**A Palm of left hand**

1. Abductor digiti minimi
2. Abductor pollicis brevis
3. Adductor pollicis
4. Distal transverse crease
5. Distal wrist crease
6. Flexor carpi radialis
7. Flexor carpi ulnaris
8. Flexor digiti minimi brevis
9. Flexor pollicis brevis
10. Head of metacarpal
11. Hook of hamate
12. Level of deep palmar arch
13. Level of superficial palmar arch
14. Longitudinal crease
15. Median nerve
16. Middle wrist crease
17. Palmaris brevis
18. Palmaris longus
19. Pisiform
20. Proximal transverse crease
21. Proximal wrist crease
22. Radial artery
23. Thenar eminence
24. Ulnar artery and nerve

**B Dorsum of left hand**

The fingers are extended at the metacarpophalangeal joints, causing the extensor tendons of the fingers (2, 3 and 4) to stand out, and partially flexed at the interphalangeal joints. The thumb is extended at the carpometacarpal joint and partially flexed at the metacarpophalangeal and interphalangeal joints. The lines proximal to the bases of the fingers indicate the ends of the heads of the metacarpals and the level of the metacarpophalangeal joints. The anatomical snuffbox (1) is the hollow between the tendons of abductor pollicis longus and extensor pollicis brevis (5) laterally and extensor pollicis longus (6) medially.

1. Anatomical snuffbox
2. Extensor digiti minimi
3. Extensor digitorum
4. Extensor indicis
5. Extensor pollicis brevis and abductor pollicis longus
6. Extensor pollicis longus
7. Extensor retinaculum
8. First dorsal interosseous
9. Head of ulna
10. Styloid process of radius
**Fingers movements**

A  flexion of the metacarpophalangeal joints and flexion of the interphalangeal joints

B  extension of the metacarpophalangeal joints and flexion of the interphalangeal joints

C  extension of the metacarpophalangeal and interphalangeal joints

When ‘making a fist’ with all finger joints flexed (A), the heads of the metacarpals (6) form the knuckles. To extend the metacarpophalangeal joints (B9) requires the activity of the long extensor tendons of the fingers, but to extend the interphalangeal joints (C10 and 5) as well requires the activity of the interossei and lumbricals, pulling on the dorsal extensor expansions. Only if the metacarpophalangeal joints remain flexed can the long extensors extend the interphalangeal joints.

1  Base of distal phalanx
2  Base of metacarpal
3  Base of middle phalanx
4  Base of proximal phalanx
5  Distal interphalangeal joint
6  Head of metacarpal
7  Head of middle phalanx
8  Head of proximal phalanx
9  Metacarpophalangeal joint
10  Proximal interphalangeal joint

**A  Muscles producing movements at the metacarpophalangeal joints**

Flexion: flexor digitorum profundus, flexor digitorum superficialis, lumbricals, interossei, with flexor digiti minimi brevis for the little finger and flexor pollicis longus, flexor pollicis brevis and the first palmar interosseous for the thumb.

Extension: extensor digitorum, extensor indicis (index finger) and extensor digiti minimi (little finger), with extensor pollicis longus and extensor pollicis brevis for the thumb.

Adduction: palmar interosseus; when flexed, the long flexors assist.

Abduction: dorsal interosseus and the long extensors, with abductor digitii minimi for the little finger.

**B  Muscles producing movements at the interphalangeal joints**

Flexion: at the proximal joints, flexor digitorum superficialis and flexor digitorum profundus; at the distal joints, flexor digitorum profundus. For the thumb, flexor pollicis longus.

Extension: with the metacarpophalangeal joints flexed, extensor digitorum, extensor indicis and extensor digiti minimi; with the metacarpophalangeal joints extended, interossei and lumbricals. For the thumb, extensor pollicis longus.

**C  Muscles producing movements at the wrist joint**

Flexion: flexor carpi radialis, flexor carpi ulnaris, palmaris longus, with assistance from flexor digitorum superficialis, flexor digitorum profundus, flexor pollicis longus and abductor pollicis longus.

Extension: extensor carpi radialis longus and brevis, extensor carpi ulnaris, assisted by extensor digitorum, extensor indicis, extensor digiti minimi and extensor pollicis longus.

