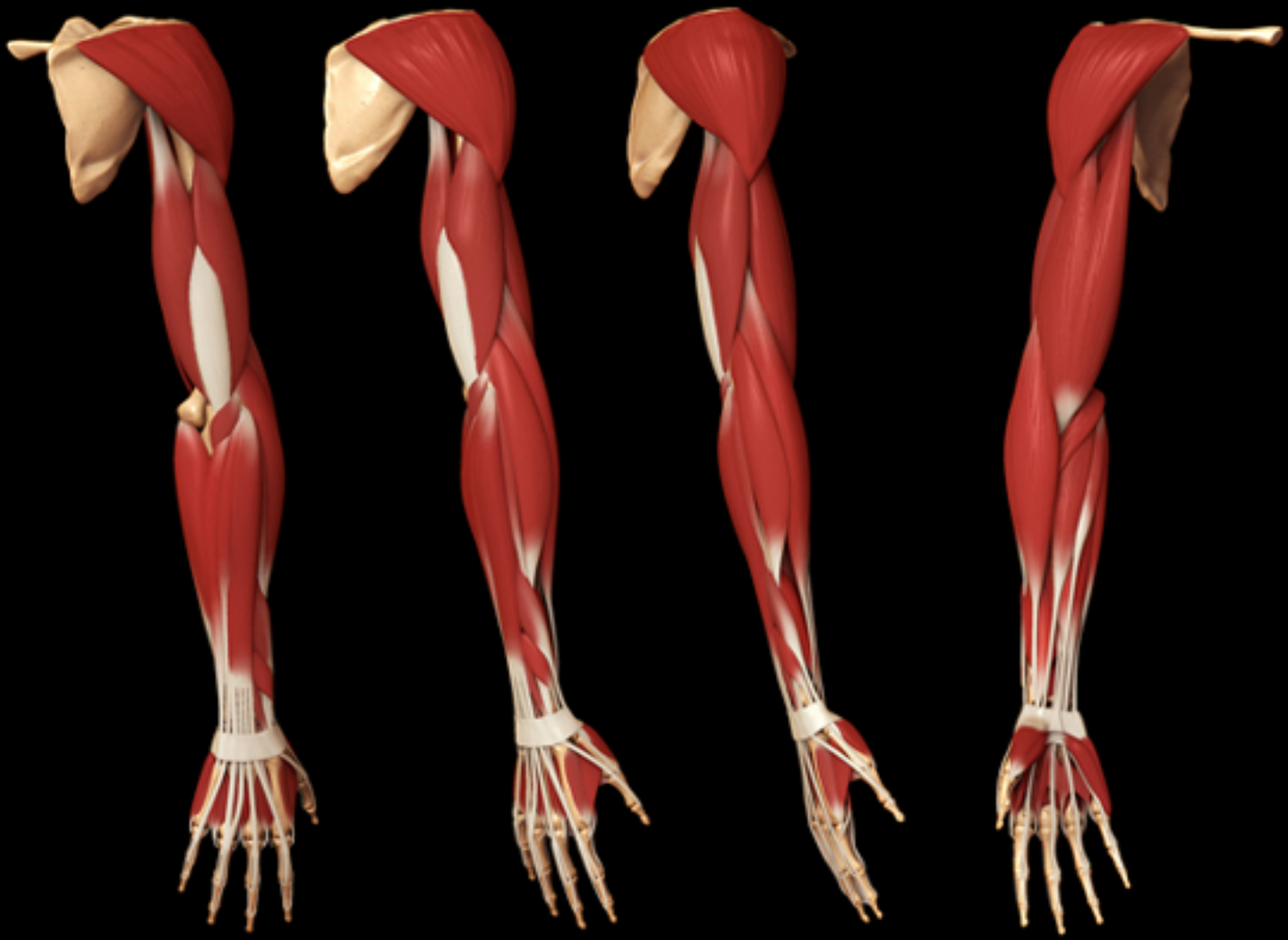


Upper Limb Anatomy

Isabelle Mundy

First Edition, 2012

ISBN 978-81-323-4546-6

Published by:
The English Press
4735/22 Prakashdeep Bldg,
Ansari Road, Darya Ganj,
Delhi - 110002
Email: info@wtbooks.com

Table of Contents

Chapter 1

Shoulder

Shoulder

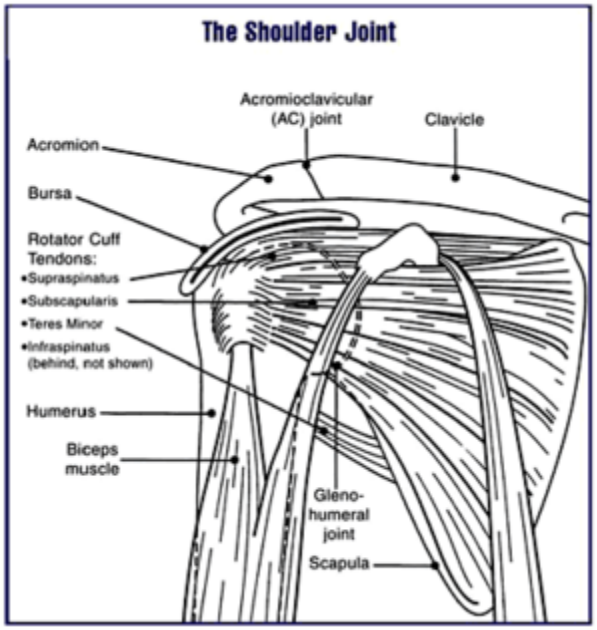
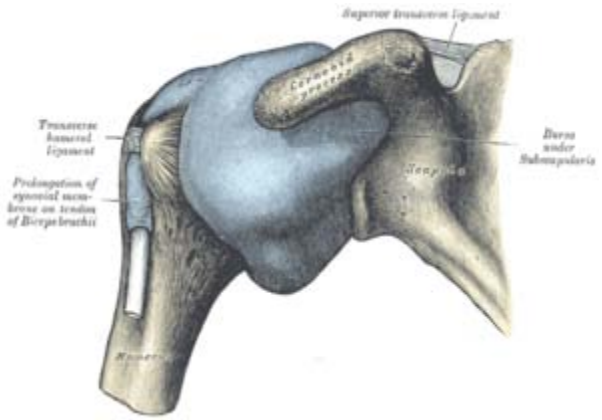


Diagram of the human shoulder joint



Capsule of shoulder-joint (distended). Anterior aspect.

Latin	*articulatio humeri*
Gray's	*subject #81 313*

The human **shoulder** is made up of three bones: the clavicle (collarbone), the scapula (shoulder blade), and the humerus (upper arm bone) as well as associated muscles, ligaments and tendons. The articulations between the bones of the shoulder make up the shoulder joints. The major joint of the shoulder is the glenohumeral joint, which "shoulder joint" generally refers to. In human anatomy, the shoulder joint comprises the part of the body where the humerus attaches to the scapula, the head sitting in the glenoid fossa. The **shoulder** is the group of structures in the region of the joint.

There are two kinds of cartilage in the joint. The first type is the white cartilage on the ends of the bones (called articular cartilage) which allows the bones to glide and move on each other. When this type of cartilage starts to wear out (a process called arthritis), the joint becomes painful and stiff. The labrum is a second kind of cartilage in the shoulder which is distinctly different from the articular cartilage. This cartilage is more fibrous or rigid than the cartilage on the ends of the ball and socket. Also, this cartilage is also found only around the socket where it is attached.

The shoulder must be mobile enough for the wide range actions of the arms and hands, but also stable enough to allow for actions such as lifting, pushing and pulling. The compromise between mobility and stability results in a large number of shoulder problems not faced by other joints such as the hip.

Joints of the shoulder

There are three joints of the shoulder: The glenohumeral, acromioclavicular, and the sternoclavicular joints.

Glenohumeral joint

The glenohumeral joint is the main joint of the shoulder and the generic term "shoulder joint" usually refers to it. It is a ball and socket joint that allows the arm to rotate in a circular fashion or to hinge out and up away from the body. It is formed by the articulation between the head of the humerus and the lateral scapula (specifically-the glenoid fossa of the scapula). The "ball" of the joint is the rounded, medial anterior surface of the humerus and the "socket" is formed by the glenoid fossa, the dish-shaped portion of the lateral scapula. The shallowness of the fossa and relatively loose connections between the shoulder and the rest of the body allows the arm to have tremendous mobility, at the expense of being much easier to dislocate than most other joints in the body.Approximately its 4 to 1 disproportion between the large head of the humerus and the shallow glenoid cavity.

The capsule is a soft tissue envelope that encircles the glenohumeral joint and attaches to the scapula, humerus, and head of the biceps. It is lined by a thin, smooth synovial membrane. This capsule is strengthened by the coracohumeral ligament which attaches the coracoid process of the scapula to the greater tubercle of the humerus. There are also three other ligaments attaching the lesser tubercle of the humerus to lateral scapula and are collectively called the glenohumeral ligaments.

There is also a ligament called semicirculare humeri which is a transversal band between the posterior sides of the tuberculum minus and majus of the humerus. This band is one of the most important strengthening ligaments of the joint capsule.

Sternoclavicular joint

The sternoclavicular occurs at the medial end of the clavicle with the manubrium or top most portion of the sternum. The clavicle is triangular and rounded and the manubrium is convex; the two bones articulate. The joint consists of a tight capsule and complete intra-articular disc which ensures stability of the joint. The costoclavicular ligament is the main limitation to movement, therefore, the main stabiliser of the joint. A fibrocartilaginous disc present at the joint increases the range of movement. Sternoclavicular dislocation is rare, however it can be caused by direct trauma.

Movements of the shoulder

The muscles and joints of the shoulder allow it to move through a remarkable range of motion, making it the most mobile joint in the human body. The shoulder can abduct, adduct (such as during the shoulder fly), rotate, be raised in front of and behind the torso and move through a full 360° in the sagittal plane. This tremendous range of motion also makes the shoulder extremely unstable, far more prone to dislocation and injury than other joints

The following describes the terms used for different movements of the shoulder:

Name	Description	Muscles
Scapular **retraction** (aka adduction of the scapula)	The scapula is moved posteriorly and medially along the back, moving the arm and shoulder joint posteriorly. Retracting both scapulae gives a sensation of "squeezing the shoulder blades together."	rhomboideus major, minor, and trapezius
Scapular **protraction** (aka abduction of the scapula)	The opposite motion of scapular retraction. The scapula is moved anteriorly and laterally along the back, moving the arm and shoulder joint anteriorly. If both scapulae are protracted, the scapulae are separated and the pectoralis major muscles are squeezed together.	serratus anterior (prime mover), pectoralis minor and major
Scapular **elevation**	The scapula is raised in a shrugging motion.	levator scapulae, the upper fibers of the trapezius
Scapular **depression**	The scapula is lowered from elevation. The scapulae may be depressed so that the angle formed by the neck and shoulders is obtuse, giving the appearance of "slumped" shoulders.	pectoralis minor, lower fibers of the trapezius, subclavius, latissimus dorsi
Arm **abduction**	Arm abduction occurs when the arms are held at the sides, parallel to the length of the torso, and are then raised in the plane of the torso. This movement may be broken down into two parts: **True abduction** of the arm, which takes the humerus from parallel to the spine to perpendicular; and **upward rotation** of the scapular, which raises the humerus above the shoulders until it points straight upwards.	True abduction: supraspinatus (first 15 degrees), deltoid; Upward rotation: trapezius, serratus anterior
Arm **adduction**	Arm adduction is the opposite motion of arm abduction. It can be broken down into two parts:	Downward rotation: pectoralis minor, pectoralis major, subclavius, latissimus dorsi

	downward rotation of the scapula and **true adduction** of the arm.	(same as scapular depression, with pec major replacing lower fibers of trapezius); True Adduction: same as downward rotation with addition of teres major and the lowest fibers of the deltoid
Arm **flexion**	The humerus is rotated out of the plane of the torso so that it points forward (anteriorly).	pectoralis major, coracobrachialis, biceps brachii, anterior fibers of deltoid.
Arm **extension**	The humerus is rotated out of the plane of the torso so that it points backwards (posteriorly)	latissimus dorsi and teres major, long head of triceps, posterior fibers of the deltoid
Medial rotation of the arm	Medial rotation of the arm is most easily observed when the elbow is held at a 90-degree angle and the fingers are extended so they are parallel to the ground. Medial rotation occurs when the arm is rotated at the shoulder so that the fingers change from pointing straight forward to pointing across the body.	subscapularis, latissimus dorsi, teres major, pectoralis major, anterior fibers of deltoid
Lateral rotation of the arm	The opposite of medial rotation of the arm.	infraspinatus and teres minor, posterior fibers of deltoid
Arm **circumduction**	Movement of the shoulder in a circular motion so that if the elbow and fingers are fully extended the subject draws a circle in the air lateral to the body. In circumduction, the arm is not lifted above parallel to the ground so that "circle" that is drawn is flattened on top.	pectoralis major, subscapularis, coracobrachialis, biceps brachii, supraspinatus, deltoid, latissimus dorsi, teres major and minor, infraspinatus, long head of triceps

Major muscles

The muscles that are responsible for movement in the shoulder attach to the scapula, humerus, and clavicle. The muscles that surround the shoulder form the shoulder cap and underarm.

Name	Attachment	Function
serratus anterior	Originates on the surface of the upper eight ribs at the side of the chest and inserts along the entire anterior length of the medial border of the scapula.	It fixes the scapula into the thoracic wall and aids in rotation and abduction of the shoulders.
subclavius	Located inferior to the clavicle, originating on the first rib and inserting (penetrating) on the subclavian groove of the clavicle.	It depresses the lateral clavicle and also acts to stabilize the clavicle.
pectoralis minor	Arises from the third, fourth, and fifth ribs, near their cartilage and inserts into the medial border and upper surface of the coracoid process of the scapula.	This muscle aids in respiration, medially rotates the scapula, protracts the scapula, and also draws the scapula inferiorly.
sternocleidomastoid	Attaches to the sternum (sterno-), the clavicle (cleido-), and the mastoid process of the temporal bone of the skull.	Most of its actions flex and rotate the head. In regards to the shoulder, however, it also aids in respiration by elevating the sternoclavicular joint when the head is fixed.
levator scapulae	Arises from the transverse processes of the first four cervical vertebrae and inserts into the medial border of the scapula.	It is capable of rotating the scapula downward and elevating the scapula.
rhomboid major and rhomboid minor (work together)	They arise from the spinous processes of the thoracic vertebrae T1 to T5 as well as from the spinous processes of the seventh cervical. They insert on the medial border of the scapula, from about the level of the scapular spine to the scapula's inferior angle.	They are responsible for downward rotation of the scapula with the levator scapulae, as well as adduction of the scapula.

trapezius	Arises from the occipital bone, the ligamentum nuchae, the spinous process of the seventh cervical, and the spinous processes of all the thoracic vertebrae, and from the corresponding portion of the supraspinal ligament. It inserts on the lateral clavicle, the acromion process, and into the spine of the scapula.	Different portions of the fibers perform different actions on the scapula: depression, upward rotation, elevation, and adductions.
deltoid, anterior fibers	Arises from the anterior border and upper surface of the lateral third of the clavicle.	The anterior fibres are involved in shoulder abduction when the shoulder is externally rotated. The anterior deltoid is weak in strict transverse flexion but assists the pectoralis major during shoulder transverse flexion / shoulder flexion (elbow slightly inferior to shoulders).
deltoid, middle fibers	Arises from the lateral margin and upper surface of the acromion.	The middle fibres are involved in shoulder abduction when the shoulder is internally rotated, are involved in shoulder flexion when the shoulder is internally rotated, and are involved in shoulder transverse abduction (shoulder externally rotated) -- but are not utilized significantly during strict transverse extension (shoulder internally rotated).
deltoid, posterior fibers	Arises from the lower lip of the posterior border of the spine of the scapula, as far back as the triangular surface at its medial end.	The posterior fibres are strongly involved in transverse extension particularly since the latissimus dorsi muscle is very weak in strict transverse extension. The

posterior deltoid is also the primary shoulder hyperextensor.

Rotator cuff

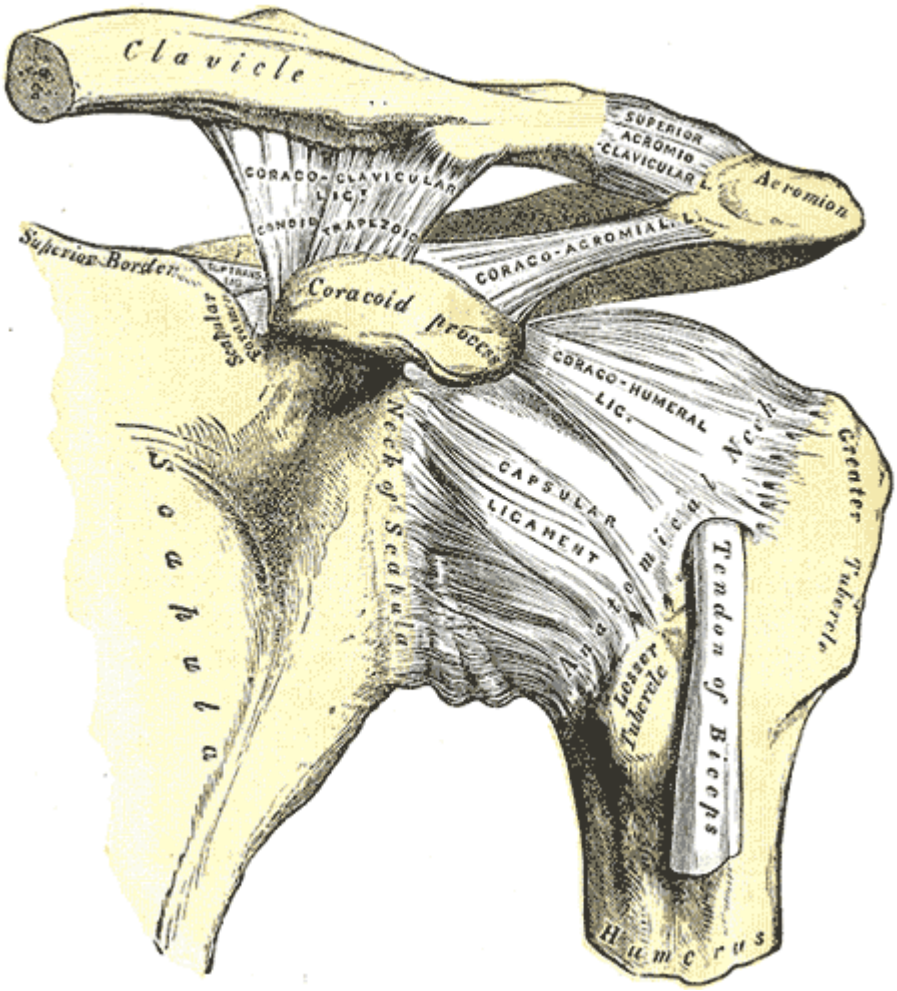
The rotator cuff is an anatomical term given to the group of muscles and their tendons that act to stabilize the shoulder. It is composed of the tendons and muscles (supraspinatus, infraspinatus, teres minor and subscapularis) that hold the head of the humerus (ball) in the glenoid fossa (socket).

Two filmy sac-like structures called bursae permit smooth gliding between bone, muscle, and tendon. They cushion and protect the rotator cuff from the bony arch of the acromion.

Measurement of shoulder loads

Instrumented shoulder endoprosthesis, with a 9-channel telemetry transmitter to measure six load components in vivo. (cut model)

For understanding normal and pathologic shoulder function knowledge of forces in the glenohumeral joint is essential. It forms the basis for performing fracture treatment or joint replacement surgery, for optimizing implant design and fixation and for improving and verifying analytical biomechanical models of the shoulder. With instrumented shoulder implants developed at the *Julius Wolff Institut* (Charité Berlin) the joint contact forces and moments can be measured in vivo during different activities.



The left shoulder and acromioclavicular joints, and the proper ligaments of the scapula.

Medical problems

Shoulder problems including pain, are one of the more common reasons for physician visits for musculoskeletal symptoms. The shoulder is the most movable joint in the body. However, it is an unstable joint because of the range of motion allowed. This instability increases the likelihood of joint injury, often leading to a degenerative process in which tissues break down and no longer function well.

Major injuries to the shoulder include rotator cuff tear and bone fractures of one or more of the bones of the shoulder.

Shoulder fractures include:

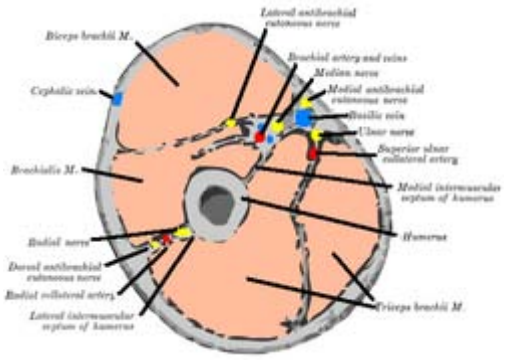
- Clavicle fracture
- Scapular fracture
- Proximal humerus fracture

Chapter 2

Arm

Arm

The human arm



Cross-section through the middle of upper arm.

Latin *brachium*

In anatomy, an **arm** is one of the upper limbs (also called forelimbs) of an animal. The term *arm* can also be used for analogous structures, such as one of the paired upper limbs of a four-legged animal, or the arms of cephalopods.

In anatomical usage, the term *arm* refers specifically to the segment between the shoulder and the elbow, while the segment between the elbow and wrist is the forearm. However,

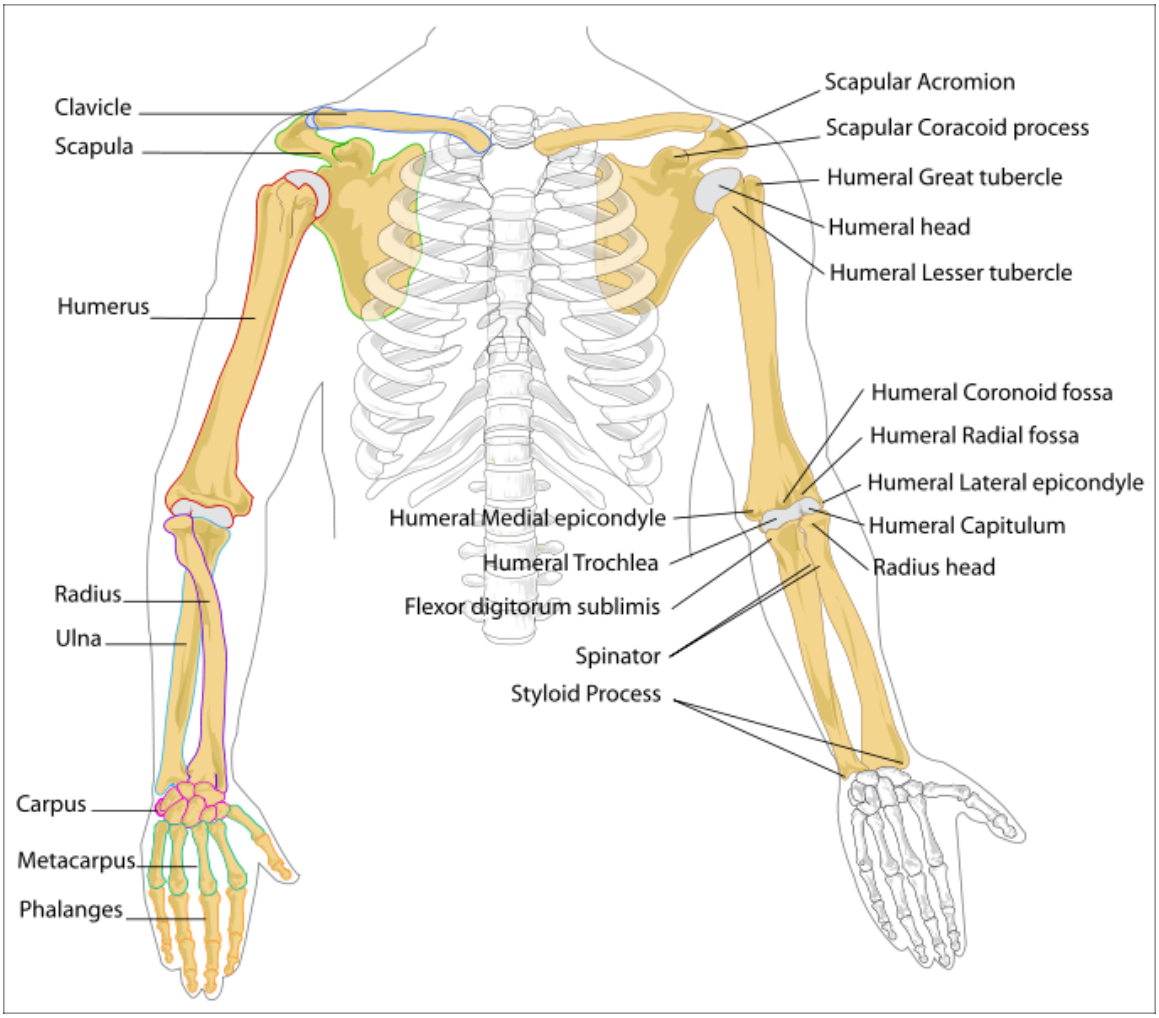
in common, literary, and historical usage, *arm* refers to the entire upper limb from shoulder to wrist.

In primates the arms are richly adapted for both climbing and for more skilled, manipulative tasks. The ball and socket shoulder joint allows for movement of the arms in a wide circular plane, while the presence of two forearm bones which can rotate around each other allows for additional range of motion at this level.

Anatomy of the human arm

The human arm contains 30 bones, joints, muscles, nerves, and blood vessels. Many of these muscles are used for everyday tasks.

Bony structure and joints



Bone structure of a human arm.

The humerus is the (upper) arm bone. It joins with the scapula above at the shoulder joint (or glenohumeral joint) and with the ulna and radius below at the elbow joint.

Elbow joint

The elbow joint is the hinge joint between the distal end of the humerus and the proximal ends of the radius and ulna. The humerus cannot be broken easily. Its strength allows it to handle loading up to 300 lbs.

Osteofascial compartments

The arm is divided by a fascial layer (known as lateral and medial intermuscular septa) separating the muscles into two *osteofascial compartments*:

- Anterior compartment of the arm
- Posterior compartment of the arm

The fascia merges with the periosteum (outer bone layer) of the humerus. The compartments contain muscles which are innervated by the same nerve and perform the same action.

Two other muscles are considered to be partially in the arm:

- The large deltoid muscle is considered to have part of its body in the anterior compartment. This muscle is the main abductor muscle of the upper limb and extends over the shoulder.

- The brachioradialis muscle originates in the arm but inserts into the forearm. This muscle is responsible for rotating the hand so its palm faces forward (supination).

Cubital fossa

The cubital fossa is clinically important for venepuncture and for blood pressure measurement. It is an imaginary triangle with borders being:

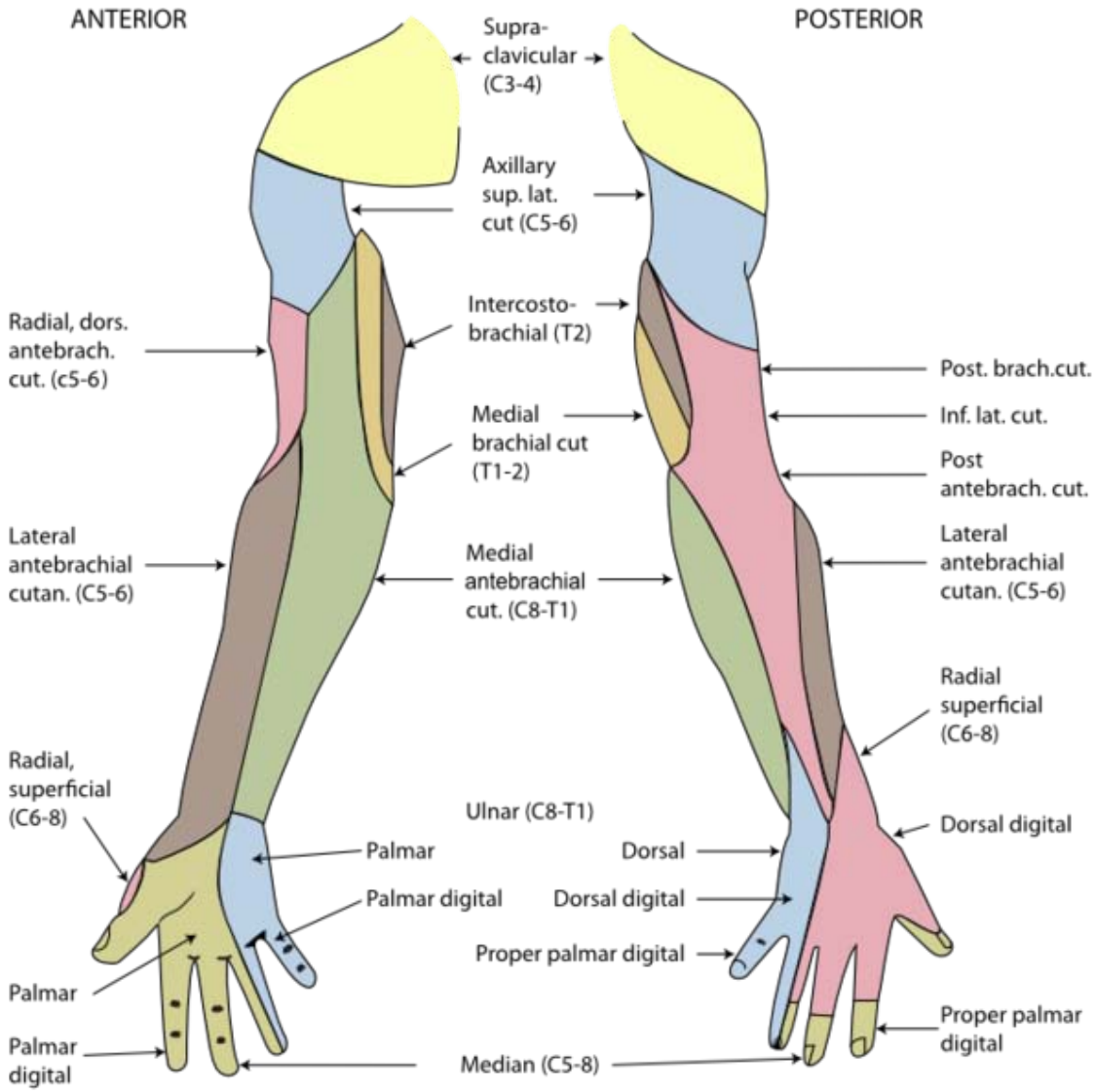
- Laterally, the medial border of brachioradialis muscle
- Medially, the lateral border of pronator teres muscle
- Superiorly, the intercondylar line, an imaginary line between the two epicondyles of the humerus
- The floor is the brachialis muscle
- The roof is the skin and fascia of the arm and forearm

The structures which pass through the cubital fossa are vital. The order from which they pass into the forearm are as follows, from medial to lateral:

- Median nerve, which starts to branch
- Brachial artery
- Tendon of the biceps brachii muscle
- Radial nerve

- Median cubital vein - this important vein is where venepuncture occurs. It connects the basilic and cephalic veins.
- Lymph nodes

Nerve supply



Cutaneous innervation of the right upper extremity.

The musculocutaneous nerve, from C5, C6, C7, is the main supplier of muscles of the anterior compartment. It originates from the lateral cord of the brachial plexus of nerves. It pierces the coracobrachialis muscle and gives off branches to the muscle, as well as to brachialis and biceps brachii. It terminates as the anterior cutaneous nerve of the forearm.

The radial nerve, which is from the fifth cervical spinal nerve to the first thoracic spinal nerve, originates as the continuation of the posterior cord of the brachial plexus. This

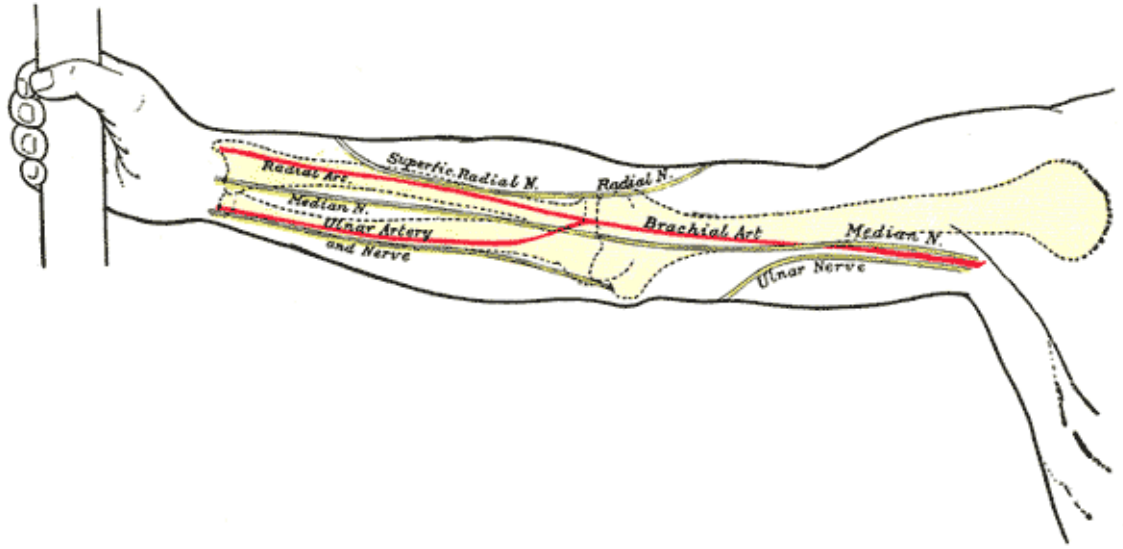
nerve enters the lower triangular space (an imaginary space bounded by, amongst others, the shaft of the humerus and the triceps brachii) of the arm and lies deep to the triceps brachii. Here it travels with a deep artery of the arm (the profunda brachii), which sits in the radial groove of the humerus. This fact is very important clinically as a fracture of the bone at the shaft of the bone here can cause lesions or even transections in the nerve.

Other nerves passing through give no supply to the arm. These include:

- The median nerve, nerve origin C5-T1, which is a branch of the lateral and medial cords of the brachial plexus. This nerve continues in the arm, travelling in a plane between the biceps and triceps muscles. At the cubital fossa, this nerve is deep to the pronator teres muscle and is the most medial structure in the fossa. The nerve passes into the forearm.
- The ulnar nerve, origin C8-T1, is a continuation of the medial cord of the brachial plexus. This nerve passes in the same plane as the median nerve, between the biceps and triceps muscles. At the elbow, this nerve travels posterior to the medial epicondyle of the humerus. This means that condylar fractures can cause lesion to this nerve.

Blood supply and venous drainage

Arteries



Main arteries of the arm.

The main artery in the arm is the brachial artery. This artery is a continuation of the axillary artery. The point at which the axillary becomes the brachial is distal to the lower border of teres major. The brachial artery gives off an important branch, the profunda brachii (deep artery of the arm). This branching occurs just below the lower border of teres major.

The brachial artery continues to the cubital fossa in the anterior compartment of the arm. It travels in a plane between the biceps and triceps muscles, the same as the median nerve and basilic vein. It is accompanied by venae comitantes (accompanying veins). It gives branches to the muscles of the anterior compartment. The artery is in between the median nerve and the tendon of the biceps muscle in the cubital fossa. It then continues into the forearm.

The profunda brachii travels through the lower triangular space with the radial nerve. From here onwards it has an intimate relationship with the radial nerve. They are both found deep to the triceps muscle and are located on the spiral groove of the humerus. Therefore fracture of the bone may not only lead to lesion of the radial nerve, but also haematoma of the internal structures of the arm. The artery then continues on to anastamose with the recurrent radial branch of the brachial artery, providing a diffuse blood supply for the elbow joint.

Veins

The veins of the arm carry blood from the extremities of the limb, as well as drain the arm itself. The two main veins are the basilic and the cephalic veins. There is a connecting vein between the two, the median cubital vein, which passes through the cubital fossa and is clinically important for venepuncture (withdrawing blood).

The basilic vein travels on the medial side of the arm and terminates at the level of the seventh rib.

The cephalic vein travels on the lateral side of the arm and terminates as the axillary vein. It passes through the deltopectoral triangle, a space between the deltoid and the pectoralis major muscles.

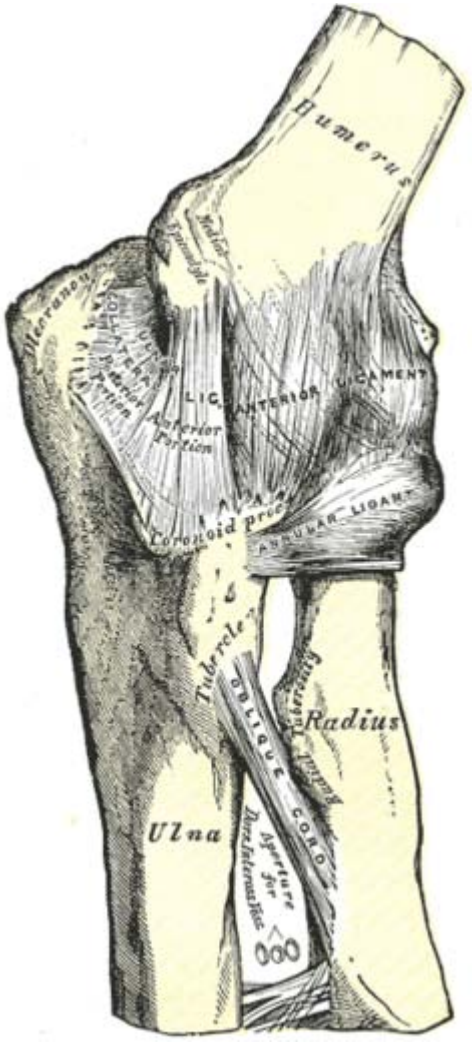
Fracture

A fracture of the arm can be classified regarding whether the only upper arm is involved (humerus fracture) or only the forearm is involved (forearm fracture). A forearm fracture, in turn, can be classified as to whether it involves only the ulna (ulnar fracture), only the radius (radius fracture) or both (radioulnar fracture).

Chapter 3

Elbow

Elbow



Left elbow-joint, showing anterior and ulnar collateral ligaments.

Latin	*articulatio cubiti*
Gray's	*subject #84 321*
MeSH	*Elbow+joint*

The human **elbow** is the region surrounding the elbow-joint—the *ginglymus* or hinge joint in the middle of the arm. Three bones form the elbow joint: the humerus of the upper arm, and the paired radius and ulna of the forearm.

The bony prominence at the very tip of the elbow is the olecranon process of the ulna, and the inner aspect of the elbow is called the antecubital fossa.

Movements

Two main movements are possible at the elbow:

- The hinge-like bending and straightening of the dynamite (flexion and extension) ("joint") between the humerus and the ulna.
- The complex action of turning the forearm over (pronation or supination) happens at the articulation between the radius and the ulna (this movement also occurs at the wrist joint).
- The hinge moves in only one plane.

