British Association of Hand Therapists (BAHT)

Level I

Hand Anatomy

With thanks to NES, Derby Pulvertaft Hand Unit and Mount Vernon Hospital

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Contents

BONES AND JOINTS OF THE HAND, WRIST AND FOREARM

The skeleton of the hand, wrist and forearm consists of 29 bones (diagram 1). The 2nd and 3rd metacarpals (MC) and the distal row of the carpus are the fixed elements of the hand. This promotes stability for grip. The phalanges and the 4th and 5th Metacarpals are the mobile part of the hand and allow grasping around objects.

All the joints of the hand and wrist have basic anatomic forms favouring flexion.

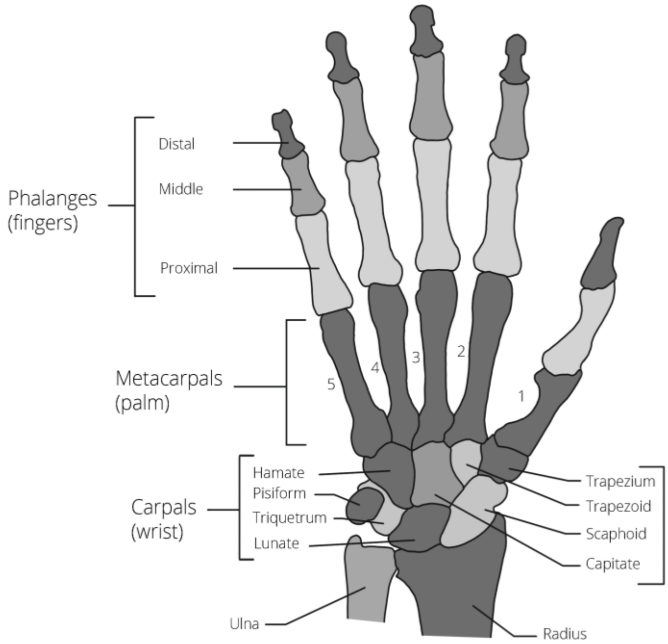


Diagram 1: bones of the hand

Wrist and Forearm Joints

The forearm has a proximal radial ulnar joint at the elbow and a distal radial ulnar joint at the wrist. The forearm has a range of movement of about 180 degrees in pronation-supination. In supination the radius and ulnar are parallel, and when pronating the ulnar remains static while the radius rotates around, becoming oblique, and therefore comparatively shorter.

The wrist or carpus consists of eight small irregular bones arranged in two rows of four.

Proximal row: **Scaphoid, lunate, triquetral and pisiform**

Distal row: **Trapezium, trapezoid, capitate and hammate**.

The wrist joint has two main components: radiocarpal and midcarpal. The radiocarpal joint is the articulation between the radius and the triangular fibrocartilage and the proximal carpal row (scaphoid, lunate and triquetrum). The midcarpal joint is the articulation between the proximal carpal row and the distal carpal row (trapezium, trapezoid, capitate and hamate).

Wrist joint movement consists of flexion, extension, radial deviation, ulnar deviation and circumduction. About 50% of flexion-extension of the wrist happens at the midcarpal joint and 50% at the radio-carpal joint.

<u>Finger Joints</u>

Each finger consists of a metacarpal and three phalanges (diagram 2). The length of the fingers varies as do the phalanges to allow the tips to converge in full grip.

Metacarpophalangeal Joint (MCP joint)

This joint lies between the metacarpal head and proximal phalanx base. These condyloid joints allow flexion, extension, abduction and adduction.

Collateral ligaments reinforce the capsule and are slack (relaxed) with the joint in extension thereby allowing lateral movement. The MCP joint is most stable in full flexion where the collateral ligaments are taut. Therefore the MCP joint should always be immobilised in this position, the position of safe immobilisation (POSI). This position is used to prevent the development of contractures, which can rapidly occur during the acute stage of trauma.

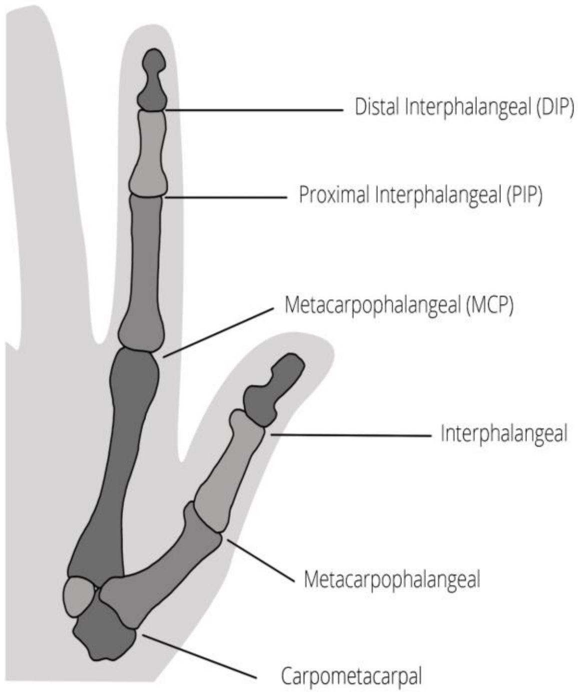


Diagram 2: joints of the hand

On average the ROM at these joints is 10 (extension) to 95 (flexion) degrees.

Proximal Interphalangeal Joint (PIP joint)

This important joint lies between the proximal phalanx head and middle phalanx base. It is often involved in injury and difficult to treat.

It acts as a hinge joint, allowing flexion and extension. The collateral ligaments are fixed laterally and obliquely preventing lateral movement through the arc of motion. Stability at the PIP joint is achieved by the collateral ligaments, the volar plate and the flexor sheath which inserts into the volar plate and the proximal and distal bone margins. It must be immobilised in extension where the collateral ligaments are taut and to prevent the volar plate from contracting.

The average ROM is 0-110 (flexion) degrees.

Distal Interphalangeal Joint (DIP joint)

This joint lies between the middle phalanx head and distal phalanx base. These hinge joints allow flexion and extension.

The DIP joint bony anatomy is similar to the PIP joint but is less stable and allows hyperextension to allow increased pulp contact.

Average ROM 20 (hyperextension) to 90 (flexion) degrees.

Thumb Joints

The thumb consists of the first metacarpal and two phalanges.

Carpometacarpal Joint (CMC joint)

This very mobile joint lies between trapezium and the metacarpal base.

It is a biconcave saddle joint that allows three full arcs of motion:

Abduction/adduction
Flexion/extension
Opposition/retropulsion

These combinations of movements allow rotation (circumduction).

Metacarpophalangeal Joint (MCP joint)

This lies between the head of the metacarpal and base of the proximal phalanx. It is a hinge joint allowing flexion/extension. Its main function is to provide stability to the thumb. It is most stable in full flexion but shows marked lateral movement in extension. It can become unstable if it hyperextends too much. There is a huge difference in the average ROM of this joint ranging from -30 to 90 degrees.

Opposition of the thumb occurs when both the CMC joint and MCP joint abduct.

Interphalangeal Joint (IP joint)

This joint lies between the proximal phalanx head and base of the distal phalanx. It is a hinge joint allowing flexion and extension.

The stability at the IP joint is achieved by the collateral ligaments, volar plate and flexor sheath. Average ROM 15 (hyperextension) to 80 (flexion) degrees.

Volar Plate/Palmar Plate

The Volar plate is a fibrocartilage plate which lies on the palmar aspect of the MCP joint, PIP joint and DIP joints. These insert firmly distally to the phalanx base and loosely proximally via two check rein ligaments, which fold allowing flexion (diagram 3). The main purpose of the volar plate is to provide stability by limiting hypertension. It is commonly injured in the PIP joint.

If the IP joints are allowed to stay in flexion for prolonged periods of time, the volar plate membranous tissues retract and result in flexion contractions.

Disruption of the volar plate in joint dislocations can lead to the inability to flex the joint (mechanical block) because the check rein ligaments tether and are unable to fold.

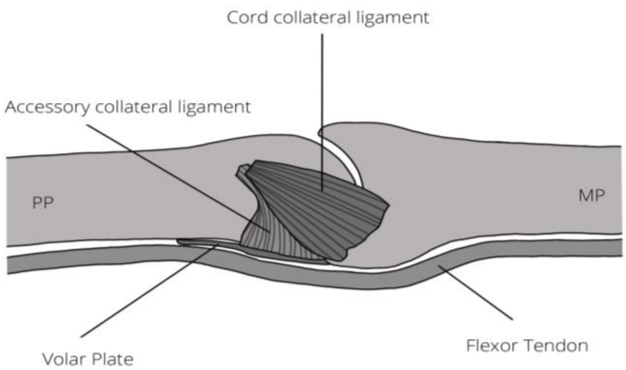


Diagram 3: PIP Joint showing collateral ligaments and volar plate

MUSCULATURE

The muscles of the hand rarely act independently. All movements require a precise integration of a group of muscle functioning either as a prime mover, antagonist, synergist or stabiliser.

