysts** and are associated with degenerative changes of the joint in elderly people. They are frequently seen as incidental findings on MRI scans and may be completely asymptomatic. Rarely do ganglia cause any pain; however, they can cause some discomfort when they appear, or when they become large. They may resolve spontaneously and may re-appear randomly. They are very common, and their occurrence is often attributed to work or sports but based on the high frequency of ganglia in the general population, assigning a specific etiological factor or event is difficult.

Figure 24. Ganglion cyst. Photo credit: Makabas

E. Hypermobility Issues

A subset of young individuals, particularly women in their late teens and twenties, have wrist and finger joints that are more mobile than average (Fig. 25). They are very flexible and sometimes called “**double-jointed**”. A genetic or pathological basis for the issue is possible, but extremely rare. Because of the **hypermobility**, these joints can become symptomatic when exposed to increased workloads, heavy lifting, or repetitive work. Physical examination may find generalized joint pain. In the wrist, the carpal bones and the midcarpal joint feel loose. Hypermobility at the base of thumb (CMC joint) may be linked to **osteoarthritis** later in life. Other joints (e.g. elbows and knees) can bend backwards (**hyperextend**) and there may be a history of knee, shoulder, or other joint pains. Patients rarely have positive imaging studies (x-rays, MRI, CT, Ultrasound scans). The cornerstone of treatment is activity modification and splinting.

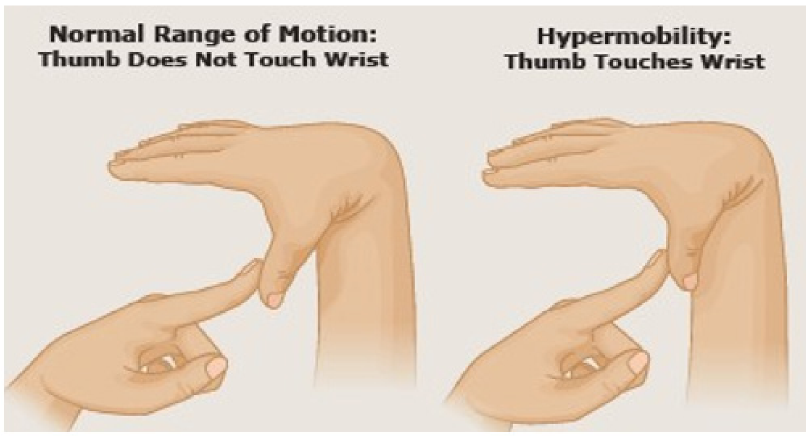

Figure 25. Hypermobility. Image credit: KidsHealth.org. For more on this topic, visit KidsHealth.org.

Marfan's syndrome is a genetic condition that affects connective tissues also resulting in very mobile joints. It affects about 1 in 5000 people but is much less common than routine hypermobility issues.

F. Kienböck's Disease

Kienböck's disease is a rare disorder of the lunate bone within the wrist that is caused by a decrease of the blood supply to the bone. This leads to the death of the lunate, known as **avascular necrosis** or **osteonecrosis** (Fig. 26). Kienböck's disease can be present for many months or years before causing symptoms. When symptoms occur, they include wrist pain, swelling, and limited motion. It usually only occurs in one wrist and most commonly affects younger adults.

Figure 26. Kienböck's disease (arrows) with progression from sclerosis to fragmentation to collapse of lunate bone. Courtesy Dr. H. von Schroeder

In most people, the reason for developing the condition simply is not known (idiopathic). People who have a specific anatomical pattern of the blood supply to the bone may be at risk, but this is impossible to prove. Another risk factor is an unusually short lunate bone. Just like some individuals have a long ulna bone (see TFCC tears above), others have a short ulna. A short ulna (ulnar negative variance) is thought to increase the mechanical load through the lunate and can potentially affect the blood supply. Kienböck's disease is also seen in people who have medical conditions such as lupus and cerebral palsy, as well as conditions that affect the blood supply such as sickle cell anemia.

Kienböck's disease is recognized as an occupational disease resulting from work-related trauma or from hand-arm vibration syndromes in some but not all countries. In general, wrist trauma is exceptionally common, but Kienböck's is very rare, and importantly, a link between trauma and the disease is not supported by the medical literature. The most common scenario is a worker who presents with wrist pain after a traumatic event. X-rays show an advanced stage of the disease but may be interpreted as an acute injury and, hence, cause-and-effect between the trauma and the disease is assigned. Given that the disease has taken years to progress, the trauma was in fact an aggravating event that brought the clinical situation to light. In such cases, it is likely that symptoms would have developed at some point in time (as per SLAC and SNAC arthritis above). The medical evidence is insufficient to determine cause-and effect between hand-arm vibration syndrome and Kienböck's disease. However, benefit of the doubt is often given to the injured worker but a careful study regarding causation is required in each individual case.

Kienböck's disease is thought to progress very slowly through four stages without treatment. In the early stage, symptoms can be mild, and x-rays are normal, with the exception of showing ulnar negative variance in some people. An MRI is required to make the diagnosis. With progression, the dead lunate will collapse and break apart. This can cause a shift in the position of the other bones in the wrist. Wrist pain increases, strength decreases, and wrist motion is limited. X-rays diagnose the condition and additional scanning (i.e. MRI, CT scans) provides further information. **In the final** stage, the collapsed and broken lunate causes arthritis through the whole wrist.