Abduction: flexor carpi radialis, extensor carpi radialis longus and brevis, abductor pollicis longus and extensor pollicis brevis.

Adduction: flexor carpi ulnaris, extensor carpi ulnaris.
Thumb movements

With the thumb in the anatomical position (A), the thumb nail is at right angles to the fingers because the first metacarpal is at right angles to the others (pages 123–124). This is a rather artificial position; in the normal position of rest, the thumb makes an angle of about 60° with the plane of the palm (i.e. it is partially abducted). Flexion (B) means bending the thumb across the palm, keeping the phalanges at right angles to the palm. Extension (C) is the opposite movement, away from the palm. In abduction (D) the thumb is lifted forwards from the plane of the palm, and continuation of this movement inevitably leads to opposition (E), with rotation of the first metacarpal, twisting the whole digit so that the pulp of the thumb can be brought towards the palm at the base of the little finger (or more commonly in everyday use, to contact or overlap any of the flexed fingers). Opposition is a combination of abduction with flexion and medial rotation at the carpometacarpal joint; it is not necessarily accompanied by flexion at the other thumb joints.

Muscles producing movements at the carpometacarpal joint of the thumb

Flexion: flexor pollicis brevis, opponens pollicis, and (when the other thumb joints are flexed) flexor pollicis longus.
Extension: abductor pollicis longus, extensor pollicis longus, extensor pollicis brevis.
Abduction: abductor pollicis brevis, abductor pollicis longus.
Adduction: adductor pollicis.
Opposition: opponens pollicis, flexor pollicis brevis, reinforced by adductor pollicis and flexor pollicis longus.
Palm of left hand

**A palmar aponeurosis**

Removal of the palmar skin reveals the palmar aponeurosis.

**B after removal of palmar aponeurosis**

Deeper dissection of the palm reveals the flexor retinaculum, the palmar branches of the median and ulnar nerves and the superficial palmar arch, flanked by the muscles of the thenar and hypothenar eminences.

1. Abductor pollicis brevis
2. Abductor digitii minimi
3. Adductor pollicis
4. Aponeurosis, central part
5. Aponeurosis, digital slips
6. Flexor carpi radialis
7. Flexor carpi ulnaris
8. Flexor digiti minimi brevis
9. Flexor pollicis brevis
10. Flexor retinaculum
11. Lumbrical
12. Median nerve
13. Median nerve, palmar branch
14. Median nerve, recurrent branch
15. Palmar digital vessels and nerves
16. Palmaris brevis
17. Radial artery
18. Superficial palmar arch
19. Superficial transverse metacarpal ligaments
20. Synovial sheaths of flexor tendons
21. Ulnar sheaths of flexor tendons
22. Ulnar nerve

CT 3D reconstruction to show flexor digitorum profundus tendons

Arteriovenous fistula, Dupuytren’s contracture, see pages 170–172.
A Palm of right hand with synovial sheaths

The synovial sheaths of the wrist and fingers have been emphasised by blue tissue. On the middle finger, the fibrous flexor sheath has been removed (but retained on the other fingers, as at 3) to show the whole length of the synovial sheath (22). On the index and ring fingers, the synovial sheath projects slightly proximal to the fibrous sheath. The synovial sheath of the little finger is continuous with the sheath surrounding the finger flexor tendons under the flexor retinaculum (the ulnar bursa, 24), and the sheath of flexor pollicis longus is the radial bursa (20), which also continues under the retinaculum (9).

In the carpal tunnel (beneath the flexor retinaculum), one synovial sheath envelops the eight tendons of flexor digitorum superficialis and profundus (A24), another envelops the flexor pollicis longus tendon (A20), and flexor carpi radialis (in its own compartment of the flexor retinaculum) has its own sheath also (A4). The synovial sheaths for flexor carpi radialis and flexor pollicis longus extend as far as the tendon insertions.

The sheath of the long finger flexors is continuous with the digital synovial sheath of the little finger, but is not continuous with the digital synovial sheaths of the ring, middle or index fingers; these fingers have their own synovial sheaths whose proximal ends project slightly beyond the fibrous sheaths within which the digital synovial sheaths lie.