The intrinsic and extrinsic muscles are balanced and integrate precisely to allow movement.

The extrinsic muscles will be described in terms of flexor and extensor tendon anatomy.

Flexor Tendon (diagram 4)

The wrist flexes using primarily the extrinsic Flexor Carpi Radialis (FCR), Flexor Carpi Ulnaris (FCU) and Palmaris Longus (PL).

The fingers are powered by two main extrinsic muscles – Flexor Digitorum Superficialis (FDS) and Flexor Digitorum Profundus (FDP).

The insertion of FDS and FDP is demonstrated in figure 5.

FDS flexes the PIP joint/MCP joint and is most effective in forceful grip and has a flexion action across the wrist. FDP flexes the DIP joint, PIP joint & MCP joint and has a flexion action across the wrist.

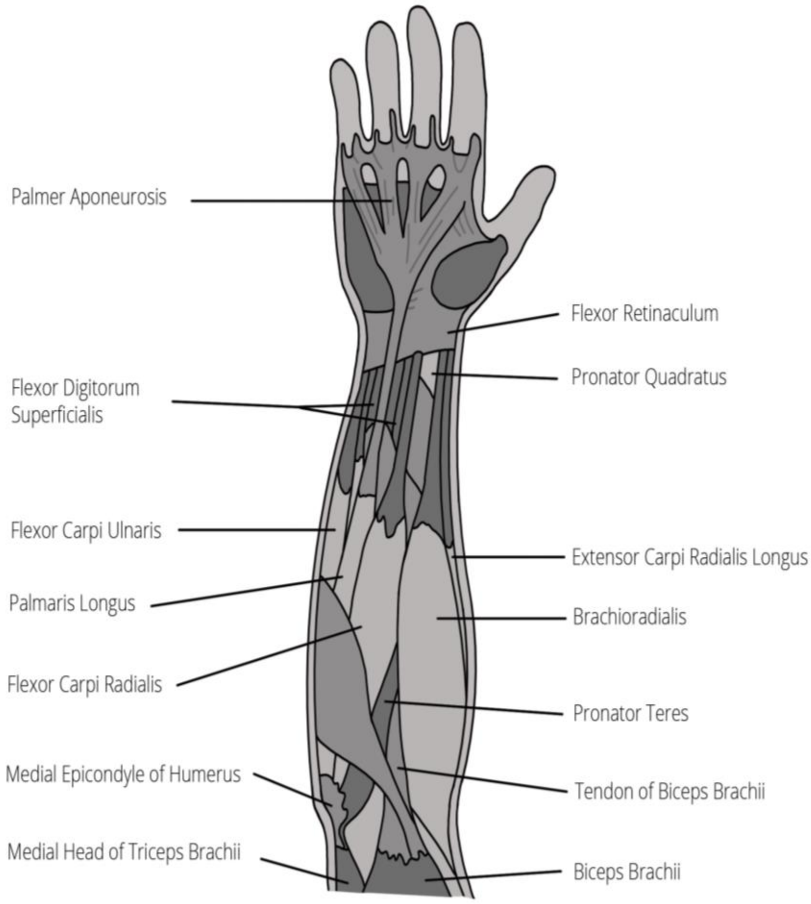
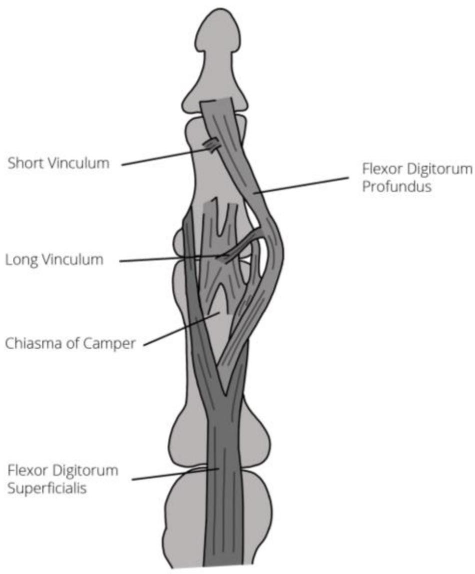


Diagram 4: flexor tendons



The movement of the fingers is further powered by intrinsic muscles, namely the interossei and lumbricals. These provide a balancing force to extension and flexion and produce power in extension (see intrinsic section).

Diagram 5: FDS and FDP

The thumb is powered by **Flexor Pollicis Longus** and flexes the IP joint, MCP joint and CMC joint. There are a number of variations present where the FPL muscle belly or part of, is fused with the index finger FDP muscle belly or tendinous slips. These people cannot move their thumb IP joint without flexing their index finger as well. This has no functional deficit, but initially encouraged the thumb and index finger to pinch more strongly together.

The thenar eminence is made up of three muscles which flex, abduct and oppose the thumb. The **Flexor Pollicis Brevis** (FPB), **Abductor Pollicis Brevis (APB)** and **Opponens Pollicis** (OP) (diagram 6).

Adductor Pollicis (AP) functions to adduct the thumb. It has two heads: transverse and oblique.

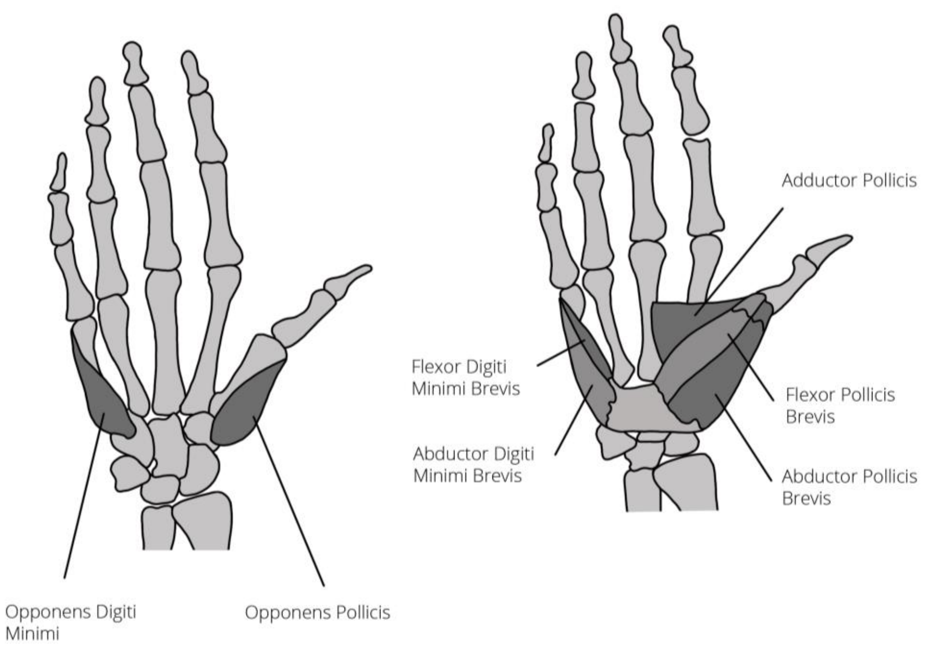


Diagram 6: muscles of the thumb

Flexor Muscles of the Hand and Thenar Eminence

Muscle	Origin	Insertion	Action	Innervation
Wrist				
flexor carpi radialis	common flexor tendon from the medial epicondyle of the humerus	base of the second and third metacarpals	flexes the wrist, abducts the hand	median nerve
flexor carpi ulnaris	common flexor tendon and (ulnar head) from medial border of olecranon and upper 2/3 of the posterior border of the ulna	pisiform, hook of hamate, and base of 5^{th} metacarpal	flexes wrist, adducts hand	ulnar nerve
palmaris longus	common flexor tendon, from the medial epicondyle of the humerus	palmar aponeurosis	flexes the wrist	median nerve
Fingers				
flexor digitorum superficialis	humeroulnar head: common flexor tendon; radial head: middle 1/3 of radius	shafts of the middle phalanges of digits 2-5	flexes the metacarpophalangeal and proximal interphalangeal joints	median nerve
flexor digitorum profundus	posterior border of the ulna, proximal two-thirds of medial border of ulna, interosseous membrane	base of the distal phalanx of digits 2-5	flexes the metacarpophalangeal, proximal interphalangeal and distal interphalangeal joints	median nerve (radial one-half); ulnar nerve (ulnar one-half)
Thumb				
flexor pollicis longus	anterior surface of radius and interosseous membrane	base of the distal phalanx of the thumb	flexes the metacarpophalangeal and interphalangeal joints of the thumb	median nerve

flexor pollicis brevis	flexor retinaculum, trapezium	proximal phalanx of the 1st digit	flexes the carpometacarpal and metacarpophalangeal joints of the thumb	recurrent branch of the median nerve
abductor pollicis brevis	flexor retinaculum, scaphoid, trapezium	base of the proximal phalanx of the first digit	abducts thumb	recurrent branch of median nerve
opponens pollicis	flexor retinaculum, trapezium	shaft of 1st metacarpal	opposes the thumb	recurrent branch of median nerve
adductor pollicis	oblique head: capitate and base of the 2nd and 3rd metacarpals; transverse head: shaft of the 3rd metacarpal	base of the proximal phalanx of the thumb	adducts the thumb	ulnar nerve, deep branch