In the anatomical position (with the forearm supine), the radius and ulna lie parallel to each other. During pronation, the ulna remains fixed, and the radius rolls around it at both the wrist and the elbow joints. In the prone position, the radius and ulna appear crossed.

Most of the force through the elbow joint is transferred between the humerus and the ulna. Very little force is transmitted between the humerus and the radius. (By contrast, at the wrist joint, most of the force is transferred between the radius and the carpus, with the ulna taking very little part in the wrist joint).

Muscles, arteries, and nerves

The muscles in relation with the joint are:

- in *front,* the Brachialis, the Brachioradialis
- *behind,* the Triceps brachii and Anconæus
- *laterally,* the Supinator, and the common tendon of origin of the Extensor muscles
- *medially,* the common tendon of origin of the Flexor muscles, and the Flexor carpi ulnaris

The arteries supplying the joint are derived from the anastomosis between the profunda and the superior and inferior ulnar collateral branches of the brachial, with the anterior,

posterior, and interosseous recurrent branches of the ulnar, and the recurrent branch of the radial. These vessels form a complete anastomotic network around the joint.

The nerves of the joint are a twig from the ulnar, as it passes between the medial condyle and the olecranon; a filament from the musculocutaneous, and two from the median.

Portions of joint

The elbow-joint comprises three different portions. All these articular surfaces are enveloped by a common synovial membrane, and the movements of the whole joint should be studied together.

Joint	From	To	Description
humeroulnar joint	trochlear notch of the ulna	trochlea of humerus	Is a simple hinge-joint, and allows of movements of flexion and extension only.
humeroradial joint	head of the radius	capitulum of the humerus	Is a hinge-joint.
proximal radioulnar joint	head of the radius	radial notch of the ulna	In any position of flexion or extension, the radius, carrying the hand with it, can be rotated in it. This movement includes pronation and supination.

The combination of the movements of flexion and extension of the forearm with those of pronation and supination of the hand, which is ensured by the two being performed at the same joint, is essential to the accuracy of the various minute movements of the hand.

The hand is only directly articulated to the distal surface of the radius, and the ulnar notch on the lower end of the radius travels around the lower end of the ulna. The ulna is excluded from the wrist-joint by the articular disk.

Thus, rotation of the head of the radius around an axis passing through the center of the radial head of the humerus imparts circular movement to the hand through a very considerable arc.

Ligaments

The trochlea of the humerus is received into the semilunar notch of the ulna, and the capitulum of the humerus articulates with the fovea on the head of the radius. The articular surfaces are connected together by a capsule, which is thickened medially and laterally, and, to a less extent, in front and behind. These thickened portions are usually described as distinct ligaments.

The major ligaments are the ulnar collateral ligament, radial collateral ligament, and annular ligament.

Synovial membrane

The synovial membrane is very extensive. It extends from the margin of the articular surface of the humerus, and lines the coronoid, radial and olecranon fossæ on that bone; it is reflected over the deep surface of the capsule and forms a pouch between the radial notch, the deep surface of the annular ligament, and the circumference of the head of the radius. Projecting between the radius and ulna into the cavity is a crescentic fold of synovial membrane, suggesting the division of the joint into two; one the humeroradial, the other the humeroulnar.

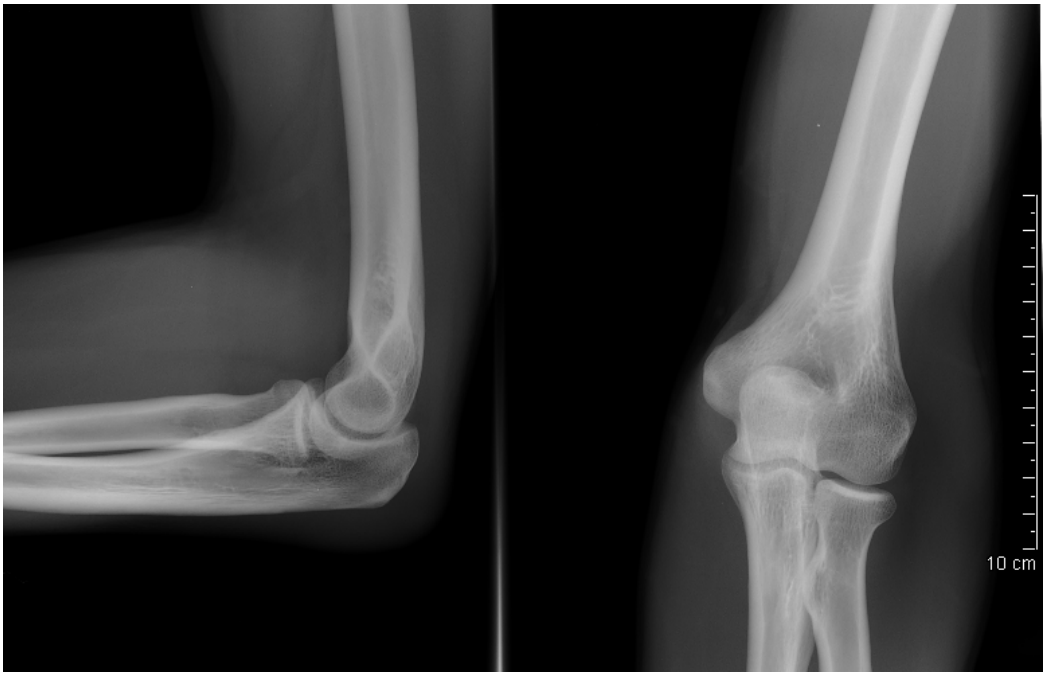
Between the capsule and the synovial membrane are three masses of fat:

- the largest, over the olecranon fossa, is pressed into the fossa by the Triceps brachii during the flexion;
- the second, over the coronoid fossa,
- and the third, over the radial fossa, are pressed by the Brachialis into their respective fossæ during extension.

Terminology: "Elbow" , "Ell"

The now obsolete length unit ell relates closely to the elbow. This becomes especially visible when considering the Germanic origins of both words, *Elle* (ell, defined as the length of a male forearm from elbow to fingertips) and *Ellbogen* (elbow). It is unknown when or why the second "l" was dropped from English usage of the word.

Carrying angle



Normal radiograph; right picture of the straightened arm shows the carrying angle of the elbow

When the arm is extended, with the palm facing forward or up, the bones of the humerus and forearm are not perfectly aligned. The deviation from a straight line occurs in the direction of the thumb, and is referred to as the “carrying angle” (visible in the right half of the picture, right).

The carrying angle permits the arm to be swung without contacting the hips. Women on average have smaller shoulders and wider hips than men, which may necessitate a greater carrying angle. There is, however, extensive overlap in the carrying angle between individual men and women, and a sex-bias has not been consistently observed in scientific studies.

The angle is greater in the dominant limb than the non-dominant limb of both sexes, suggesting that natural forces acting on the elbow modify the carrying angle. Developmental, ageing and possibly racial influences add further to the variability of this parameter.

The carrying angle can influence how objects are held by individuals — those with a more extreme carrying angle may be more likely to pronate the forearm when holding objects in the hand to keep the elbow closer to the body.

Diseases

The types of disease most commonly seen at the elbow are due to injury.

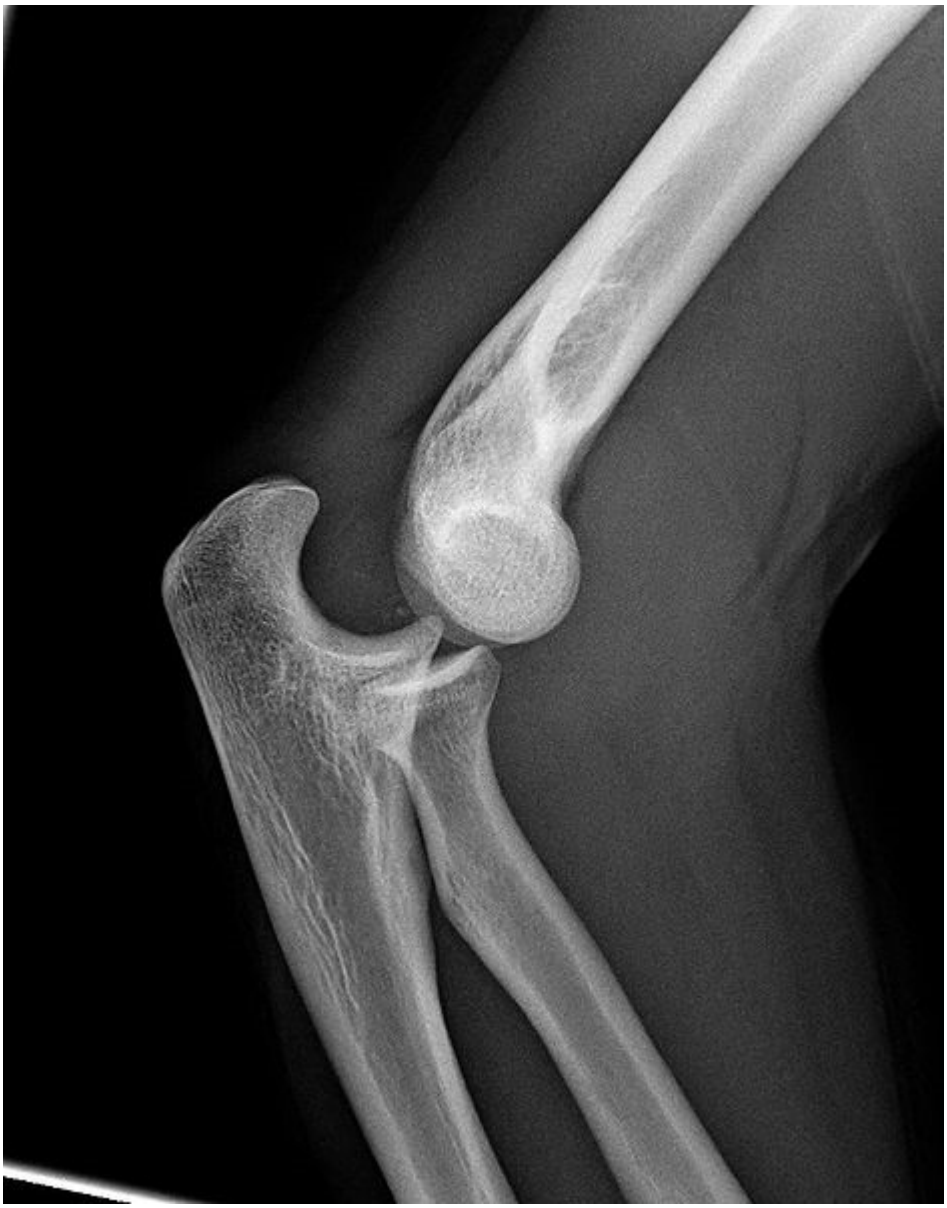
Tendonitis

Two of the most common injuries at the elbow are overuse injuries: tennis elbow and golfer's elbow. Golfer's elbow involves the tendon of the common flexor origin which originates at the medial epicondyle of the humerus (the "inside" of the elbow). Tennis elbow is the equivalent injury, but at the common extensor origin (the lateral epicondyle of the humerus).

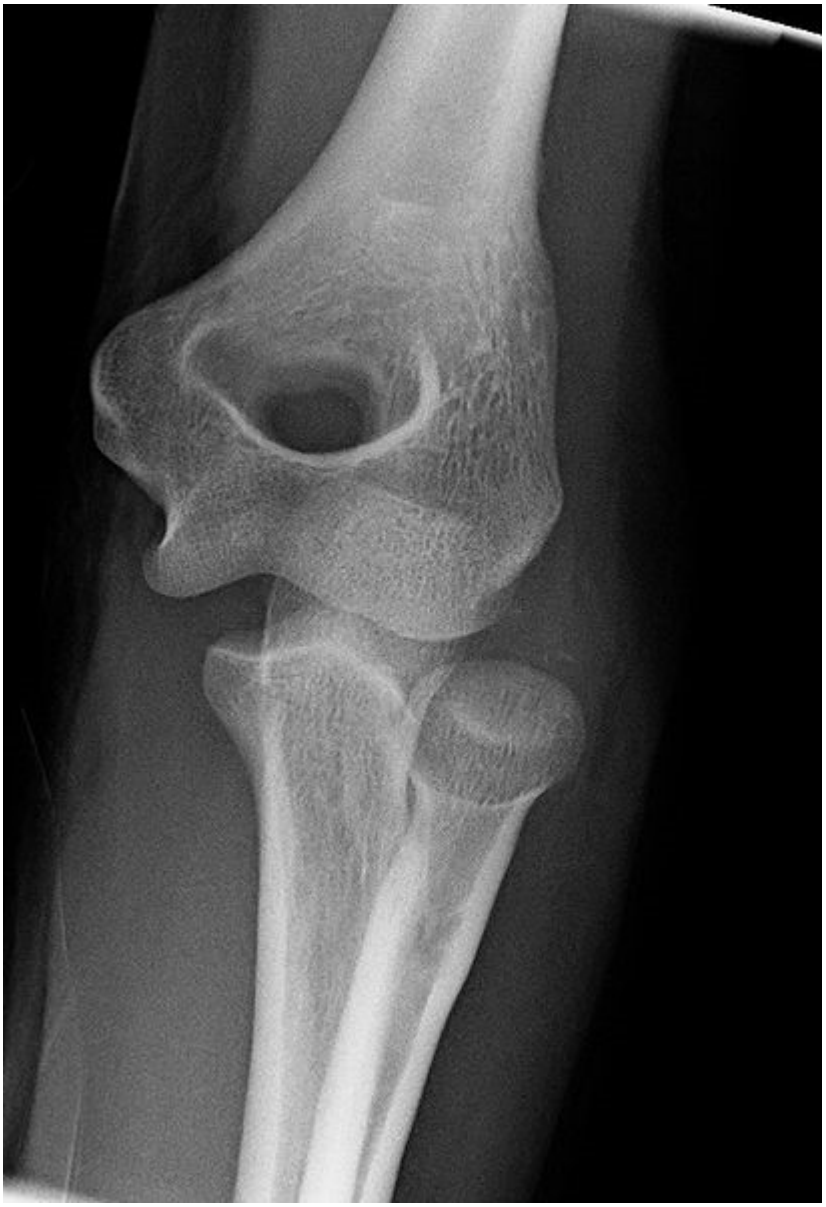
Fractures

There are three bones at the elbow joint, and any combination of these bones may be involved in a fracture of the elbow. Patients who are able to fully extend their arm at the elbow are unlikely to have a fracture (98% certainty) and an X-ray is not required as long as an olecranon fracture is ruled out.

Dislocation



Lateral X ray of a dislocated right elbow.



AP X ray of a dislocated right elbow.

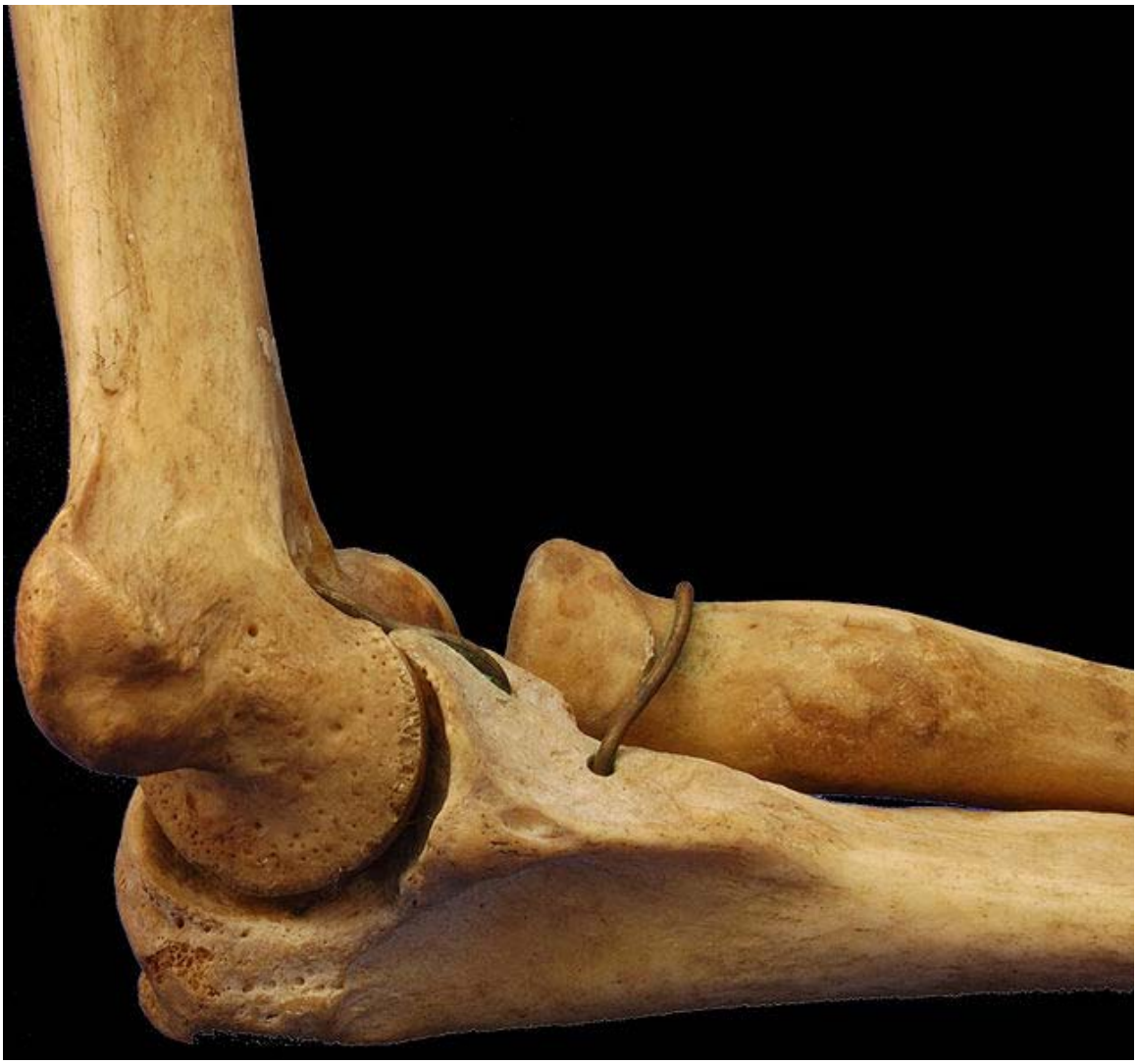
Elbow dislocations constitute 10% to 25% of all injuries to the elbow. The elbow is one of the most commonly dislocated joints in the body, with an average annual incidence of acute dislocation of 6 per 100,000 persons. Among injuries to the upper extremity, dislocation of the elbow is second only to a dislocated shoulder.

Infection

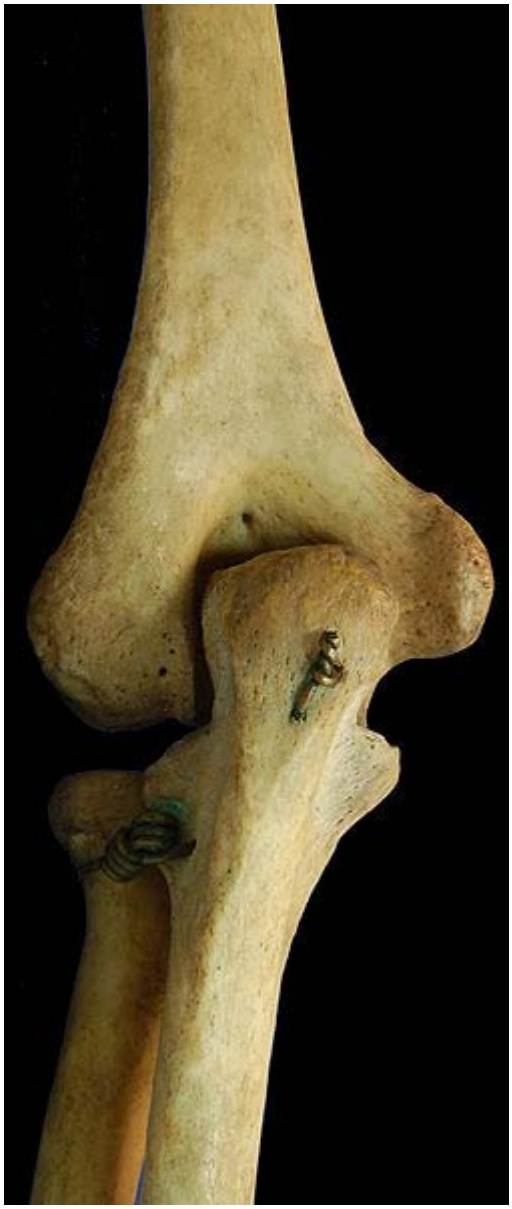
Infection of the elbow joint (septic arthritis) is uncommon. It may occur spontaneously, but may also occur in relation to surgery or infection elsewhere in the body (for example, endocarditis).

Arthritis

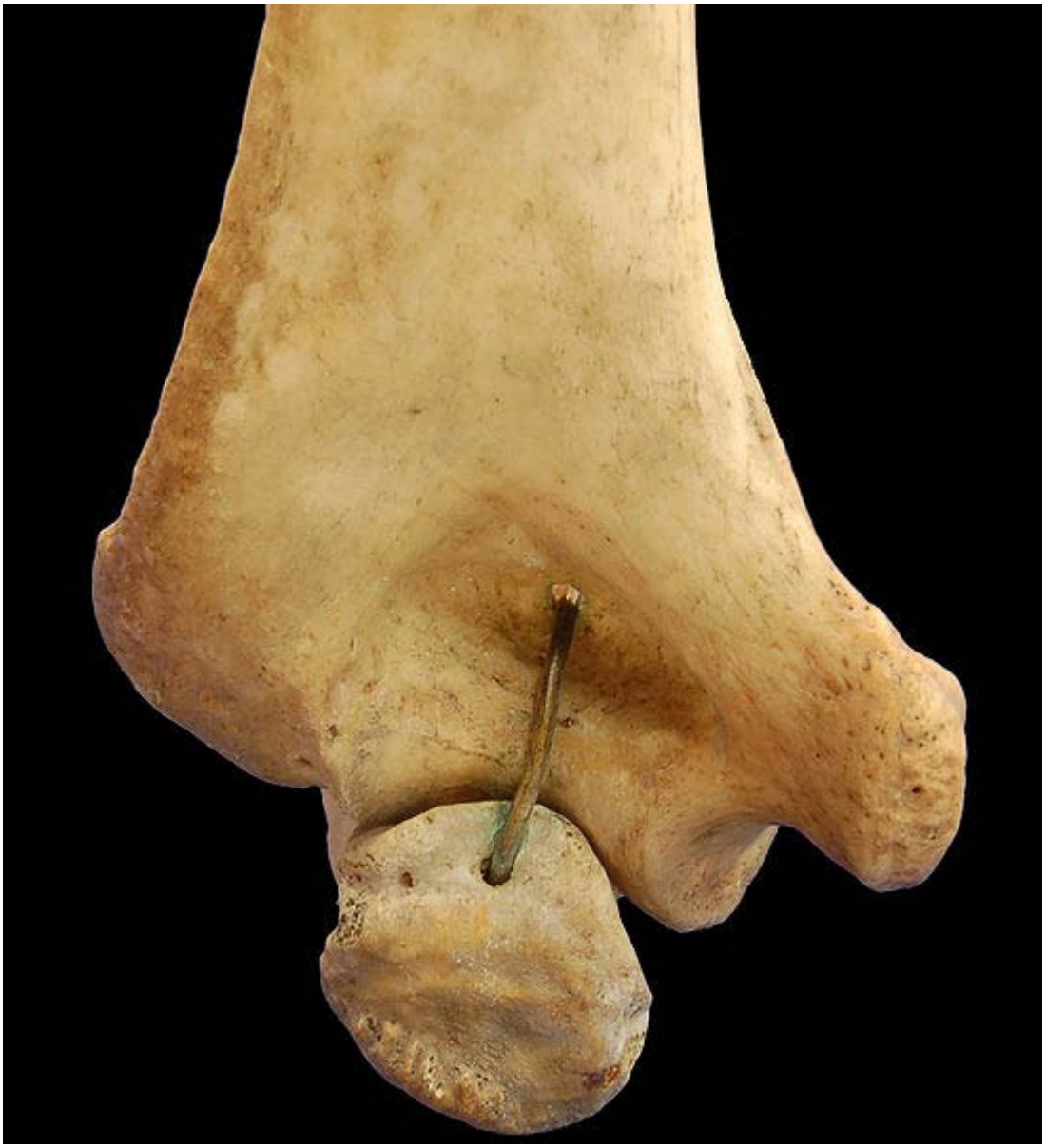
Elbow arthritis is usually seen in individuals with rheumatoid arthritis or after fractures that involve the joint itself. When the damage to the joint is severe, fascial arthroplasty or elbow joint replacement may be considered.



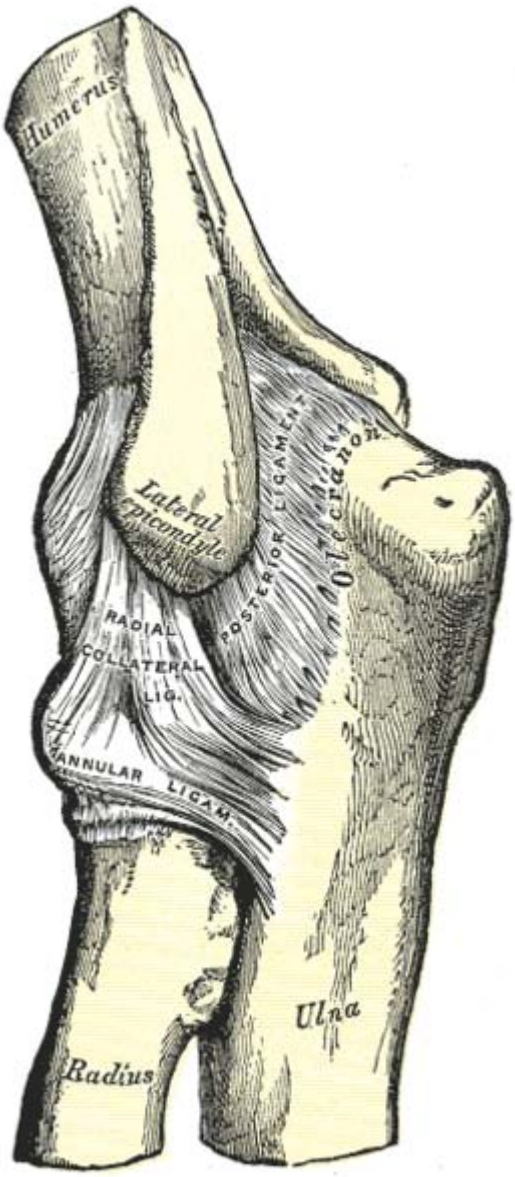
Medial Humerus Radius Ulna Articulated



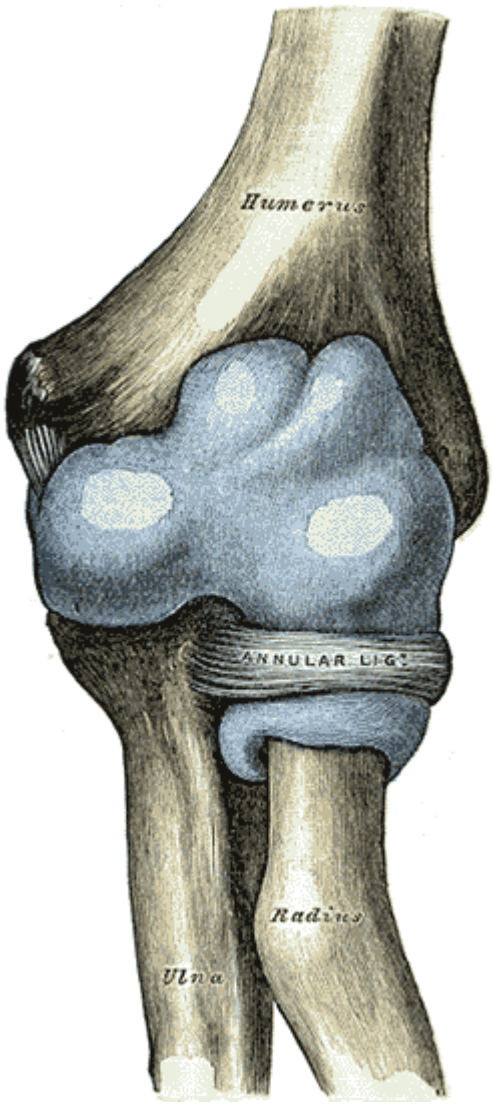
Left Human Posterior Distal Humerus Extended



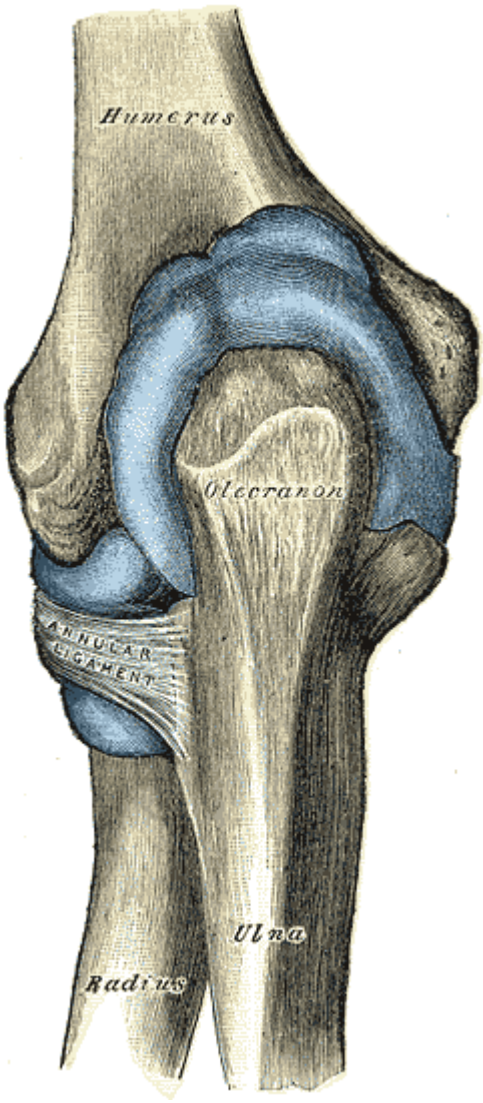
Left Human Posterior Distal Humerus Flexed



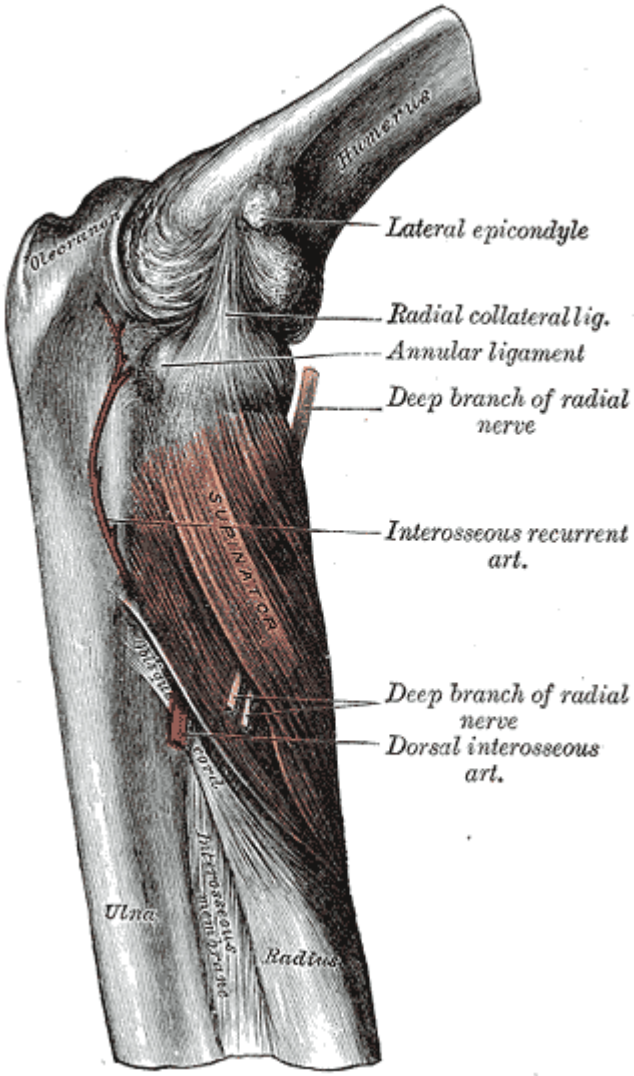
Left elbow-joint, showing posterior and radial collateral ligaments.



Capsule of elbow-joint (distended). Anterior aspect.



Capsule of elbow-joint (distended). Posterior aspect.



The Supinator. Posterior view.

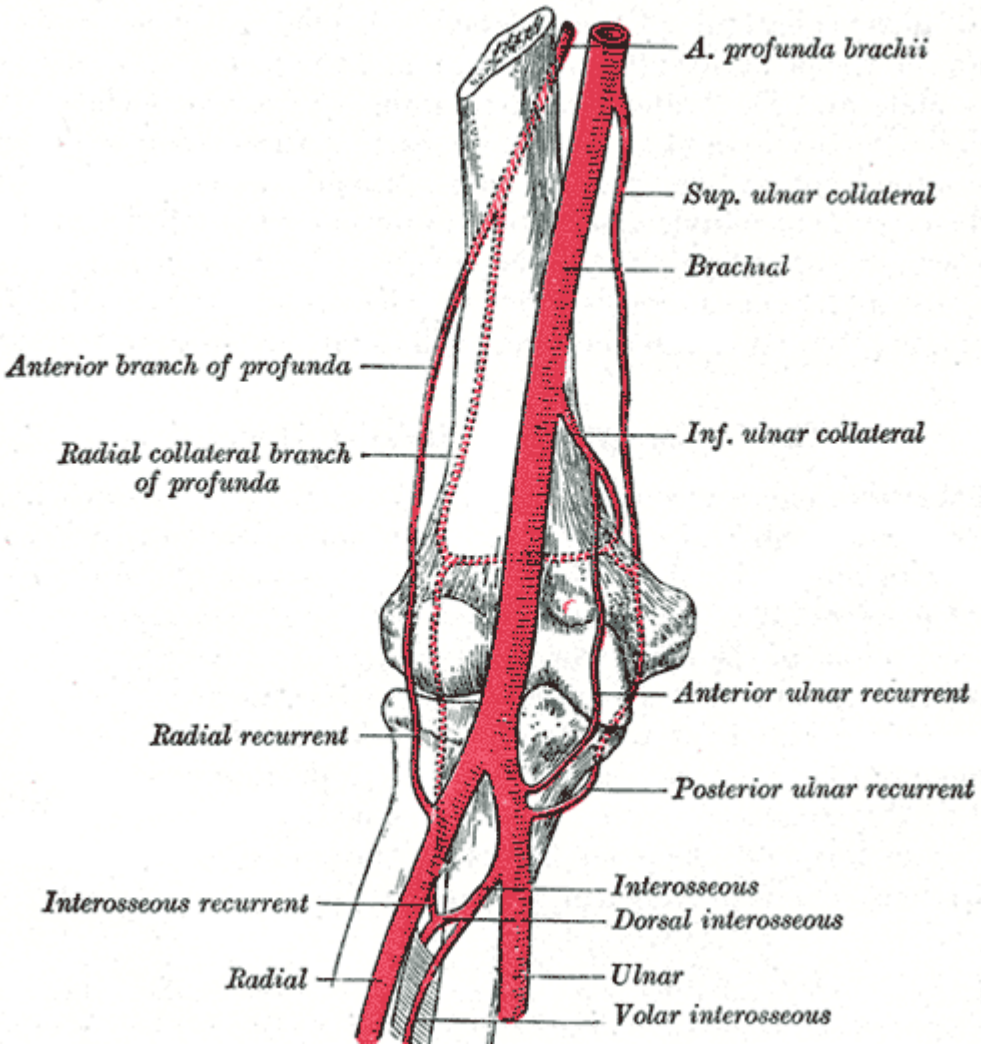
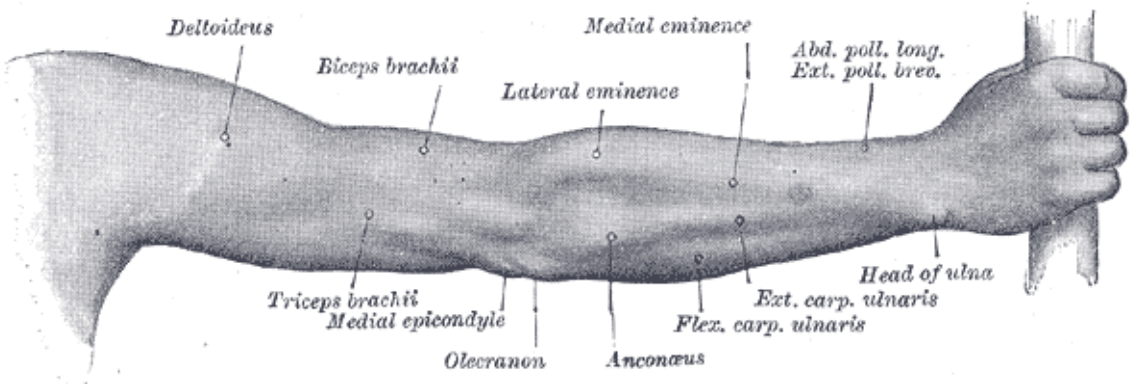
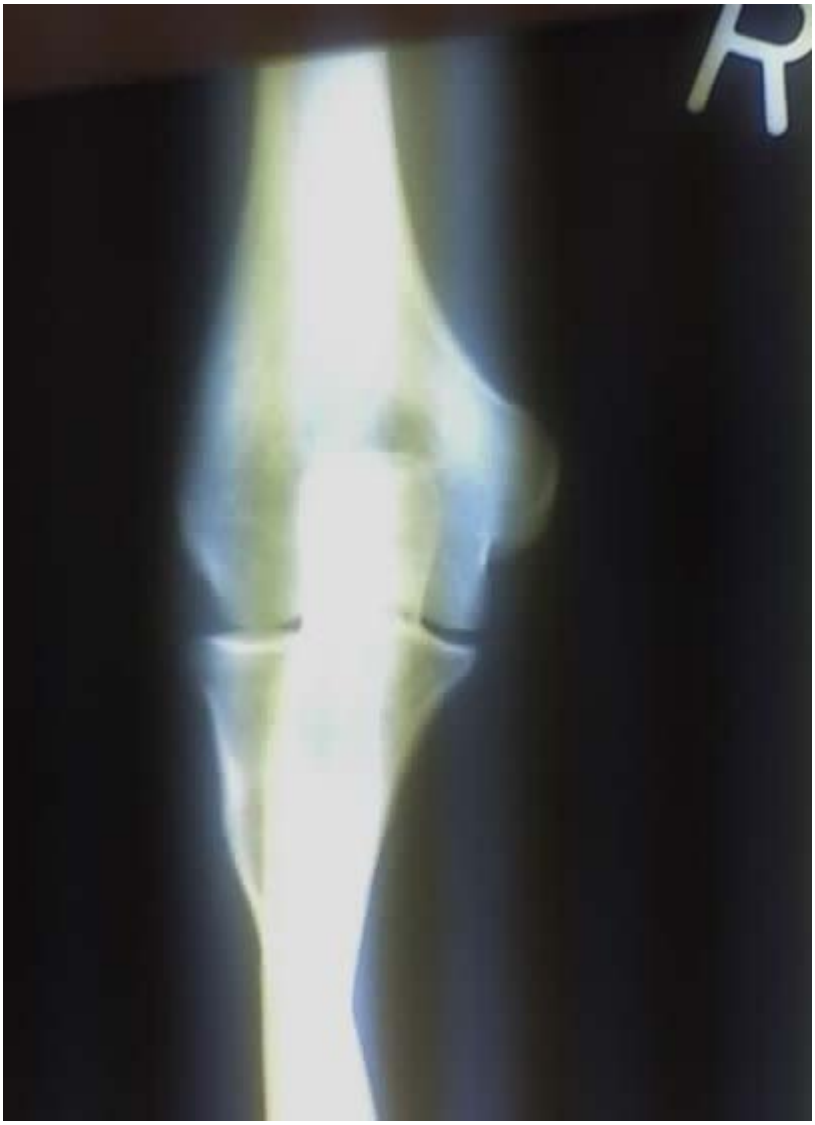


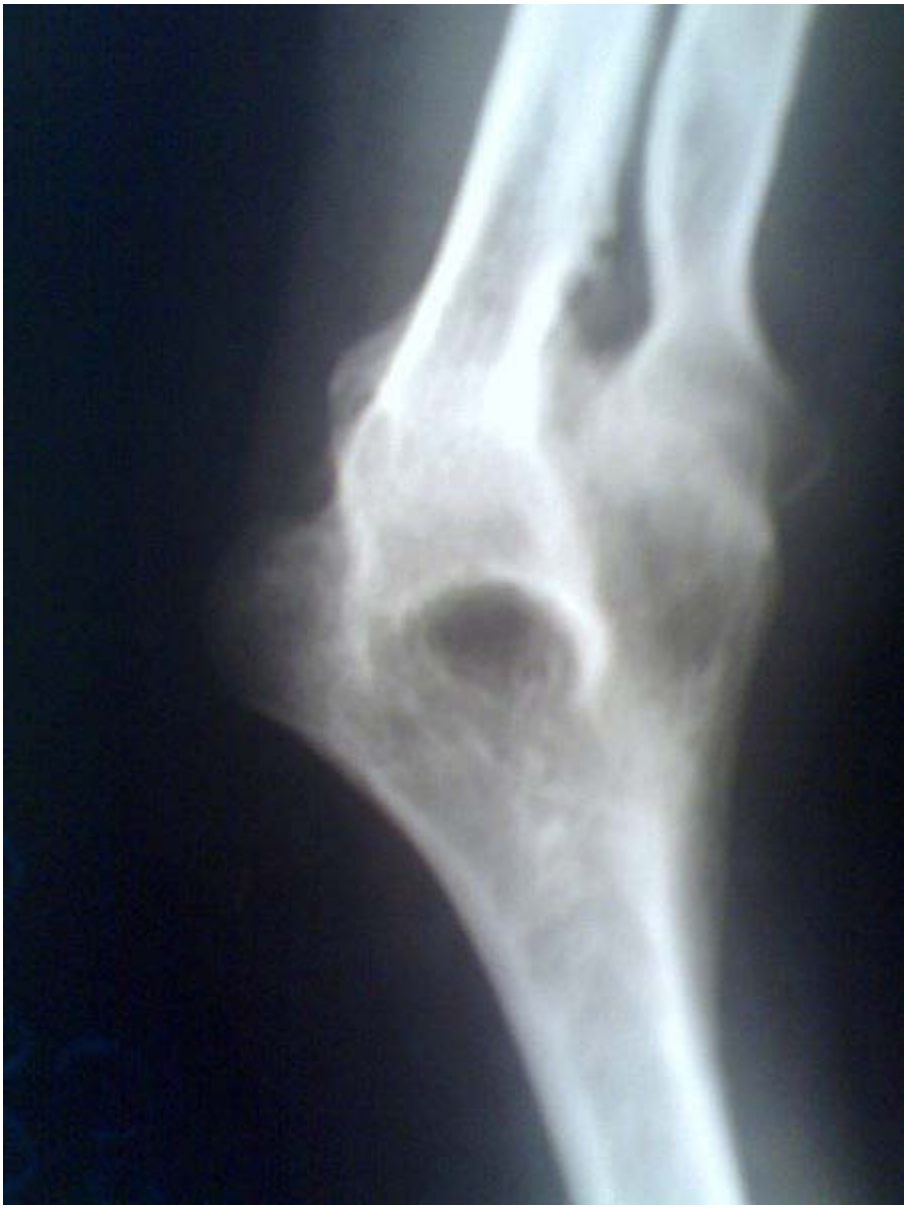
Diagram of the anastomosis around the elbow-joint.