The muscular (recurrent) branch (A11) of the median nerve usually supplies abductor pollicis brevis, flexor pollicis brevis and opponens pollicis, but of all the muscles in the body flexor pollicis brevis (A8) is the one most likely to have an anomalous supply: in about one-third of hands by the median nerve, in another third by the ulnar nerve, and in the rest by both the median and ulnar nerves.

B Right index finger long tendons, vincula and relations

1 First lumbrical muscle
2 Flexor digitorum profundus
3 Flexor digitorum superficialis
4 Long vinculum of superficialis tendon
5 Metacarpal arterial branch
6 Palmar digital nerve
7 Princeps pollicis artery
8 Radialis indicis artery
9 Short vinculum of profundus tendon
10 Superficial palmar arterial arch
11 Thumb
Parts of the fibrous flexor sheaths of the fingers (A21) have also been excised to show the contained tendons of flexor digitorum superficialis (A12) and flexor digitorum profundus (A11). In the palm, the lumbrical muscles (A7 and 22) arise from the profundus tendons. Compare features in the MR image with the dissection.

The lumbrical muscles have no bony attachments. They arise from the tendons of flexor digitorum profundus (A11) – the first and second (A7 and A22) from the tendons of the index and middle fingers respectively, and the third and fourth from adjacent sides of the middle and ring, and ring and little fingers respectively. Each is attached distally to the radial side of the dorsal digital expansion of each finger (page 166).
Superficial palmar arch

**A** incomplete in the left hand

**B** complete in the right hand

In two-thirds of hands, the superficial palmar arch is not complete (as in A29). In the other third, it is usually completed by the superficial palmar branch of the radial artery (B30).

In the palm the superficial arterial arch (29) and its branches (as at 1) lie superficial to the common palmar digital nerves (22 and 7), but on the fingers the palmar digital nerves (as at 3) lie superficial (anterior) to the palmar digital arteries (as at 2).

1. A common palmar digital artery
2. A palmar digital artery
3. A palmar digital nerve
4. Abductor digiti minimi
5. Abductor pollicis brevis
6. Abductor pollicis longus
7. Common palmar digital branch of ulnar nerve
8. Common origin of 28 and 26
9. Deep branch of ulnar artery
10. Deep branch of ulnar nerve
11. Deep palmar arch
12. First lumbrical
13. Flexor carpi radialis
14. Flexor carpi ulnaris and pisiform
15. Flexor digitorum profundus
16. Flexor digitorum superficialis
17. Flexor pollicis brevis
18. Flexor pollicis longus
19. Flexor retinaculum
20. Fourth lumbral
21. Median nerve
22. Median nerve dividing into common palmar digital branches
23. Muscular (recurrent) branch of median nerve
24. Opponens digitii minimi
25. Palmaris brevis
26. Princeps pollicis artery
27. Radial artery
28. Radialis indicis artery
29. Superficial palmar arch
30. Superficial palmar branch of radial artery
31. Ulnar artery
32. Ulnar nerve

Arterial puncture at the wrist, Guyon's canal syndrome, see pages 170–172.
Most muscles and tendons have been removed and the arteries have been distended by injection. The deep palmar arch (5) is seen giving off the palmar metacarpal arteries (10) which join the common palmar digital arteries (3) from the superficial arch. Compare C with the vessels in the arteriogram.

1 Abductor pollicis longus
2 Branch of anterior interosseous artery to anterior carpal arch
3 Common palmar digital arteries (from superficial arch)
4 Deep branch of ulnar artery
5 Deep palmar arch
6 Flexor carpi radialis
7 Flexor carpi ulnaris and pisiform
8 Head of ulna
9 Palmar digital arteries
10 Palmar metacarpal arteries
11 Princeps pollicis artery
12 Radial artery
13 Radialis indicis artery (anomalous origin)
14 Superficial palmar branch of radial artery
15 Ulnar artery

Trigger finger, see pages 170–172.
The long flexor tendons (15 and 14) and lumbricals (12) have been cut off near the heads of the metacarpals, and parts of the hypothenar muscles removed to show the deep branches of the ulnar nerve and artery (8 and 7) running into the palm and curling laterally to pass between the transverse and oblique heads of adductor pollicis (23 and 19).