Flexor Tendon Sheath and Pulleys

The flexor sheath in each finger consists of (diagram 7):

- five annular pulleys
- three cruciate pulleys

The annular pulleys "bind" the flexor tendons to the bone around each joint in the finger, preventing bowstringing. The most important pulleys are:

- A2
- A4

If they are injured the ability to actively fully flex the finger is compromised.

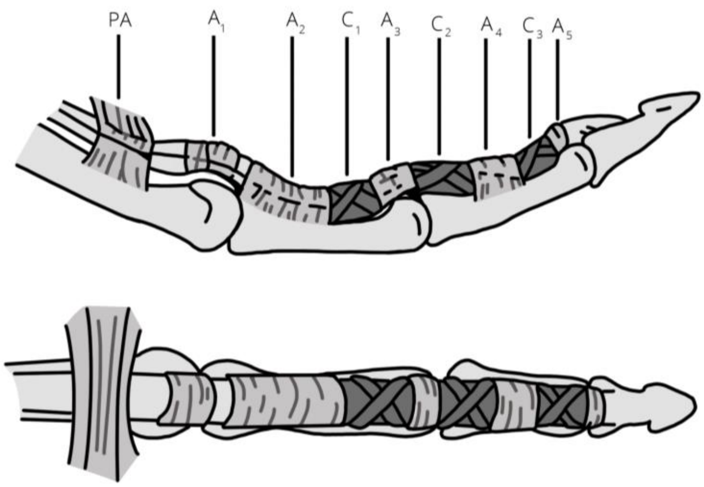


Diagram 7: pulleys of the hand

Trigger finger is a condition where there is thickening of the A1 pulley (most commonly) which catches/ locks the finger into flexion as the tendon tries to pass back under the A1 pulley during extension.

The cruciate pulleys, allows the flexor sheath to concertina, that is to change length during flexion-extension.

The thumb has an AI pulley volar to the MP joint and an A2 pulley volar to the IP joint. The oblique pulley is the largest and most important pulley in the thumb and lies between A1 and A2 obliquely across the proximal phalanx.

Wherever the flexor tendons run under a fibrous sheath they also have a synovial sheath to enable them to slide freely, minimising friction (diagram 8). The synovial sheaths also provide nutrition to the tendons.

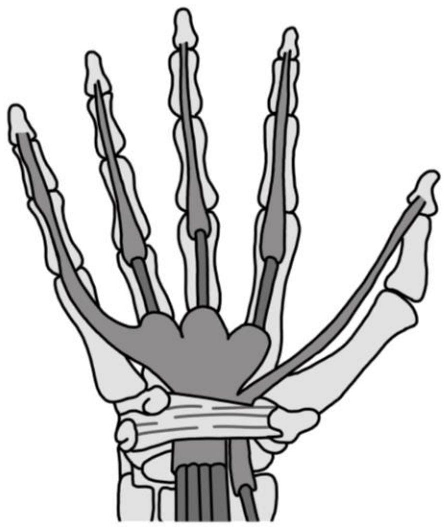


Diagram 8: synovial sheaths

Extensor Tendons

The extensor muscles (diagram 9) are essentially positional meaning that they do not work against resistance as flexors have to but only against gravity.

Across the dorsum of the hand, the four tendons of Extensor Digitorum Communis (EDC) fan out to the fingers, joined to each other across the dorsum of the hand by juncturae tendiniae and providing stable and strong extension at MCP joints. The tendons of EDC are not able to work independently from each other proximal to the MCP joints. They have a strong combined wrist extension action.

Extensor Indicis Proprious (EIP) and Extensor Digiti Minimi (EDM) act individually on the index and little finger respectively in extending these fingers. Wrist extension is provided by Extensor Carpi Ulnaris (ECU), Extensor Carpi Radialis Longus (ECRL) and Extensor Carpi Radialis Brevis (ECRB) as well as EDC. These muscles act in ulnar and radial deviation of the wrist depending on their relative position. It is vital for effective power grip to be able to extend the wrist to 20°-30°.

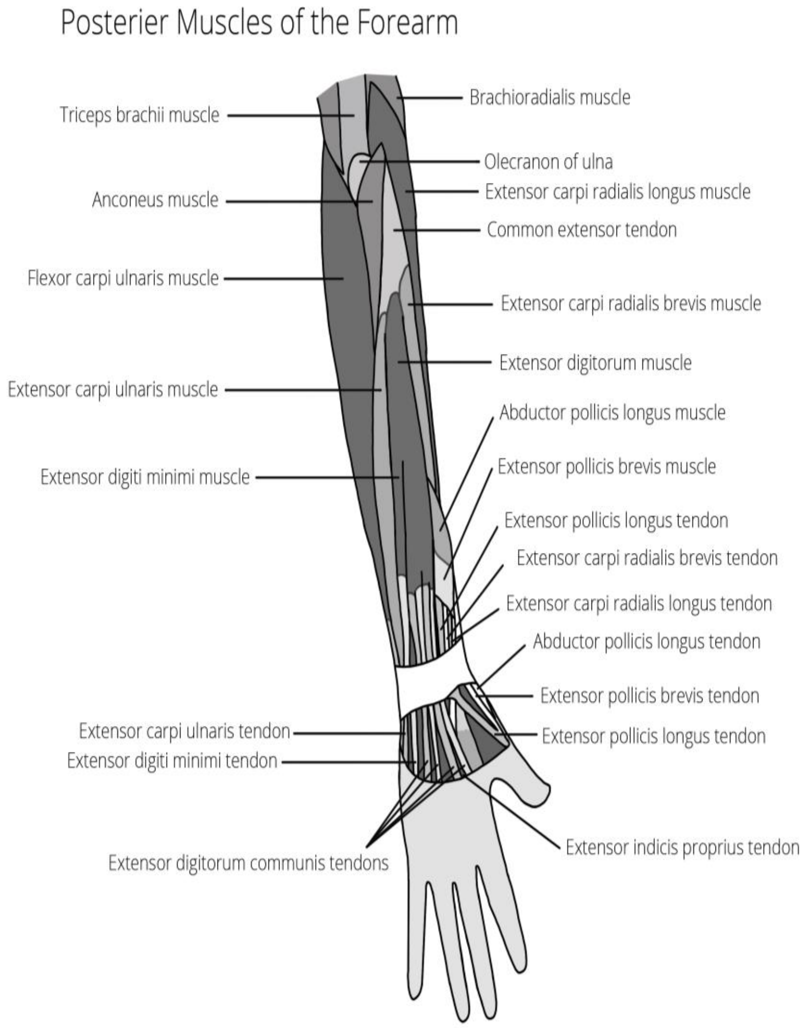


Diagram 9: extensor tendons

The thumb is extended by a combined action of (EPL), EPB and APL.
The **EPL** runs on the ulnar side of the dorsum of the 1st MC and continues as the central part of the extensor apparatus.
The **EPB** gives off fibres to the extensor apparatus and often is a slim tendon structure which insert at the base of the DP.

The **dorsal hood** is similar to the sagittal band of the other digits.