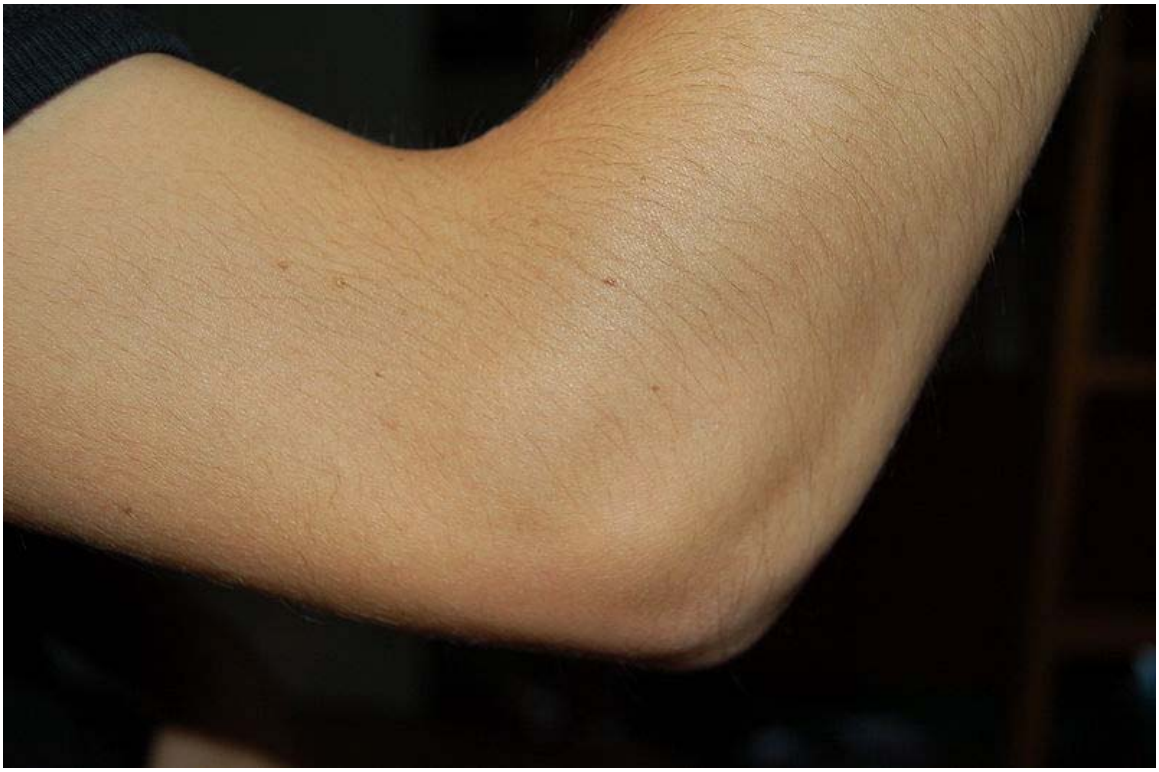
Back of right upper extremity.



Close-up radiograph, right elbow-joint



Pathological fusion of three bones at elbow.



Elbow

Chapter 4

Forearm

Forearm

Upper limb, forearm pronated. The forearm is the part of the upper limb between the elbow and the wrist.

Latin *antebrachium*

MeSH *Forearm*

The **forearm** is the structure and distal region of the upper limb, between the elbow and the wrist. The term forearm is used in anatomy to distinguish it from the arm, a word which is most often used to describe the entire appendage of the upper limb but in anatomy, technically means only the region of the upper arm whereas the lower "arm" is

called the forearm. It is homologous to the leg that lies between the knee and the ankle joints.

The forearm contains two long bones, the radius and the ulna, forming the **radioulnar joint**. The interosseous membrane connects these bones. Ultimately, the forearm is covered by skin, the anterior surface usually being less hairy than the posterior surface.

The forearm contains many muscles, including the flexors and extensors of the digits, a flexor of the elbow (brachioradialis), and pronators and supinators that turn the hand to face down or upwards, respectively. In cross-section the forearm can be divided into two fascial compartments. The posterior compartment contains the extensors of the hands, which are supplied by the radial nerve. The anterior compartment contains the flexors, and is mainly supplied by the median nerve. The ulnar nerve also runs the length of the forearm.

The radial and ulnar arteries, and their branches, supply the blood to the forearm. These usually run on the anterior face of the radius and ulna down the whole forearm. The main superficial veins of the forearm are the cephalic, median antebrachial and the basilic vein. These veins can be used for cannularisation or venipuncture, although the cubital fossa is a preferred site for getting blood.

Anatomy

Bones

- radius
- ulna

Joints

- **proximal to forearm**
  - elbow
- **in the forearm**
  - proximal radioulnar joint
  - distal radioulnar joint
- *distal to forearm*
  - wrist

Muscles

Compartment	Level	Muscle	E/I	Nerve
Anterior	superficial	flexor carpi radialis	E	median
Anterior	superficial	palmaris longus	E	median
Anterior	superficial	flexor carpi ulnaris	E	ulnar
Anterior	superficial	pronator teres	I	median

Anterior	superficial (or intermediate)	flexor digitorum superficialis (sublimis)	E	median
Anterior	deep	flexor digitorum profundus	E	ulnar + median
Anterior	deep	flexor pollicis longus	E	median
Anterior	deep	pronator quadratus	I	median
Posterior		brachioradialis	I	radial
Posterior	superficial	extensor carpi radialis longus	E	radial
Posterior	superficial	extensor carpi radialis brevis	E	radial
Posterior	intermediate	extensor digitorum (communis)	E	radial
Posterior	intermediate	extensor digiti minimi (proprius)	E	radial
Posterior	superficial	extensor carpi ulnaris	E	radial
Posterior	deep	abductor pollicis longus	E	radial
Posterior	deep	extensor pollicis brevis	E	radial
Posterior	deep	extensor pollicis longus	E	radial
Posterior	deep	extensor indicis (proprius)	E	radial
Posterior	deep	supinator	I	radial
Posterior	deep	anconeus	I	radial

- "E/I" refers to "extrinsic" or "intrinsic". The intrinsic muscles of the forearm act on the forearm, meaning, across the elbow joint and the proximal and distal radioulnar joints (resulting in pronation or supination, whereas the extrinsic muscles act upon the hand and wrist. In most cases, the extrinsic anterior muscles are *flexors*, while the extrinsic posterior muscles are *extensors*.

- The Brachioradialis, flexor of the forearm, is unusual in that it is located in the posterior compartment, but it is actually in the anterior portion of the forearm.

Nerves

- Median nerve – principle nerve of the anterior compartment (PT, FCR, PL, FDS).
  - anterior interosseous nerve (supplies FPL, lat. 1/2 of FDP, PQ).
- Radial nerve – supplies muscles of the posterior compartment (ECRL, ECRB).
  - Superficial branch of radial nerve
  - Deep branch of radial nerve, becomes Posterior interosseus nerve and supplies muscles of the posterior compartment (ED, EDM, ECU, APL, EPB, EPL, EI).
- Ulnar nerve - supplies some medial muscles (FCU, med. 1/2 of FDP).

Vessels

- Brachial artery

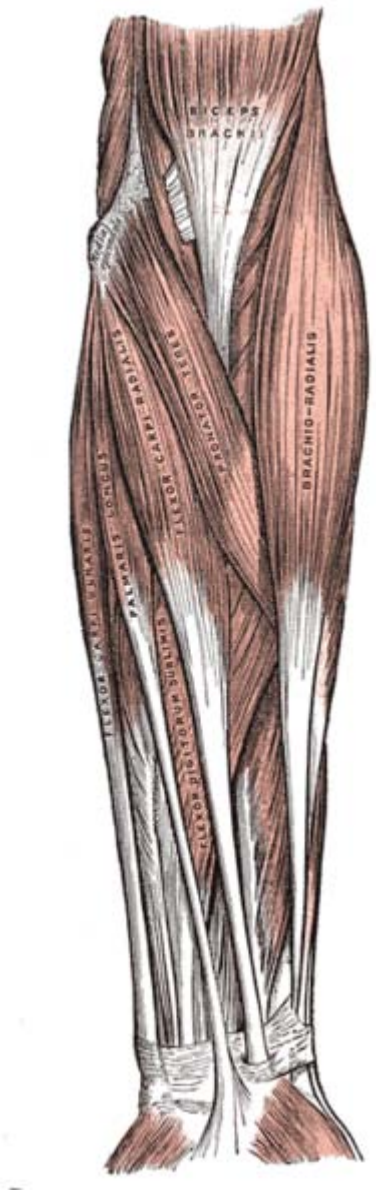
- Radial artery
  - Radial recurrent artery
- Ulnar artery
  - Pulmonary artery
  - Anterior ulnar recurrent artery and posterior ulnar recurrent artery
  - Common interosseous artery
    - Posterior interosseous artery
    - Anterior interosseous artery

Other structures

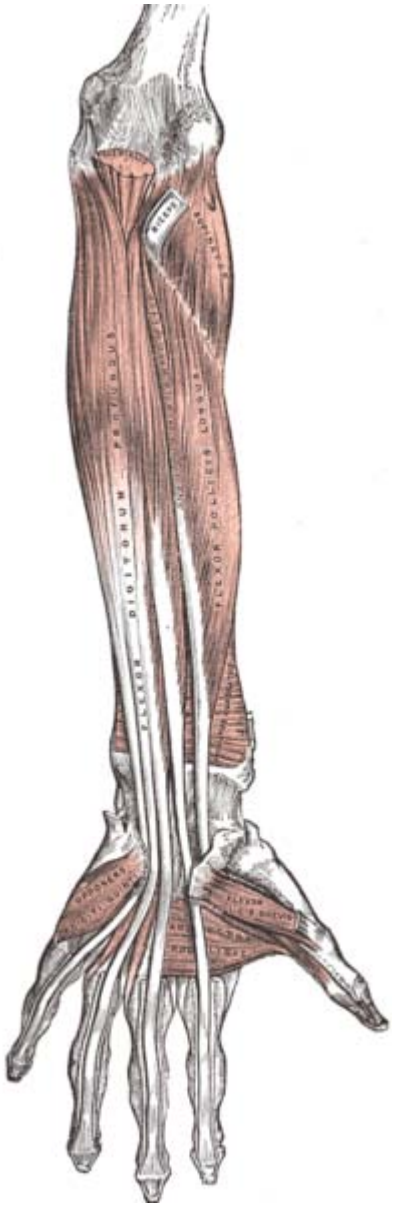
- Interosseous membrane of forearm
- Annular ligament of ulna

Fracture

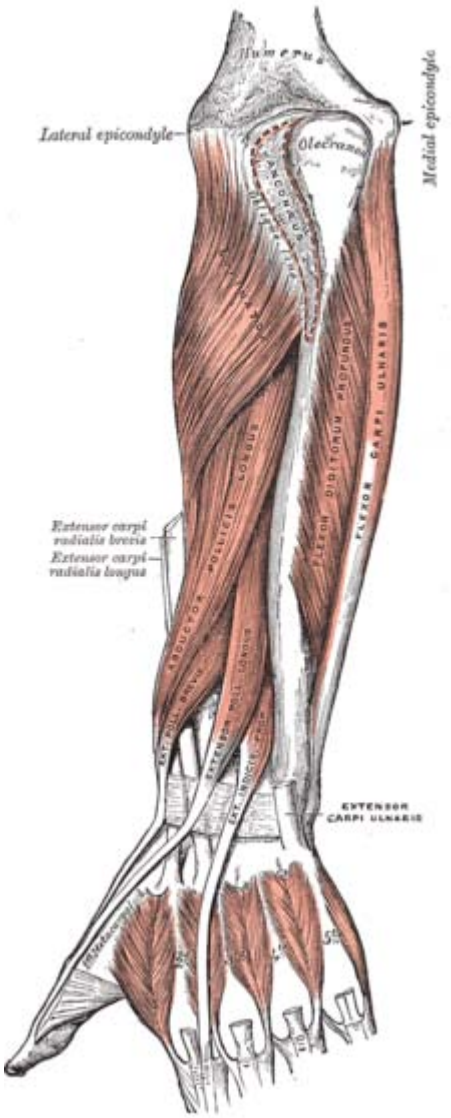
A fracture of the forearm can be classified as to whether it involves only the ulna (ulnar fracture), only the radius (radius fracture) or both (radioulnar fracture)



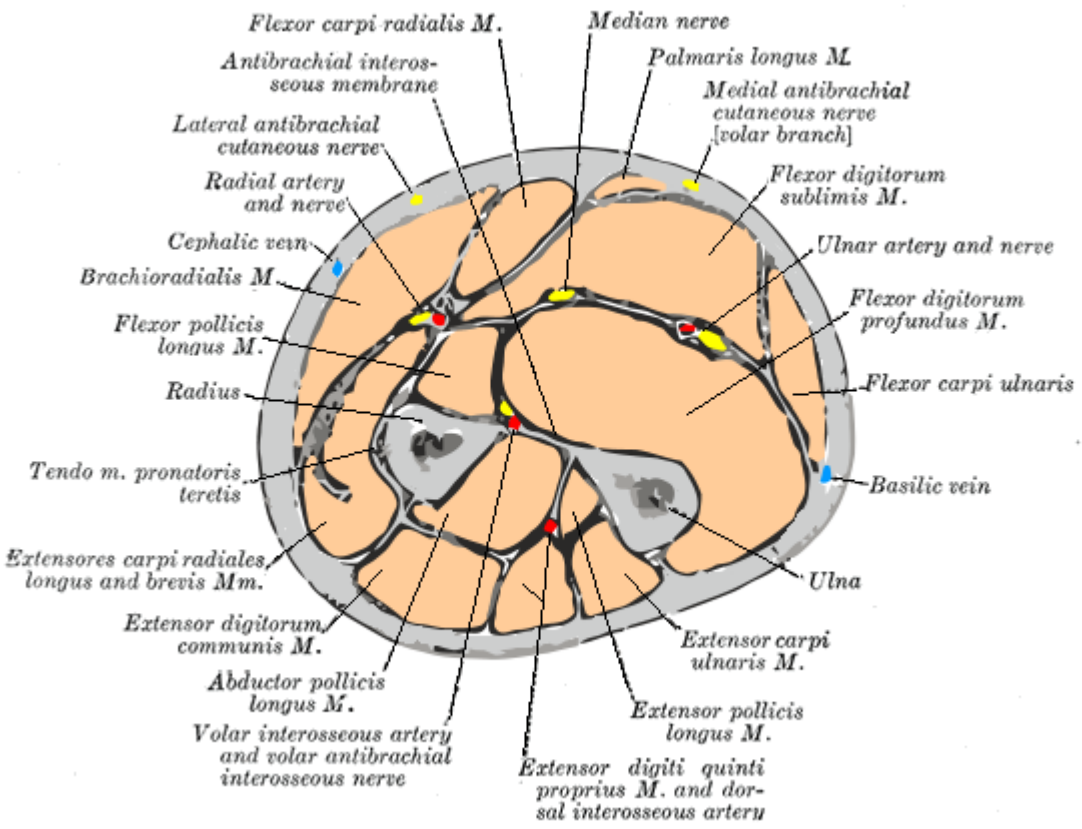
Superficial muscles of the forearm



Deep muscles of the anterior forearm



Deep muscles of the posterior forearm

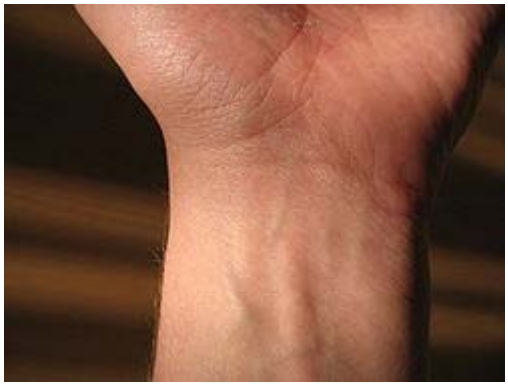


Cross-section through the middle of the forearm.

Chapter 5

Wrist

wrist joint



A human wrist.

Latin	*articulatio radiocarpea*
Gray's	*subject #86 327*
MeSH	*Wrist+joint*

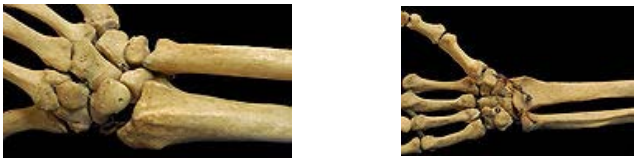
In human anatomy, the **wrist** is variously defined as 1) the carpus or carpal bones, the complex of eight bones forming the proximal skeletal segment of the hand; (2) the **wrist joint** or **radiocarpal joint**, the joint between the radius and the carpus; and (3) the anatomical region surrounding the carpus including the distal parts of the bones of the forearm and the proximal parts of the metacarpus or five metacarpal bones and the series of joints between these bones, thus referred to as *wrist joints*. This region also includes the carpal tunnel, the anatomical snuff box, the flexor retinaculum, and the extensor retinaculum.

As a consequence of these various definitions, fractures to the carpal bones are referred to as carpal fractures, while fractures such as distal radius fracture are considered fractures to the wrist.

Etymology

The English word "wrist" is etymologically derived from the prehistoric German word *wristiz* from which are derived modern German *rist* ("instep", "wrist") and modern Swedish *vrist* ("instep", "ankle"). The base *writh-* and its variants are associated with Old English words "wreath", "wrest", and "writhe". The *wr-* sound of this base seems originally to have been symbolic of the action of twisting.

Anatomy



Posterior and anterior aspects of right human wrist

Ligaments of wrist. Posterior and anterior views

Articulations

The radiocarpal, intercarpal, midcarpal, carpometacarpal, and intermetacarpal joints often intercommunicate through a common synovial cavity.

Extrinsic hand

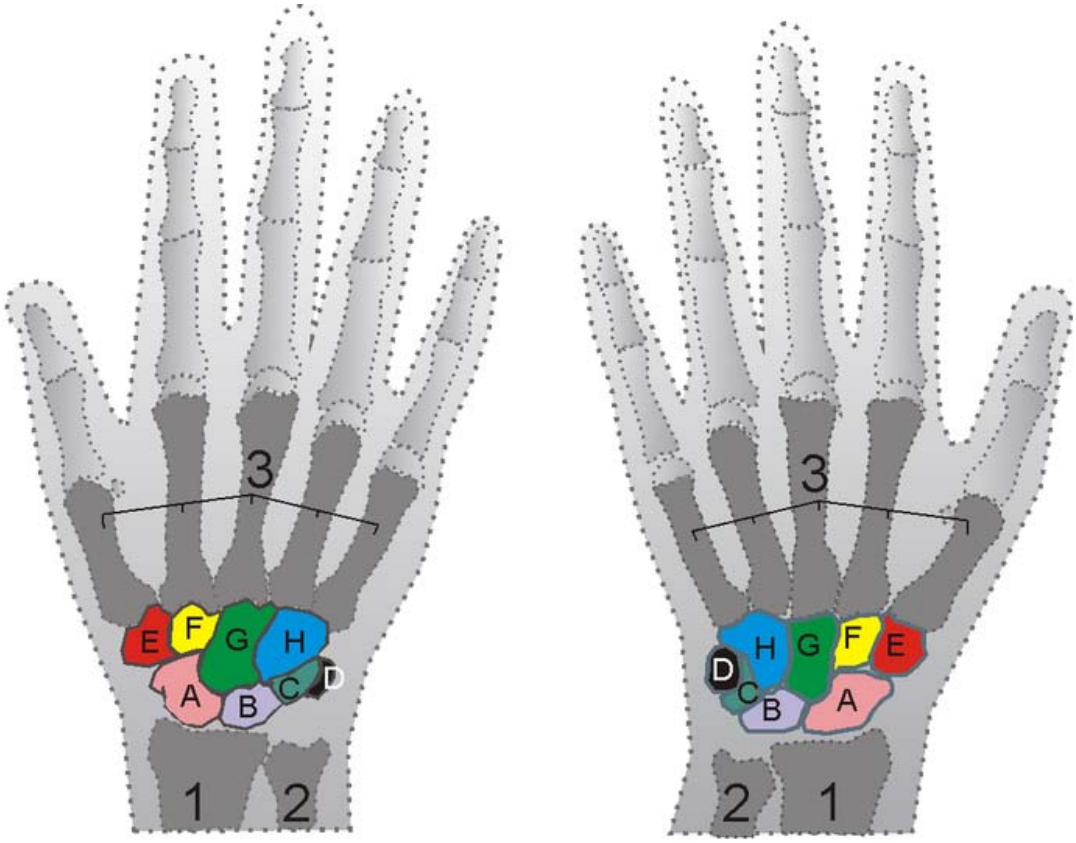
The distal radioulnar joint is a pivot joint located between the bones of the forearm, the radius and ulna. Formed by the head of ulna and the ulnar notch of radius, this joint is separated from the radiocarpal joint by an articular disk lying between the radius and the styloid process of ulna. The capsule of the joint is lax and extends from the inferior sacciform recess to the ulnar shaft. Together with the proximal radioulnar joint, the distal radioulnar joint permits pronation and supination.

The radiocarpal joint or wrist joint is an ellipsoid joint formed by the radius and the articular disk proximally and the proximal row of carpal bones distally. The carpal bones

on the ulnar side only make intermittent contact with the proximal side — the triquetrum only makes contact during ulnar abduction. The capsule, lax and un-branched, is thin on the dorsal side and can contain synovial folds. The capsule is continuous with the midcarpal joint and strengthened by numerous ligaments, including the palmar and dorsal radiocarpal ligaments, and the ulnar and radial collateral ligaments.

The parts forming the radiocarpal joint are the lower end of the radius and under surface of the articular disk above; and the scaphoid, lunate, and triquetral bones below. The articular surface of the radius and the under surface of the articular disk form together a transversely elliptical concave surface, the receiving cavity. The superior articular surfaces of the scaphoid, lunate, and triquetrum form a smooth convex surface, the condyle, which is received into the concavity.

Intrinsic hand



Carpus

In the hand proper a total of 13 bones form part of the wrist: eight carpal bones— scaphoid, lunate, triquetral, pisiform, trapezium, trapezoid, capitate, and hamate— and five metacarpal bones—the first, second, third, fourth, and fifth metacarpal bones.

The midcarpal joint is the S-shaped joint space separating the proximal and distal rows of carpal bones. The intercarpal joints, between the bones of each row, are strengthened by

the radiate carpal and pisohamate ligaments and the palmar, interosseous, and dorsal intercarpal ligaments. Some degree of mobility is possible between the bones of the proximal row while the bones of the distal row are connected to each others and to the metacarpal bones —at the carpometacarpal joints— by strong ligaments —the pisometacarpal and palmar and dorsal carpometacarpal ligament— that makes a functional entity of these bones. Additionally, the joints between the bases of the metacarpal bones —the intermetacarpal articulations— are strengthened by dorsal, interosseous, and palmar intermetacarpal ligaments.

Movements and muscles

The extrinsic hand muscles are located in the forearm where their bellies form the proximal fleshy roundness. When contracted, most of the tendons of these muscles are prevented from standing up like taut bowstrings around the wrist by passing under the flexor retinaculum on the palmar side and the extensor retinaculum on the dorsal side. On the palmar side the carpal bones form the carpal tunnel through which some of the flexor tendons pass in tendon sheaths that enable them to slide back and forth through the narrow passageway.

Starting from the mid-position of the hand, the movements permitted in the wrist proper are (muscles in order of importance):

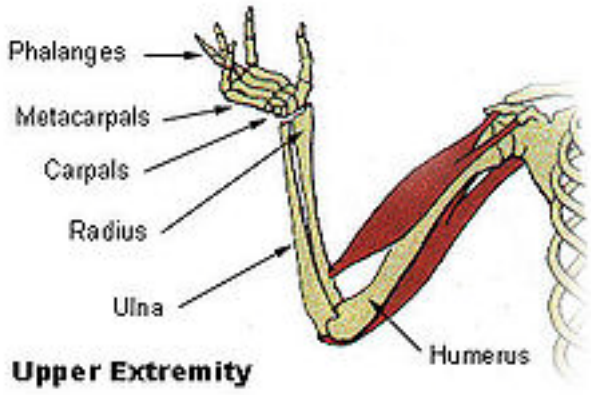
- Marginal movements: radial deviation (abduction, movement towards the thumb) and ulnar deviation (adduction, movement towards the little finger). These movements take place at the radiocarpal and midcarpal joints through a transverse axis passing through the capitate bone.
    - Radial abduction: extensor carpi radialis longus, abductor pollicis longus, extensor pollicis longus, flexor carpi radialis, flexor pollicis longus
    - Ulnar abduction: extensor carpi ulnaris, flexor carpi ulnaris, extensor digitorum, extensor digiti minimi
- Movements in the plane of the hand: flexion (palmar flexion, tilting towards the palm) and extension (dorsiflexion, tilting towards the back of the hand). These movements take place about a dorsopalmar axis (back to front) passing through the capitate bone. Palmar flexion is the most powerful of these movements because the flexors, especially the finger flexors, are considerably stronger than the extensors.
    - Extension: extensor digitorum, extensor carpi radialis longus, extensor carpi radialis brevis, extensor indicis, extensor pollicis longus, extensor digiti minimi
    - Palmar flexion: flexor digitorum superficialis, flexor digitorum profundus, flexor carpi ulnaris, flexor pollicis longus, flexor carpi radialis, abductor pollicis longus
- Intermediate or combined movements

However, movements at the wrist can not be properly described without including movements in the distal radioulnar joint in which the rotary actions of supination and pronation occur and this joint is therefore normally regarded as part of the wrist.

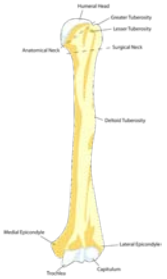
Chapter 6

Humerus

Bone: Humerus



Upper extremity



Gray's *subject #51 209*
MeSH *Humerus*

The **humerus** (ME from Latin *humerus, umerus* upper arm, shoulder; Gothic *ams* shoulder, Greek *ōmos*) is a long bone in the arm or forelimb that runs from the shoulder to the elbow.

Anatomically, it connects the scapula and the lower arm (consisting of the radius and ulna), and consists of three sections. The upper extremity consists of a rounded head, a

narrow neck, and two short processes (tubercles, sometimes called tuberosities.) Its body is cylindrical in its upper portion, and more prismatic below. The lower extremity consists of 2 epicondyles, 2 processes (trochlea & capitulum), and 3 fossae (radial fossa, coronoid fossa, and olecranon fossa). As well as its true anatomical neck, the constriction below the greater and lesser tubercles of the humerus is referred to as its surgical neck due to its tendency to commonly get fractured, thus often becoming the focus of surgeons.

Muscles attached to the humerus

The deltoid originates on the lateral third of the clavicle, acromion and the crest of the spine of the scapula. It is inserted on the deltoid tuberosity of the humerus and has several actions including abduction, extension, and rotation of the shoulder. The supraspinatus also originates on the spine of the scapula. It inserts on the greater tubercle of the humerus, and assists in abduction of the shoulder.

The pectoralis major, teres major, and latissimus dorsi insert at the *intertubercular groove* of the humerus. They work to adduct and medially, or internally, rotate the humerus.

The infraspinatus and teres minor insert on the greater tubercle, and work to laterally, or externally, rotate the humerus. In contrast, the subscapularis muscle inserts onto the lesser tubercle and works to medially, or internally, rotate the humerus.

The biceps brachii, brachialis, coracobrachialis, and brachioradialis (which attaches distally) act to flex the elbow. (The biceps, however, does not attach to the humerus.) The triceps brachii and anconeus extend the elbow, and attach to the posterior side of the humerus.

The four muscles of supraspinatus, infraspinatus, teres minor and subscapularis form a musculo-ligamentous girdle called the rotator cuff. This cuff stabilizes the very mobile but inherently unstable glenohumeral joint. The other muscles are used as counterbalances for the actions of lifting/pulling and pressing/pushing.

Articulations

At the shoulder, the head of the humerus articulates with the glenoid fossa of the scapula. More distally, at the elbow, the capitulum of the humerus articulates with the head of the radius, and the trochlea of the humerus articulates with the olecranon process of the ulna.

Nerves

The axillary nerve is located at the proximal end, against the shoulder girdle. The most common type of shoulder dislocation is an anterior or inferior dislocation of the humerus's glenohumeral joint, which has the potential to injure the axillary nerve or the axillary artery. Signs and symptoms of this dislocation include a loss of the normal shoulder contour and a palpable depression under the acromion.

The radial nerve follows the humerus closely. At the midshaft of the humerus, the radial nerve travels from the posterior to the anterior aspect of the bone in the *spiral groove*. A fracture of the humerus in this region can result in radial nerve injury.

The ulnar nerve at the distal end of the humerus near the elbow is sometimes referred to in popular culture as 'the funny bone'. Striking this nerve can cause a tingling sensation ("funny" feeling), and sometimes a significant amount of pain.

In other animals

Primitive fossil amphibians had little, if any, shaft connecting the upper and lower extremities, making their limbs very short. In most living vertebrates, however, the humerus has a similar form to that of humans. In many reptiles and some primitive mammals, the lower extremity includes a large foramen, or opening, into which nerves and blood vessels pass.