Deep to the adductor pollicis and the flexor tendons lie the pronator quadratus proximally and the extensive deep palmar branches of the ulnar nerve and deep palmar arch distally.
The capsule of the carpometacarpal joint of the thumb (between the base of the first metacarpal and the trapezium) has been removed, to show the saddle-shaped joint surfaces, which allow the unique movement of opposition of the thumb to occur. The palmar and lateral ligaments (11 and 8) of the joint remain intact. The capsule of the distal radio-ulnar joint has also been removed to show the articular disc, but the wrist joint, the ulnar part of which lies distal to the disc, has not been opened.

1. Articular disc of distal radio-ulnar joint
2. Base of first metacarpal
3. Collateral ligament of interphalangeal joint
4. Deep transverse metacarpal ligament
5. Head of capitulate
6. Hook of hamate
7. Interosseous metacarpal ligament
8. Lateral ligament of carpometacarpal joint of thumb
9. Lunate
10. Marker in groove on trapezium for flexor carpi radialis tendon
11. Palmar ligament of carpometacarpal joint of thumb
12. Palmar ligament of metacarpophalangeal joint with groove for flexor tendon
13. Palmar radiocarpal ligament
14. Palmar ulnocarpal ligament
15. Pisiform
16. Pisohamate ligament
17. Pisometacarpal ligament
18. Sacciform recess of capsule of distal radio-ulnar joint
19. Sesamoid bones of flexor pollicis brevis tendons (with adductor pollicis on ulnar side)
20. Trapezium
21. Tubercle of scaphoid
22. Tubercle of trapezium
23. Ulnar collateral ligament of wrist joint

The collateral ligaments of the metacarpophalangeal and interphalangeal joints (D2, C3) pass obliquely forwards from the posterior part of the side of the head of the proximal bone to the anterior part of the side of the base of the distal bone.

Opposition of the thumb is a combination of flexion and abduction with medial rotation of the first metacarpal (page 156). The saddle-shape of the joint between the base of the first metacarpal and the trapezium, together with the way that the capsule and its reinforcing ligaments are attached to the bones, ensures that when flexor pollicis brevis and opponens pollicis contract they produce the necessary metacarpal rotation.

The articular disc (1) holds the lower ends of the radius and ulna together, and separates the distal radio-ulnar joint from the wrist joint, so that the cavities of these joints are not continuous (unlike those of the elbow and proximal radio-ulnar joints, which have one continuous cavity – page 146).

**D Right index finger**

**Metacarpophalangeal (MP) joint, from the radial side**

Part of the capsule has been removed to define the collateral ligament (2).

Gamekeeper’s thumb, see pages 170–172.
The boundaries of the "anatomical snuff box" are the tendons of extensor pollicis brevis (14) and abductor pollicis longus (23) muscles laterally, and the tendon of extensor pollicis longus (15) muscle medially. The base of the snuffbox triangle is bounded by the styloid process of the radius, and in its floor lies the scaphoid bone. In this image the cephalic vein traverses the roof of the snuffbox.
B Dorsum of left hand

C Dorsum of right wrist and hand

**synovial sheaths**

Fascia and cutaneous branches of the ulnar nerve have been removed; the extensor reticulum (13) and the radial nerve (2) have been preserved and the synovial sheaths have been emphasised by blue tissue. From the radial to the ulnar side, the six compartments of the extensor retinaculum contain the tendons of: (a) abductor pollicis longus and extensor pollicis brevis (1 and 11); (b) extensor carpi radialis longus and brevis (6 and 5); (c) extensor pollicis longus (12); (d) extensor digitorum and extensor indicis (9 and 10); (e) extensor digiti minimi (8); (f) extensor carpi ulnaris (7).