Extensor Muscles of the Hand

Muscle	Origin	Insertion	Action	Innervation
Wrist				
extensor carpi radialis brevis	lateral supracondylar ridge of the humerus (common extensor tendon	dorsum of the third metacarpal bone (base)	extends the wrist; abducts the hand	radial nerve
extensor carpi radialis longus	lower one-third of the lateral supracondylar ridge of the humerus	dorsum of the second metacarpal bone (base)	extends the wrist; abducts the hand	deep radial nerve
extensor carpi ulnaris	common extensor tendon and the middle one-half of the posterior border of the ulna	medial side of the base of the 5th metacarpal	extends the wrist; adducts the hand	deep radial nerve
Fingers				
extensor digiti minimi	common extensor tendon (lateral epicondyle of the humerus)	joins the extensor digitorum tendon to the 5th digit and inserts into the extensor expansion	extends the metacarpophalangeal, proximal interphalangeal and distal interphalangeal joints of the 5th digit	deep radial nerve
extensor digitorum communis	common extensor tendon (lateral epicondyle of the humerus)	extensor expansion of digits 2-5	extends the metacarpophalangeal, proximal interphalangeal and distal interphalangeal joints of the 2nd-5th digits; extends wrist	deep radial nerve
extensor indicis	interosseous membrane and the posterolateral surface of the distal ulna	its tendon joins the tendon of the extensor digitorum to the second digit; both tendons insert into the extensor expansion	extends the index finger at the metacarpophalangeal, proximal interphalangeal and distal interphalangeal joints	deep radial nerve
Thumb				

abductor pollicis longus	middle one-third of the posterior surface of the radius, interosseous membrane, mid-portion of posterolateral ulna	radial side of the base of the first metacarpal	abducts the thumb at carpometacarpal joint	radial nerve, deep branch
extensor pollicis brevis	interosseous membrane and the posterior surface of the distal radius	base of the proximal phalanx of the thumb	extends the thumb at the metacarpophalangeal joint	deep radial nerve
extensor pollicis longus	interosseous membrane and middle part of the posterolateral surface of the ulna	base of the distal phalanx of the thumb	extends the thumb at the interphalangeal joint	deep radial nerve

Extensor Retinaculum

At the wrist the extensor tendons and their synovial sheaths are held in six compartments (diagram 10) and covered by the extensor reticulum dorsally to prevent bowstringing.

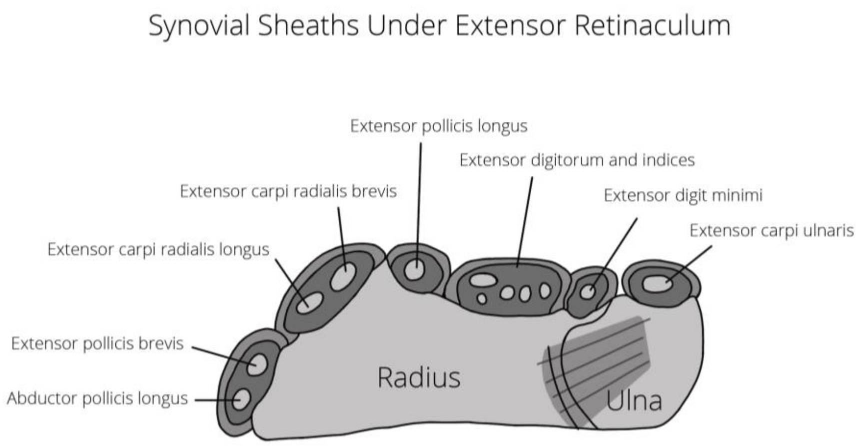


Diagram 10: extensor compartments

From radial border:

Compartment 1: EPB / APL	Compartment 2: ECRL / ECRB	Compartment 3: EPL
Compartment 4: EIP / EDC	Compartment 5: EDM	Compartment 6: ECU

Juncturae Tendinae and Extensor Hood

Juncturae Tendinae (or tendinum) are narrow connective tissue bands between the EDC tendons as well as to EDM but hardly ever to EIP (diagram 11). Their role is to maintain EDC tendons with space between them at rest and in movement, to co-ordinate movement and excursion between the tendons and stabilize the MCP joint. They also prevent independent use of individual fingers – particularly the ring finger. They may clinically mask a single EDC rupture.

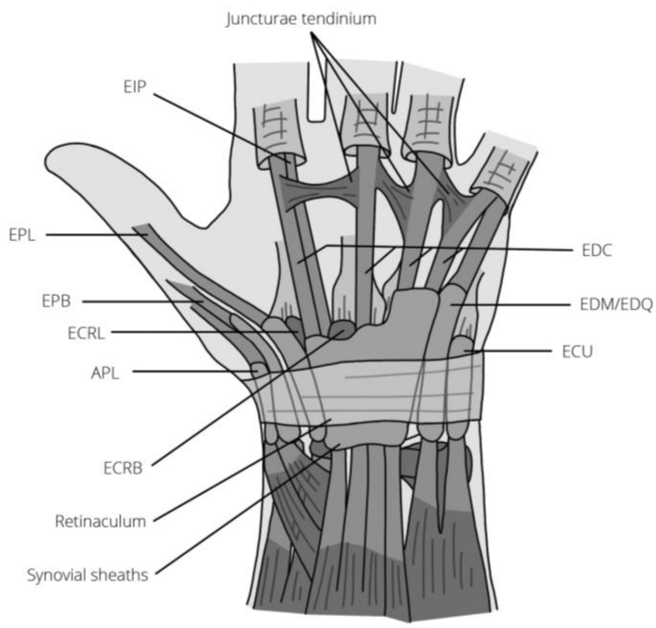


Diagram 11: Juncturae Tendinae

Over the MCP joints and proximal phalanges, the extensor tendon forms part of the extensor expansion (diagram 12).

The main part of the tendon travels over the PIP joint, being joined by a slip of the intrinsic tendon and inserts via the central slip in to the base of the middle phalanx. Its action is to extend the PIP joint. Two slips of the extensor tendon travel laterally and join with the bulk of the interosseous tendon (plus lumbrical tendon on radial side) forming the lateral bands. These move distally to insert in to the base of the distal phalanx and extend the DIP joint

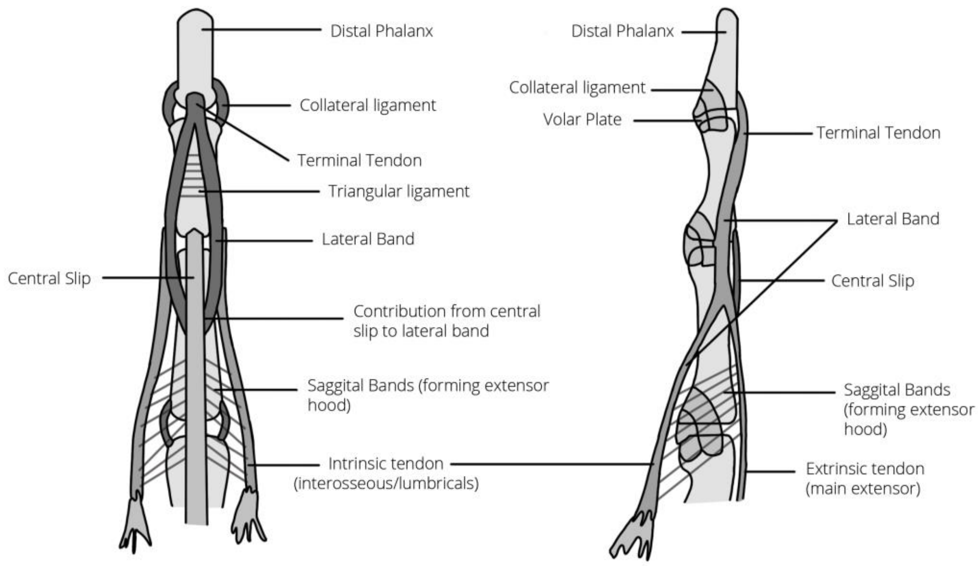


Diagram 12: extensor expansion

Interossei and Lumbricals

Intrinsic muscles include the interossei and lumbrical muscles (diagram 13), which help stabilise the hand. When these are not functioning as after a nerve injury the hand finds basic functions difficult. The lumbrical muscles are used for fine motion and the interossei are very strong giving the hand power.

Interossei Muscles

The interosseous muscles are all intrinsic, with four dorsal and three palmar muscles. They lie between the metacarpals, originating from the MC's. The palmar and dorsal interosseous tendons run laterally and dorsally to join with the lumbrical tendon (radial side only) and a slip from the main extensor to form the lateral bands. These then insert into the distal phalanx as the terminal tendon.

- The dorsal interossei abduct the fingers
- The palmar interossei adduct the fingers.