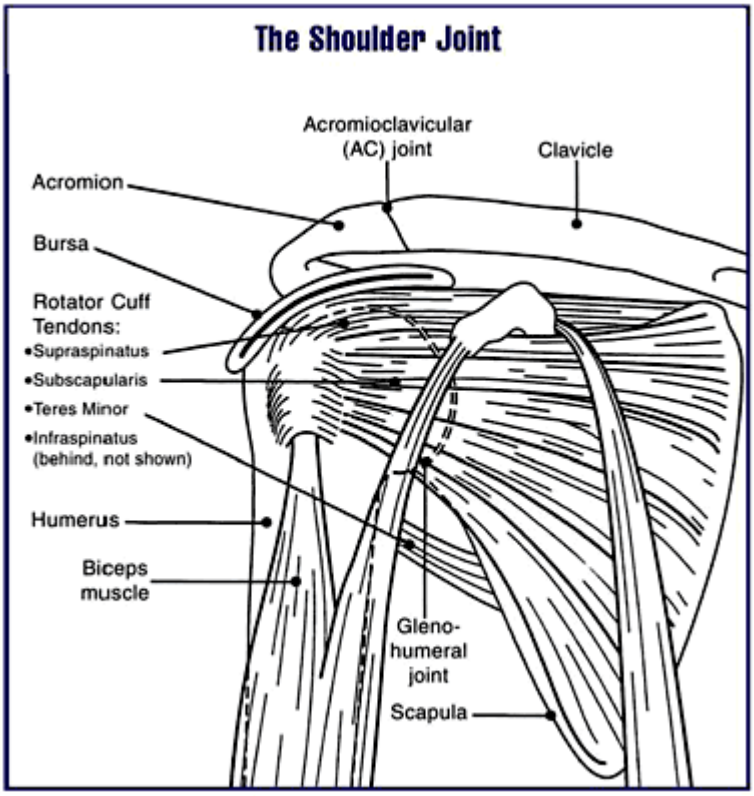
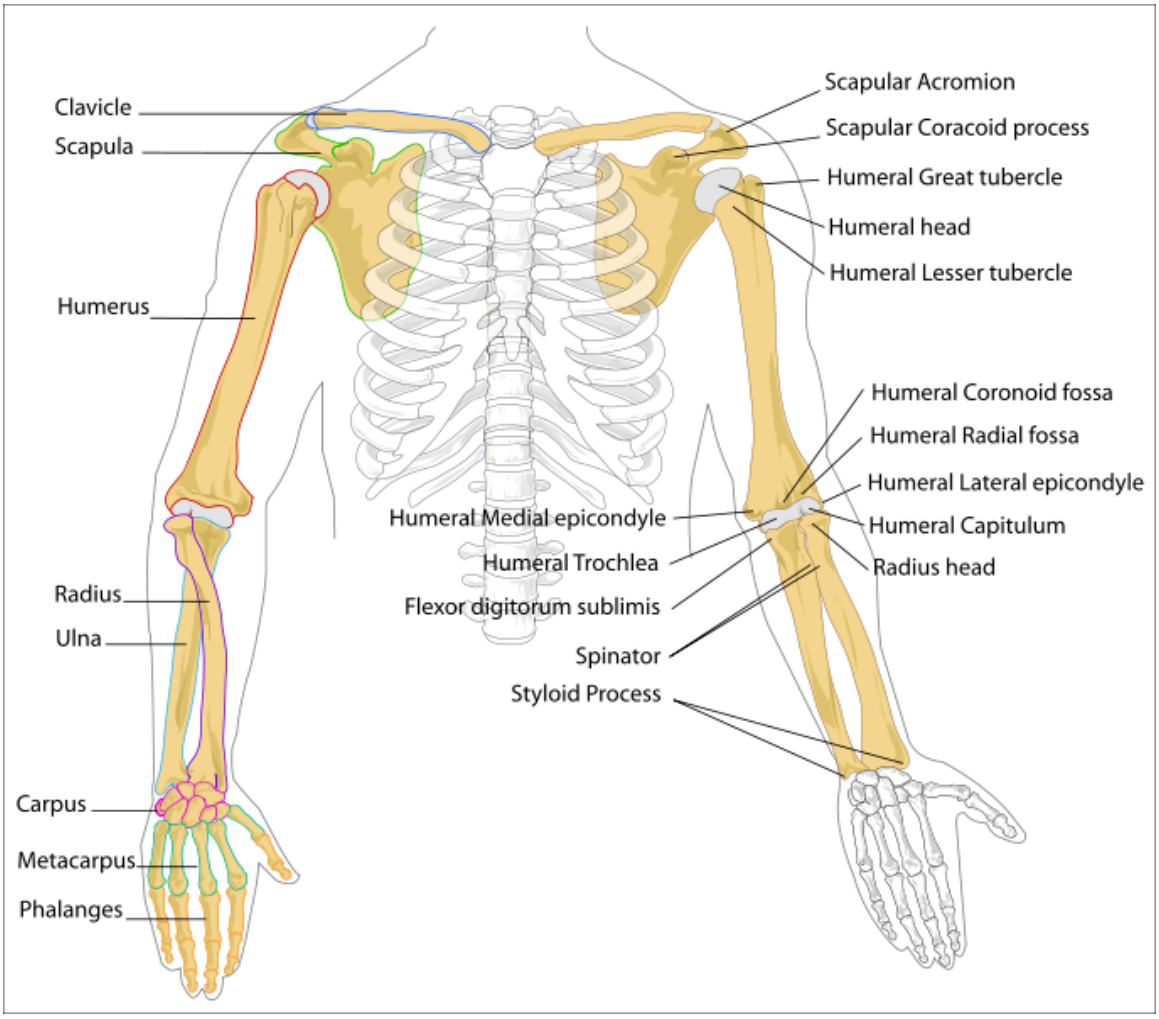


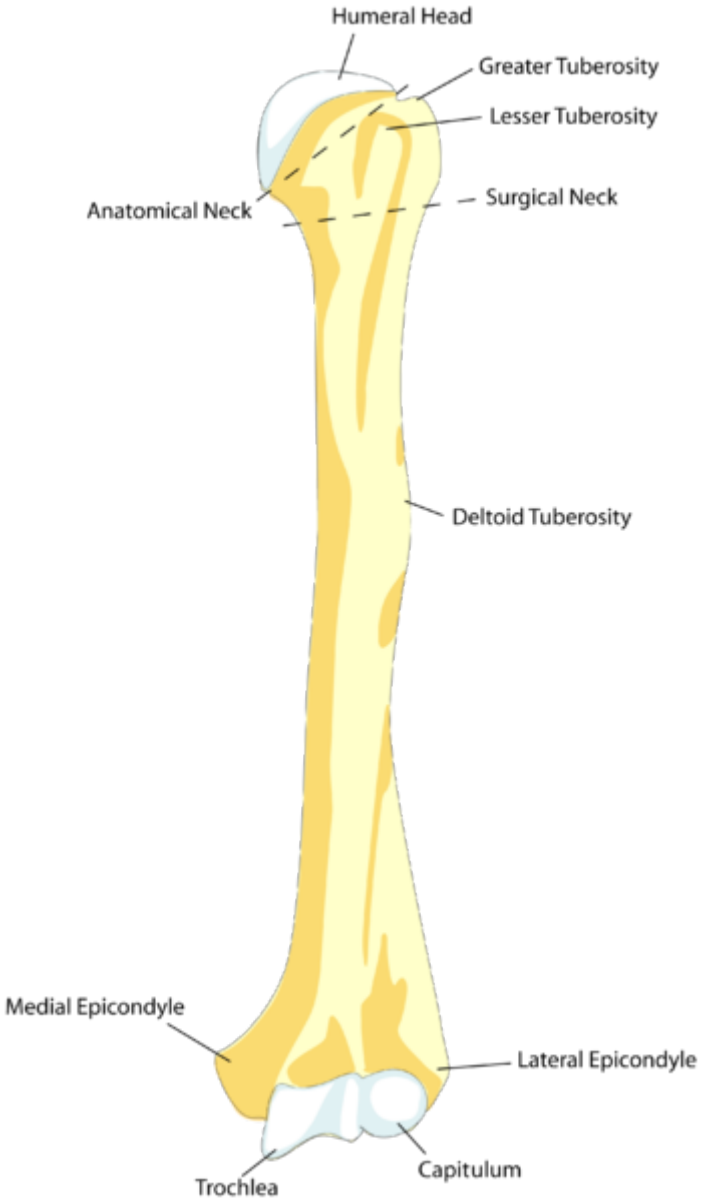
Diagram of the human shoulder joint



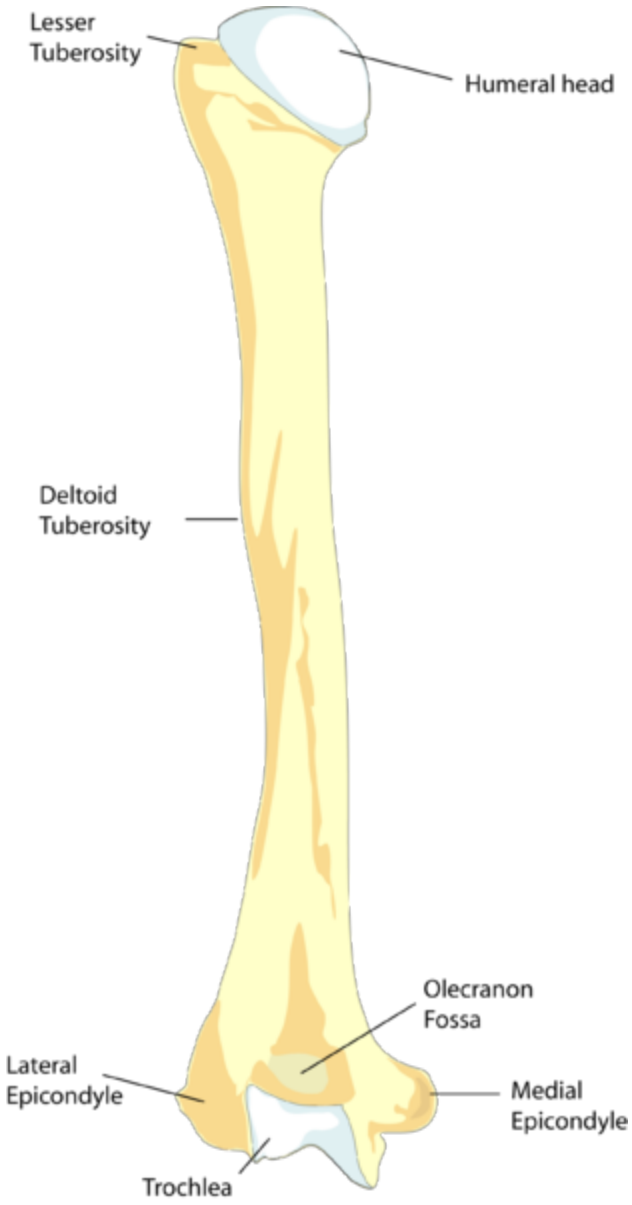
Human arm bones diagram

Humerus (right) - anterior view

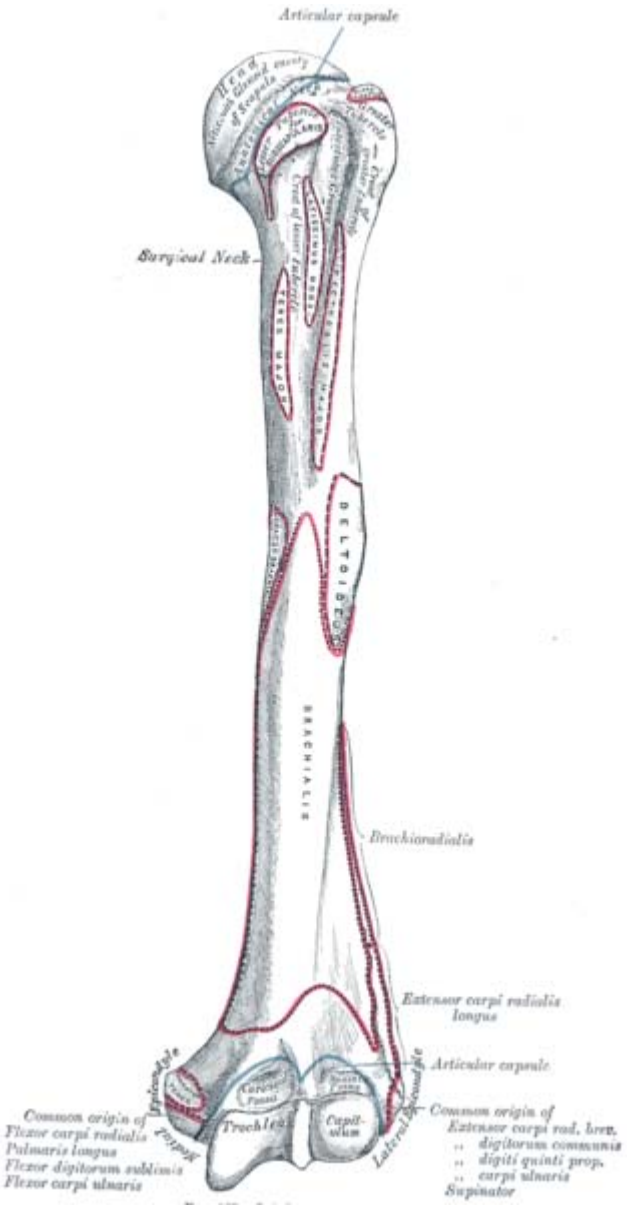
Humerus (right) - posterior view



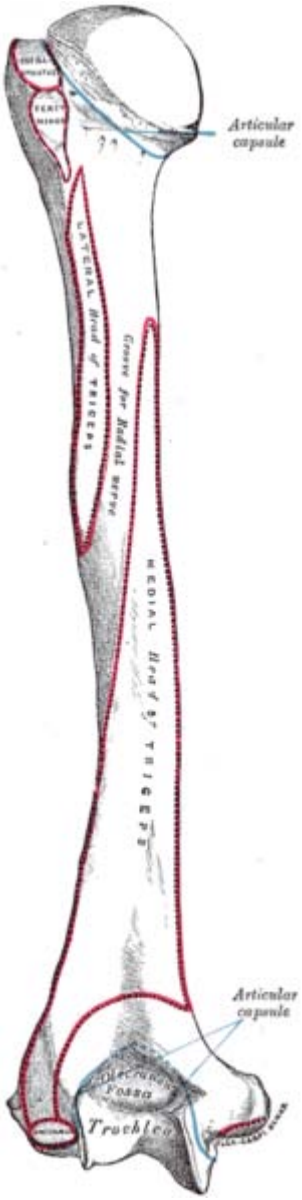
Left humerus. Anterior view.



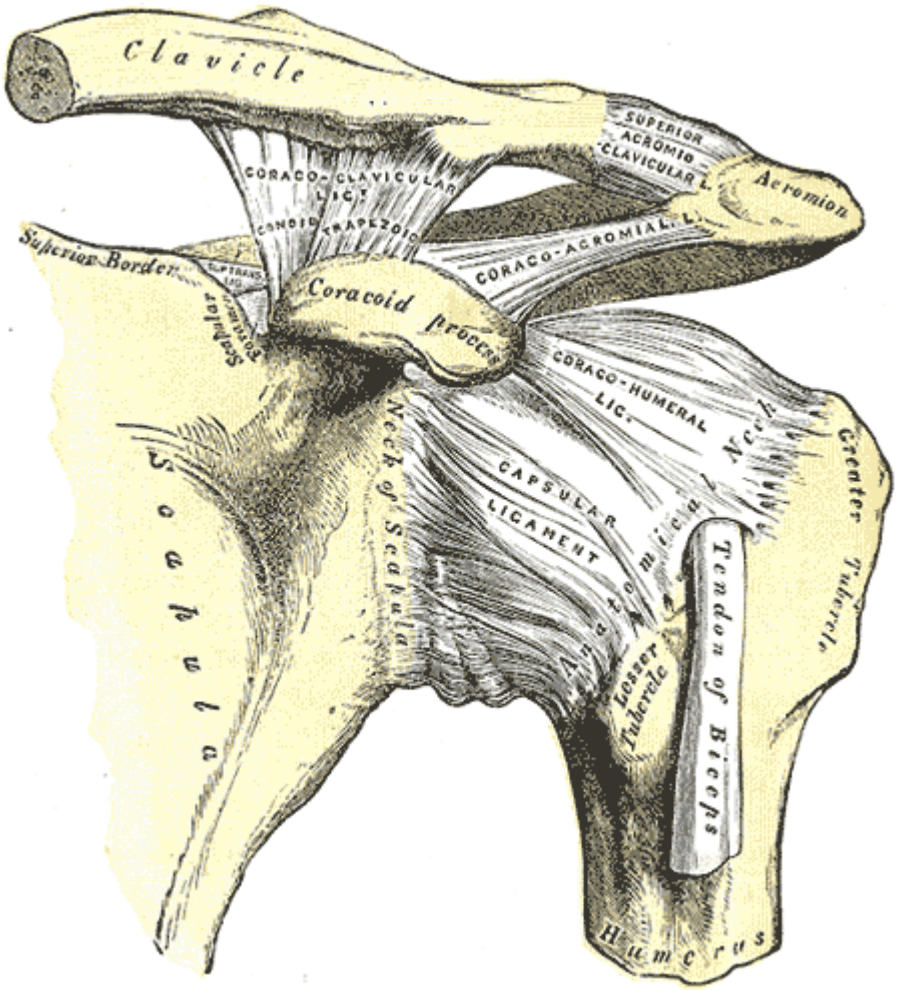
Left humerus. Posterior view.



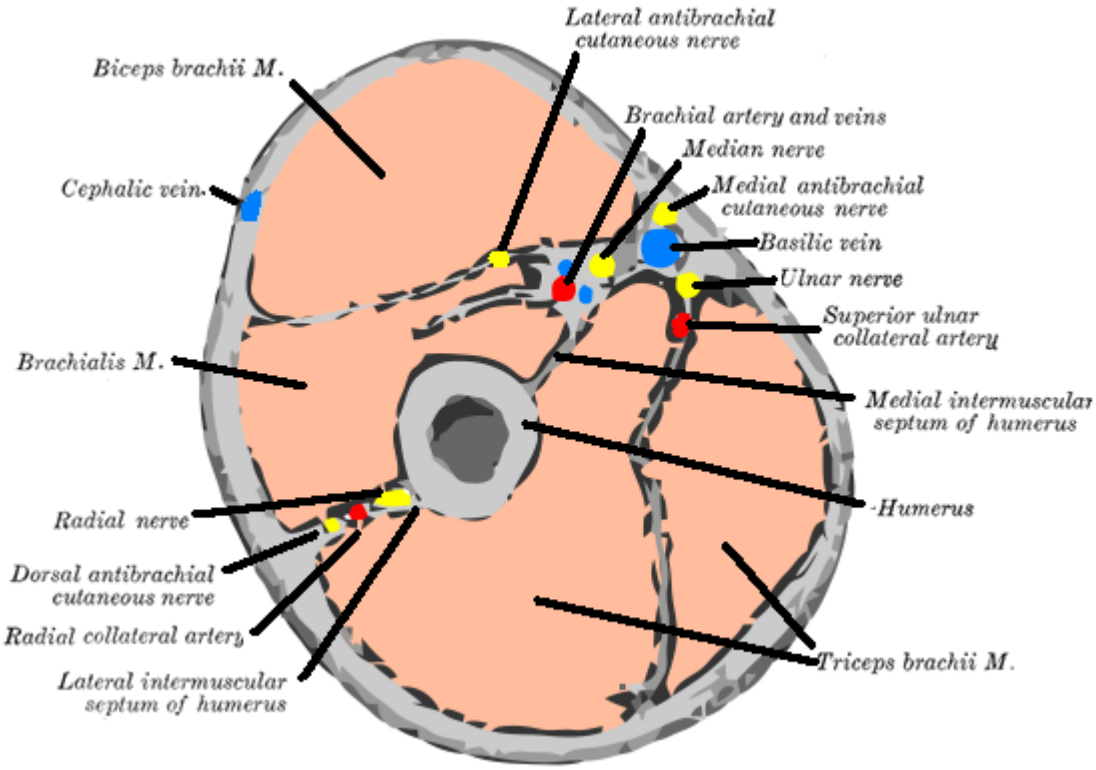
Left humerus with muscle attachments. Anterior view.



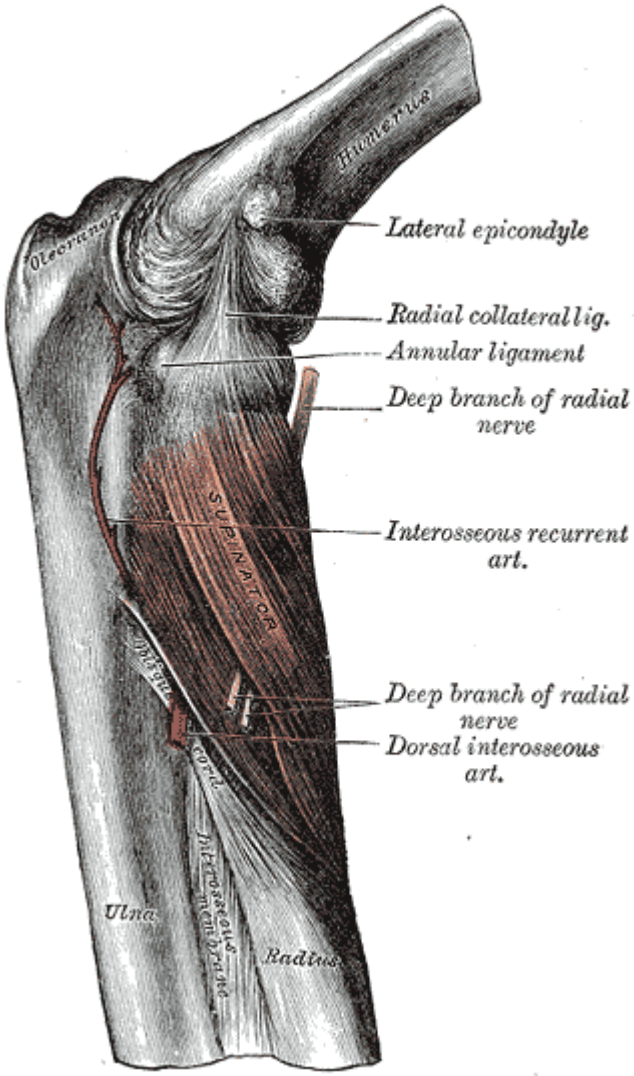
Left humerus with muscle attachments. Posterior view.



The left shoulder and acromioclavicular joints, and the proper ligaments of the scapula.



Cross-section through the middle of upper arm.

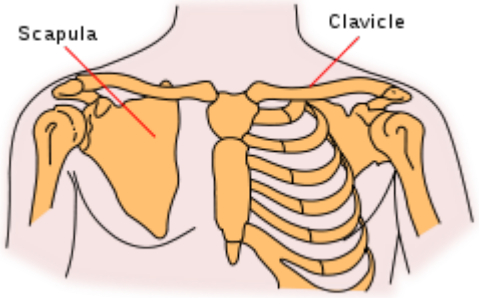


The Supinator.

Chapter 7

Clavicle

Bone: Clavicle

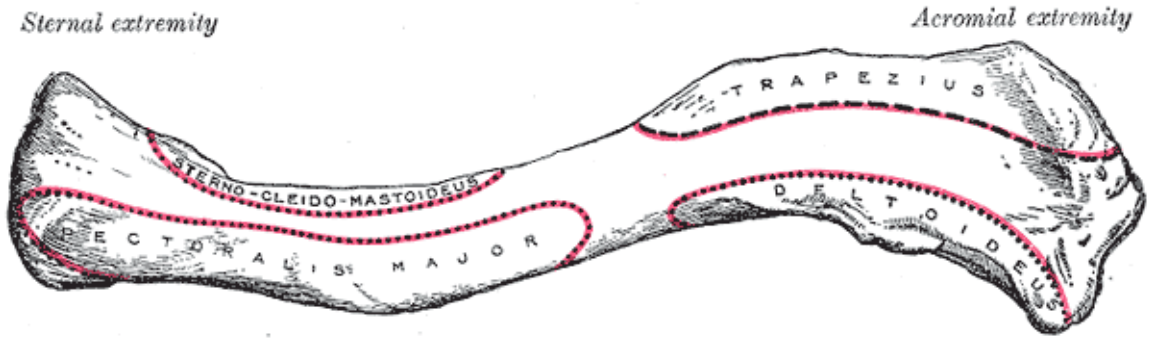


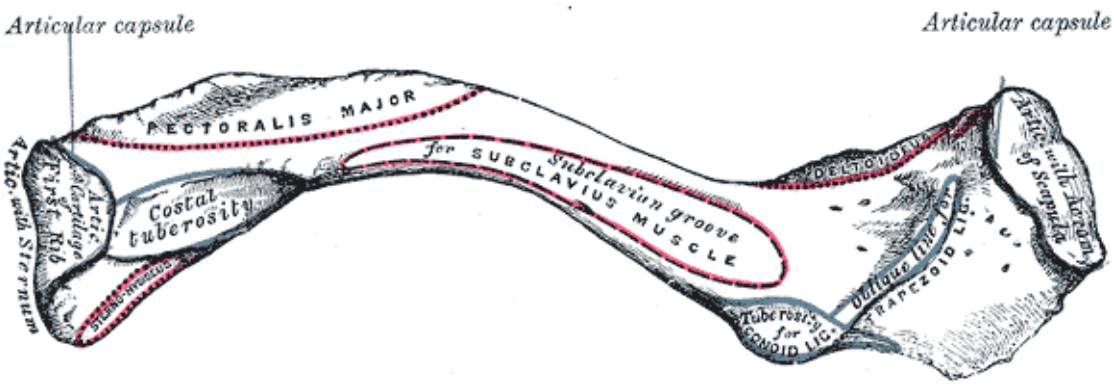
Gray's *subject #49 200*
MeSH *Clavicle*

In human anatomy, the **clavicle** or **collar bone** is a long bone of short length that serves as a strut between the scapula and the sternum. It is the only long bone in body that lies horizontally. It makes up part of the shoulder and the pectoral girdle and is palpable in all people, and, in people who have less fat in this region, the location of the bone is clearly visible as it creates a bulge in the skin.

It receives its name from the Latin: *clavicula* ("little key") because the bone rotates along its axis like a key when the shoulder is abducted.

Right clavicle — from below, and from above.





Left clavicle — from above, and from below.

The clavicle is a doubly curved short bone that connects the arm (upper limb) to the body (trunk), located directly above the first rib. It acts as a strut to keep the scapula in position so the arm can hang freely. Medially, it articulates with the manubrium of the sternum (breast-bone) at the sternoclavicular joint. At its lateral end it articulates with the acromion of the scapula (shoulder blade) at the acromioclavicular joint. It has a rounded medial end and a flattened lateral end.

From the roughly pyramidal sternal end, each clavicle curves laterally and anteriorly for roughly half its length. It then forms a smooth posterior curve to articulate with a process of the scapula (acromion). The flat, acromial end of the clavicle is broader than the sternal end. The acromial end has a rough inferior surface that bears prominent line, Trapezoid line and a small rounded projection, Conoid tubercle. These surface features are attachment sites for muscles and ligaments of the shoulder.

It can be divided into three parts. Medial end, lateral end and shaft.

Medial End

The medial end is quadrangular and articulates with clavicular notch of menubrium sterni to form sternoclavicular joint. Articular surface extends to anterior aspect for attachment with first costal cartilage.

It gives attachments to
1. Fibrous capsule of sternoclavicular joint **all around**
2. Articular disc **superoposteriorly**
3. Interclavicular ligament **superiorly**

Lateral End

The lateral end is flat from above downward downward. It bears a facet for attachment to acromion process of scapula forming acromioclavicular joint. The area surrounding the joint gives attachment to joint capsule.

Shaft

The shaft is divided into medial 2/3 and lateral 1/3. Medial 2/3 is thicker than lateral 1/3.

Medial 2/3 of shaft

Medial 2/3 of shaft has 4 surfaces and no borders.

Anterior surface is convex forward and gives origin to pectoralis major. **Posterior surface** is smooth and gives origin to sternohyoid muscle at its medial end. **Superior surface** is rough at its medial part and gives origin to sternocleidomastoid muscle . **Inferior surface** has an oval impression at its medial end for costoclavicular ligament. At the lateral side of inferior surface, there is a subclavian groove for insertion of subclavius muscle. At the lateral side of subclavian groove, nutrient foramen lies.

Lateral 1/3 of shaft

It has 2 borders and 2 surfaces.

Anterior border is concave forward and gives origin to deltoid muscle. **Posterior border** is convex backward and gives attachment to trapezius muscle . **Superior surface** is subcutaneous. **Inferior surface** has a ridge called trapezoid line and a tubercle, the conoid tubercle for attachment with trapezoid and conoid part of Coracoclavicular ligament that serves to connect the clavicle with the coracoid process of the scapula.

Attachments

Muscles and ligaments that attach to the clavicle include:

Attachment on clavicle	Muscle/Ligament	Other attachment
Superior surface and anterior border	Deltoid muscle	deltoid tubercle, anteriorly on the lateral third
Superior surface	Trapezius muscle	posteriorly on the lateral third
Inferior surface	Subclavius muscle	subclavian groove
Inferior surface	Conoid ligament (the medial part of the coracoclavicular ligament)	conoid tubercle
Inferior surface	Trapezoid ligament (the lateral part of the coracoclavicular ligament)	trapezoid line
Anterior border	Pectoralis major muscle	medial third (rounded border)
Posterior border	Sternocleidomastoid muscle (clavicular	superiorly, on the medial

	head)	third
Posterior border	Sternohyoid muscle	inferiorly, on the medial third
Posterior border	Trapezius muscle	lateral third

The levator claviculae muscle, present in 2–3% of people, originates on the transverse processes of the upper cervical vertebrae and is inserted in the lateral half of the clavicle.

Functions

The clavicle serves several functions:

- It serves as a rigid support from which the scapula and free limb (arm) are suspended; an arrangement that keeps the upper limb away from the thorax so that the arm has maximum range of movement. Acting as flexible, crane-like strut, it allows the scapula to move freely on the thoracic wall.
- Covering the cervicoaxillary canal, it protects the neurovascular bundle that supply the upper limb.
- Transmits physical impacts from the upper limb to the axial skeleton.

Development

The clavicle is the first bone to begin the process of ossification (laying down of minerals onto a preformed matrix) during development of the embryo, during the 5th and 6th weeks of gestation. However, it is one of the last bones to finish ossification, at about 21–25 years of age. It forms by intramembranous ossification. It consists of a mass of cancellous bone surrounded by a compact bone shell. The cancellous bone forms via two ossification centres, one medial and one lateral, which fuse later on. The compact forms as the layer of fascia covering the bone stimulates the ossification of adjacent tissue. The resulting compact bone is known as a periosteal collar.

Even though it is classified as a long bone, the clavicle has no medullary (bone marrow) cavity like other long bones. It is made up of spongy (trabecular) bone with a shell of compact bone. It is a dermal bone derived from elements originally attached to the skull.

Variations

The shape of the clavicle varies more than most other long bones. It is occasionally pierced by a branch of the supraclavicular nerve. In manual workers it is thicker and more curved and the sites of muscular attachments are more pronounced. The right clavicle is usually stronger and shorter than the left clavicle.

Common clavicle injuries

- Acromioclavicular dislocation
- Clavicle fractures
- Degeneration of the clavicle
- The collarbones are sometimes partly or completely absent in cleidocranial dysostosis
- Osteolysis
- Sternoclavicular dislocations

Evolutionary variation

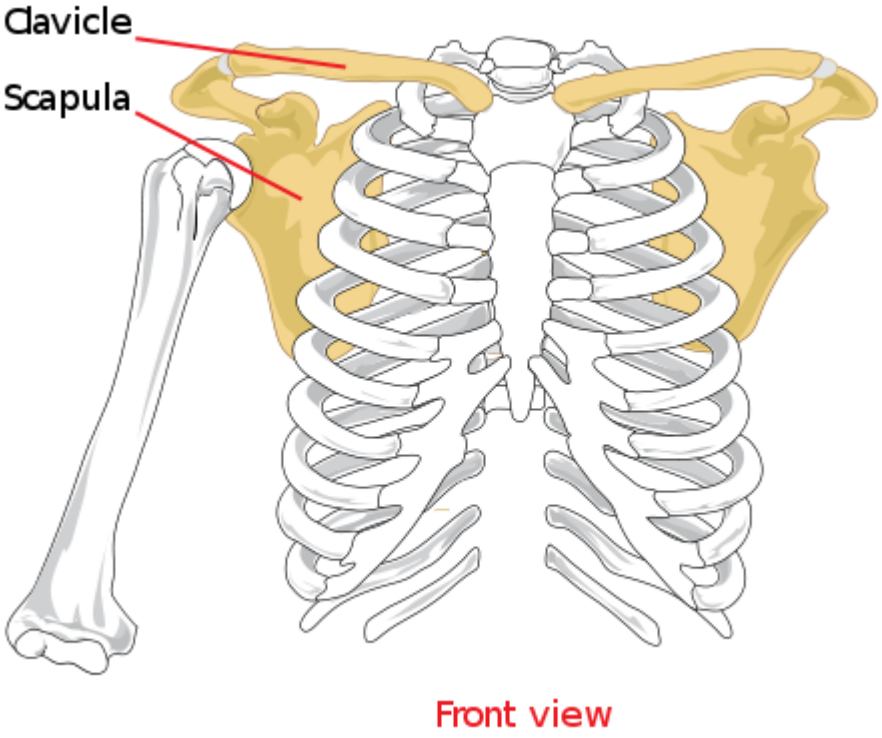
The clavicle first appears as part of the skeleton in primitive bony fish, where it is associated with the pectoral fin; they also have a bone called the cleithrum. In such fish, the paired clavicles run behind and below the gills on each side, and are joined by a solid symphysis on the fish's underside. They are, however, absent in cartilagenous fish and in the vast majority of living bony fish, including all of the teleosts.

The earliest tetrapods retained this arrangement, with the addition of a diamond-shaped **interclavicle** between the base of the clavicles, although this is not found in living amphibians. The cleithrum disappeared early in the evolution of reptiles, and is not found in any living amniotes, but the interclavicle is present in most modern reptiles, and also in monotremes. In modern forms, however, there are a number of variations from the primitive pattern. For example, crocodilians and salamanders lack clavicles altogether (although crocodilians do retain the interclavicle), while in turtles, they form part of the armoured plastron.

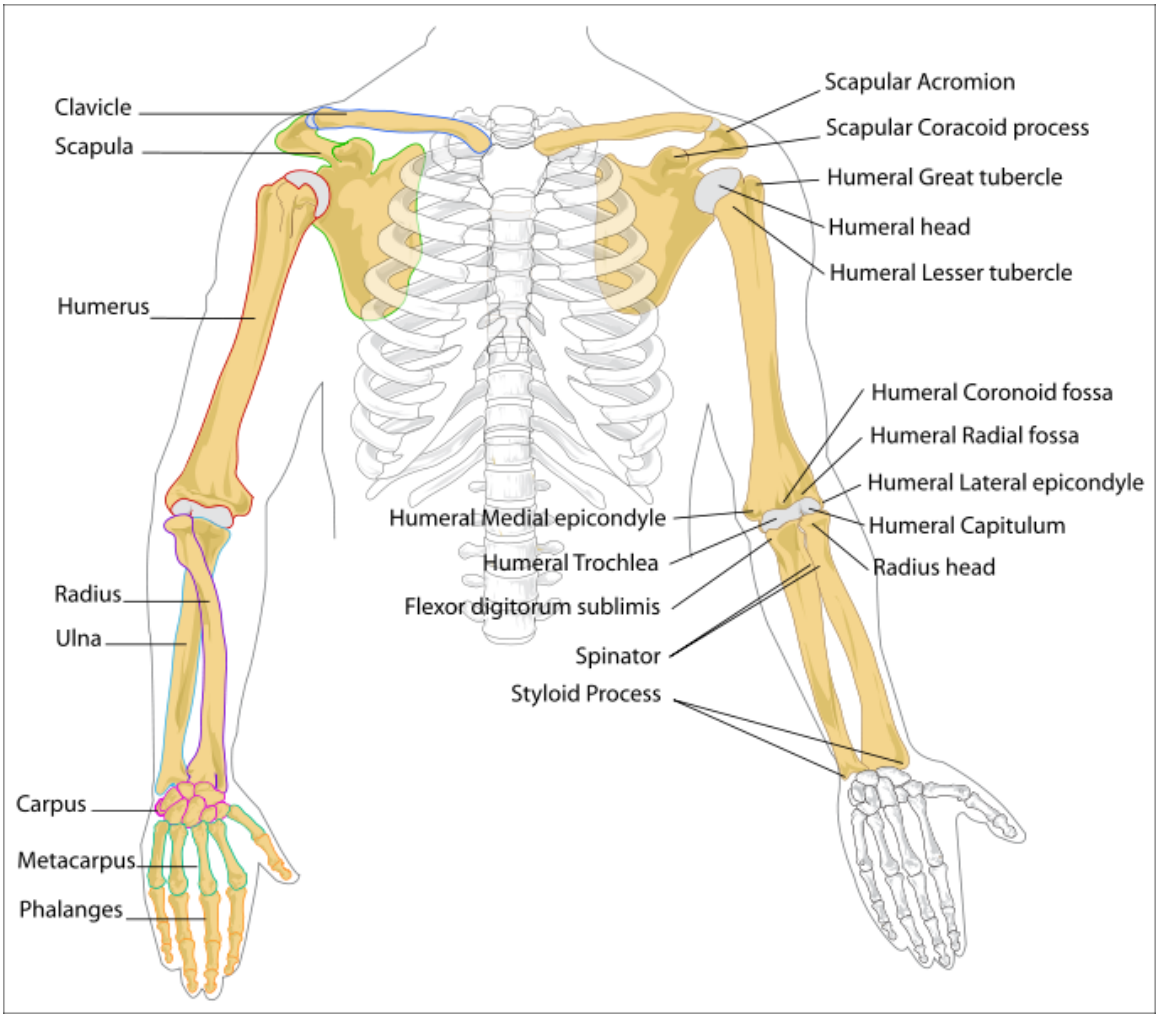
In birds, the clavicles and interclavicle have fused to form a single Y-shaped bone, the furcula or "wishbone".

The interclavicle is absent in marsupials and placental mammals. In many mammals, the clavicles are also reduced, or even absent, to allow the scapula greater freedom of motion, which may be useful in fast-running animals.

Though a number of fossil hominin (humans and chimpanzees) clavicles have been found, most of these are mere segments offering limited information on the form and function of the pectoral girdle. One exception is the clavice of AL 333x6/9 attributed to *Australopithecus afarensis* which has a well-preserved sternal end. One interpretation of this specimen, based on the orientation of its lateral end and the position of the deltoid attachment area, suggests that this clavicle is distinct from those found in extant apes (including humans), and thus that the shape of the human shoulder dates back to less than 3 to 4 million years ago. However, analyses of the clavicle in extant primates suggest that the low position of the scapula in humans is reflected mostly in the curvature of the medial portion of the clavicle rather than the lateral portion. This part of the bone is similar in *A. afarensis* and it is thus possible that this species had a high shoulder position similar to that in modern humans.