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1. Abductor pollicis longus
2. Branches of radial nerve
3. Cephalic vein
4. Common sheath for 5 and 6
5. Extensor carpi radialis brevis
6. Extensor carpi radialis longus
7. Extensor carpi ulnaris
8. Extensor digiti minimi
9. Extensor digitorum
10. Extensor indicis
11. Extensor pollicis brevis
12. Extensor pollicis longus
13. Extensor retinaculum
The arteries have been injected and the long finger tendons removed to display the dorsal carpal arch (7) and dorsal metacarpal arteries (as at 13 and 16). Above the wrist pronator quadratus has been removed to show the branch (6) of the anterior interosseous artery (4), which continues towards the palm; the anterior interosseous itself passes to the dorsal surface to join the posterior interosseous artery (14).

**B Left ring finger extensor expansion (dorsal digital expansion)**

Three tendons pass to different levels of the thumb: abductor pollicis longus (A2) to the base of the first metacarpal, extensor pollicis brevis (A11) to the base of the proximal phalanx, and extensor pollicis longus (A12) to the base of the distal phalanx.
A Dorsum of right hand
ligaments and joints

Most joint capsules have been removed, including the radial parts of the wrist joint capsule, thus showing the articulation between the scaphoid (6) and the lower end of the radius (7).

1. Dorsal radiocarpal ligament
2. Fifth metacarpal
3. First metacarpal
4. Hamate
5. Radial collateral ligament of wrist joint
6. Scaphoid
7. Styloid process of radius
8. Styloid process of ulna
9. Triquetral

Viewed from the dorsal surface, the section has passed through the wrist near this surface, and the first and fifth metacarpals have not been included in the cut. The arrows between the two rows of carpal bones indicate the line of the midcarpal joint. Compare the MR image with the section.
Right midcarpal and wrist joints

A midcarpal joint, opened up in forced flexion

B wrist joint, opened up in forced extension

Both joints have been opened up (far beyond the normal range of movement) in order to demonstrate the bones of the joint surfaces. The wrist joint in B has been forced open in extension. A has been forced open in flexion. The proximal (wrist joint) surfaces of the scaphoid (21), lunate (13) and triquetral (24) are seen in B, and their distal (midcarpal joint) surfaces in A.
The epiphysis at the lower end of the radius appears on a radiograph at 2 years and in the ulna at 6 years. The first carpal bone to appear is the capitate at 1 year.

Compare the epiphyses of the metacarpals and phalanges seen in B with the bony specimens in J and K on page 125.

- A: dorsopalmar projection
- B: oblique projection
- C: posteroanterior projection
- D: lateral projection

1. Base of first metacarpal
2. Base of phalanx
3. Base of third metacarpal
4. Capitate
5. Distal phalanx of middle finger
6. Distal phalanx of thumb
7. Hamate
8. Head of first metacarpal
9. Head of phalanx
10. Head of third metacarpal
11. Head of ulna
12. Hook of hamate
13. Lunate
14. Middle phalanx of middle finger
15. Pisiform
16. Position of articular disc (triangular fibrocartilage)
17. Proximal phalanx of middle finger
18. Proximal phalanx of thumb
19. Scaphoid
20. Sesamoid bone in flexor pollicis brevis
21. Shaft of phalanx
22. Styloid process at lower end of radius
23. Styloid process of ulna
24. Trapezium
25. Trapezoid
26. Triquetral
Upper limb

Clinical thumbnails, see website for details and further clinical images to download into your own notes.

Accessory ossicles
Acromioclavicular separation
Anterior interosseous nerve entrapment
Arterial puncture at the elbow
Arterial puncture at the wrist
Arteriovenous fistula

Auscultation of the brachial pulse
Avascular necrosis of the scaphoid
Avulsion medial epicondyle
Axillary artery aneurysm
Axillary-subclavian vein thrombosis
Bar room fracture

Biceps tendon reflex
Bicipital tendinitis and rupture
Brachial plexus block
Calcific tendinitis
Carpal tunnel syndrome
Cervical rib

Colles’ fracture
de Quervain’s disease
Digital development abnormality
Digital nerve block
Dislocation of the elbow
Dislocation of the finger

Dislocation of humerus
Dislocation of the lunate
Dislocation of the radial head
Dupuytren’s contracture
Elbow arthroscopy
Erb’s palsy