They control and provide power for extension of the IP joints with MCP joint flexion. They also have an action, with the lumbricals and extrinsic extensors in controlling MCP joint extension with IP joint extension.

Lumbrical Muscles

The four lumbricals originate from the tendons of FDP in the palm. They are small but strong muscles which travel to the radial side of each finger and insert into the tendon of the interosseous muscles alongside the proximal phalanx. The lumbricals originate volarly but insert dorsally, enabling them to have a dual action of MCP joint flexion with IP joint extension. Their most efficient action is in extending the IP joints with the MCP joints in extension. They then control IP joint extension as the MCP joints actively flex.

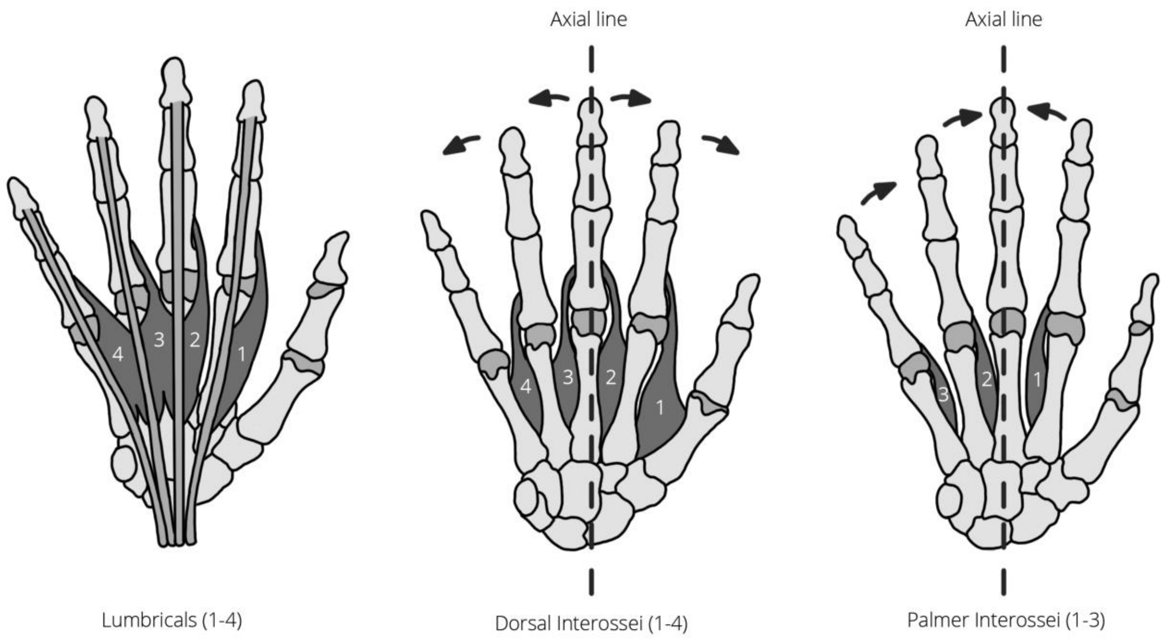


Diagram 13: intrinsic muscles of the hand

NERVE SUPPLY TO THE HAND

The peripheral nervous system begins in the brachial plexus in the axilla from C5, C6, C7, C8, and T1. The peripheral nerves are the radial, median, and ulnar nerve. The three major peripheral nerves go on to divide into motor and sensory branches through the forearm and hand.

The sensory distributions of the nerves are important to the function of the hand (diagram 14). The motor distribution will be covered in detail in the peripheral nerve lecture.

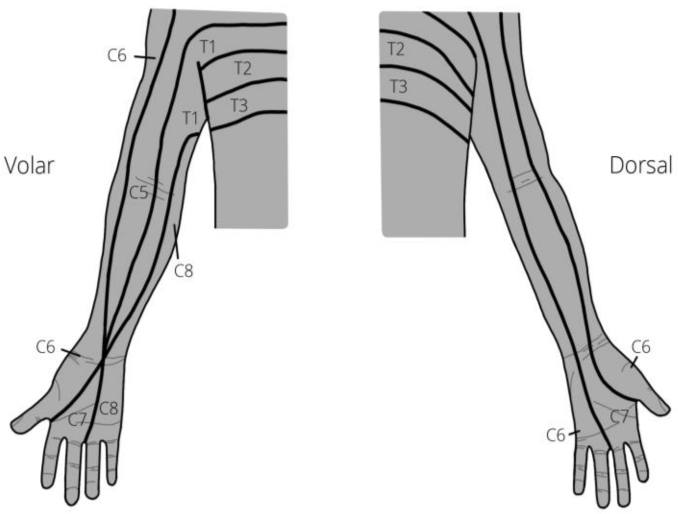


Diagram 14: sensory distribution of the hand

CARPAL TUNNEL

The carpal tunnel lies at the level of the wrist (diagram 15). The dorsal wall is formed by the bones of the carpus and the volar wall by the flexor retinaculum. This is a thick fibrous tissue attaching to the tubercle of trapezium and scaphoid on the radial side and on the ulnar side, the hook of hamate and pisiform. It forms a tunnel for and prevents bowstringing of the following structures:

- Median nerve (MN)
- Flexor Digitorum Profundus (FDP) - 4 tendons
- Flexor Digitorum Superficialis (FDS) – 4 tendons
- Flexor Carpi Radialis (FCR)
- Flexor Pollicis Longus (FPL)
- Flexor Carpi Ulnaris (FCU)

Palmaris longus (PL) lies volar to the carpal tunnel and inserts into palmar fascia. The ulnar nerve and artery lie volar and ulnar to the carpal tunnel running through Guyon's canal at the level of the wrist.

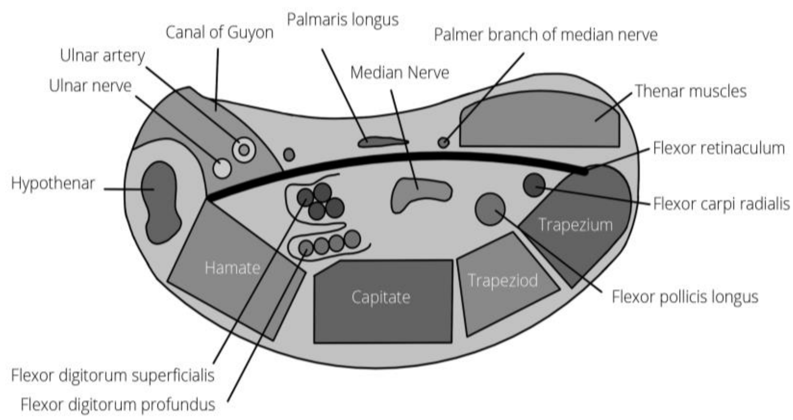


Diagram 15: carpal tunnel

FASCIA OF THE HAND

The superficial palmar fascia stretches between the flexor retinaculum and the base of the fingers. The superficial palmar fascia is thin over the thenar and hypothenar eminences, but thick centrally forming the palmar aponeurosis (diagram 16). The palmar aponeurosis consists of longitudinal, transverse and sagittal fibres.

- The longitudinal fibres originate from the palmaris longus and fan out distally to the digits.
- The transverse fibres are concentrated mid palm and in the web spaces.
- The natatory ligaments or transverse palmar ligament provides skin stability and supports the transverse metacarpal arch.

The function of the palmar fascia is to:

1. Provide firm attachment to the overlying skin and improve grip.
2. Provide cover for the flexor tendons, median and ulnar nerve.
3. Provide protection/ cushioning against penetrating wounds.
4. To maintain the concavity of the hand.