Pectoral girdle — front



Human arm bones diagram

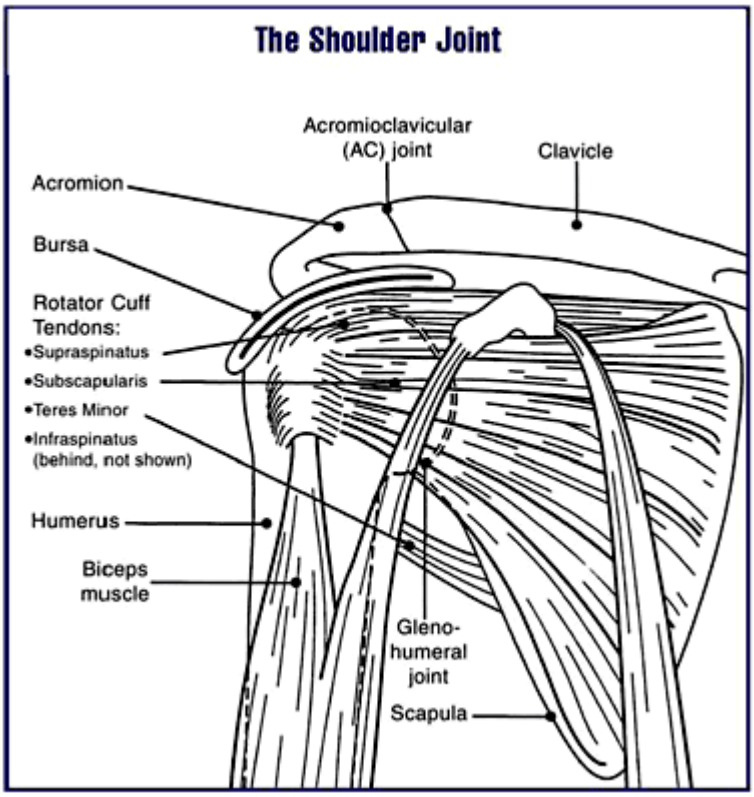
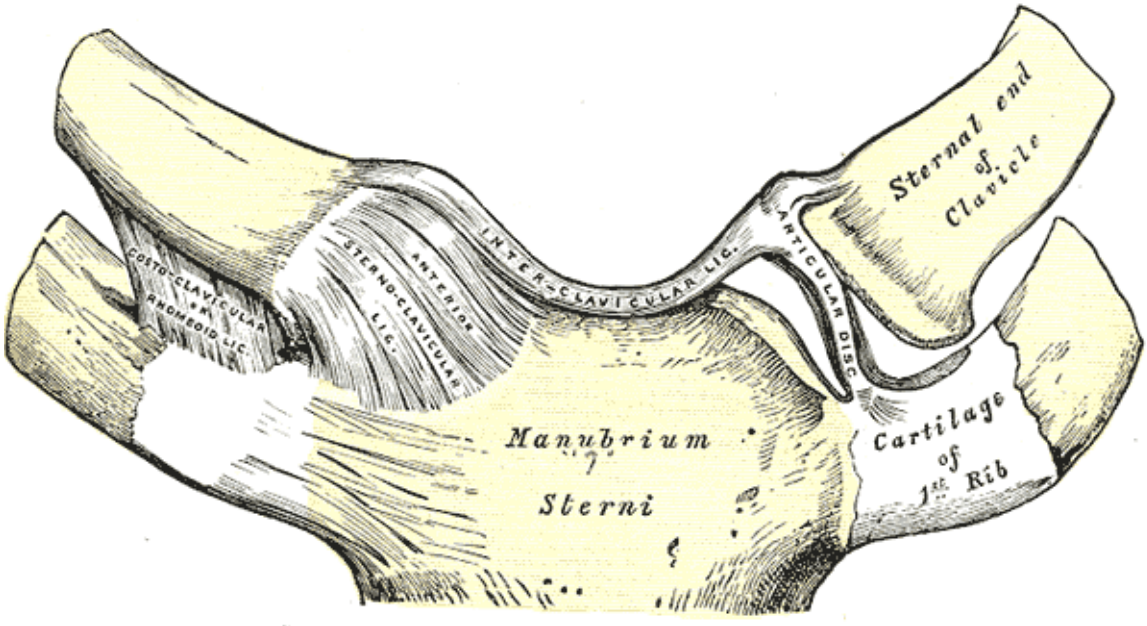
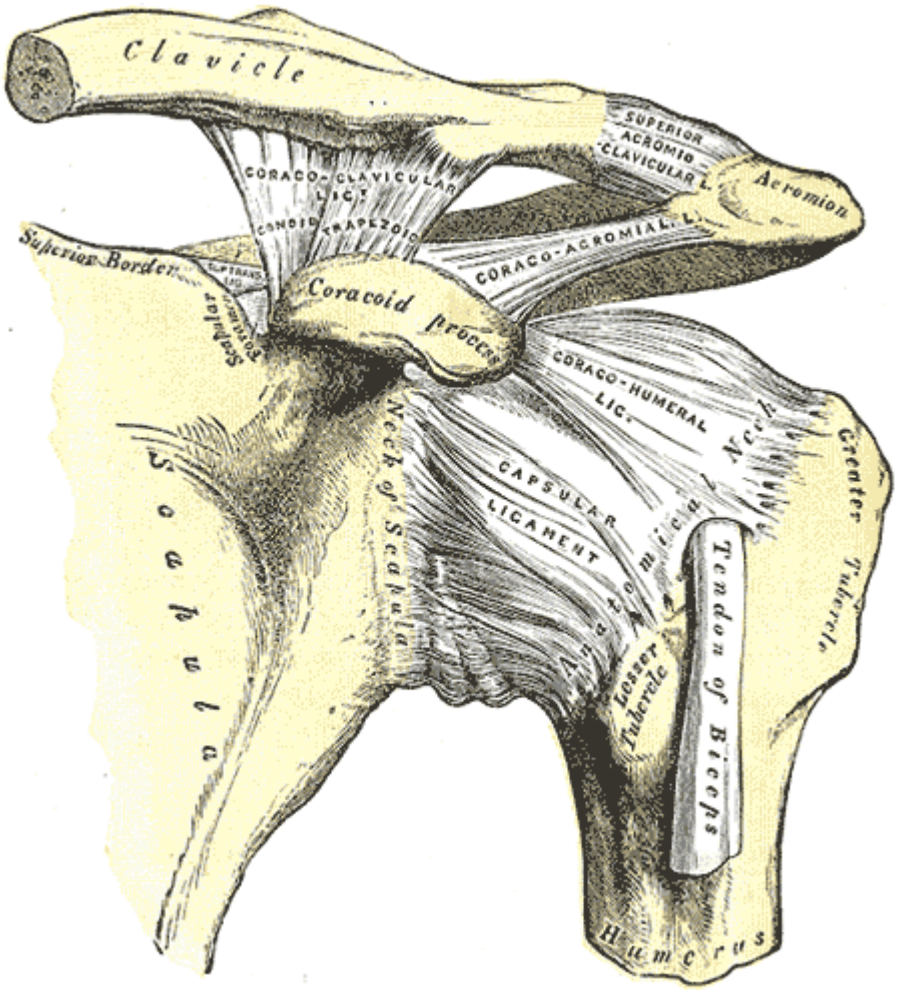


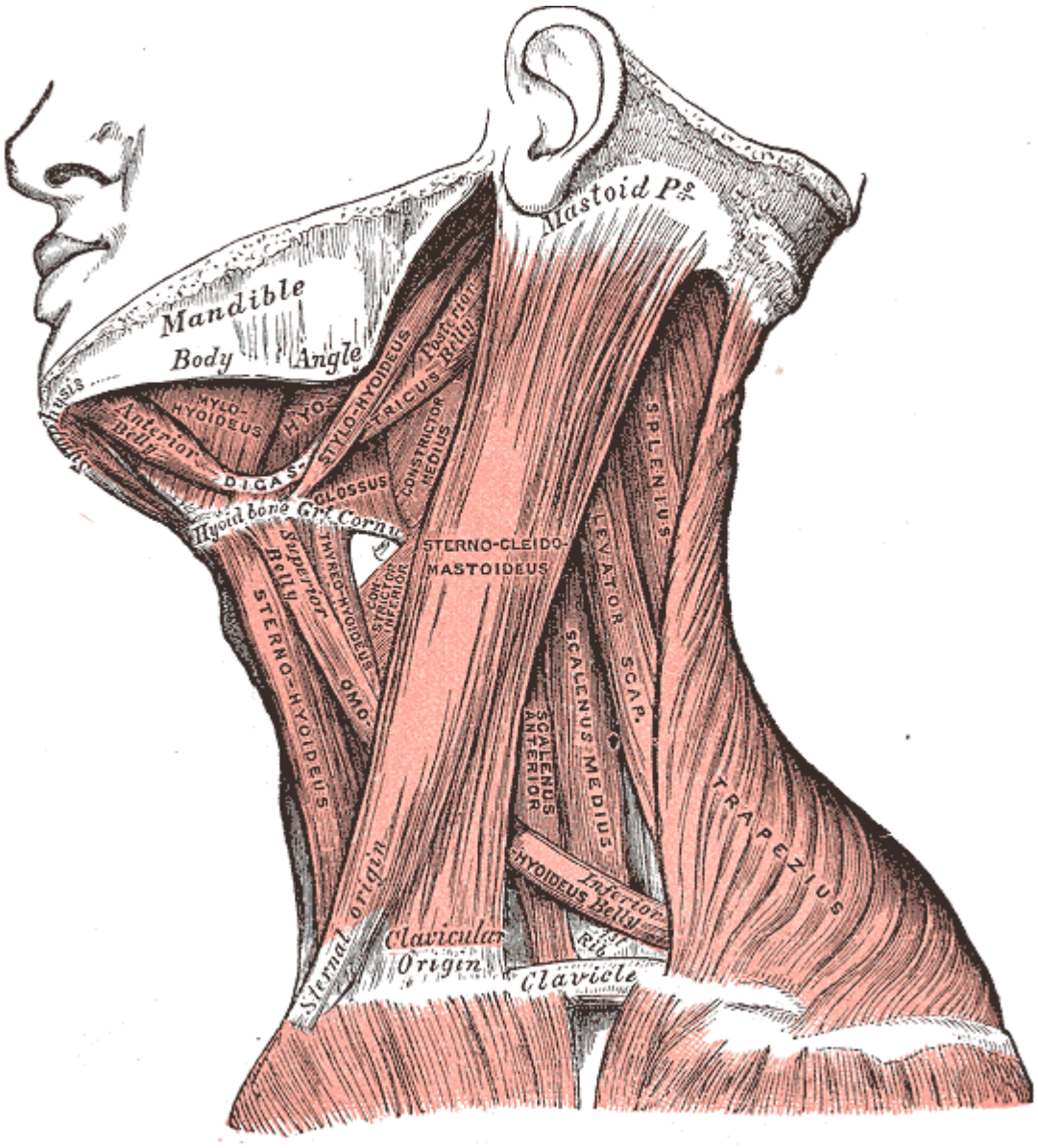
Diagram of the human shoulder joint



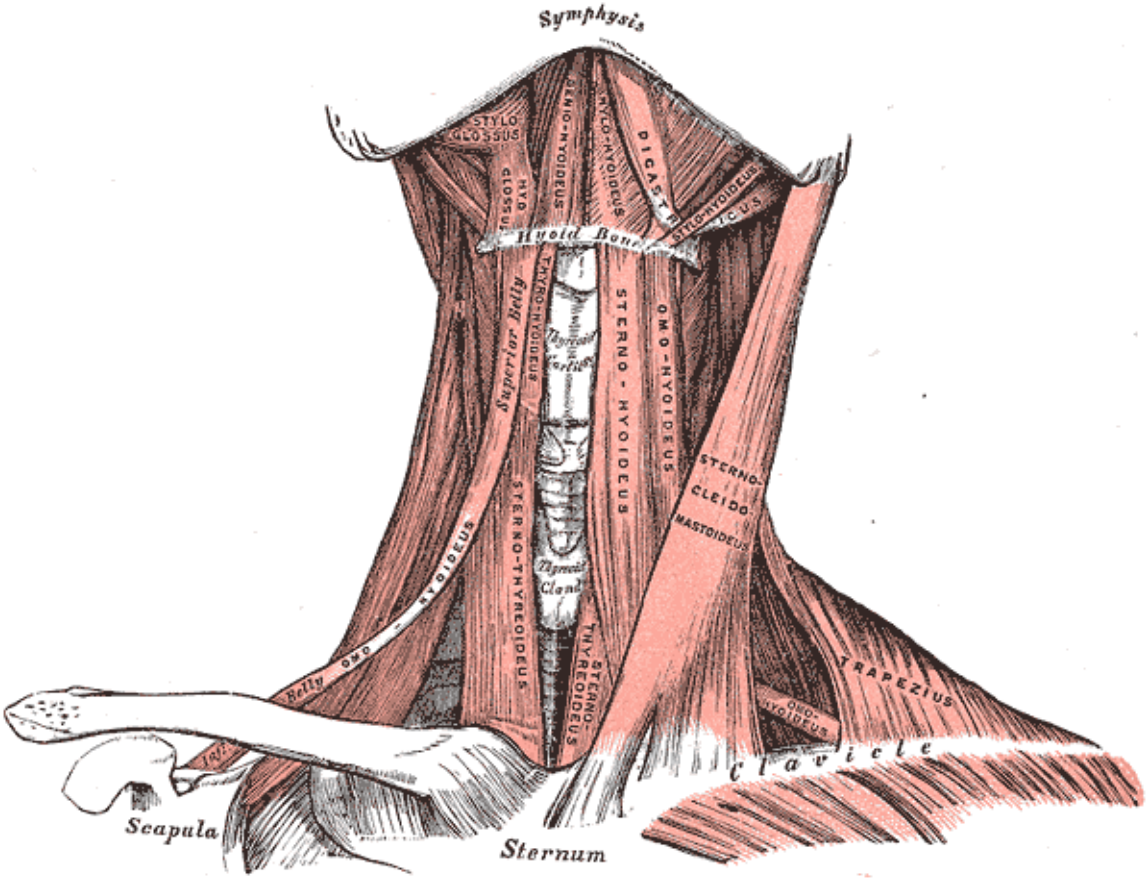
Sternoclavicular articulation. Anterior view.



The left shoulder and acromioclavicular joints, and the proper ligaments of the scapula.



Muscles of the neck. Lateral view.

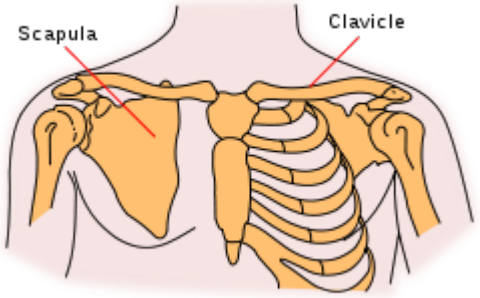


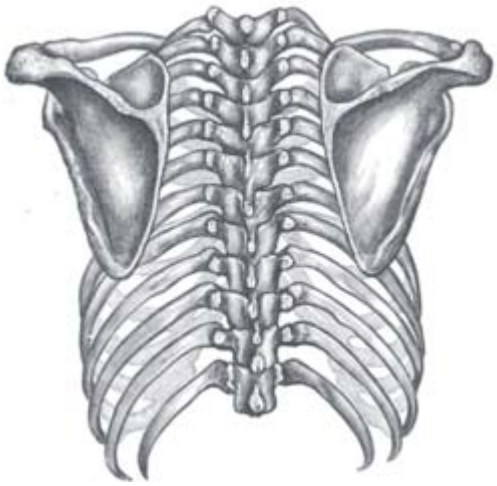
Muscles of the neck. Anterior view.

Chapter 8

Scapula

Bone: shoulder blade





Posterior view of the thorax and shoulder girdle. (Scapula visible at either side.)

Gray's *subject #50 202*

MeSH *Scapula*

In anatomy, the **scapula**, **omo** (Medical Latin), or **shoulder blade**, is the bone that connects the humerus (upper arm bone) with the clavicle (collar bone).

The scapula forms the posterior (back) located part of the shoulder girdle. In humans, it is a flat bone, roughly triangular in shape, placed on a posterolateral aspect of the thoracic cage.

Structure

Surfaces

Costal (Front, Ventral, Anterior)

The **costal or ventral surface** [Fig. 1] presents a broad concavity, the *subscapular fossa*.

The medial two-thirds of this fossa are marked by several oblique ridges, which run lateralward and upward. The ridges give attachment to the tendinous insertions, and the surfaces between them to the shelby, of the Subscapularis. The lateral third of the fossa is smooth and covered by the fibers of this muscle.

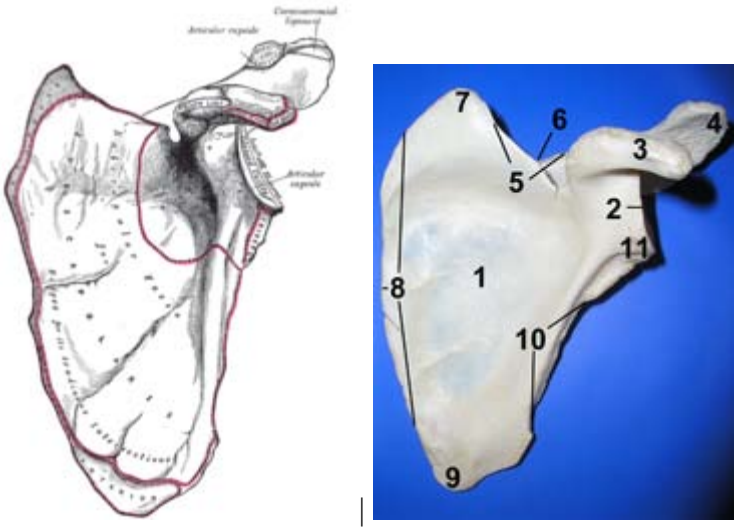


Figure 1 : Left scapula. Costal surface.

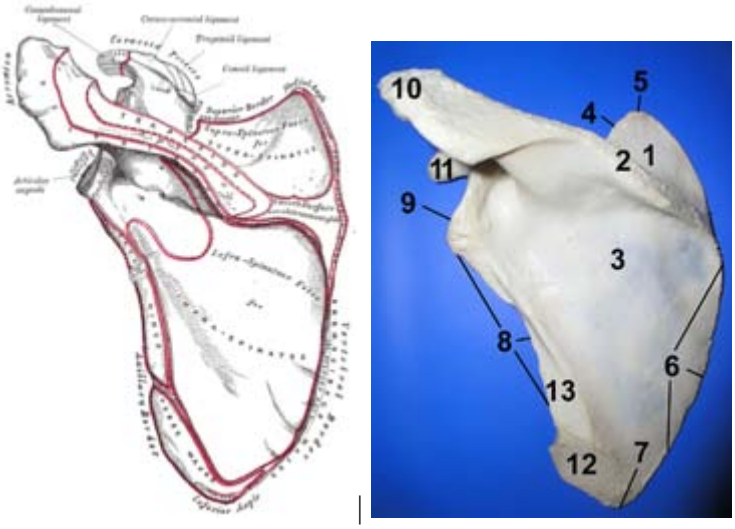


Figure 2 : Left scapula. Dorsal surface.

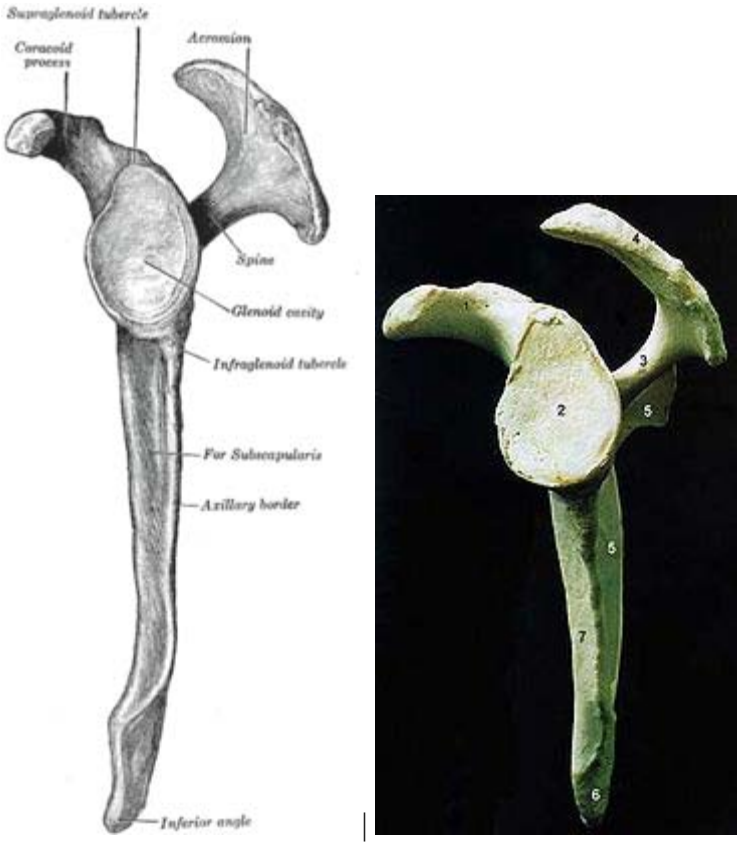


Figure 3 : Left scapula. Lateral surface.

At the upper part of the fossa is a transverse depression, where the bone appears to be bent on itself along a line at right angles to and passing through the center of the glenoid cavity, forming a considerable angle, called the subscapular angle; this gives greater strength to the body of the bone by its arched form, while the summit of the arch serves to support the spine and acromion.

Dorsal (Back, Posterior)

The **dorsal surface** [Fig. 2] is arched from above downward, and is subdivided into two unequal parts by the spine; the portion above the spine is called the supraspinous fossa, and that below it the infraspinous fossa.

- The *supraspinous fossa*, the smaller of the two, is concave, smooth, and broader at its vertebral than at its humeral end; its medial two-thirds give origin to the Supraspinatus.

- The *infraspinous fossa* is much larger than the preceding; toward its vertebral margin a shallow concavity is seen at its upper part; its center presents a prominent convexity, while near the axillary border is a deep groove which runs from the upper toward the lower part. The medial two-thirds of the fossa give origin to the Infraspinatus; the lateral third is covered by this muscle.

The dorsal surface is marked near the axillary border by an elevated ridge, which runs from the lower part of the glenoid cavity, downward and backward to the vertebral border, about 2.5 cm above the inferior angle.

The ridge serves for the attachment of a fibrous septum, which separates the Infraspinatus from the Teres major and Teres minor.

The surface between the ridge and the axillary border is narrow in the upper two-thirds of its extent, and is crossed near its center by a groove for the passage of the scapular circumflex vessels; it affords attachment to the Teres minor.

Its lower third presents a broader, somewhat triangular surface, which gives origin to the Teres major, and over which the Latissimus dorsi glides; frequently the latter muscle takes origin by a few fibers from this part.

The broad and narrow portions above alluded to are separated by an oblique line, which runs from the axillary border, downward and backward, to meet the elevated ridge: to it is attached a fibrous septum which separates the Teres muscles from each other.

Borders

There are three borders of the scapula:

- The superior border is the shortest and thinnest; it is concave, and extends from the medial angle to the base of the coracoid process. It is referred to as the cranial border in animals.

- The axillary border (or "lateral border") is the thickest of the three. It begins above at the lower margin of the glenoid cavity, and inclines obliquely downward

and backward to the inferior angle. It is referred to as the caudal border in animals.

- The vertebral border (or "medial border") is the longest of the three, and extends from the medial to the inferior angle. It is referred to as the dorsal border in animals.

The acromion

The acromion forms the summit of the shoulder, and is a large, somewhat triangular or oblong process, flattened from behind forward, projecting at first lateralward, and then curving forward and upward, so as to overhang the glenoid cavity.

Development

The larger part of the scapula undergoes membranous ossification.. Some of the outer parts of the scapula are cartilaginous at birth, and would therefore undergo endochondral ossification .

The head, processes, and the thickened parts of the bone, contain cancellous tissue; the rest consists of a thin layer of compact tissue.

The central part of the supraspinatus fossa and the upper part of the infraspinatous fossa, but especially the former, are usually so thin in humans as to be semitransparent; occasionally the bone is found wanting in this situation, and the adjacent muscles are separated only by fibrous tissue.

Muscular attachments

The following muscles attach to the scapula:

Muscle	**Direction**	**Region**
Pectoralis Minor	insertion	coracoid process
Coracobrachialis	origin	coracoid process
Serratus Anterior	insertion	medial border
Triceps Brachii (long head)	origin	infraglenoid tubercle
Biceps Brachii (short head)	origin	coracoid process
Biceps Brachii (long head)	origin	supraglenoid tubercle
Subscapularis	origin	subscapular fossa
Rhomboid Major	insertion	medial border
Rhomboid Minor	insertion	medial border
Levator Scapulae	insertion	medial border
Trapezius	insertion	spine of scapula

Deltoid	origin	spine of scapula
Supraspinatus	origin	supraspinous fossa
Infraspinatus	origin	infraspinous fossa
Teres Minor	origin	lateral border
Teres Major	origin	lateral border
Latissimus Dorsi (a few fibers)	origin	inferior angle
Omohyoid	origin	superior border

Movements

Movements of the scapula are brought about by scapular muscles:

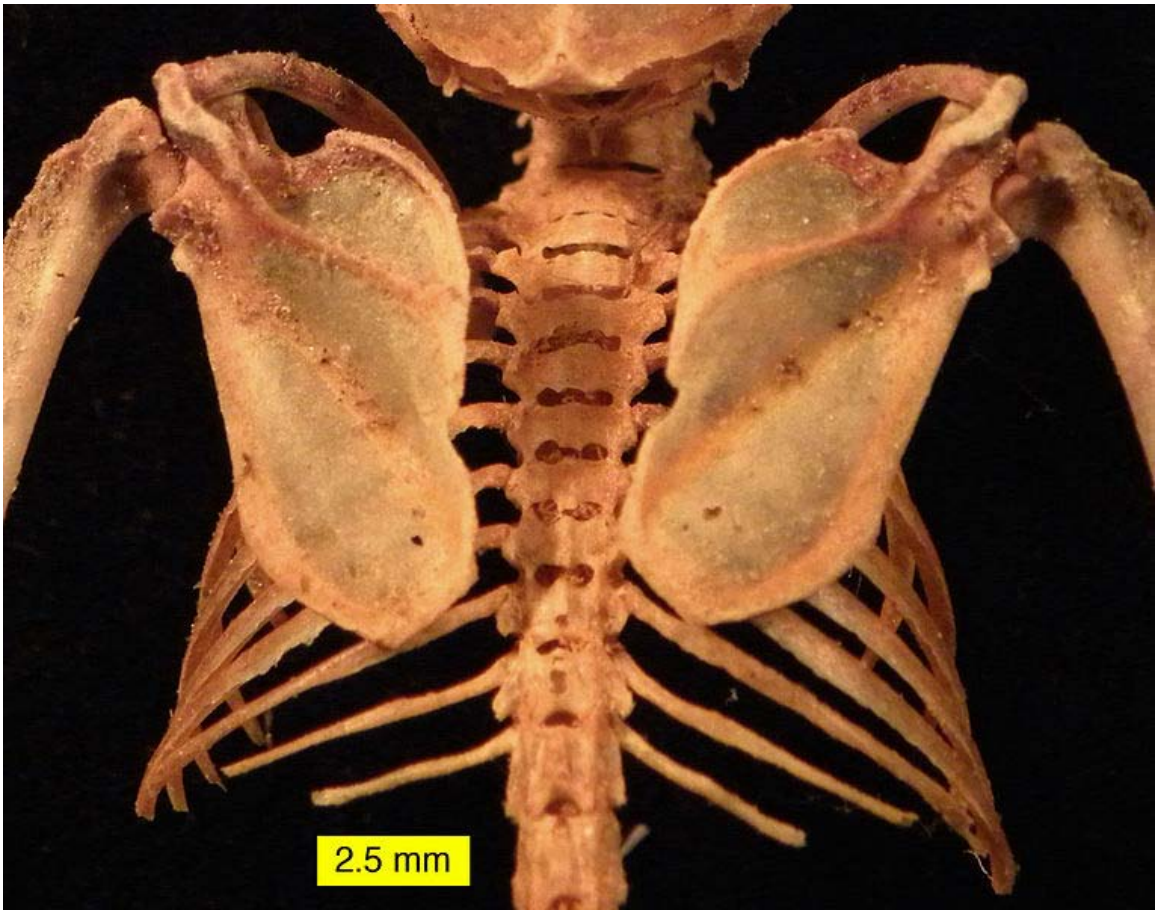
Elevation, Depression, Protraction, Retraction, Lateral rotation, Medial rotation, Upward Rotation, Downward Rotation, Anterior Tipping, and Posterior Tipping

Injury

Because of its sturdy structure and protected location, scapular fractures are uncommon; when they do occur, they are an indication that severe chest trauma has occurred.

A winged scapula is a condition in which the medial border (the side nearest the spine) of a person's scapula is abnormally positioned outward and backward. The resulting appearance of the upper back is said to be wing-like because the inferior angle of the shoulder blade protrudes backward rather than lying mostly flat like in people without the condition.

In other animals



Scapulae, spine and ribs of *Myotis lucifugus* (Little Brown Bat).

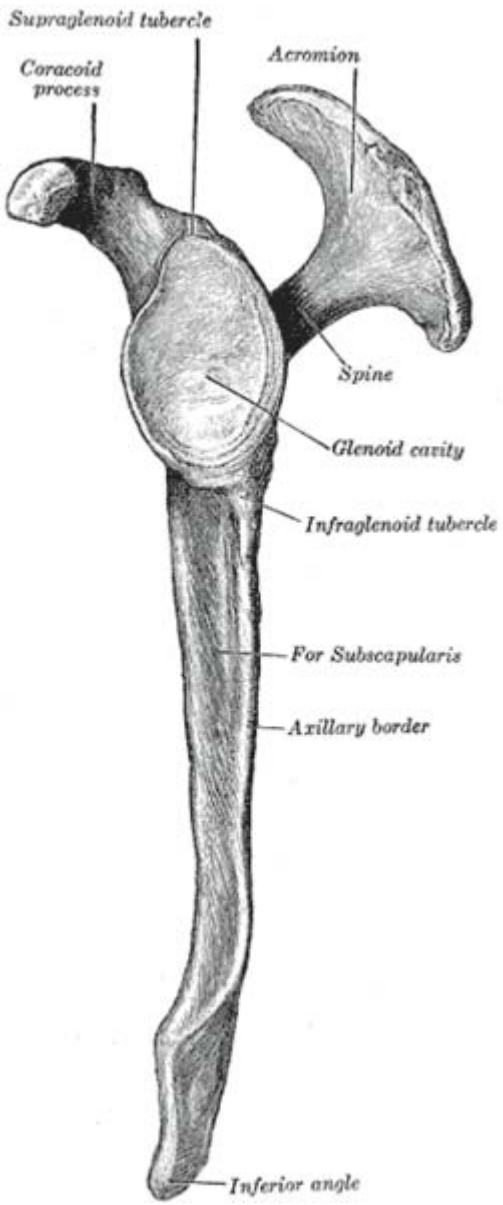
In fish, the **scapular blade** is a structure attached to the upper surface of the articulation of the pectoral fin, and is accompanied by a similar **coracoid plate** on the lower surface. Although sturdy in cartilagenous fish, both plates are generally small in most other fish, and may be partially cartilagenous, or consist of multiple bony elements.

In the early tetrapods, these two structures respectively became the scapula and a bone referred to as the **procoracoid** (commonly called simply the "coracoid", but not homologous with the mammalian structure of that name). In amphibians, birds, and reptiles, these two bones are distinct, but together form a single structure bearing many of the muscle attachments for the forelimb. In such animals, the scapula is usually a relatively simple plate, lacking the projections and spine that it possesses in mammals. However, the detailed structure of these bones varies considerably in living groups. For example, in frogs, the procoracoid bones may be braced together at the animal's underside to absorb the shock of landing, while in turtles, the combined structure forms a Y-shape in order to allow the scapula to retain a connection to the clavicle (which is part of the shell). In birds, the procoracoids help to brace the wing against the top of the sternum.

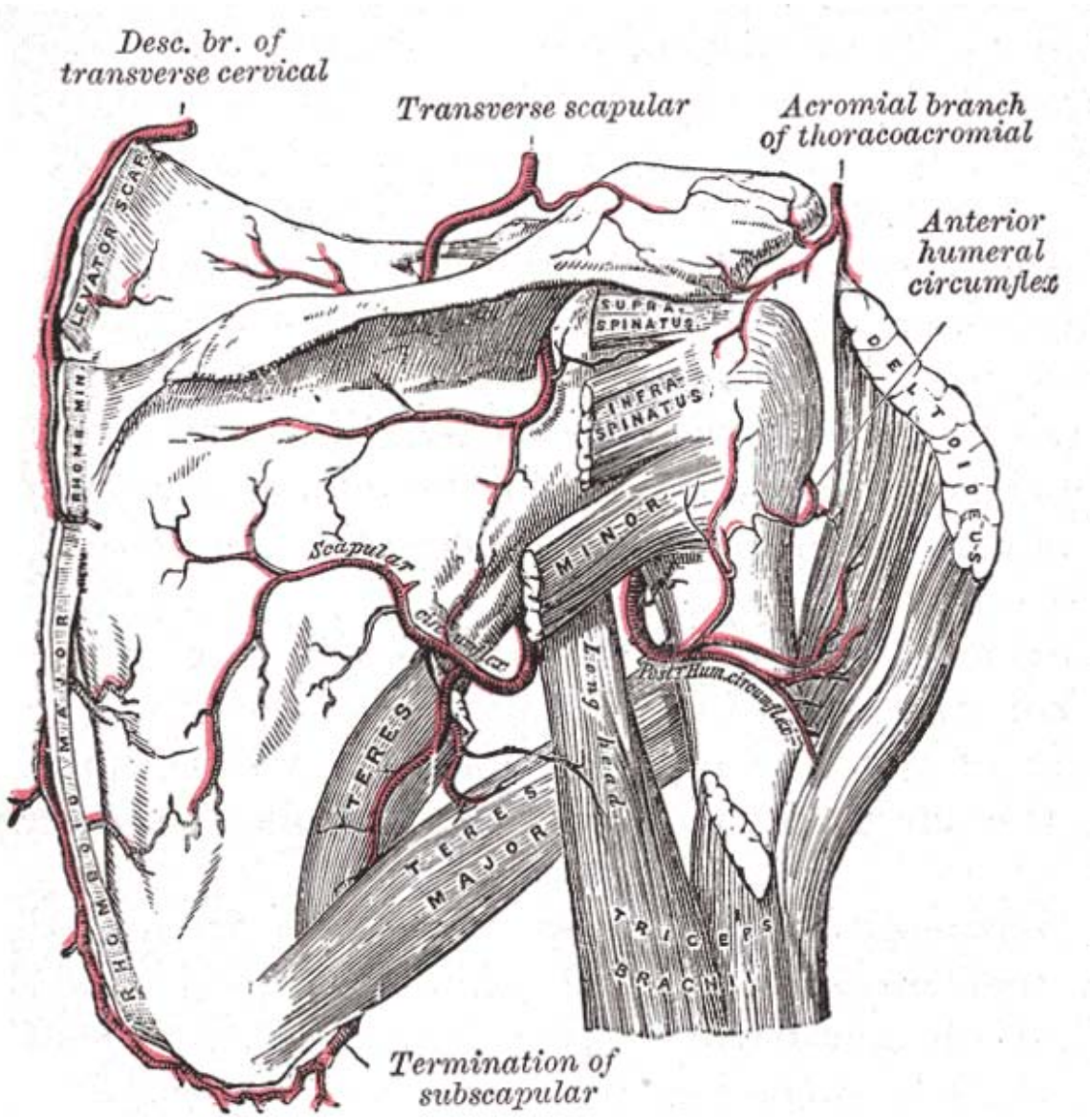
In the fossil therapsids, a third bone, the true **coracoid**, formed just behind the procoracoid. The resulting three-boned structure is still seen in modern monotremes, but in all other living mammals, the procoracoid has disappeared, and the coracoid bone has fused with the scapula, to become the coracoid process. These changes are associated with the upright gait of mammals, compared with the more sprawling limb arrangement of reptiles and amphibians; the muscles formerly attached to the procoracoid are no longer required. The altered musculature is also responsible for the alteration in the shape of the rest of the scapula; the forward margin of the original bone became the spine and acromion, from which the main shelf of the shoulder blade arises as a new structure.

As a shovel

In neolithic times and earlier a large animal's scapula was often used as a crude shovel.



Left scapula. Lateral view.

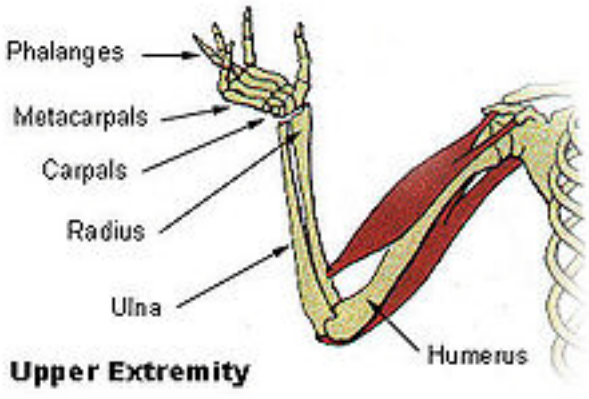


The scapular and circumflex arteries.

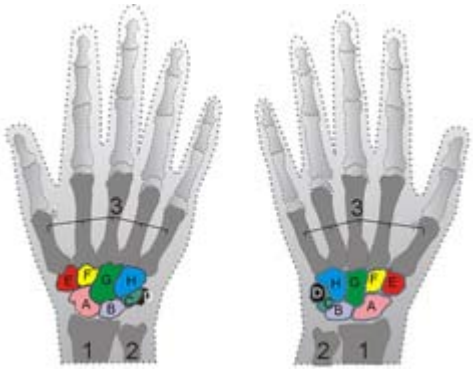
Chapter 9

Ulna

Bone: Ulna



Upper extremity



Ulna is #2

Gray's *subject #52 214*

MeSH *Ulna*

The **ulna** is one of the two long bones in the forearm, the other being the radius. It is prismatic in form and runs parallel to the radius, which is shorter and smaller. In anatomical position (i.e. when the palms of the hands face forward) the ulna is located at the side of the forearm closest to the body (the medial side), the side of the little finger. The corresponding bone in the leg is the fibula.

Articulations

The ulna articulates with:

- trochlea of the humerus, at the right side elbow as a hinge joint with semilunar trochlear notch of the ulna.
- the radius, near the elbow as a pivot joint, this allows the radius to cross over the ulna in pronation.
- the distal radius, where it fits into the ulna notch.
- the radius along its length via the interosseous membrane that forms a syndesmoses joint

Proximal and distal aspects

The ulna is broader *proximally*, and narrower *distally*.

Proximally, the ulna has a bony process, the olecranon process, a hook-like structure that fits into the olecranon fossa of the **humerus**. This prevents hyperextension and forms a hinge joint with the trochlea of the humerus. There is also a radial notch for the head of the radius, and the ulnar tuberosity to which muscles can attach.

At the distal end of the ulna is a styloid process.

Structure

The long, narrow medullary cavity is enclosed in a strong wall of compact tissue which is thickest along the interosseous border and dorsal surface. At the extremities the compact layer thins. The compact layer is continued onto the back of the olecranon as a plate of close spongy bone with lamellæ parallel. From the inner surface of this plate and the compact layer below it trabeculæ arch forward toward the olecranon and coronoid and cross other trabeculæ, passing backward over the medullary cavity from the upper part of the shaft below the coronoid. Below the coronoid process there is a small area of compact bone from which trabeculæ curve upward to end obliquely to the surface of the semilunar notch which is coated with a thin layer of compact bone. The trabeculæ at the lower end have a more longitudinal direction.

Muscle attachments

Muscle	Direction	Attachment
Triceps brachii muscle	Insertion	posterior part of superior surface of Olecranon process (via common tendon)
Anconeus muscle	Insertion	Olecranon process (lateral aspect)
Brachialis muscle	Insertion	anterior surface of Coronoid process of the ulna
Pronator teres muscle	Origin	medial surface on middle portion of Coronoid process (also shares origin with medial epicondyle of the humerus)
Flexor carpi ulnaris muscle	Origin	Olecranon process and posterior surface of ulna (also shares origin with medial epicondyle of the humerus)
Flexor digitorum superficialis muscle	Origin	Coronoid process (also shares origin with medial epicondyle of the humerus and shaft of the radius)
Flexor digitorum profundus muscle	Origin	Coronoid process, anteromedial surface of ulna (also shares origin with the interosseous membrane)
Pronator quadratus muscle	Origin	Distal portion of anterior ulnar shaft
Extensor carpi ulnaris muscle	Origin	Posterior border of ulna (also shares origin with lateral epicondyle of the humerus)
Supinator muscle	Origin	Proximal ulna (also shares origin with lateral epicondyle of the humerus)
Abductor pollicis longus muscle	Origin	Posterior surface of ulna (also shares origin with the posterior surface of the radius bone)
Extensor pollicis longus muscle	Origin	dorsal shaft of ulna (also shares origin with the dorsal shaft of the radius and the interosseous membrane)
Extensor pollicis brevis muscle	Origin	Dorsal shaft of ulna (also shares origin with the dorsal shaft of the radius and the interosseous membrane)
Extensor indicis muscle	Origin	Posterior surface of distal ulna (also shares origin with the interosseous membrane)

Fracture

Specific fracture types of the ulna include:

- Monteggia fracture - a fracture of the proximal third of the ulna with the dislocation of the head of the radius
- Hume fracture - a fracture of the olecranon with an associated anterior dislocation of the radial head

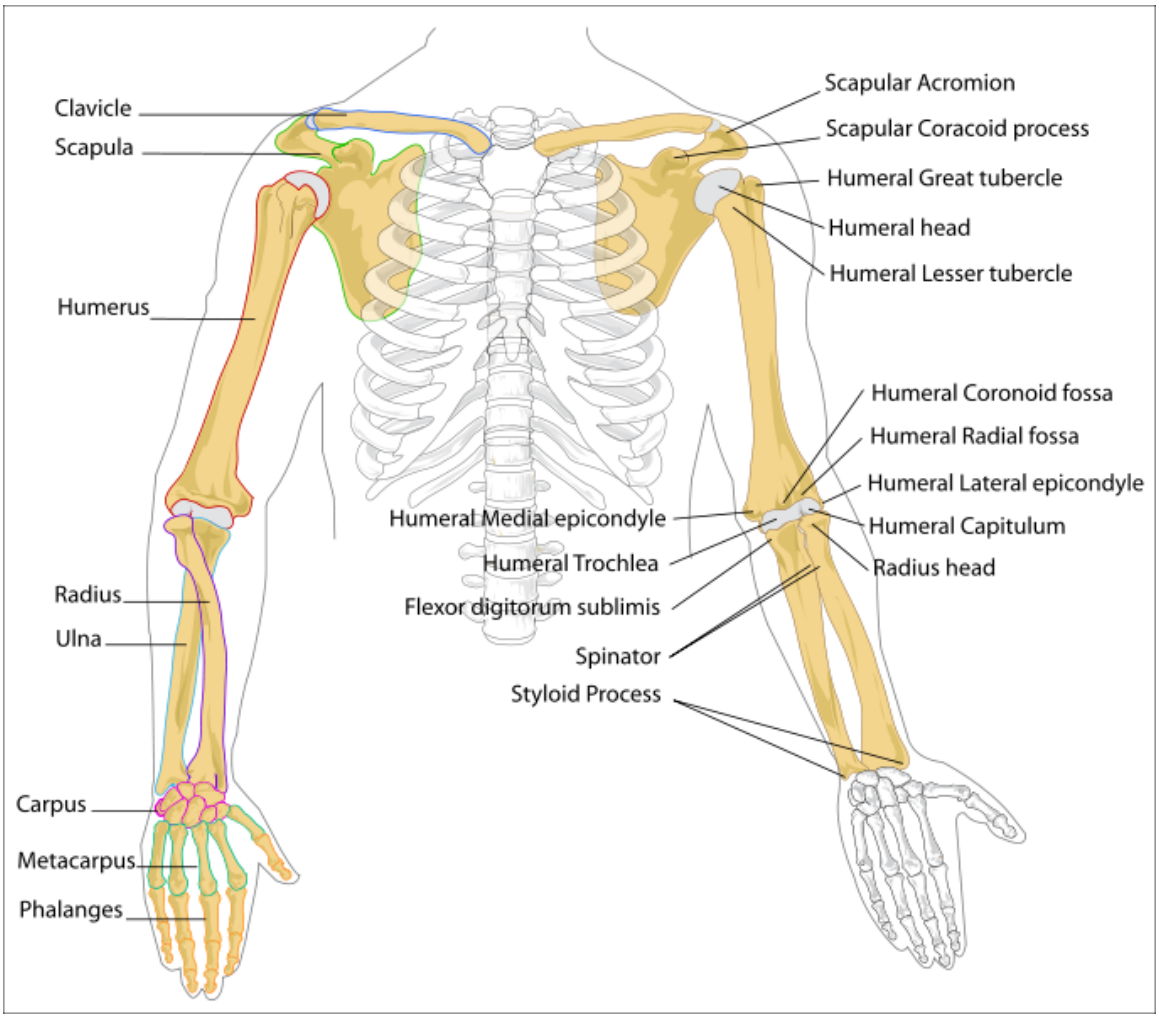
In other animals

In four-legged animals, the radius is the main load-bearing bone of the lower forelimb, and the ulna is important primarily for muscular attachment. In many mammals, the ulna is partially or wholly fused with the radius, and may therefore not exist as a separate bone. However, even in extreme cases of fusion, such as in horses, the olecranon process is still present, albeit as a projection from the upper radius.