Based on the stage of the disorder, Kienböck's disease treatment options vary. For early stages, anti-inflammatory medication and immobilization are helpful. For advanced cases, corticosteroid injections are useful for symptom control. Several surgical options may be required to help with further progression of the disease.

Frequently Asked Questions

1. **What kind of x-rays changes indicate that a degenerative condition (e.g. primary osteoarthritis, SNAC or SLAC wrist, Kienböck's disease) is "pre-existing" prior to an index event?**

   Degenerative changes on an x-ray will consist of **narrowing of a joint space**, bone spurs (**osteophytes**), thickening of the bones (**sclerosis**), **bone cysts** or **erosions**, possible **subluxation** of the joint, and eventual **change in the shape** of a bone. Any of these changes indicate that the degeneration was pre-existing, as they all take many months to years to develop.

2. **A worker develops pain or has an injury and x-rays show osteoarthritic changes. Can the arthritis be work-related?**

   Osteoarthritis takes years to develop and would therefore be "**pre-existing**". Patients typically state that they had few or no symptoms before the injury, despite the x-ray changes. An arthritic joint is prone to pain and injury, sometimes with minimal force, and arthritis is therefore a risk factor for future issues. In these scenarios, cumulative years of work (and not the acute event or injury) are sometimes used to rationalize the symptoms. Often, work is assigned as an **aggravating factor** to such an underlying or pre-existing condition.

3. **A worker with wrist pain has an MRI that reveals a ganglion or a TFCC tear. Are these findings work-related?**

   These may be "false-positive" MRI findings and may or may not be related to the pain. A careful physical examination is therefore required as a first step towards an accurate diagnosis. If either of these conditions are a probable cause of the pain, a causal link between work activities and the physical findings would be useful since they are exceptionally common with similar frequencies in workers and non-workers.

4. **If a worker has developed carpal tunnel syndrome, are they more likely to develop other issues in the hand such as osteoarthritis of the thumb or a trigger finger?**

   Yes. These conditions tend to cluster together based on the general demographics and risk factors, but not necessarily because of work activities. This is particularly true for workers or patients with diabetes. There is a slightly higher risk of developing a trigger finger after carpal tunnel release surgery, likely due to the slight change in the mechanical pull of the tendons following the surgery.

5. **A worker has a traumatic wrist injury and develops pain and severe stiffness of the shoulder and the fingers on the same side. Are these a part of the worker's claim?**

   Yes. There are two common scenarios in which this occurs:

i) The other parts of the upper extremity were injured, but not recognized at the time of the index injury. For example, during a traumatic fall that resulted in a radius fracture, the fingers may have hyperextended, and the shoulder abducted to injure these respective joints, resulting in pain and stiffness. The deformity and swelling of the most injured part often result in a very focused assessment, causing other injuries to be overlooked until the injured worker complains about them at a later time. Patients can rarely describe the mechanism of injury well enough to establish all potential injury sites.

ii) Uninjured parts of the extremity can simply become stiff and painful. This may be due to swelling that tracks to the digits, or prolonged or inappropriate immobilization. This scenario is more frequent if there are underlying (often previously asymptomatic) degenerative changes, such as osteoarthritis of the small joints or a partial rotator cuff tear of the shoulder. In some cases, small finger joints appear to have an arthritic flare with focal pain and swelling despite not being injured. Although stiffness and pain can be very serious, they do not represent a complex regional pain syndrome or shoulder-hand syndrome that have a different etiology.

6. A worker has a severe hand injury and develops pain on the opposite side. Is this a part of the worker's claim?

It is common that patients will notice minor aches and pains when performing tasks with their opposite uninjured side, particularly if it is their non-dominant side. Many of these issues resolve spontaneously over time or as their injured side improves. If the uninjured side has persistent or severe issues, this is referred to as a compensable consequence and represents a chain of events that would generally not have occurred otherwise.

7. Why is it difficult to assign causation for repetitive strain injury/issue (RSI) and overuse syndromes and why are these conditions not always accepted as a work-related disease?

These are a complicated set of conditions, and the term "overuse" incorrectly implies that manual tasks are responsible for the conditions, when, in fact, they are multifactorial. What makes it problematic is that they can be difficult to accurately diagnose and treat. The conditions are vague or generalized, can have a prolonged onset, have varying symptom, and can become chronic. The incidences are similar in non-workers, particularly athletes and musicians, but these types of epidemiological data exclude relevant information when adjudicating on individual cases. Repetition is itself not supported as a major risk factor, although commonly assumed to be so. Arbitrary technical and exposure limit values should only be used as guidelines and not as thresholds since there is no specific type of work or intensity of work resulting in greater risk. In fact, work is specifically excluded as a cause of these conditions in some Western countries, particularly because the conditions are largely also scientifically unproven. Some physicians and experts deny these conditions exist. The biases and competing interests of patients, family members, and employers must also be taken into account when collecting decision-making information.

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