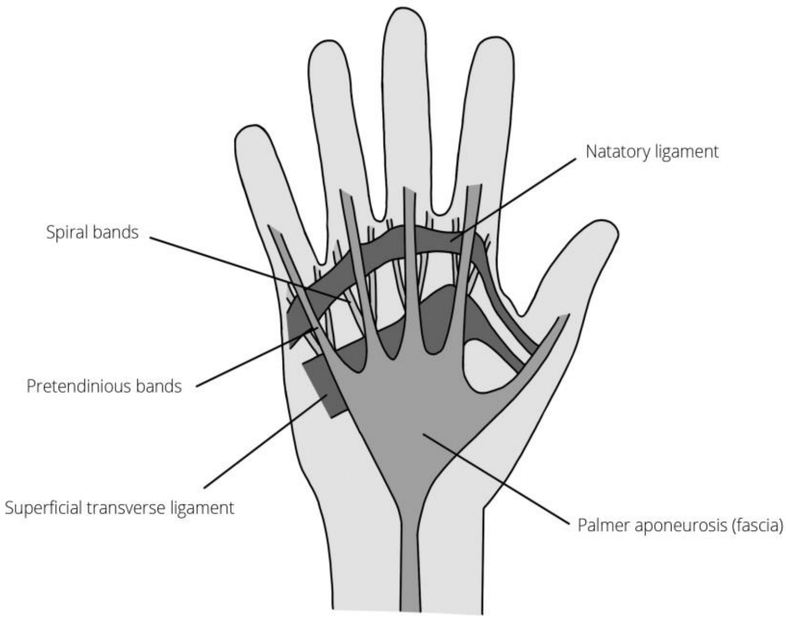


Diagram 16: fascia of the hand

SKIN OF THE HAND

The volar skin has many creases. Its characteristics include:

- Thick, hairless and inelastic
- High percentage of sweat glands
- Rich supply of sensory nerve receptors
- Skin creases to allow full flexion

The dorsal skin has different characteristics:

- It is fine, supple and mobile
- It allows full stretch into flexion i.e. adjusts to extremes in movement
- Hair follicles which are tactile and protect the underlying tissues
- Significant venous and lymphatic drainage channels

LIGAMENTOUS STRUCTURES

These are dense connective tissue thickenings and extensions of the joint capsule.

The table below describes the most commonly known ligaments of the hand.

LIGAMENT	LOCATION	FUNCTION	CLINICAL SIGNIFICANCE
Transverse Retinacular Ligament	Originates edge of flexor tendon sheath at PIP, inserts into lateral edges of conjoined lateral bands.	Prevents excessive dorsal shift of the lateral bands.	Taut when the finger is flexed.
Oblique Retinacular Ligament	Originates volar lateral crest of proximal phalanx, inserts into lateral terminal extensor tendon.	Extends DIP's when PIP's are extended.	Taut when PIP joint is extended, relaxed when PIP joint is flexed; tightness of this ligament may limit DIP flexion.
Triangular Ligament	Transversely directed fascia bounded proximally by the insertion of the central tendon laterally by lateral bands, distally by terminal extensor tendon.	Prevents excessive volar shift of lateral bands.	Taut when PIP joint is flexed, relaxed when PIP joint extended.
Sagittal Bands	Originates from central tendon inserts volar periostreum of proximal phalanx and borders of volar plate.	Stabilises extensor tendons at midline, prevents dorsal "bowstringing" limits excursion of extensor communis tendon.	
Collateral Ligaments MCP Joints	Obliquely from dorsolateral aspect of the metacarpal head to palmar lateral aspect of the base of proximal phalanx.	Joint stability.	Taut in MCP flexion, relaxed in MCP extension. Contractures of this ligament are a contributing factor to limited MP flexion.

VASCULAR SUPPLY TO THE HAND

The hand has a complex and rich vascular network (diagram 17). The radial and ulnar arteries, which are branches of the brachial artery, provide the blood supply to the hand. In the palm there is the superficial and deep palmar arch. The superficial palmar arch is formed predominantly by the ulnar artery and has a minor supply from the superficial branch of the radial artery. The deep palmar arch is formed predominantly by the deep branch of the radial artery and has a minor supply from the deep branch of the ulnar artery. The superficial palmar arch lies directly beneath the palmar fascia. It gives rise to the volar common digital arteries. The dorsal arteries originate proximally from the posterior interosseous artery and a branch of the anterior interosseous artery.

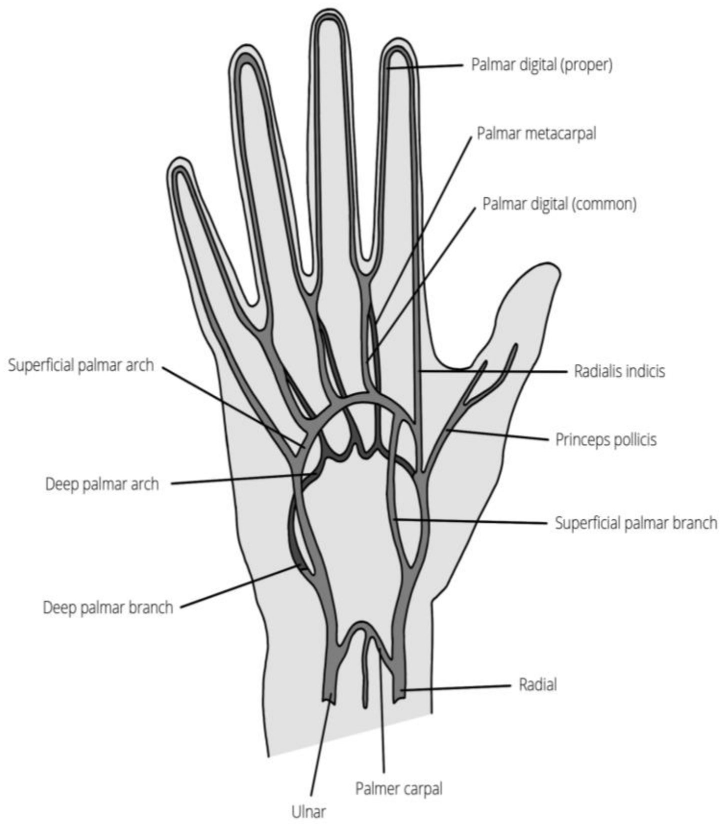


Diagram 17: vascular supply

Veins follow the deep arterial system. There is a superficial venous system on the dorsum of the hand.

FUNCTIONAL ANATOMY

The hand is a unique organ of reception, execution and communication. The most important digit in the hand is the thumb, which has the unique ability of opposition. This is a combination of abduction, flexion and axial rotation. This movement distinguishes humans from other primates who cannot oppose their thumbs. Consequently primates exhibit a single palmar crease whereas humans exhibit a double palmar crease (diagram 18). The index and middle fingers are mobile digits, which participate in precision functions.

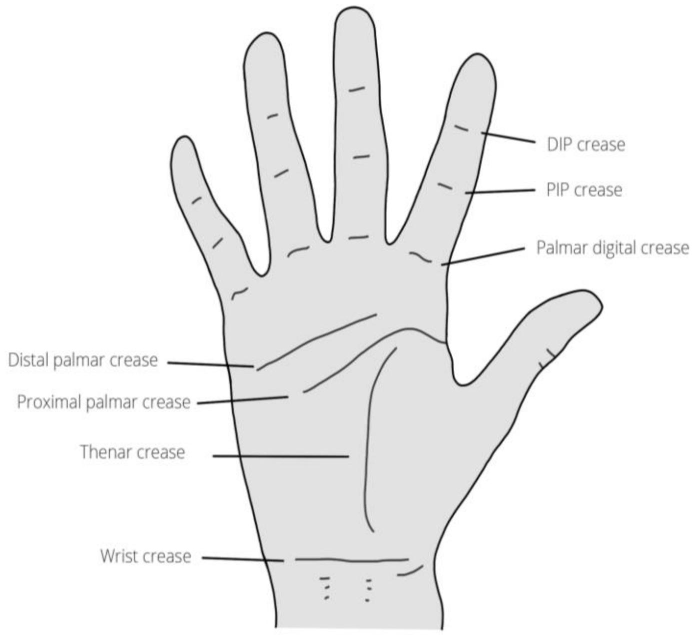


Diagram 18: creases of the hand

The ring and little fingers provide power to functions of the hand and are rarely used in precision tasks

Posture of the Hand

At rest, the hand relaxes into a cascade of the fingers from radial to ulnar across metacarpal heads. The cascade is also obvious in a tight fist and promotes power on the ulnar border of the hand.

When the fingers are flexed at the MCP joints and PIP joints, the finger tips point towards the scaphoid (diagram 19). If there is a rotational deformity e.g. post fracture this will become obvious as the injured digit will not point towards the scaphoid but will overlap another finger (Fig 11b).