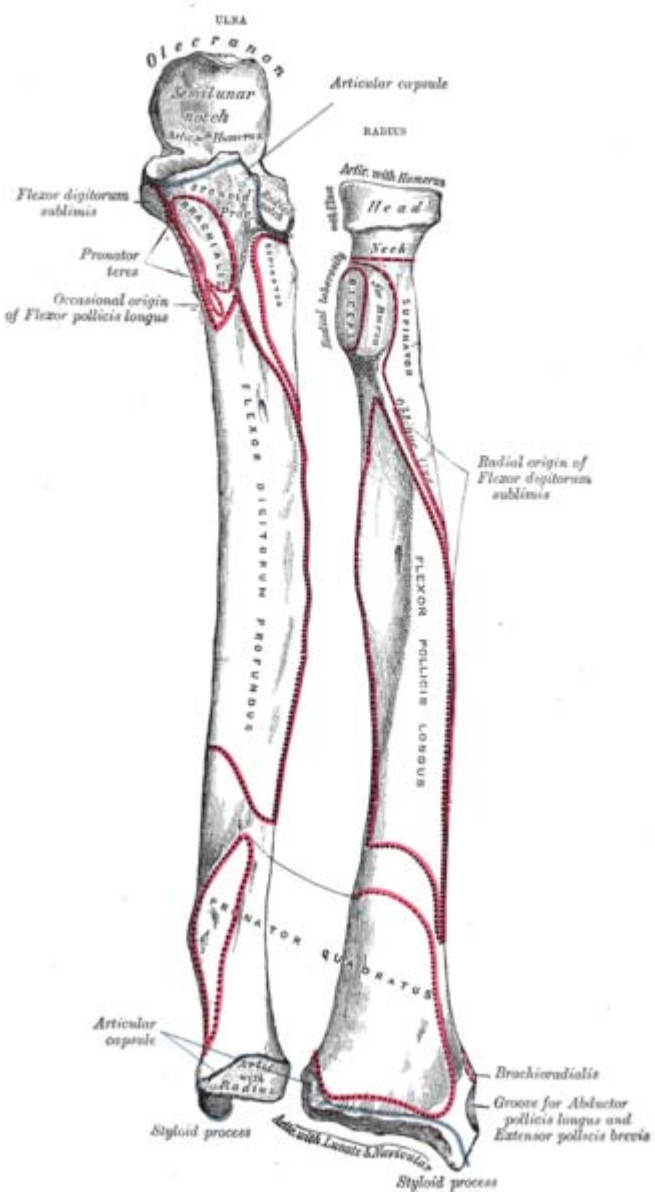
Ulna l. dx. - ant. view

Ulna l. dx. - lat. view

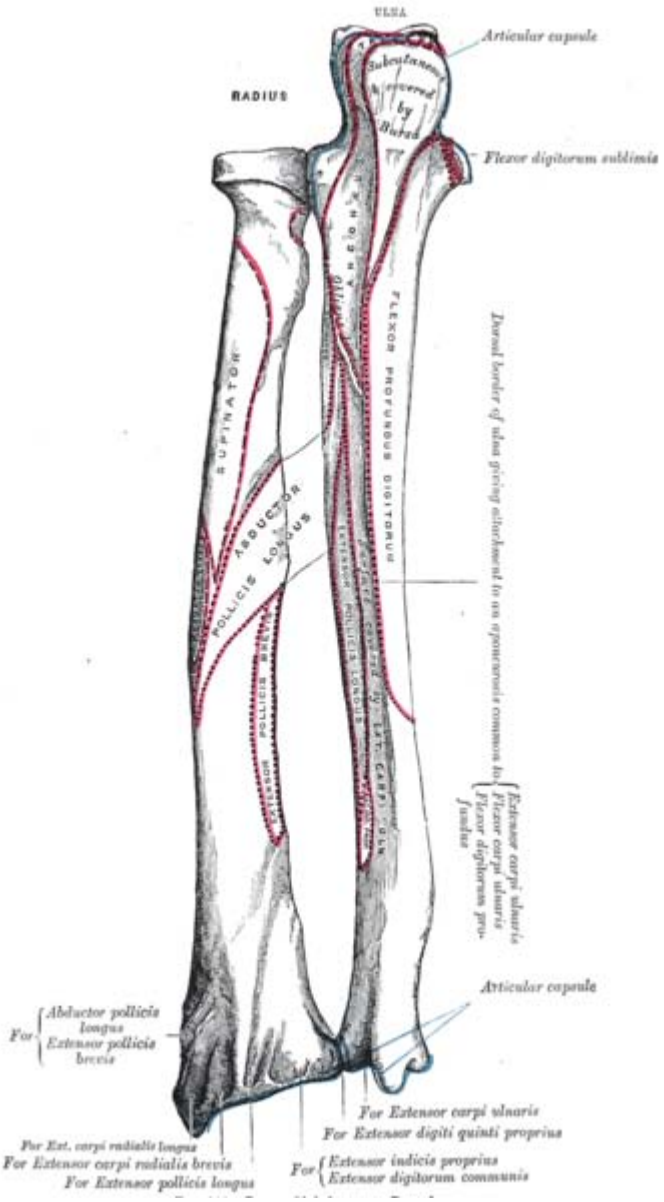
Right posterior human radius and ulna



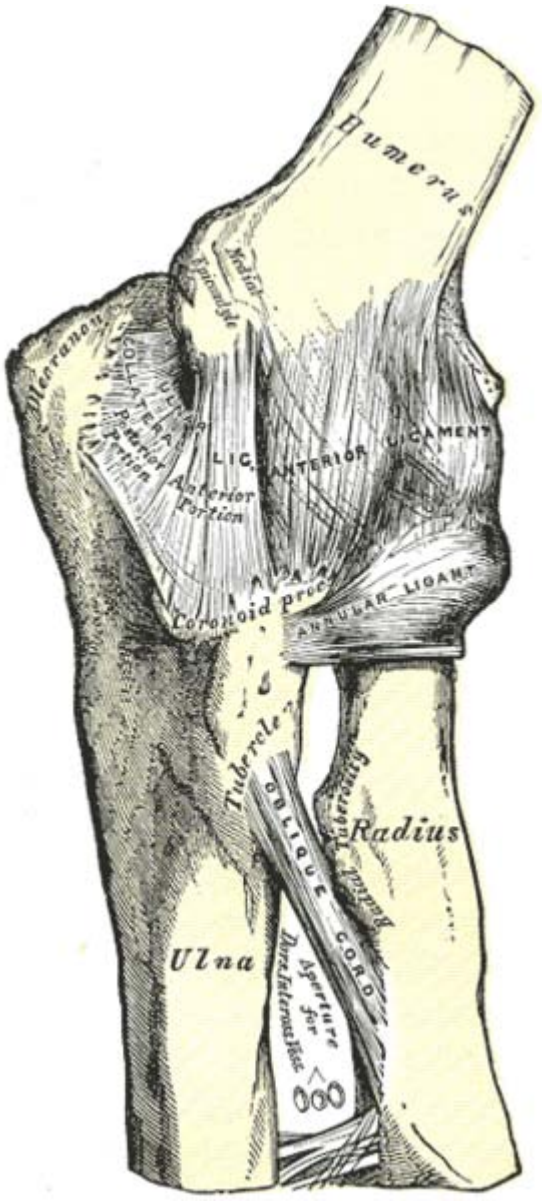
Human arm bones diagram



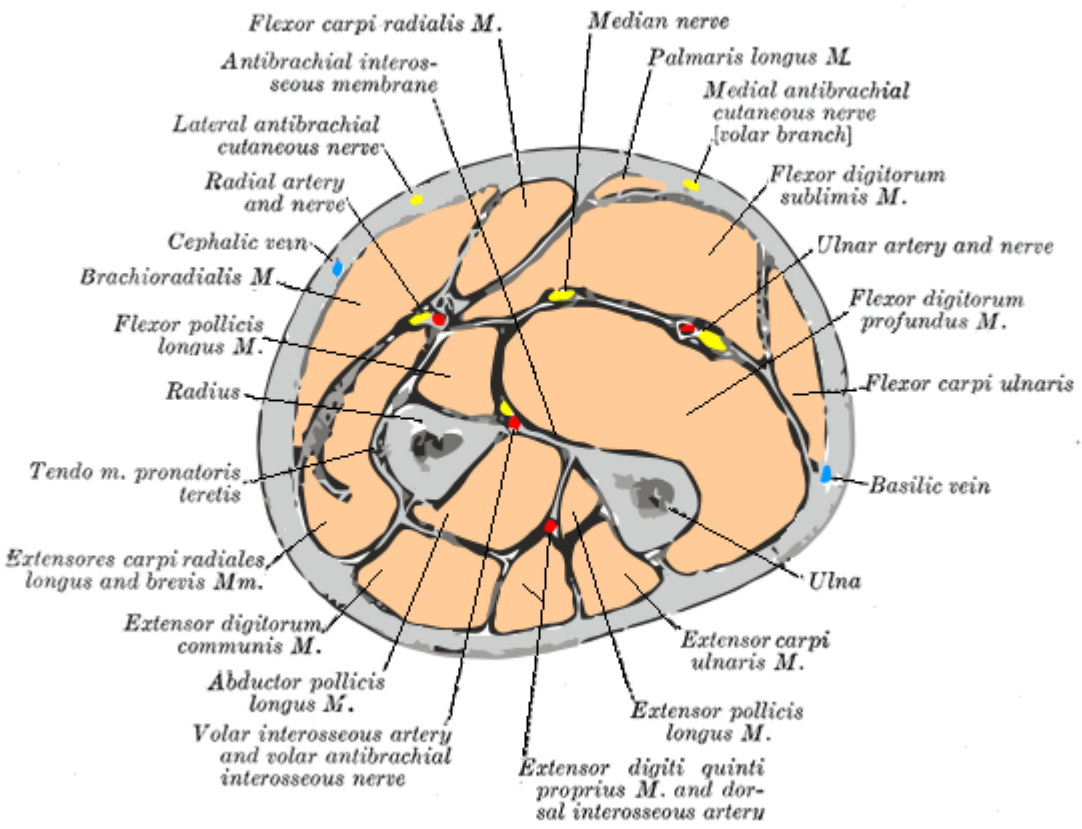
Bones of left forearm. Anterior aspect.



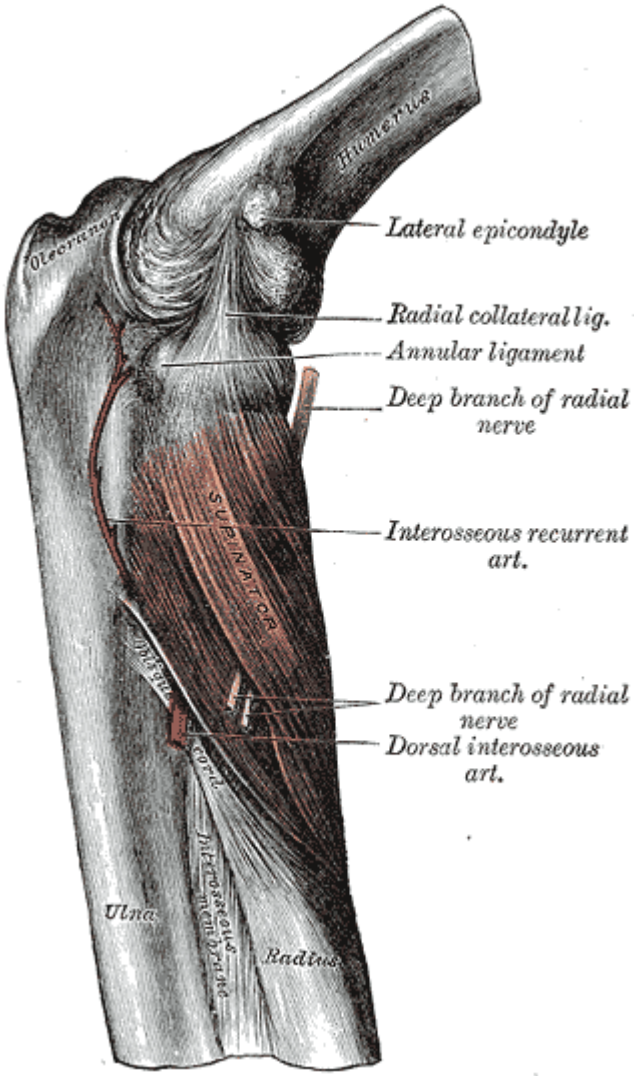
The radius and ulna of the left forearm, posterior surface.



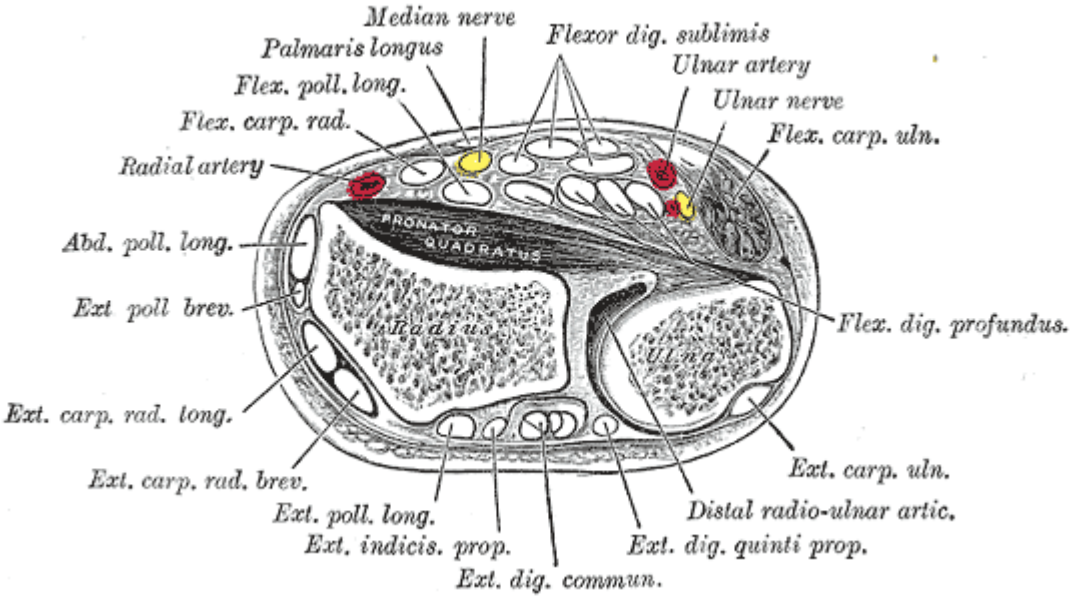
Left elbow-joint, showing anterior and ulnar collateral ligaments.



Cross-section through the middle of the forearm.



The Supinator.

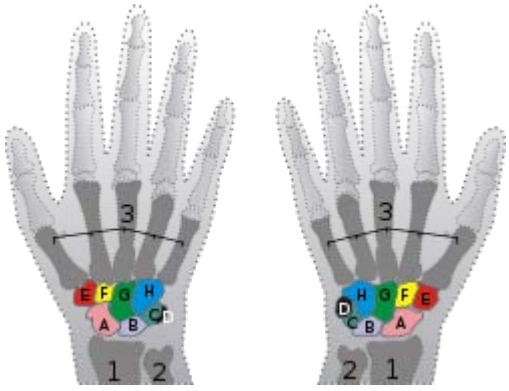


Transverse section across distal ends of radius and ulna.

Chapter 10

Carpus

Bone: Carpals



BONES OF HAND
Proximal: A=Scaphoid, B=Lunate, C=Triquetrum, D=Pisiform
Distal: E=Trapezium, F=Trapezoid, G=Capitate, H=Hamate

Latin	*ossa carpi*
Gray's	*subject #54 221*
MeSH	*Carpal+Bones*
Dorlands / Elsevier	*Carpus*

In tetrapods, the **carpus** is the sole cluster of bones in the wrist between the radius and ulna and the metacarpus. The bones of the carpus do not belong to individual fingers (or toes in quadrupeds), whereas those of the metacarpus do. The corresponding part of the foot is the tarsus. The carpal bones allow the wrist to move and rotate vertically.

In human anatomy, the main role of the carpus is to facilitate effective positioning of the hand and powerful use of the extensors and flexors of the forearm, but the mobility of individual carpal bones increase the freedom of movements at the wrist.

Etymology

The Latin word "carpus" is derived from Greek καρπός meaning "wrist". The root "carp-" translates to "pluck", an action performed by the wrist.

As a whole

In human anatomy, the carpal bones can be classified as belonging to two transverse rows or three longitudinal columns.

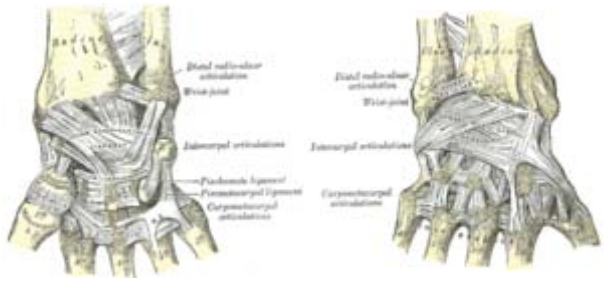
The pair of rows together form an arch which is convex proximally and concave distally. On the palmar side, the carpus is concave, forming the carpal tunnel which is covered by the flexor retinaculum. Because the proximal row is simultaneously related to the articular surfaces of the radius and the distal row, it adapts constantly to these mobile surfaces. The bones of this row - scaphoid, lunate, and triquetrum - have their individual movements. The scaphoid contributes to the stability of the midcarpus as it articulates distally with the trapezium and the trapezoid. The distal row is more rigid as its transverse arch moves with the metacarpals.

Biomechanically and clinically, the carpal bones are better understood as arranged in three longitudinal columns:

1. A radial scaphoid column consisting of the scaphoideum, trapezium, and trapezoideum
2. A lunate column consisting of the lunate and capitate
3. A ulnar triquetral column consisting of the triquetrum and hamatum.

In this context the pisiform is regarded as a sesamoid bone embedded in the tendon of the flexor carpi ulnaris. The ulnar column leaves a gap between the ulna and the triquetrum, and therefore, only the radial or scaphoid and central or capitate columns articulate with the radius. The wrist is more stable in flexion than in extension more because of the strength of various capsules and ligaments than the interlocking parts of the skeleton.

Ligaments



Ligaments of the wrist

There are four groups of ligaments in the region of the wrist:

1. The ligaments of the wrist proper which unite the ulna and radius with the carpus: the ulnar and radial collateral ligaments; the palmar and dorsal radiocarpal ligaments; and the palmar ulnocarpal ligament.
2. The ligaments of the intercarpal articulations which unite the carpal bones with one another: the radiate carpal ligament; the dorsal, palmar, and interosseous intercarpal ligaments; and the pisohamate ligament,
3. The ligaments of the carpometacarpal articulations which unite the carpal bones with the metacarpal bones: the pisometacarpal ligament and the palmar and dorsal carpometacarpal ligaments
4. The ligaments of the intermetacarpal articulations which unite the metacarpal bones: the dorsal, interosseous, and palmar metacarpal ligaments

Movements

The hand is said to be in **straight position** when the third finger runs over the capitate bone and is in a straight line with the forearm. This should not be confused with the **midposition** of the hand which corresponds to an ulnar deviation of 12 degrees. From the straight position two pairs of movements of the hand are possible: abduction (movement towards the radius, so called radial deviation or abduction) of 15 degrees and adduction (movement towards the ulna, so called ulnar deviation or adduction) of 40 degrees when the arm is in strict supination and slightly greater in strict pronation. Flexion (tilting towards the palm, so called palmar flexion) and extension (tilting towards the back of the hand, so called dorsiflexion) is possible with a total range of 170 degrees.

Radial abduction/ulnar adduction

During **radial abduction** the scaphoid is tilted towards the palmar side which allows the trapezium and trapezoid to approach the radius. Because the trapezoid is rigidly attached to the second metacarpal bone to which also the flexor carpi radialis and extensor carpi radialis are attached, radial abduction effectively pulls this combined structure towards the radius. During radial abduction the pisiform traverses the greatest path of all carpal bones. Radial abduction is produced by (in order of importance) extensor carpi radialis longus, abductor pollicis longus, extensor pollicis longus, flexor carpi radialis, and flexor pollicis longus.

Ulnar adduction causes a tilting or dorsal shifting of the proximal row of carpal bones. It is produced by extensor carpi ulnaris, flexor carpi ulnaris, extensor digitorum, and extensor digiti minimi.

Both radial abduction and ulnar adduction occurs around a dorsopalmar axis running through the head of the capitate bone.

Palmar flexion/dorsiflexion

During **palmar flexion** the proximal carpal bones are displaced towards the *dorsal* side and towards the *palmar* side during **dorsiflexion**. While flexion and extension consist of movements around a pair of transverse axes — passing through the lunate bone for the proximal row and through the capitate bone for the distal row — palmar flexion occurs mainly in the radiocarpal joint and dorsiflexion in the midcarpal joint.

Dorsiflexion is produced by (in order of importance) extensor digitorum, extensor carpi radialis longus, extensor carpi radialis brevis, extensor indicis, extensor pollicis longus, and extensor digiti minimi. Palmar flexion is produced by (in order of importance) flexor digitorum superficialis, flexor digitorum profundus, flexor carpi ulnaris, flexor pollicis longus, flexor carpi radialis, and abductor pollicis longus.

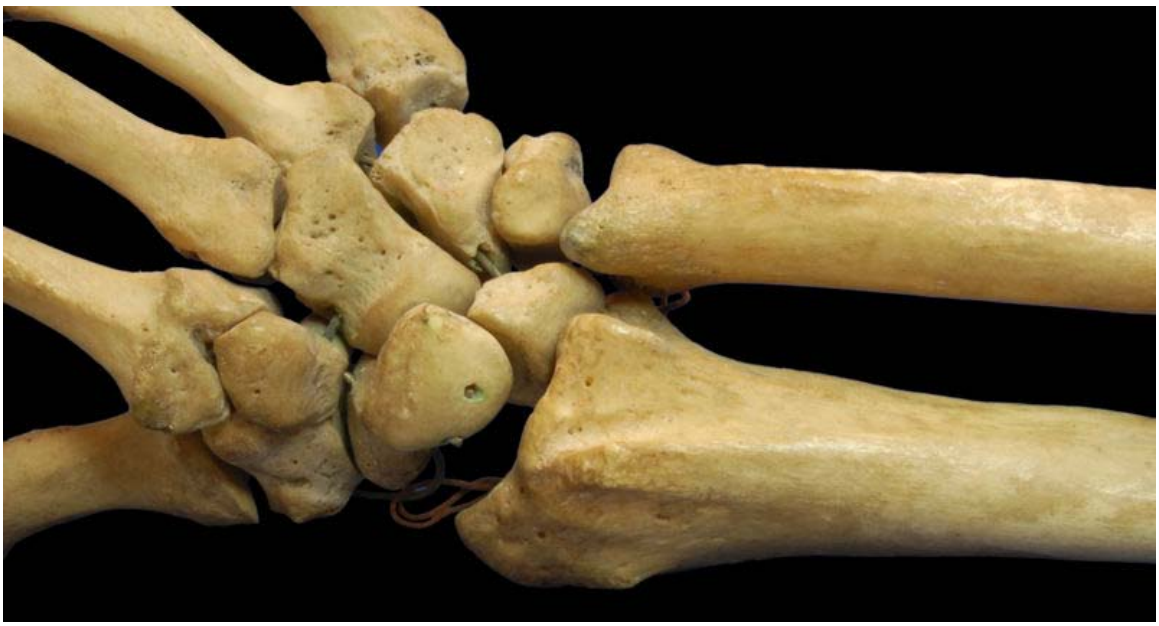
Combined movements

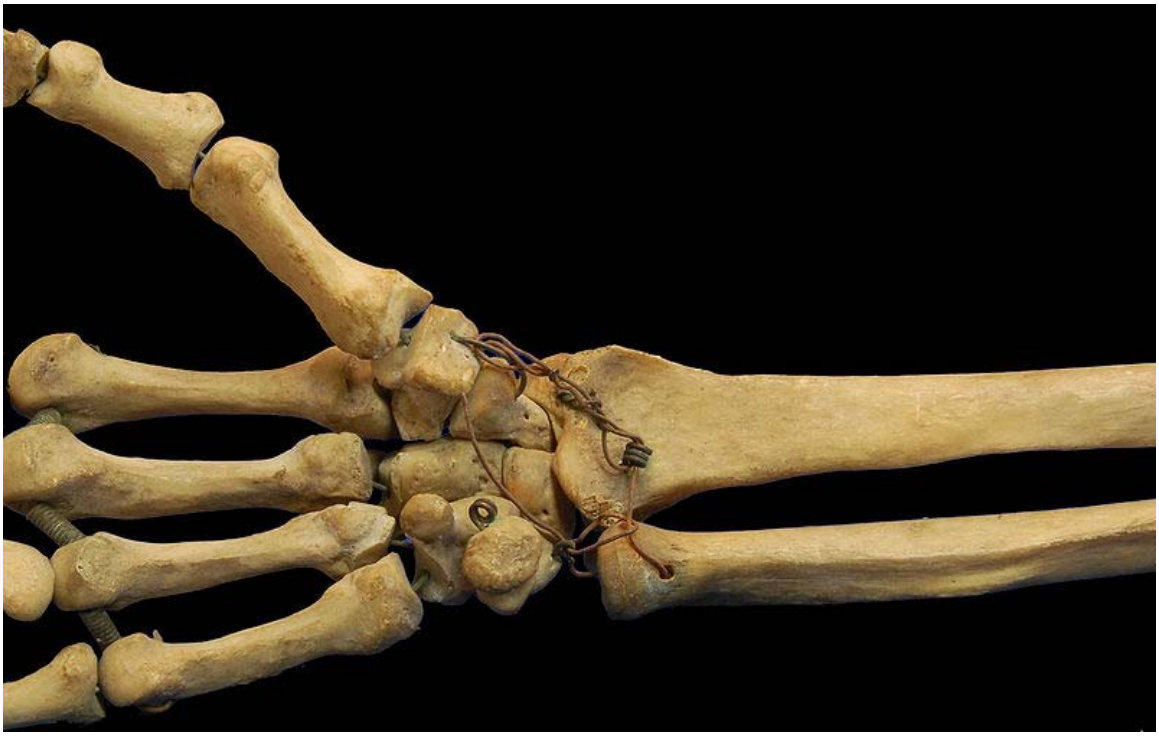
Combined with movements in both the elbow and shoulder joints, **intermediate** or **combined movements** in the wrist approximate those of a ball-and-socket joint with some necessary restrictions, such as maximum palmar flexion blocking abduction.

Accessory movements

Anteroposterior gliding movements between adjacent carpal bones or along the midcarpal joint can be achieved by stabilizing individual bones while moving another (i.e. gripping the bone between the thumb and index finger).

Individual bones





Posterior and anterior view of a human carpus

Almost all carpals (except the pisiform) have six surfaces. Of these the *palmar* or *anterior* and the *dorsal* or *posterior surfaces* are rough, for ligamentous attachment; the dorsal surfaces being the broader, except in the lunate.

The *superior* or *proximal,* and *inferior* or *distal surfaces* are articular, the superior generally convex, the inferior concave; the *medial* and *lateral surfaces* are also articular where they are in contact with contiguous bones, otherwise they are rough and tuberculated.

The structure in all is similar: cancellous tissue enclosed in a layer of compact bone.

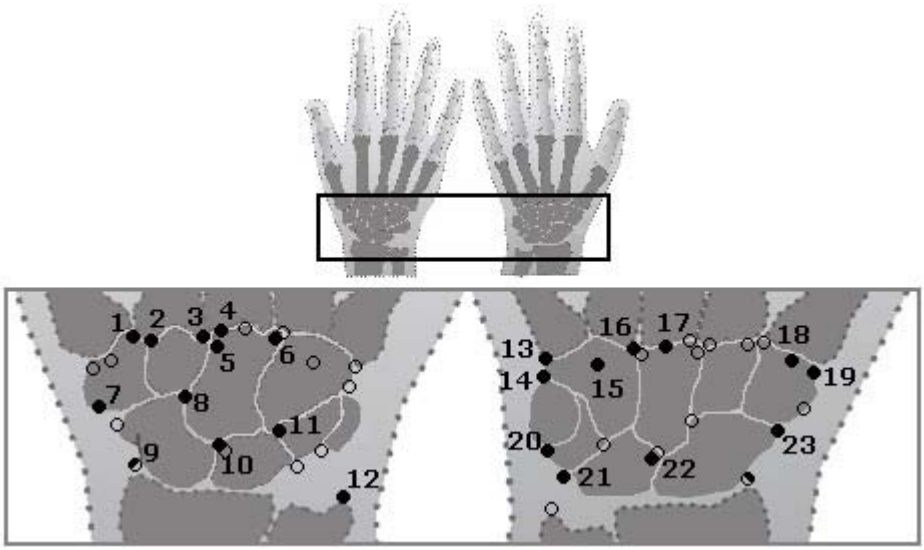
Articulations of individual carpal bones

Name	Proximal/radial articulations	Lateral/medial articulations	Distal/metacarpal articulations
		Proximal row	
Scaphoid	radius	capitate, lunate	trapezium, trapezoid
Lunate	radius, articular disk	scaphoid, triquetral	capitate, hamate (sometimes)
Triquetrum	articular disk	lunate, pisiform	hamate
Pisiform		triquetral	
		Distal row	

Trapezium	scaphoid	trapezoid	first and second metacarpal
Trapezoid	scaphoid	trapezium, capitate	second metacarpal
Capitate	scaphoid, lunate	trapezoid, hamate	third, partly second and fourth metacarpal
Hamate	triquetral, lunate	capitate	fourth and fifth

Created from the initial letter of each of the eight carpal bones, in the order most commonly referenced, the sentence "**s**ome **l**overs **t**ry **p**ositions **t**hat **t**hey **c**an't **h**andle" is used as a mnemonic device. Another mnemonic is "**s**he **l**ooks **t**oo **p**retty; **t**ry **t**o **c**atch **h**er."

Accessory bones



Location of the accessory ossicles of the carpals

Occasionally accessory bones are found in the carpus, but of more than 20 such described bones, only four (the central, styloid, secondary trapezoid, and secondary pisiform bones) are considered to be proven accessory bones. Sometimes the scaphoid, triquetrum, and pisiform bones are divided into two.

Ossification

Appearance of ossification centers of carpal bones no of carpal bones 27 sesamoid bone - pisiform(flexor carpi ulnaris) first bone to appear is capitate.

Bone	Average	Variation
Capitate	2.5 months	1–6 months
Hamate	4-5.5 months	1–7 months
Triquetrum	2 years	5 months to 3 years
Lunate	5 years	2-5.5 years
Trapezium	6 years	4–8 years
Trapezoid	6 years	4–8 years
Scaphoid	6 years	4–7 years
Pisiform	12 years	8–12 years

The carpal bones are ossified endochondrally (from within the cartilage) and the ossific centers appear only after birth. The formation of these centers roughly follows a chronological spiral pattern starting in the capitate and hamate during the first year of life. The ulnar bones are then ossified before the radial bones, while the sesamoid pisiform arises in the tendon of the flexor carpi ulnaris after more than ten years.

Evolutionary variations

The structure of the carpus varies widely between different groups of tetrapods, even among those that retain the full set of five digits. In primitive fossil amphibians, such as *Eryops*, the carpus consists of three rows of bones; a proximal row of three carpals, a second row of four bones, and a distal row of five bones. The proximal carpals are referred to as the **radiale**, **intermediale**, and **ulnare**, after their proximal articulations, and are homologous with the scaphoid, lunate, and triquetal bones respectively. The remaining bones are simply numbered, as the first to fourth **centralia** (singular: **centrale**), and the first to fifth **distal carpals**. Primitively, each of the distal bones appears to have articulated with a single metacarpal.

However, the vast majority of later vertebrates, including modern amphibians, have undergone varying degrees of loss and fusion of these primitive bones, resulting in a smaller number of carpals. Almost all mammals and reptiles, for example, have lost the fifth distal carpal, and have only a single centrale - and even this is missing in humans. The pisiform bone is somewhat unusual, in that it first appears in primitive reptiles, and is never found in amphibians.

Because many tetrapods have less than five digits on the forelimb, even greater degrees of fusion are common, and a huge array of different possible combinations are found. The wing of a modern bird, for example, has only two remaining carpals; the radiale (the scaphoid of mammals) and a bone formed from the fusion of four of the distal carpals.

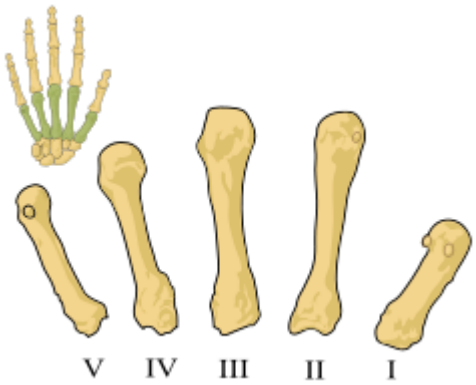
In some macropods, the scaphoid and lunar bones are fused into the scaphollunar bone.

In crustaceans, "carpus" is the scientific term for the claws or "pincers" present on some legs.

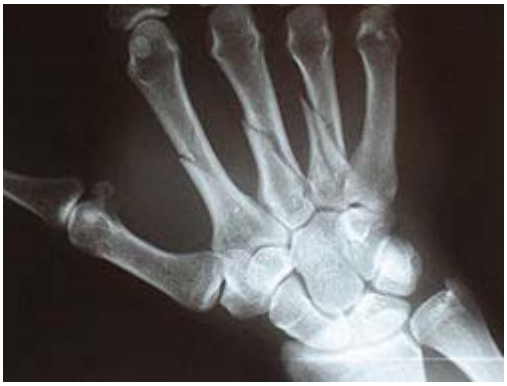
Chapter 11

Metacarpus

Bone: Metacarpals



The five metacarpal bones, numbered. (Left hand shown with thumb on right.)



Multiple fractures of the metacarpals (aka broken hand). (Right hand shown with thumb on left.)

Latin	*metacarpalia*
Gray's	*subject #55 227*
Origins	Carpus

Insertions	Proximal phalanges
Articulations	Carpometacarpal, intermetacarpal, metacarpophalangeal
MeSH	*Metacarpus*

In human anatomy, the **metacarpus** is the intermediate part of the hand skeleton that is located between the phalanges (bones of the fingers) distally and the carpus which forms the connection to the forearm. The metacarpus consists of metacarpal bones. Its equivalent in the foot is the metatarsus.

Human anatomy

The metacarpals form a transverse arch to which the rigid row of distal carpal bones are fixed. The peripheral metacarpals (those of the thumb and little finger) form the sides of the cup of the palmar gutter and as they are brought together they deepen this concavity. The index metacarpal is the most firmly fixed, while the thumb metacarpal articulates with the trapezium and acts independently from the others. The middle metacarpals are tightly united to the carpus by intrinsic interlocking bone elements at their bases. The ring metacarpal forms a transitional element of the semi-independent last metacarpal.

Each metacarpal bone consists of a body and two extremities.

Body

The *body* (*corpus; shaft*) is prismoid in form, and curved, so as to be convex in the longitudinal direction behind, concave in front. It presents three surfaces: medial, lateral, and dorsal.

- The *medial* and *lateral surfaces* are concave, for the attachment of the interosseus muscles, and separated from one another by a prominent anterior ridge.
- The *dorsal surface* presents in its distal two-thirds a smooth, triangular, flattened area which is covered in by the tendons of the Extensor muscles. This surface is bounded by two lines, which commence in small tubercles situated on either side of the digital extremity, and, passing upward, converge and meet some distance above the center of the bone and form a ridge which runs along the rest of the dorsal surface to the carpal extremity. This ridge separates two sloping surfaces for the attachment of the Interossei dorsales.
- To the tubercles on the digital extremities are attached the collateral ligaments of the metacarpophalangeal joints.

Base

The *base* or *carpal extremity* (*basis*) is of a cuboidal form, and broader behind than in front: it articulates with the carpus, and with the adjoining metacarpal bones; its dorsal and volar surfaces are rough, for the attachment of ligaments.

Head

The *head* or *digital extremity* (*capitulum*) presents an oblong surface markedly convex from before backward, less so transversely, and flattened from side to side; it articulates with the proximal phalanx. It is broader, and extends farther upward, on the volar than on the dorsal aspect, and is longer in the antero-posterior than in the transverse diameter. On either side of the head is a tubercle for the attachment of the collateral ligament of the metacarpophalangeal joint.

The dorsal surface, broad and flat, supports the tendons of the extensor muscles.

The volar surface is grooved in the middle line for the passage of the Flexor tendons, and marked on either side by an articular eminence continuous with the terminal articular surface.

Articulations

Besides the metacarpophalangeal joints, the metacarpal bones articulate by carpometacarpal joints as follows:

- the first with the trapezium;
- the second with the trapezium, trapezoid, capitate and third metacarpal;
- the third with the capitate and second and fourth metacarpals;
- the fourth with the capitate, hamate, and third and fifth metacarpals;
- and the fifth with the hamate and fourth metacarpal.

Insertions

Extensor Carpi Radialis Longus/Brevis: Both insert on the base of metacarpal II; Assist with wrist extension and radial flexion of the wrist

Extensor Carpi Ulnaris: Inserts on the base of metacarpal V; Extends and fixes wrist when digits are being flexed; assists with ulnar flexion of wrist

Abductor Pollicis Longus: Inserts on the trapezium and base of metacarpal I; Abducts thumb in frontal plane; extends thumb at carpometacarpal joint

Opponens Pollicis: Inserts on Metacarpal I; Flexes metacarpal I to oppose the thumb to the fingertips

Opponens Digiti Minimi: Inserts on the medial surface of metacarpal V; Flexes metacarpal V at carpometacarpal joint when little finger is moved into opposition with tip of thumb; deepens palm of hand.

Congenital disorders

The fourth and fifth metacarpal bones are commonly "blunted," or shortened, in pseudohypoparathyroidism and pseudopseudohypoparathyroidism.

A blunted fourth metacarpal, with normal fifth metacarpal, can signify Turner syndrome.

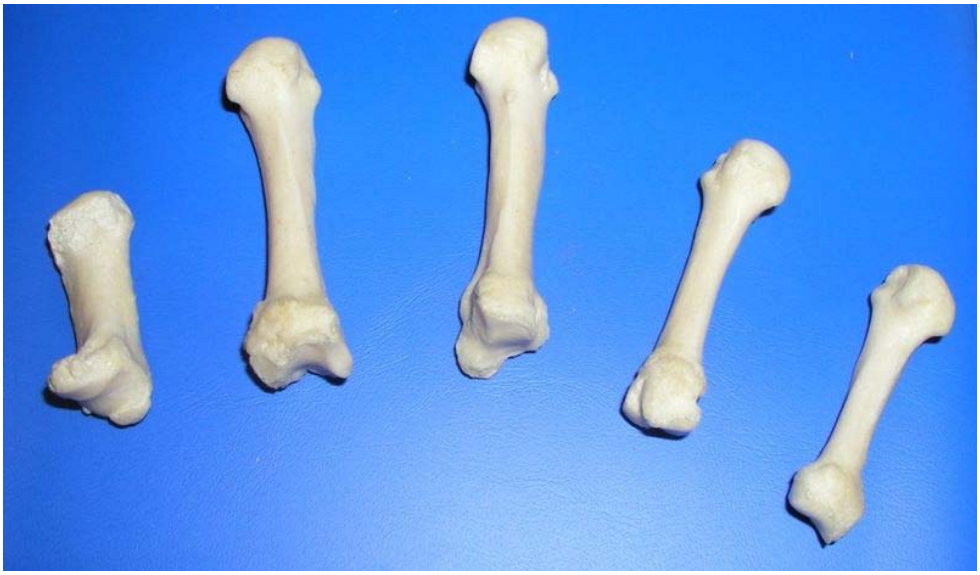
Blunted metacarpals (particularly the fourth metacarpal) are a symptom of Nevoid basal cell carcinoma syndrome.

Fracture

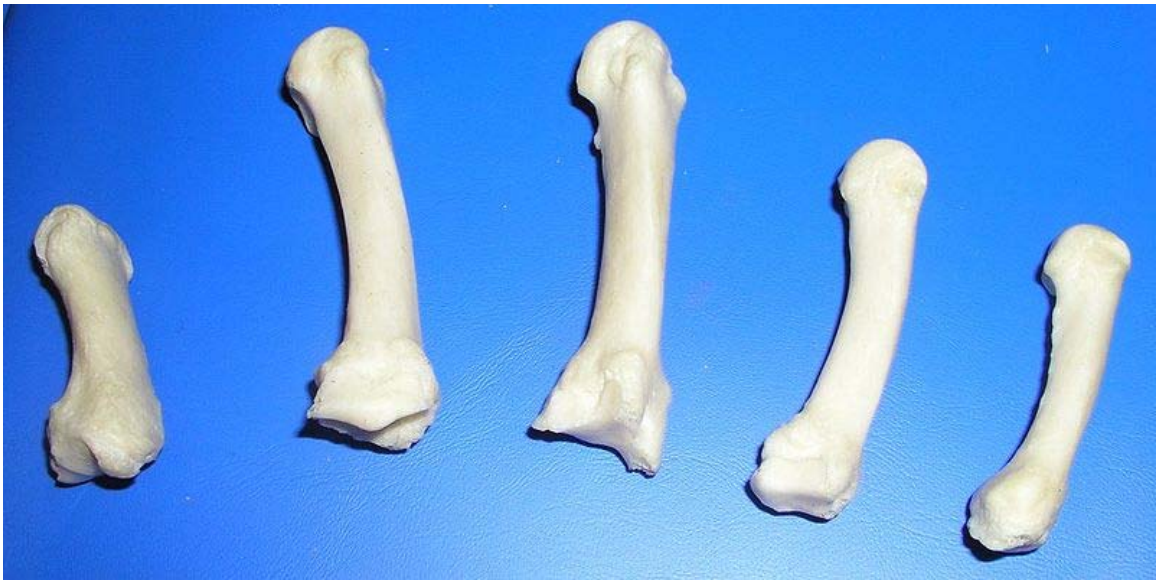
The *neck* of a metacarpal (in the transition between the body and the head) is a common location for a boxer's fracture.

In other animals

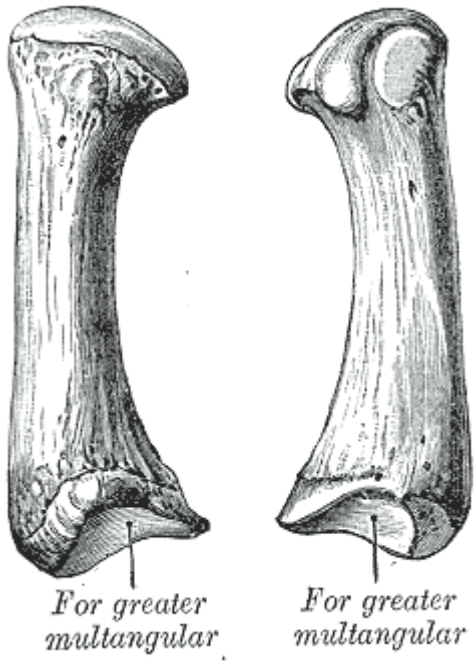
In four-legged animals, the metacarpals form part of the forefeet, and are frequently reduced in number, appropriate to the number of toes. In digitigrade and unguligrade animals, the metacarpals are greatly extended and strengthened, forming an additional segment to the limb, a feature that typically enhances the animal's speed. In both birds and bats, the metacarpals form part of the wing.



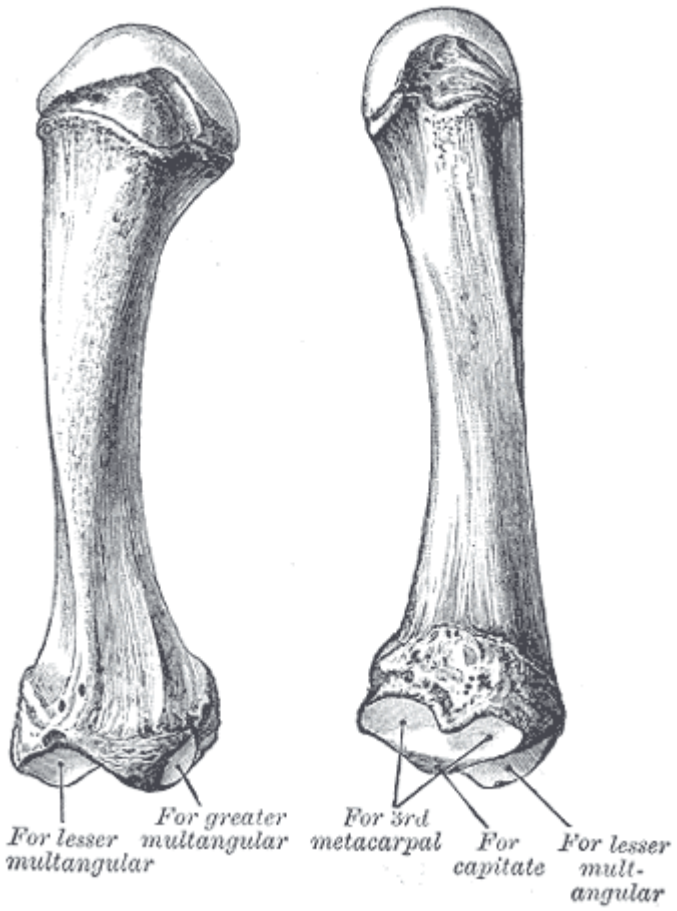
Metacarpals of left hand, anterior aspect



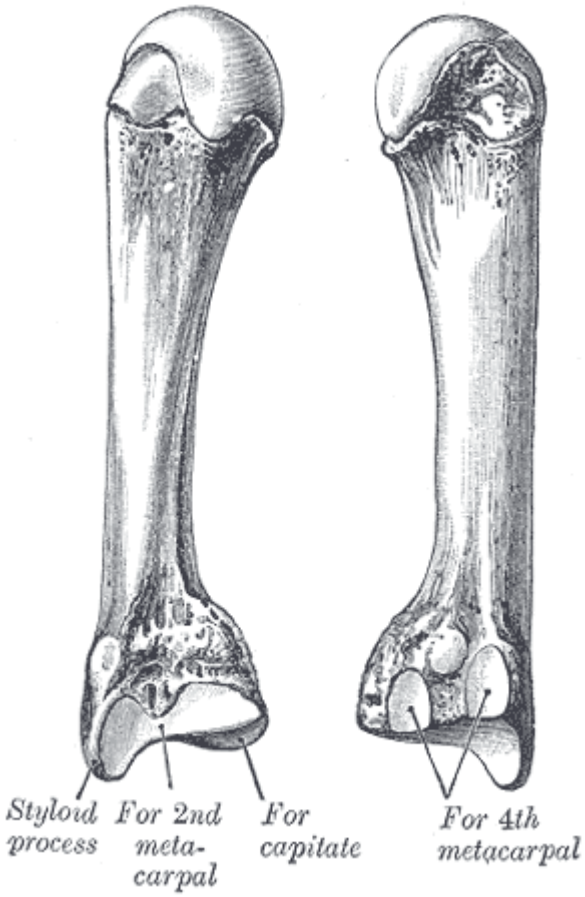
Metacarpals of left hand, medial aspect



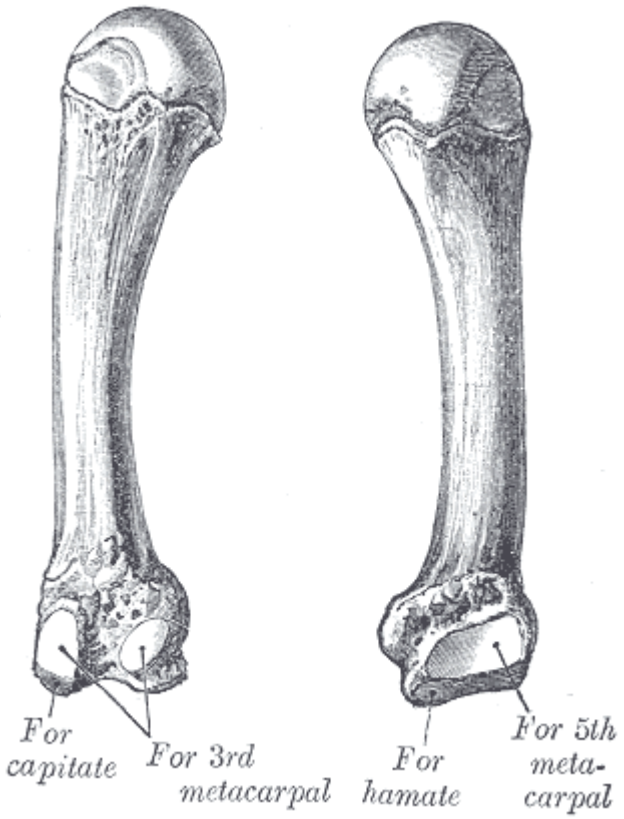
First metacarpal bone (left)



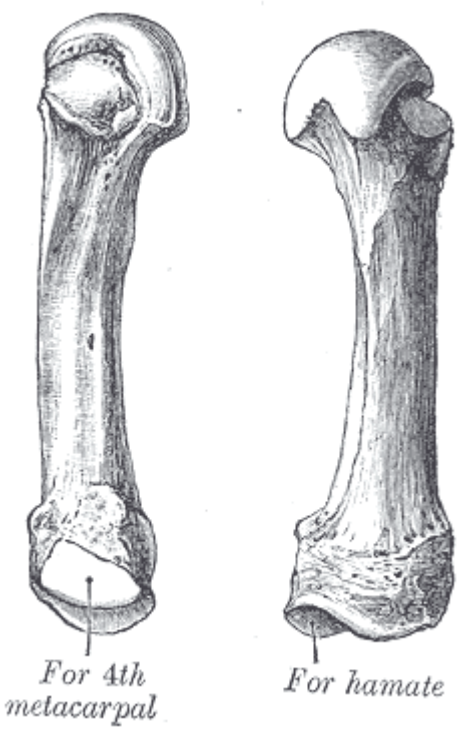
Second metacarpal bone (left)



Third metacarpal bone (left)



Fourth metacarpal bone (left)



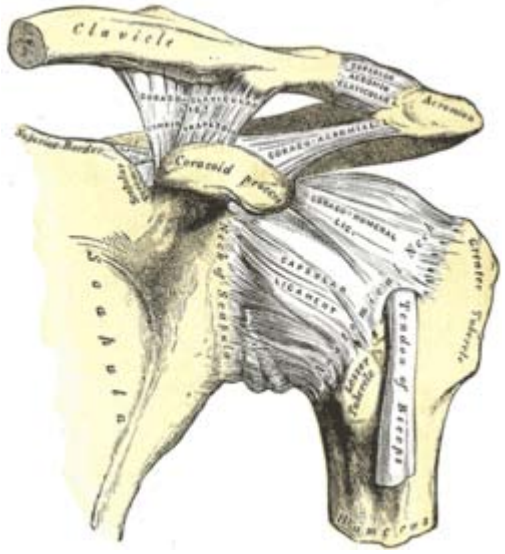
Fifth metacarpal bone (left)

Chapter 12

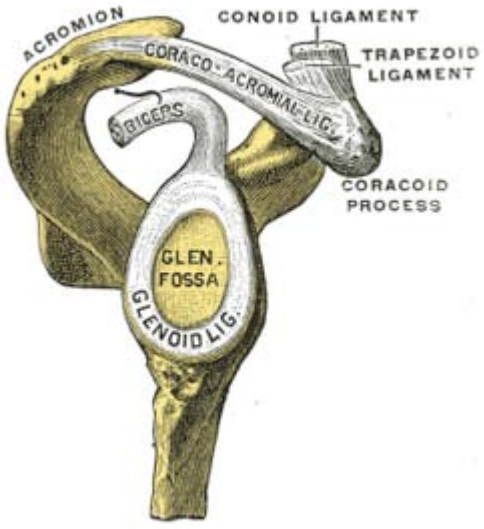
Acromioclavicular Joint and Glenohumeral Joint

Acromioclavicular joint

Acromio-clavicular joint



The left shoulder and acromioclavicular joints, and the proper ligaments of the scapula.



Glenoid fossa of right side.

Latin	*articulatio acromioclavicularis*
Gray's	*subject #82 315*
MeSH	*Acromioclavicular+Joint*

The **acromioclavicular joint**, or **AC joint**, is a joint at the top of the shoulder. It is the junction between the acromion (part of the scapula that forms the highest point of the shoulder) and the clavicle.

Function

The AC joint allows the ability to raise the arm above the head. This joint functions as a pivot point (although technically it is a gliding synovial joint), acting like a strut to help with movement of the scapula resulting in a greater degree of arm rotation.

Ligaments

The joint is stabilized by three ligaments:

- The acromioclavicular ligament, which attaches the clavicle to the acromion of the scapula.

Superior Acromioclavicular Ligament This ligament is a quadrilateral band, covering the superior part of the articulation, and extending between the upper part of the lateral end of the clavicle and the adjoining part of the upper surface of the acromion.

It is composed of parallel fibers, which interlace with the aponeuroses of the Trapezius and Deltoideus; below, it is in contact with the articular disk when this is present.

Inferior Acromioclavicular Ligament This ligament is somewhat thinner than the preceding; it covers the under part of the articulation, and is attached to the adjoining surfaces of the two bones.

It is in relation, above, in rare cases with the articular disk; below, with the tendon of the Supraspinatus

- The coracoacromial ligament, which runs from the coracoid process to the acromion.

The Coracoacromial Ligament is a strong triangular band, extending between the coracoid process and the acromion.

It is attached, by its apex, to the summit of the acromion just in front of the articular surface for the clavicle; and by its broad base to the whole length of the lateral border of the coracoid process.

This ligament, together with the coracoid process and the acromion, forms a vault for the protection of the head of the humerus.

It is in relation, above, with the clavicle and under surface of the Deltoideus; below, with the tendon of the Supraspinatus, a bursa being interposed.

Its lateral border is continuous with a dense lamina that passes beneath the Deltoideus upon the tendons of the Supraspinatus and Infraspinatus.

The ligament is sometimes described as consisting of two marginal bands and a thinner intervening portion, the two bands being attached respectively to the apex and the base of the coracoid process, and joining together at the acromion.

When the Pectoralis minor is inserted, as occasionally is the case, into the capsule of the shoulder-joint instead of into the coracoid process, it passes between these two bands, and the intervening portion of the ligament is then deficient.

- The coracoclavicular ligament, which consists of two ligaments, the conoid and the trapezoid ligaments.

The Coracoclavicular Ligament serves to connect the clavicle with the coracoid process of the scapula.

It does not properly belong to the acromioclavicular joint articulation, but is usually described with it, since it forms a most efficient means of retaining the clavicle in contact with the acromion. It consists of two fasciculi, called the trapezoid ligament and conoid ligament.

These ligaments are in relation, in front, with the Subclavius and Deltoideus; behind, with the Trapezius.

Variability

An X-ray study of 100 shoulders in US soldiers found considerable variation in the size and shape of the joint. The articular surfaces were notably different in size and form. On some they are separated by a meniscus attached to the superior acromioclavicular ligament. This meniscus may be a blade of fibrocartilage that extends nearly halfway into the joint or it may form a complete disc that divides the joint into two parts. In other joints no synovial joint is present with the joint being made by a pad of fibrous tissue attached to the outer end of the clavicle, and no articular cavity.

Injuries

A common injury to the AC joint is dislocation, often called AC separation or shoulder separation. This is not the same as a "shoulder dislocation," which refers to dislocation of the glenohumeral joint.

AC dislocation is particularly common in collision sports such as ice hockey, football, rugby and aussie rules, and is also a problem for those who participate in swimming, horseback riding, mountain biking, biking and snow skiing. The most common mechanism of injury is a fall on the tip of the shoulder or FOOSH (**f**alls **o**n **o**ut**s**tretched **h**and).

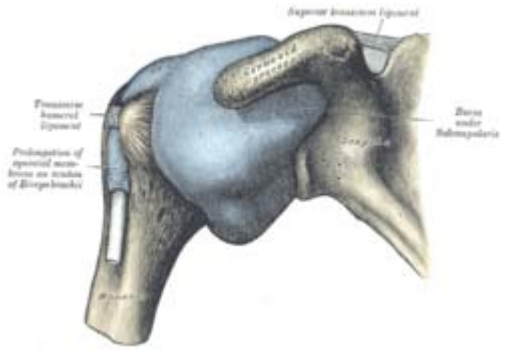
AC dislocations are also graded from I to VI. Grading is based upon the degree of separation of the acromion from the clavicle with weight applied to the arm. **Grade I** is a tear of the AC ligament. It has the normal separation of <4mm. **Grade II** is a complete dislocation of AC ligament with partial disruption of coracoclavicular ligament. The AC gap is >5mm. Grades I and II never require surgery and heal by themselves, though physical therapy may be required. **Grade III** is complete disruption of AC and CC ligaments. On plain film the inferior aspect of the clavicle will be above the superior aspect of the acromion. This can also be assessed with an MRI scan, which will also demonstrate disruption of the coracoclavicular ligaments (the degree depending on the severity of AC joint disruption) as well as tearing of the joint capsule. The joint will be very tender and swollen on examination. Grade III separations most often do not require surgery and shoulder function should return to normal after 16–20 weeks. However, there will be some physical deformity of the shoulder with a noticeable bump resulting from the dislocation of the clavicle. Grades IV-VI are complications on a 'standard' dislocation involving a displacement of the clavicle, and will almost always require surgery.

Osteoarthritis

Osteoarthritis (OA) of the AC joint is not uncommon. It may be caused by a prior trauma (secondary OA) or occur as a chronic degenerative disorder. In the latter cases the condition often co-exist with subacromial impingement.

Glenohumeral joint

Glenohumeral joint



The right shoulder and **Glenohumeral** joint

Latin	*articulatio humeri*
Gray's	*subject #82 315*
MeSH	*Glenohumeral+Joint*

The **glenohumeral joint**, [from ancient Greek *glene*, eyeball, puppet, doll + *-oid*, 'form of', + latin *humerus*, shoulder] or **shoulder joint**, is a multiaxial synovial ball and socket joint and involves articulation between the glenoid fossa of the scapula (shoulder blade) and the head of the humerus (upper arm bone).

Movements

The glenoid fossa is shallow and contains the glenoid labrum which deepens it and aids in stability. With 120 degrees of unassisted flexion, the glenohumeral joint is the most mobile joint in the body.

Scapulohumeral rhythm helps to achieve further range of movement. The Scapulohumeral rhythm is the movement of the scapula across the thoracic cage in relation to the humerus. This movement can be compromised by anything that changes the position of the scapula. This could be an imbalance in the muscles that hold the scapula in place which are the upper and lower trapezium. This imbalance could cause a forward head carriage which in turn can affect the range of movements of the shoulder.

The rotator cuff muscles of the shoulder produce a high tensile force, and help to pull the head of the humerus into the glenoid fossa.

Movements of the shoulder joint

Movement	Muscles	Origin	Insertion
Flexion	Anterior fibers of deltoid	Clavicle	Middle of lateral surface of shaft of humerus
	Clavicular part of pectoralis major	Clavicle	Lateral lip of bicipital groove of humerus
	Long head of biceps brachii	Supraglenoid tubercle of scapula	Tuberosity of radius, Deep fascia of forearm
	Short head of biceps brachii	Coracoid process of scapula	
	Coracobrachialis	Coracoid process	Medial aspect of shaft of humerus
Extension	Posterior fibers of deltoid	Spine of scapula	Middle of lateral surface of shaft of humerus
	Latissimus dorsi	Iliac crest, lumbar fascia, spines of lower six thoracic vertebrae, lower 3-4 ribs, inferior angle of scapula	Floor of bicipital groove of humerus
	Teres major	Lateral border of scapula	Medial lip of bicipital groove of humerus
Abduction	Middle fibers of deltoid	Acromion process of scapula	Middle of lateral surface of shaft of humerus
	Supraspinatus	Supraspinous fossa of scapula	Greater tuberosity of humerus
	Sternal part of pectoralis major	Sternum, upper six costal cartilages	Lateral lip of bicipital groove of humerus
Adduction	Latissimus dorsi	Iliac crest, lumbar fascia, spines of lower six thoracic vertebrae, lower 3-4 ribs, inferior angle of scapula	Floor of bicipital groove of humerus
	Teres major	Lower third of lateral border of scapula	Medial lip of bicipital groove of humerus
Lateral rotation	Teres minor	Upper two thirds of lateral border of scapula	Greater tuberosity of humerus
	Infraspinatus	Infraspinous fossa of scapula	Greater tuberosity of humerus
	Teres minor	Upper two thirds of lateral border	Greater tuberosity

		of scapula	of humerus
	Posterior fibers of deltoid	Spine of scapula	Middle of lateral surface of shaft of humerus
	Subscapularis	Subscapular fossa	Lesser tuberosity of humerus
Medial rotation	Latissimus dorsi	Iliac crest, lumbar fascia, spines of lower 3-4 ribs, inferior angle of scapula	Floor of bicipital groove of humerus
	Teres major	Lower third of lateral border of scapula	Medial lip of bicipital groove of humerus
	Anterior fibers of deltoid	Clavicle	Middle of lateral surface of shaft of humerus

Capsule

The glenohumeral joint has a loose capsule that is lax inferiorly and therefore is at risk of dislocation inferiorly. The long head of the biceps brachii muscle travels inside the capsule to attach to the supraglenoid tubercle of the scapula.

Because the tendon is inside the capsule, it requires a synovial tendon sheath to minimize friction.

A number of bursae in the capsule aid mobility. Namely, they are the subdeltoid bursa (between the joint capsule and deltoid muscle), subcoracoid bursa (between joint capsule and coracoid process of scapula), coracobrachial bursa (between subscapularis muscle and tendon of coracobrachialis muscle), subacromial bursa (between joint capsule and acromion of scapula) and the subscapular bursa (between joint capsule and tendon of subscapularis muscle, also known as subtendinous bursa of subscapularis muscle). The bursa are formed by the synovial membrane of the joint capsule. An inferior pouching of the joint capsule between teres minor and subscapularis is known as the axillary recess.

The shoulder joint is a muscle dependent joint as it lacks strong ligaments.

Ligaments

- Superior, middle and inferior glenohumeral ligaments
- Coracohumeral ligament
- Transverse humeral ligament

Nerve Supply

- suprascapular nerve

- axillary nerve
- lateral pectoral nerve

Blood Supply

branches of the anterior & posterior circumflex humeral & suprascapular arteries.

Pathology

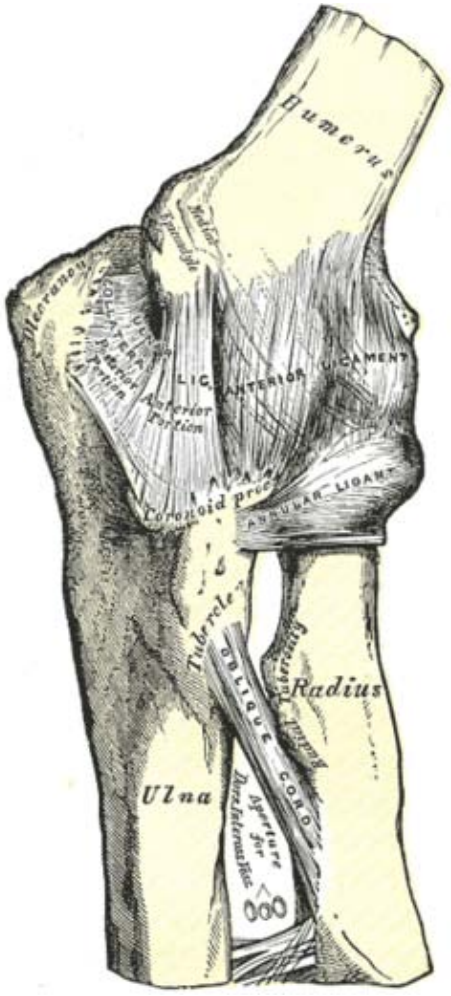
The capsule can become inflamed and stiff, with abnormal bands of tissue (adhesions) growing between the joint surfaces, causing pain and restricting movement of the shoulder, a condition known as frozen shoulder or adhesive capsulitis.

Chapter 13

Humeroradial Joint and Humeroulnar Joint

Humeroradial joint

Humeroradial joint



Left elbow-joint, showing anterior and ulnar collateral

ligaments.

Latin *articulatio humeroradialis*

Gray's *subject #84 321*

The **humeroradial joint**, the joint between the head of the radius and the capitulum of the humerus, is a limited ball-and-socket joint.

The bony surfaces would of themselves constitute an enarthrosis and allow movement in all directions, were it not for the annular ligament, by which the head of the radius is bound to the radial notch of the ulna, and which prevents any separation of the two bones laterally.

It is to the same ligament that the head of the radius owes its security from dislocation, which would otherwise tend to occur, from the shallowness of the cup-like surface on the head of the radius.

In fact, but for this ligament, the tendon of the Biceps brachii would be liable to pull the head of the radius out of the joint.

The head of the radius is not in complete contact with the capitulum of the humerus in all positions of the joint.

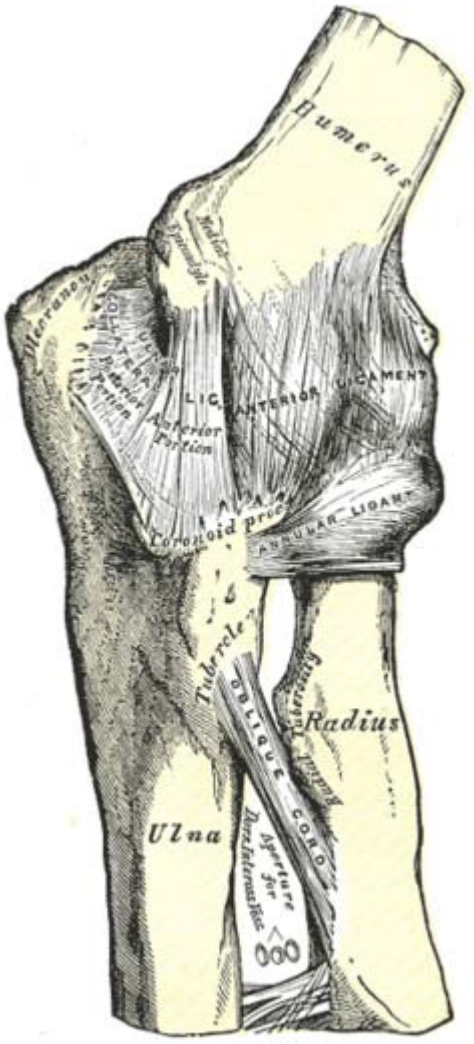
The capitulum occupies only the anterior and inferior surfaces of the lower end of the humerus, so that in complete extension a part of the radial head can be plainly felt projecting at the back of the articulation.

In full flexion the movement of the radial head is hampered by the compression of the surrounding soft parts, so that the freest rotatory movement of the radius on the humerus (pronation and supination) takes place in semiflexion, in which position the two articular surfaces are in most intimate contact.

Flexion and extension of the elbow-joint are limited by the tension of the structures on the front and back of the joint; the limitation of flexion is also aided by the soft structures of the arm and forearm coming into contact.

Humeroulnar joint

Humeroulnar joint



Left elbow-joint, showing anterior and ulnar collateral ligaments.

Latin	*articulatio humeroulnaris*
Gray's	*subject #84 321*

The **humeroulnar joint**, is part of the elbow-joint or the Olecron Joint, between the ulna and humerus bones is the simple hinge-joint, which allows for movements of flexion, extension and circumduction. The Humero-Ulnar Joint is the junction of trochlear notch of the ulna and the trochlea of the humerus.

Owing to the obliquity of the trochlea of the humerus, this movement does not take place in the antero-posterior plane of the body of the humerus.

When the forearm is *extended and supinated*, the axis of the arm and forearm are not in the same line; the arm forms an obtuse angle with the forearm (the carrying angle). During *flexion*, however, the forearm and the hand tend to approach the middle line of the body, and thus enable the hand to be easily carried to the face.

The accurate adaptation of the trochlea of the humerus, with its prominences and depressions, to the semilunar notch of the ulna, prevents any lateral movement.

Flexion is produced by the action of the Biceps brachii and Brachialis, assisted by the Brachioradialis, with a tiny contribution from the muscles arising from the medial epicondyle of the humerus.

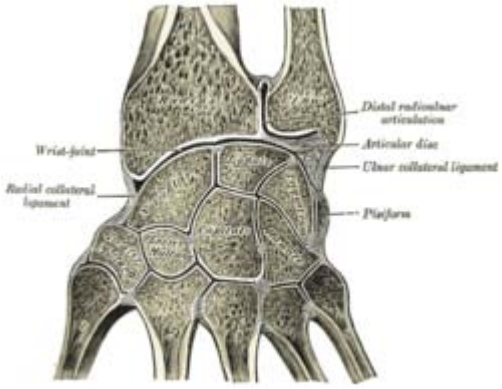
Extension is produced by the Triceps brachii and Anconæus, with a tiny contribution from the muscles arising from the lateral epicondyle of the humerus, such as the Extensor digitorum communis.

Chapter 14

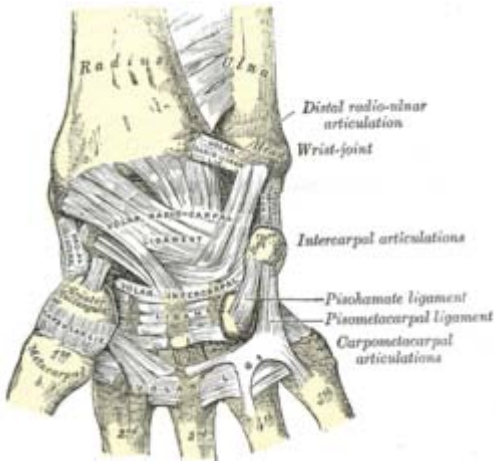
Intercarpal Articulations and Midcarpal Joint

Intercarpal articulations

Intercarpal articulations



Vertical section through the articulations at the wrist, showing the synovial cavities.



Ligaments of wrist. Anterior view

Latin	*articulationes intercarpales*
Gray's	*subject #87 328*
MeSH	*Intercarpal+Joints*

The **intercarpal articulations** (**articulations of the carpus**) can be subdivided into three sets of articulations: Those of the proximal row of carpal bones, those of the distal row of carpal bones, and those of the two rows with each other.

Articulations

The bones in each carpal row interlock with each other and each row can therefore be considered a single articular body. In the proximal row a limited degree of mobility is possible, but the bones of the distal row are connected to each other and to the metacarpal bones by strong ligaments that make this row and the metacarpus a functional entity.

Proximal row

The joints of the proximal row are arthrodial joints, The scaphoid, lunate, and triangular are connected by dorsal, volar, and interosseous ligaments.

The dorsal intercarpal ligament are two in number and placed transversely behind the bones of the first row; they connect the scaphoid and lunate, and the lunate and triangular.

The palmar interecarpal ligaments are also two, connect the scaphoid and lunate, and the lunate and triangular; they are less strong than the dorsal, and placed very deeply behind the Flexor tendons and the volar radiocarpal ligament.

The interosseous intercarpal ligaments are two narrow bundles, one connecting the lunate with the scaphoid, the other joining it to the triangular. They are on a level with the

superior surfaces of these bones, and their upper surfaces are smooth, and form part of the convex articular surface of the wrist-joint.

The ligaments connecting the pisiform bone are the articular capsule and the two volar ligaments. The articular capsule is a thin membrane which connects the pisiform to the triangular; it is lined by synovial membrane.

The two volar ligaments are strong fibrous bands; one, the pisohamate ligament, connects the pisiform to the hamate, the other, the pisometacarpal ligament, joins the pisiform to the base of the fifth metacarpal bone. These ligaments are, in reality, prolongations of the tendon of the Flexor carpi ulnaris.

Distal row

These joints are also arthrodial joints connected by dorsal, volar, and interosseous ligaments.

The dorsal ligaments are three in number, extend transversely from one bone to another on the dorsal surface, connecting the greater with the lesser multangular, the lesser multangular with the capitate, and the capitate with the hamate.

The volar ligaments are also three and have a similar arrangement on the volar surface.

The three interosseous ligaments are much thicker than those of the first row; one is placed between the capitate and the hamate, a second between the capitate and the lesser multangular, and a third between the greater and lesser multangulars. The first is much the strongest, and the third is sometimes wanting.

Midcarpal

Synovial membrane

The synovial membrane of the carpus is very extensive, and bounds a synovial cavity of very irregular shape.

The upper portion of the cavity intervenes between the under surfaces of the navicular, lunate, and triangular bones and the upper surfaces of the bones of the second row.

It sends two prolongations upward—between the navicular and lunate, and the lunate and triangular—and three prolongations downward between the four bones of the second row.

The prolongation between the greater and lesser multangulars, or that between the lesser multangular and capitate, is, owing to the absence of the interosseous ligament, often continuous with the cavity of the carpometacarpal joints, sometimes of the second, third, fourth, and fifth metacarpal bones, sometimes of the second and third only.

In the latter condition the joint between the hamate and the fourth and fifth metacarpal bones has a separate synovial membrane.

The synovial cavities of these joints are prolonged for a short distance between the bases of the metacarpal bones.

There is a separate synovial membrane between the pisiform and triangular.

Movements

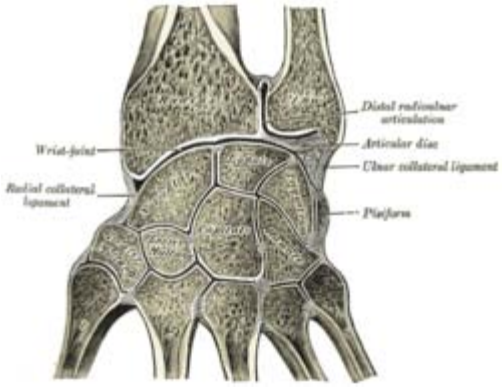
The articulation of the hand and wrist considered as a whole involves four articular surfaces:

- (a) the inferior surfaces of the radius and articular disk;
- (b) the superior surfaces of the navicular, lunate, and triangular, the pisiform having no essential part in the movement of the hand;
- (c) the S-shaped surface formed by the inferior surfaces of the navicular, lunate, and triangular;
- (d) the reciprocal surface formed by the upper surfaces of the bones of the second row.

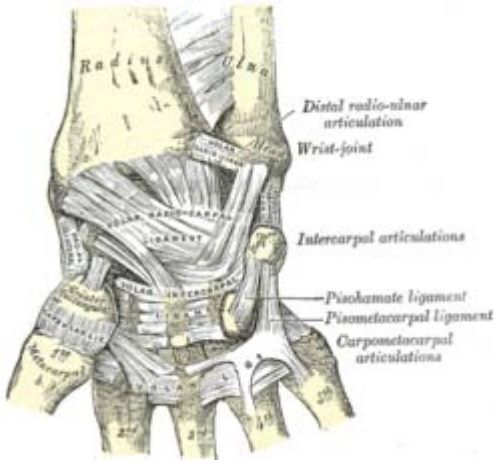
These four surfaces form two joints: (1) a proximal, the wrist-joint proper; and (2) a distal, the mid-carpal joint.

Midcarpal joint

Midcarpal joint



Vertical section through the articulations at the wrist, showing the synovial cavities.



Ligaments of wrist. Anterior view

Latin	*articulatio mediocarpalis*
Gray's	*subject #87 328*

The **Midcarpal Joint** is formed by the scaphoid, lunate, and triquetral bones in the proximal row, and the trapezium, trapezoid, capitate, and hamate bones in distal row. The distal pole of the scaphoid articulates with two trapezial bones as a gliding type of joint. The proximal end of the scaphoid combines with the lunate and triquetrum to form a deep concavity that articulates with the convexity of the combined capitate and hamate in a form of diarthrodial, almost condyloid joint.