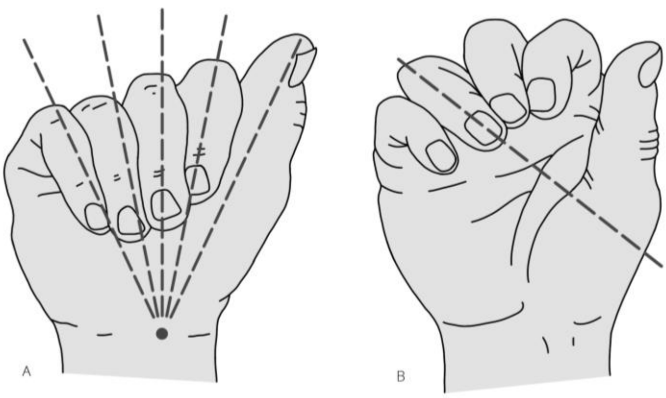


Diagram 19A: Normal finger flexion towards the scaphoid. Diagram 19B: Rotational deformity of the ring finger (J. Weinzweig (2000) Hand and wrist surgery secrets. Philadelphia. Hanley and Belfus, Inc.)

Arches of the Hand

The bones of the hand are arranged in arches (diagram 20).

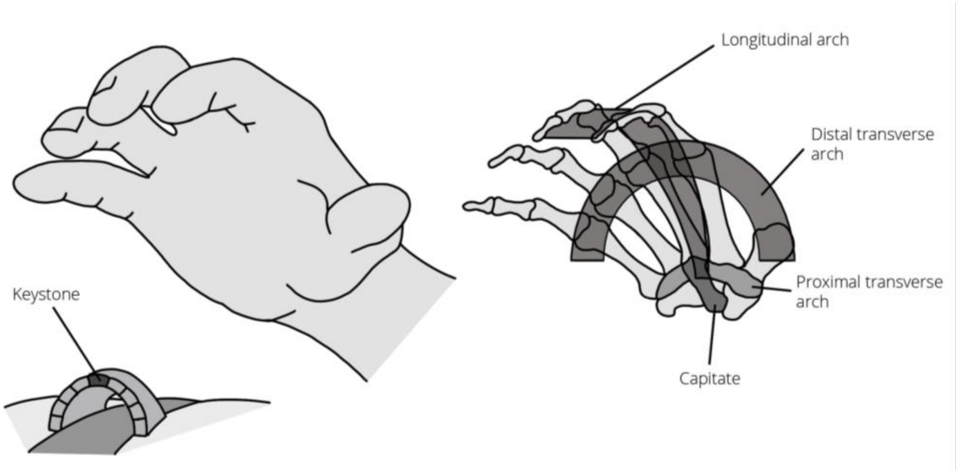


Diagram 20: arches of the hand

Proximal Transverse Arch = keystone of which is the capitate, lies at the level of the distal part of the carpus and is reasonably fixed.

Distal Transverse Arch – passes through the metacarpal head and is more mobile. The two transverse arches are connected by the rigid portion of the longitudinal arch, consisting of the 2nd and 3rd metacarpals – i.e. index finger and long fingers distally and the central carpus proximally.

Longitudinal Arch – completed by the individual rays and the mobility of the 1st, 4th and 5th rays around the 2nd and 3rd allows the palm to flatten or cup – accommodates objects of various sizes and shapes.

Collapse in the arches can result in severe disability or deformity.

There are four oblique arches of opposition (diagram 21). The most useful and functional is between the index finger and the thumb for precision grips.

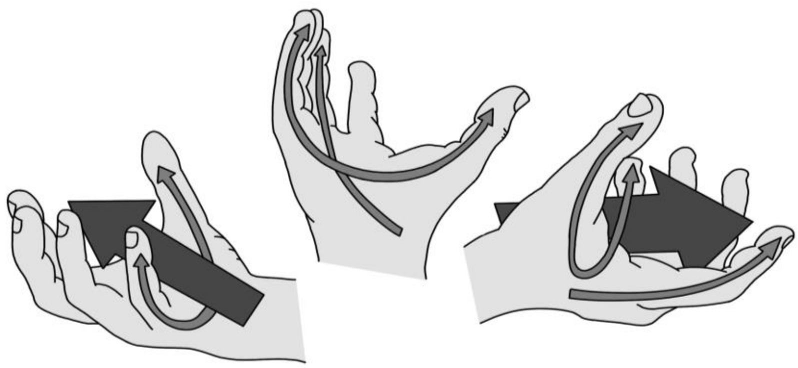


Diagram 21: Oblique arches of the hand between thumb and fingers

Tenodesis Effect

This is achieved when all muscles are balanced and relaxed. It may be used as an assessment for tendon ruptures or contracture. It is performed by observing the natural position of the digit when the wrist joint is passively moved (diagram 22).

When the wrist joint is passively flexed with the hand relaxed the;

- The fingers should be pulled into extension at the MCP and IP joints whilst maintaining the normal cascade of the hand
- The thumb sits in abduction.

When the wrist joint is placed into passive extension with the hand relaxed:

- The fingers are pulled into flexion towards the direction of the scaphoid whilst maintaining the normal cascade
- The thumb moves into adduction and opposition.

Any variation form this normal pattern can indicate injury to nerves, tendons, joint contractures etc.

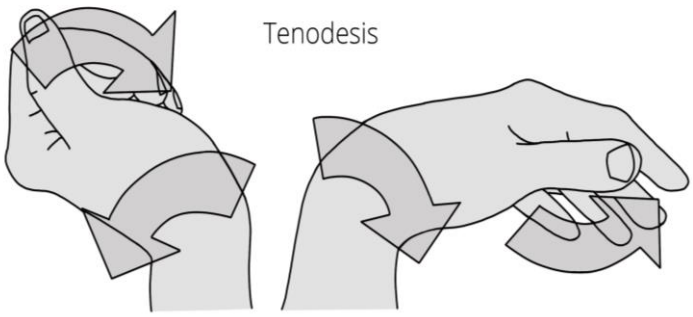


Diagram 22: tenodesis

Hand Function

The hand is vital to the functioning of all human beings.

It is an organ designed to obtain information and an organ of execution – specialised anatomy expresses these two functions which are both essential in our dealings with the environment.

A 'normal' functioning hand is capable of:

- expressing
- palpating
- grasping
- manipulating
- pushing
- carrying
- counting

To have a functional hand you must have:

- stability of the trunk and arm
- mobility and stability of structures with the hand

Functional importance of the digits

The unique nature of the thumb secures its position as the most important digit. Loss of the thumb results in loss of opposition, precision grip and dexterity.

The index has sometimes been considered to be the most important digit after the thumb because of its independent musculature, range of abduction and proximity to the thumb. Loss of the index finger results in a loss of about 20% of flexion force but the hand (or rather the brain) adapts well and all the function of the index can be substituted usually by the middle finger. Loss of the index finger does though result in loss of width of grasp.

Loss of the middle finger results in loss of more flexion strength in than when the index finger is lost. Its loss also leaves a gap in the palm resulting in the inability to hold objects like coins.

The middle and ring fingers produce the greatest aesthetic deformity when absent. Loss of the ring finger also leaves a gap in the palm again resulting in the inability to hold objects like coins, but produces the least functional deficit of all the fingers.

The little finger contributes to power grip and its loss leaves a deficiency out of proportion to its size. Its peripheral location gives it a special role in power grip especially when combined with the hypothenar mass. The ability of the little metacarpal to flex at the carpometacarpal joint increases its ability to grip tools and its loss therefore results in substantial narrowing of the digital and palmar span. Furthermore, its role as the prehensile border digit of the hand has implications on receptive function when the hand explores its environment.

Grips

Many attempts have been made to classify the different patterns of hand function and various types of grasp and pinch have been described. The more simplified analysis of ‘power grasp’ and ‘precision handling’ is the easiest to consider.

The force of the flexor tendons is influenced by the position of the wrist and in order for grip to have maximum force, the wrist must be in slight extension and ulnar deviation, requiring the synergistic action of extensor carpi radialis longus and brevis, and extensor carpi ulnaris (Tubiana et al, 1998).

Power Grip – combination of strong thumb flexion and adduction with the powerful flexion of the ring and small fingers on the ulnar side of the hand. In power grip the wrist is in an extended position that allows the extrinsic digital flexors to press the object firmly against the palm while the thumb is closed tightly around the object. The thumb, ring and small fingers are the most important participants. In a power grip all extrinsic muscles of the thenar eminence and the interossei.

Precision Handing – employs the radial side of the hand – involving the thumb, index and middle fingers.

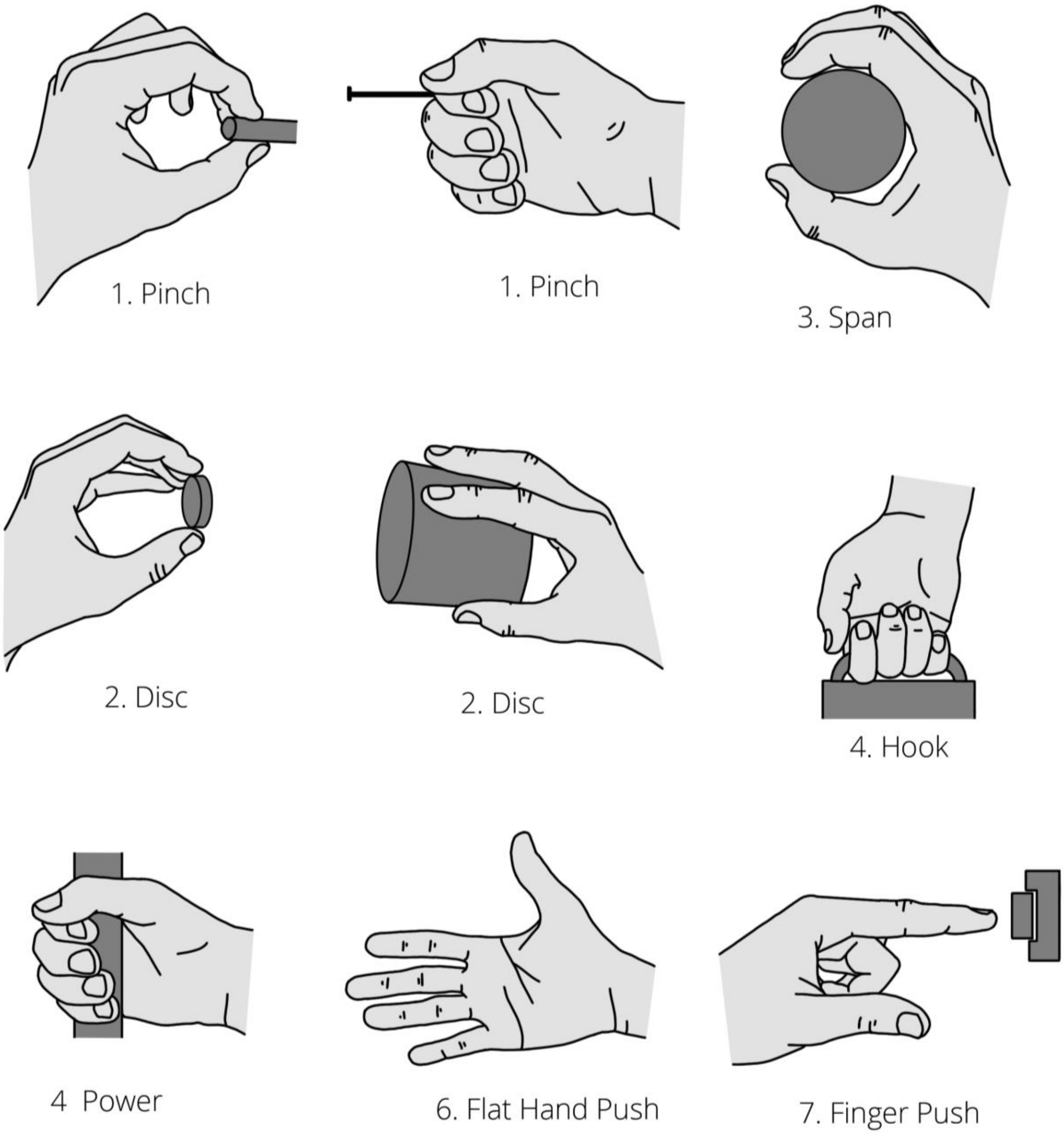
In precision grasp the wrist position is of less importance and the thumb is opposed to the semi flexed fingers with the intrinsic tendons providing most of the finger movement. Compression force is primarily provided by the extrinsic muscles assisted by the interossei, flexor pollicis brevis and adductor pollicis.

The opponens assists through rotation of the 1st metacarpal. With soft opposition of the thumb to fingers, the opponens pollicis is the most active of the thenar muscles and flexor pollicis brevis is the least active.

Certain activities may require combinations of power and precision grips. Pinching between the thumb and the combined index and long fingers is a further refinement of precision grip and may be classified as tip grip, palmar grip, lateral or tripod.

Grip	Structures Involved	Function
Lateral Pinch (precision)	Uses radial border of index finger (can involve other fingers) and palmar surface of distal phalanx of thumb.	Holding key or plate.
Pinch Grip/Tip Pinch (precision)	Uses thumb and index finger or thumb with any other of the fingers, e.g. thumb and ring finger.	Used to pick up small objects, e.g. picking up a pin.
Tripod/3 Jaw Chuck (precision)	Uses thumb and index finger and supported by radial surface of middle finger.	Turning on small screw top. Holding a pen.
Span (precision)	Involves all the fingers and the thumb, whose tips are used to encircle objects. The arches of the hand make this possible.	Opening bottles and jars. Picking up cello tape, etc.
Hook (power)	The fingers are flexed strongly at the PIP joints and the arches of the hand are flattened. This grip is reliant on the strength of the long finger flexor – mainly FDS.	Used for carrying, e.g. handbag/bucket.
Cylinder (power)	The fingers and thumb are flexed around the object with the wrist in 20-30° extension. The power in this grip is provided by the strength of the ring and little finger opposing that of the thumb.	Power grip may be single, e.g. using a hammer, or double handed, e.g. using a shovel.

<u>Grips of the Hand</u>



TERMINOLOGY and ABBREVIATIONS

Abduction	Movement away from the midline
Adduction	Movement towards the midline
ADL	Activities of Daily Living
CRPS	Complex Regional Pain Syndrome
DES	Dynamic Extension Splint
Distal	Farthest from head or source
Extension	Straightening of a flexed limb
Flexion	Act of bending
H/T	Hand Therapy
IF	Index Finger
K-Wire	Kirschnel Wire
Lateral	Sideways movement away from midline
Medial	Pertaining to or near the midline
MF	Middle Finger
NAD	No Abnormalities Discovered
NBI	No Bony Injury
OT	Occupational Therapy
POSI	Position of Safe Immobilisation
Proximal	Nearest to head or source
PT	Physiotherapy
RF	Ring Finger
ROM	Range of Movement
ROS	Removal of Sutures
SF/LF	Small Finger / Little Finger
#	Fracture

Joints

CMC	Carpometacarpal
DIP	Distal Interphalangeal
IP	Interphalangeal
MCP	Metacarpophalangeal
PIP	Proximal Interphalangeal

Muscles and Tendons

ADM	Abductor Digiti Minimi
APB	Abductor Pollicis Brevis
APL	Abductor Pollicis Longus
ECRB	Extensor Carpi Radialis Brevis
ECRL	Extensor Carpi Radialis Longus
ECU	Extensor Carpi Ulnaris
EDC	Extensor Digitorum Communis
EDM	Extensor Digiti Minimi
EI	Extensor Indices
EPB	Extensor Pollicis Brevis
EPL	Extensor Pollicis Longus
FCR	Flexor Carpi Radialis
FCU	Flexor Carpi Ulnaris
FDM	Flexor Digiti Minimi
FDP	Flexor Digitorum Profundus
FDS	Flexor Digitorum Superficialis
ODM	Opponens Digiti Minimi
PL	Palmaris Longus
PT	Pronator Teres

REFERENCES and ESSENTIAL READING

Essential reading

Basic anatomy of the hand and forearm, including:

- Tendon
- Muscle
- Ligaments
- Bones
- Surface markings

Suggestions for finding this information:

Palastanga N, Field D, Soames R. Anatomy and human movement 5th ed. Oxford, Butterworth and Heinemann, 2002

- Chapter 3: The upper limb
    - bones/ligaments pp 57-60
    - muscles pp 86-108
    - joints pp 177-200
    - Nerves pp 206-210

Lumely S.P. Surface anatomy 3rd ed. The anatomical basis if clinical examination; Philadelphia, Elsevier, 2002

Additional resources:

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- Barmakian J T. Anatomy of the joints of the thumb. Hand Clinics 1992; 8 (4): 683-691
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- Hayes EP, Carey K, Wof J, Moriatis Smith J, Akelman E. Ch 36 Carpal Tunnel Syndrome in: Hunter, Mackin, Callahan (eds). Rehabilitation lf the hand and the upper extremity. Vol I, 5th edition. Missouri. Mosby; 2002. P643-659
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- Warwick D, Dunn R, Melikyan E, Vadher J. Handbooks in Surgery: Hand Surgery; Oxford, Oxford University Press, 2009
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Statement: This hand-out aims to provide delegates with basic hand anatomy knowledge. This does not ensure you are fully skilled in the assessment and treatment of patients