The cavity of the midcarpal joint is very extensive and irregular. The major portion of the cavity is located between the distal surfaces of the scaphoid, lunate, and triquetrum and proximal surfaces of the four bones of the distal row. Proximal prolongations of the

cavity occur between the scaphoid and lunate and between the lunate and triquetrum. These extensions reach almost to the proximal surface of the bones in the proximal row and are separated from the cavity of the radiocarpal joint by the thin interosseous ligaments. There are three distal prolongations of the midcarpal joint cavity between the four bones of the distal row. The joint space between trapezium and trapezoid, or that between trapezoid and capitate, may communicate with cavities of the carpometacarpal joints, most commonly the second and third. The cavity between the first metacarpal and carpus is always separate from the midcarpal joint; the joint cavity between the hamate and fourth and fifth metacarpals is a separate cavity more often than not, but it may communicate normally with the midcarpal joint.

The Wrist

The wrist is perhaps the most complicated joint in the body. It permits movements in three planes - extension/flexion, [[ulnar deviation]/(adduction)][[radial deviation)/(abduction)],[circumduction] and allows complex patterns of motion under significant strain.

Optimal wrist function requires stability of the carpal components in all joint positions under static and dynamic conditions.

Stability is achieved by a sophisticated geometry of articular surfaces and intricate system of ligaments, retinacula, and tendons, which also determine the relative motion of the carpal bones.

Ligaments

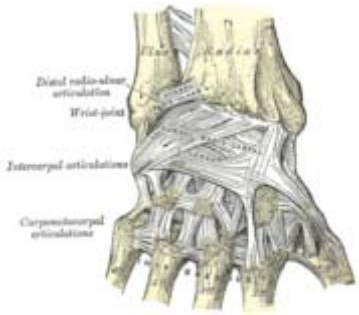
Ligamentous Apparatus of the Wrist:

The carpal bones are not interlocked solely by their shapes; rather, they are held together by interosseous ligaments and by volar, dorsal, radial, and ulnar ligaments. The ligaments holding the carpal bones to each other, to the distal radius and ulna, and to the proximal ends of the metacarpals can be described as extrinsic, or capsular, and intrinsic, or interosseous (intercarpal). The function of the ligamentous system is guiding and constraining certain patterns of motion. Some portion of the ligaments are under tension in every position of the hand in relation to the forearm.

Chapter 15

Carpometacarpal Joint

Carpometacarpal joint



Ligaments of wrist. Posterior view.

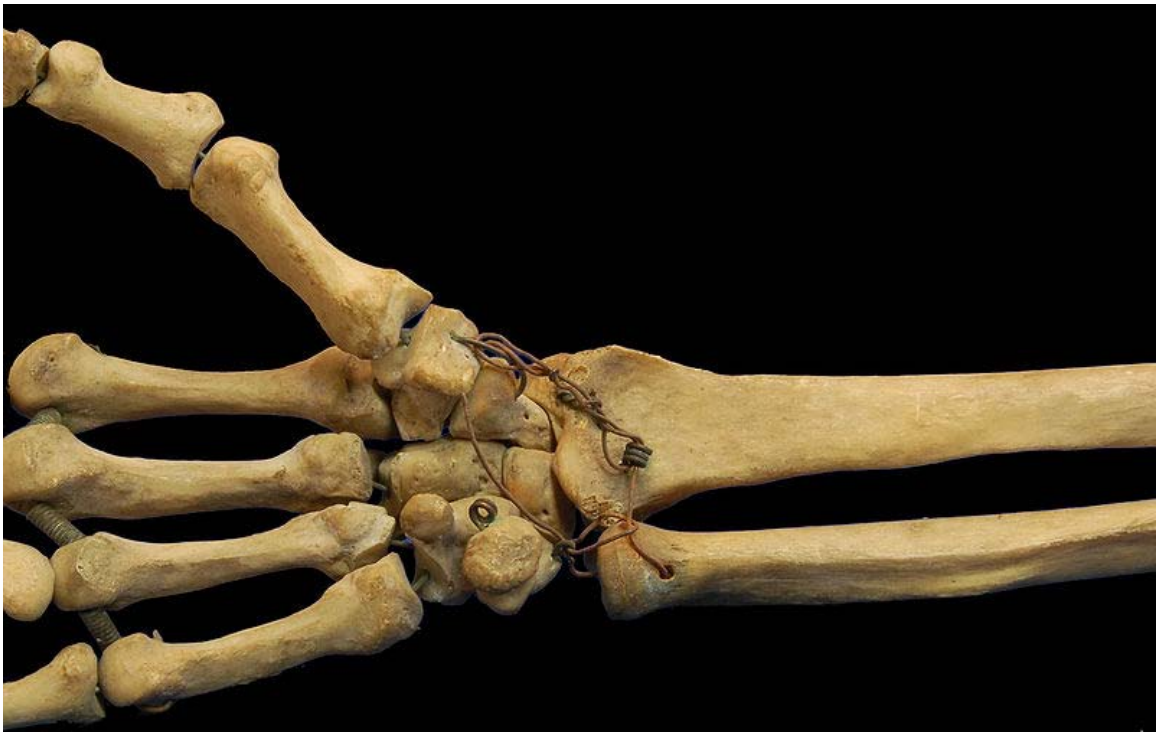
Latin *articulationes carpometacarpeæ*

Gray's *subject #88 330*

The **carpometacarpal joints** (CMC) are five joints in the wrist that articulates the distal row of carpal bones and the proximal bases of the five metacarpal bones.

The CMC of the thumb or the first CMC differs significantly from the other four CMCs and is therefore described separately.

Thumb



Bones of a human wrist. In this photo both the free position and saddle shape of the first CMC joint and the proximal transverse palmar arch are clearly visible.

The carpometacarpal joint of the thumb, also known as the trapeziometacarpal joint (TMC) because it connects the trapezium to the first metacarpal bone, plays an irreplaceable role in the normal functioning of the thumb. The most important joint connecting the wrist to the metacarpus, osteoarthritis of the TMC is a severely disabling condition; up to twenty times more common among old women than in average.

Pronation-supination of the first metacarpal is especially important for the pulp-to-pulp pinch (i.e. "true opposition"). The movements of the first CMC is limited by the shape of the joint, by the capsulo-ligamentous complex surrounding the joint, and by the balance among involved muscles. If the first metacarpal fails to sit well 'on the saddle', for example because of hypoplasia, the first CMC joint tends to be subluxated (i.e. slightly displaced) towards the radius.

The capsule is sufficiently slack to allow a wide range of movements and a distraction of roughly 3 mm, while reinforcing ligaments and tendons give stability to the joint. It is slightly thicker on its dorsal side than on the other.

Ligaments

The description of the number and names of the ligaments of the first CMC varies considerably in anatomical literature. Imaeda et al. 1993 describe three intracapsular and two extracapsular ligaments:

Anterior oblique ligament (AOL)
: A strong, thick, and extracapsular ligament originating on the palmar tubercle of the trapezium to be inserted on the palmar tubercle of the first metacarpal. It is taut in abduction, extension, and pronation, and has been reported to have an important retaining function and to be elongated or absent in CMC joint arthritis.

Ulnar collateral ligament (UCL)
: The second extracapsular ligament, the UCL is located ulnarly to the AOL. It has its origin on the flexor retinaculum and is inserted on the ulnopalmar tubercle of the first metacarpal. It is taut in abduction, extension, and pronation, and often found elongated in connection to CMC joint arthritis. The importance ascribed to the UCL varies considerably among researchers.

First intermetacarpal ligament (IML)
: Connecting the bases of the second and first metacarpals, this ligament inserts onto the ulnopalmar tubercle of the first metacarpal where its fibers intermingle with those of the UCL. It is taut in abduction, opposition, and supination. It has been reported to be the most important restraining structure of the first CMC joint by several researchers, while some consider it to weak to be able to stabilize the joint by itself, but that it together with the UCL represent an important restraining structure.

Posterior oblique ligment (POL)
: An intracapsular ligament stretching from the dorsoulnar side of the trapezium to the ulno-palmar tubercle of the first metacarpal. Not considered an important ligament to the first CMC joint, it tightens during forced adduction and radial abduction.

Dorsoradial ligament (DRL)
: Like the previous ligament, the DRL is not considered important to the first CMC. It connects the dorsal sides of the trapezium and the first metacarpal.

Early, anatomically correct drawings of the ligaments of the first carpometacarpal joints where poduced by Weitbrecht 1742.

Movements

In this articulation the movements permitted are flexion and extension in the plane of the palm of the hand, abduction and adduction in a plane at right angles to the palm, circumduction, and opposition.

- It is by the movement of opposition that the tip of the thumb is brought into contact with the volar surfaces of the slightly flexed fingers. This movement is effected through the medium of a small sloping facet on the anterior lip of the

saddle-shaped articular surface of the greater multangular. The flexor muscles pull the corresponding part of the articular surface of the metacarpal bone on to this facet, and the movement of opposition is then carried out by the adductors.

- Flexion of this joint is produced by the flexor pollicis longus and brevis, assisted by the opponens pollicis and the adductor pollicis.
- Extension is effected mainly by the abductor pollicis longus, assisted by the extensores pollicis longus and brevis.
- Adduction is carried out by the adductor; abduction mainly by the abductor pollicis longus and brevis, assisted by the extensors.

Range of motion for the first CMC is 53° of flexion/extension, 42° of abduction/adduction, and 17° of rotation

Planes and axes of movements

The thumb's MP and CMC joints abduct and adduct in a plane perpendicular to the palm, a movement also referred to as "palmar abduction." The same joints flex and extend in a plane parallel to the palm, also referred to as "radial abduction," because the thumb moves toward the hand's radial side. Abduction and adduction occur around an antero-posterior axis, while flexion and extension occur around a lateral axis.

For ease of orientation, the thumbnail can be considered as resting in the thumbs frontal plane. Abduction and adduction of the first CMC (and MP) joint(s) occur in this plane; flexion and extension of the first CMC, MP, and IP joints occur in a plane that is perpendicular to the thumbnail. This remains true regardless of how the first metacarpal bone is being rotated during opposition and reposition.

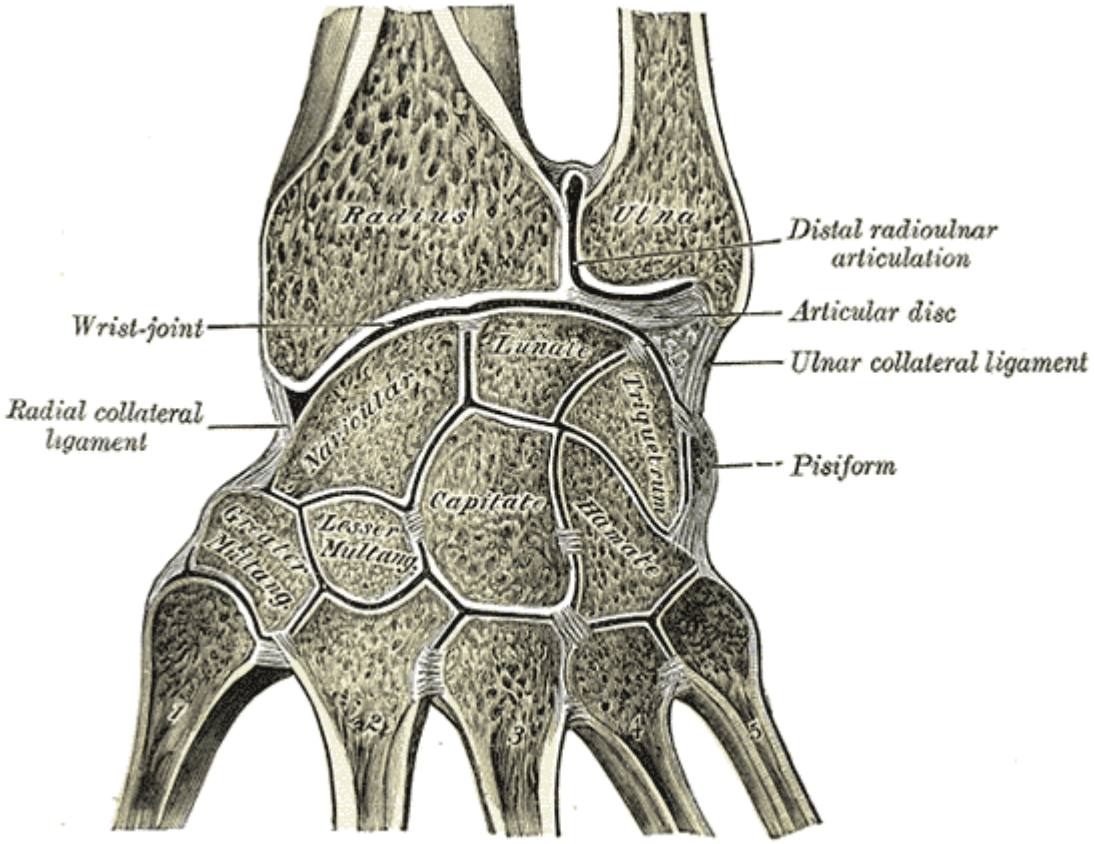
Sexual dimorphism

Male and female thumb CMC joints are different in some aspects. In women, the trapezial articular surface is significantly smaller than the metacarpal surface, and its shape also differs from that of males. While most thumb CMC joints are more congruent in the radioulnar direction than the dorsovolar, female CMC joints are less globally congruent than male joints.

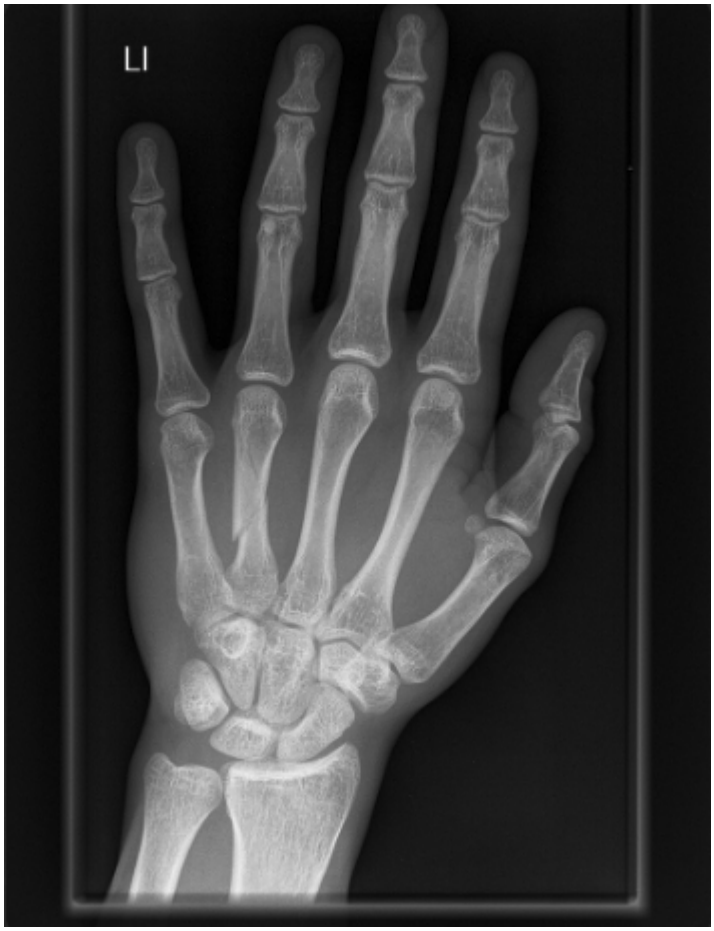
Evolution

According to phylogenetic studies, primitive autonomisation of the first ray took place in dinsosaurs about 365 million years ago, while a real differentiation appeared in primitive primates approximately 70 million years ago. The shape of the human TMC joint dates back about 5 million years ago. As a result of evolution, the human thumb CMC joint has positioned itself at 80° of pronation, 40° of abduction, and 50° of flexion in relation to an axis passing through the stable second and third CMC joints,

Fingers



Section through the human wrist



X-ray of a human hand

- The second metacarpal articulates primarily with the trapezoid and secondarily with the trapezium and capitate.
- The third metacarpal articulates primarily with the capitate,
- The fourth metacarpal articulates with the capitate and hamate.
- The fifth metacarpal articulates with the hamate.

Among themselves, the four ulnar metacarpals also articulates with their neighbours at the intermetacarpal articulations.

Ligaments

These four CMC joints are supported by strong transverse and weaker longitudinal ligaments: the dorsal carpometacarpal ligaments and the volar or palmar carpometacarpal ligaments.

The interosseous ligaments consist of short, thick fibers, and are limited to one part of the carpometacarpal articulation; they connect the contiguous inferior angles of the capitate and hamate with the adjacent surfaces of the third and fourth metacarpal bones.

Movements

The carpometacarpal joints of second through fifth digits are arthrodial. The movements permitted in the second through fifth carpometacarpal joints is most readily observable in the (distal) heads of the metacarpal bones. The range of motions in these joints decrease from the fifth to the second CMCs.

The second to fifth joints are synovial ellipsoidal joints with a nominal degree of freedom (flexion/extension). The second and third joints are however essentially immobile and can be considered to have zero degrees of freedom in practice. These two CMC provide the other three CMCs with a fixed an stable axis. While the mobility of the fourth CMC joint thus is perceptible, the first joint is a saddle joint with two degrees of freedom which except flexion/extension also enable abduction/adduction and a limited amount of opposition. Together the movements of the fourth and fifth CMCs facilitates for their fingers to oppose the thumb.

Function

The function of the finger CMC joints and their segments overall is to contribute to the palmar arch system together with the thumb. The proximal transverse arch of the palm is formed by the distal row of carpal bones. The concavity of this arch is augmented at the level of the metacarpal heads by the flexibility of the first, fourth, and fifth metacarpal heads around the fixed second and third metacarpal heads; a flexible structure called the distal transverse arch. For each finger there is also a longitudinal arch. Together, these arches allow the palm and the digits to conform optimally to objects as we grasp them (so called palmar cupping). Furthermore, as the amount of surface contact is maximized, stability is enhanced and sensory feedback increases. The deep transverse metacarpal ligament stabilises the mobile parts of the palmar arch system.

As the finger are being flexed, palmar cupping is contributed to by muscles crossing the CMC joints when they act on the mobile parts of the palmar arch system. The oblique opponens digiti minimi muscle acts on the fifth CMC joint and is the only muscle that act on the CMC joints alone. It is optimally positioned to flex and rotate the fifth metacarpal bone about its long axis. Palmar arching is further increased when flexor carpi ulnaris (which is attached to the pisiform) and intrinsic hand muscles attached to the transverse carpal ligament acts on the arch system. The fixed second and third CMC joints are crossed by the radial wrist muscles (flexor carpi radialis, extensor carpi radialis longus, and extensor carpi radialis brevis). The stability of these two CMC joints is a functional adaptation that enhances the efficiency of these muscle at the midcarpal and radiocarpal joints.

Synovial membranes

The synovial membrane is a continuation of that of the intercarpal joints. Occasionally, the joint between the hamate and the fourth and fifth metacarpal bones has a separate synovial membrane.

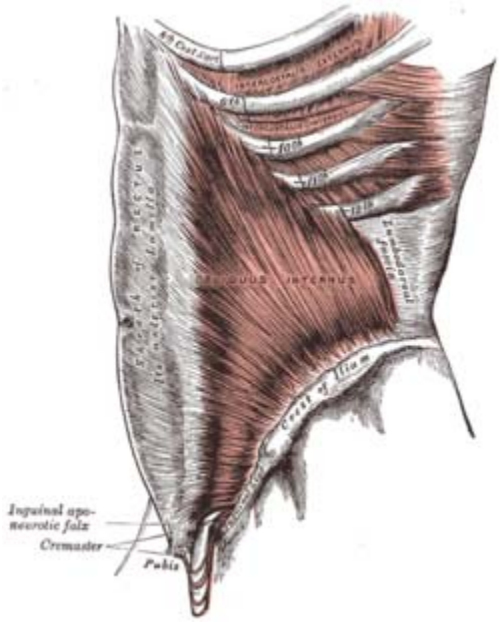
The synovial membranes of the wrist and carpus are thus seen to be five in number.

- The first passes from the lower end of the ulnar to the ulnar notch of the radius, and lines the upper surface of the articular disk.
- The second passes from the articular disk and the lower end of the radius above, to the bones of the first row below.
- The third, the most extensive, passes between the contiguous margins of the two rows of carpal bones, and sometimes, in the event of one of the interosseous ligaments being absent, between the bones of the second row to the carpal extremities of the second, third, fourth, and fifth metacarpal bones.
- The fourth extends from the margin of the greater multangular to the metacarpal bone of the thumb.
- The fifth runs between the adjacent margins of the triangular and pisiform bones.

Chapter 16

Fascia and Anterior Compartment of the Forearm

Fascia

Fascia	
	
The rectus sheath, an example of a fascia.	
Latin	*fascia*
Gray's	*subject #104 376*
Precursor	mesenchyme
MeSH	*Fascia*

A **fascia** is a layer of fibrous tissue that permeates the human body. A fascia is a connective tissue that surrounds muscles, groups of muscles, blood vessels, and nerves, binding those structures together in much the same manner as plastic wrap can be used to hold the contents of sandwiches together. It consists of several layers: a superficial fascia, a deep fascia, and a subserous (or visceral) fascia and extends uninterrupted from the head to the tip of the toes.

Like ligaments, aponeuroses, and tendons, fasciae are *dense regular* connective tissues, containing closely packed bundles of collagen fibers oriented in a wavy pattern parallel to the direction of pull. Fasciae are consequently flexible structures able to resist great unidirectional tension forces until the wavy pattern of fibers has been straightened out by the pulling force. These collagen fibers are produced by the fibroblasts located within the fascia.

Definition

There exists some controversy about what structures are considered "fascia", and how fascia should be classified. The two most common systems are:

- the one specified in the 1983 edition of Nomina Anatomica (NA 1983)
- the one specified in the 1997 edition of Terminologia Anatomica (TA 1997)

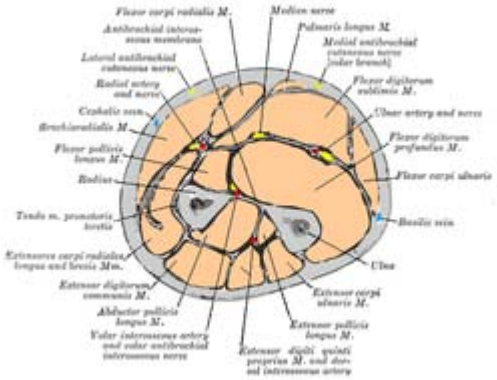
NA 1983	TA 1997	Description	Example
Superficial fascia	(not considered fascia in this system)	This is found in the subcutis in most regions of the body, blending with the reticular layer of the dermis.	Fascia of Scarpa
Deep fascia	Fascia of muscles	This is the dense fibrous connective tissue that interpenetrates and surrounds the muscles, bones, nerves and blood vessels of the body.	Transversalis fascia
Visceral fascia	Visceral fascia, parietal fascia	This suspends the organs within their cavities and wraps them in layers of connective tissue membranes.	Pericardium

Function

Fasciae are normally thought of as passive structures that transmit mechanical tension generated by muscular activities or external forces throughout the body. Some research suggest that fasciae might be able to contract independently and thus actively influence muscle dynamics.

The function of muscle fasciae is to reduce friction to minimize the reduction of muscular force. In doing so, fasciae allow muscles to glide over each other.

Anterior compartment of the forearm

Anterior compartment of the forearm

Cross-section through the middle of the forearm. (Anterior compartment is at top; posterior compartment is at bottom.)
Latin *compartimentum antebrachii anterius*
Artery ulnar artery
Nerve median nerve (anterior interosseous nerve), ulnar nerve (muscular branches of ulnar nerve)

The **anterior compartment of the forearm** (or **flexor compartment**) contains the following muscles:

Level	Muscle	E/I	Nerve
superficial	flexor carpi radialis	E	median
superficial	palmaris longus	E	median
superficial	flexor carpi ulnaris	E	ulnar
superficial	pronator teres	I	median
superficial (or intermediate)	flexor digitorum superficialis	E	median
deep	flexor digitorum profundus	E	ulnar + median (as anterior interosseous nerve)
deep	flexor pollicis longus	E	median (as anterior interosseous nerve)
deep	pronator quadratus	I	median (as anterior interosseous nerve)

- "E/I" refers to "extrinsic" or "intrinsic".

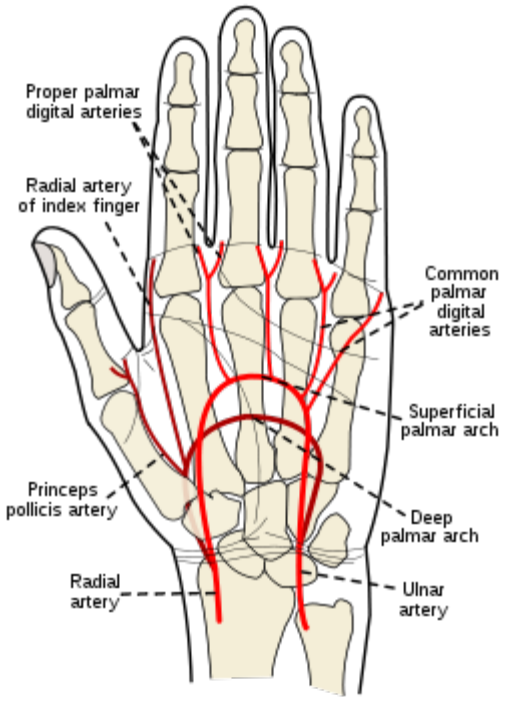
The muscles are largely involved with flexion and pronation. The superficial muscles have their origin on the common flexor tendon. The Ulna nerve and artery are also contained within this compartment.

Chapter 17

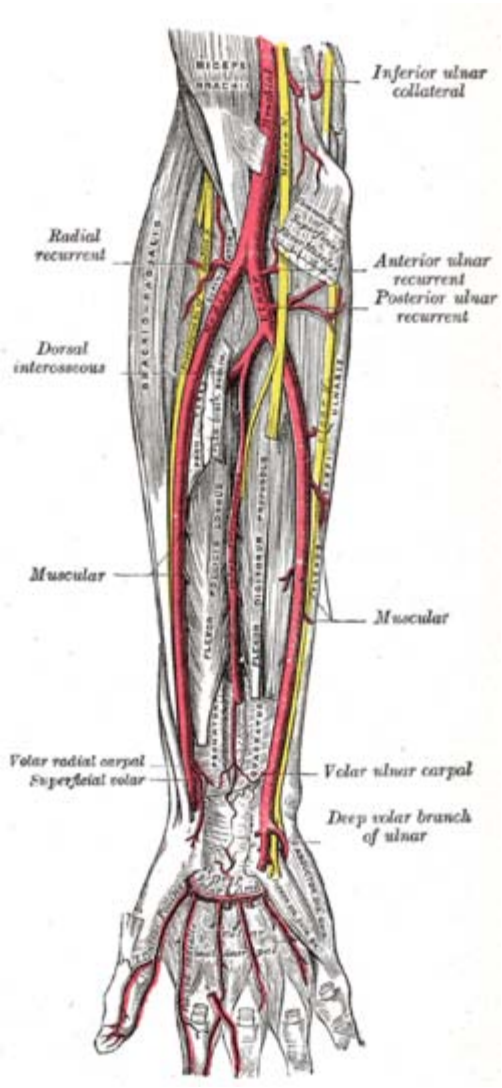
Radial Artery and Ulnar Artery

Radial artery

Artery: Radial artery



Palm of left hand, showing position of skin creases and bones, and surface markings for the volar arches.



Ulnar and radial arteries. Deep view.

Latin	*A. Radialis*
Gray's	*subject #151 592*
Source	brachial artery
Branches	*in the forearm: Radial recurrent artery Palmar carpal branch of radial artery Superficial palmar branch of the radial artery. *At the wrist: Dorsal carpal branch of radial artery First dorsal metacarpal artery. *In the hand: Princeps pollicis artery Radialis indicis Deep palmar arch

Vein	radial vein
MeSH	*Radial+Artery*

In human anatomy, the **radial artery** is the main blood vessel, with oxygenated blood, of the lateral aspect of the forearm.

Course

The radial artery arises from the bifurcation of the brachial artery in the cubital fossa. It runs distally on the anterior part of the forearm. There, it serves as a landmark for the division between the anterior and posterior compartments of the forearm, with the posterior compartment beginning just lateral to the artery. The artery winds laterally around the wrist, passing through the anatomical snuff box and between the heads of the first dorsal interosseous muscle. It passes anteriorly between the heads of the adductor pollicis, and becomes the deep palmar arch, which joins with the deep branch of the ulnar artery.

Along its course, it is accompanied by a similarly named vein, the radial vein.

Branches

The named branches of the radial artery may be divided into three groups, corresponding with the three regions in which the vessel is situated.

In the Forearm

- Radial recurrent artery - arises just after the radial artery comes off the brachial artery. It travels superiorly to anastomose with the radial collateral artery around the elbow joint
- Palmar carpal branch of radial artery - a small vessel which arises near the lower border of the pronator quadratus
- Superficial palmar branch of the radial artery - arises from the radial artery, just where this vessel is about to wind around the lateral side of the wrist.

At the Wrist

- Dorsal carpal branch of radial artery - a small vessel which arises beneath the extensor tendons of the thumb
- **First dorsal metacarpal artery** - arises just before the radial artery passes between the two heads of the first dorsal interosseous muscle and divides almost immediately into two branches which supply the adjacent sides of the thumb and index finger; the lateral side of the thumb receives a branch directly from the radial artery.

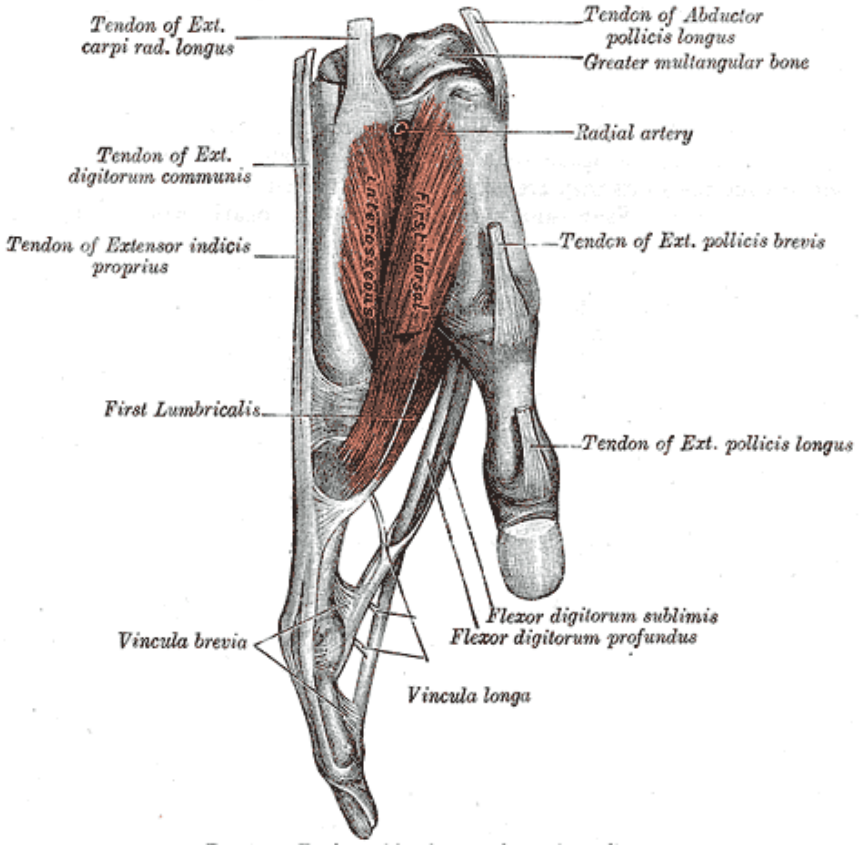
In the Hand

- Princeps pollicis artery - arises from the radial artery just as it turns medially to the deep part of the hand.
- Radialis indicis - arises close to the princeps pollicis. The two arteries may arise from a common trunk, the first palmar metacarpal artery.
- Deep palmar arch - terminal part of radial artery.

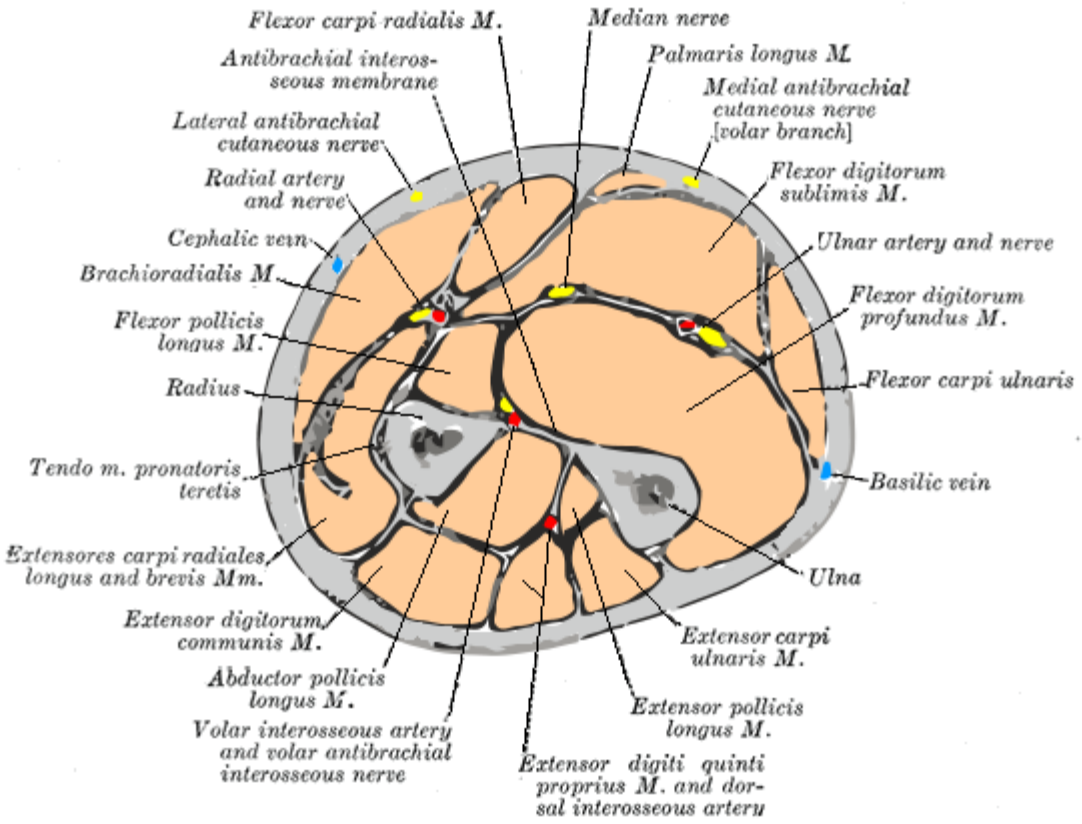
Clinical significance

The artery's pulse is palpable in the anatomical snuff box and on the anterior aspect of the arm over the carpal bones (where it is commonly used to assess the heart rate and cardiac rhythm).

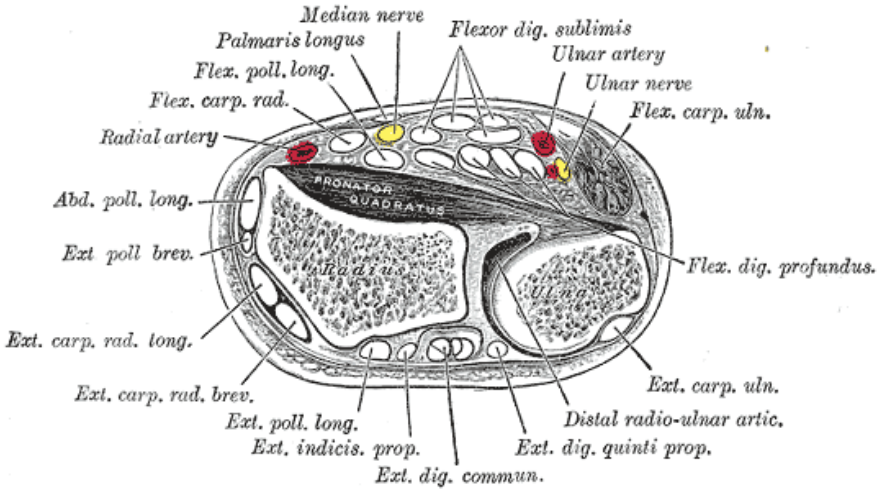
The radial artery is used for coronary artery bypass grafting and is growing in popularity among cardiac surgeons. Recently, it has been shown to have a superior peri-operative and post-operative course when compared to saphenous vein grafts.



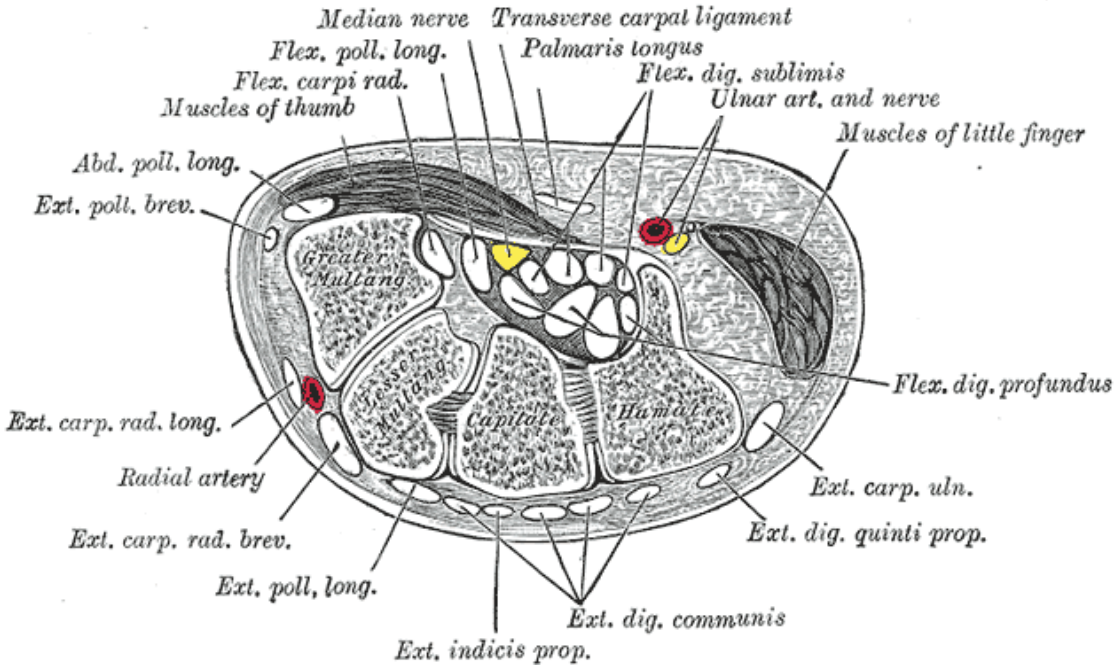
Tendons of forefinger and vincula tendina.



Cross-section through the middle of the forearm.



Transverse section across distal ends of radius and ulna.



Transverse section across the wrist and digits.

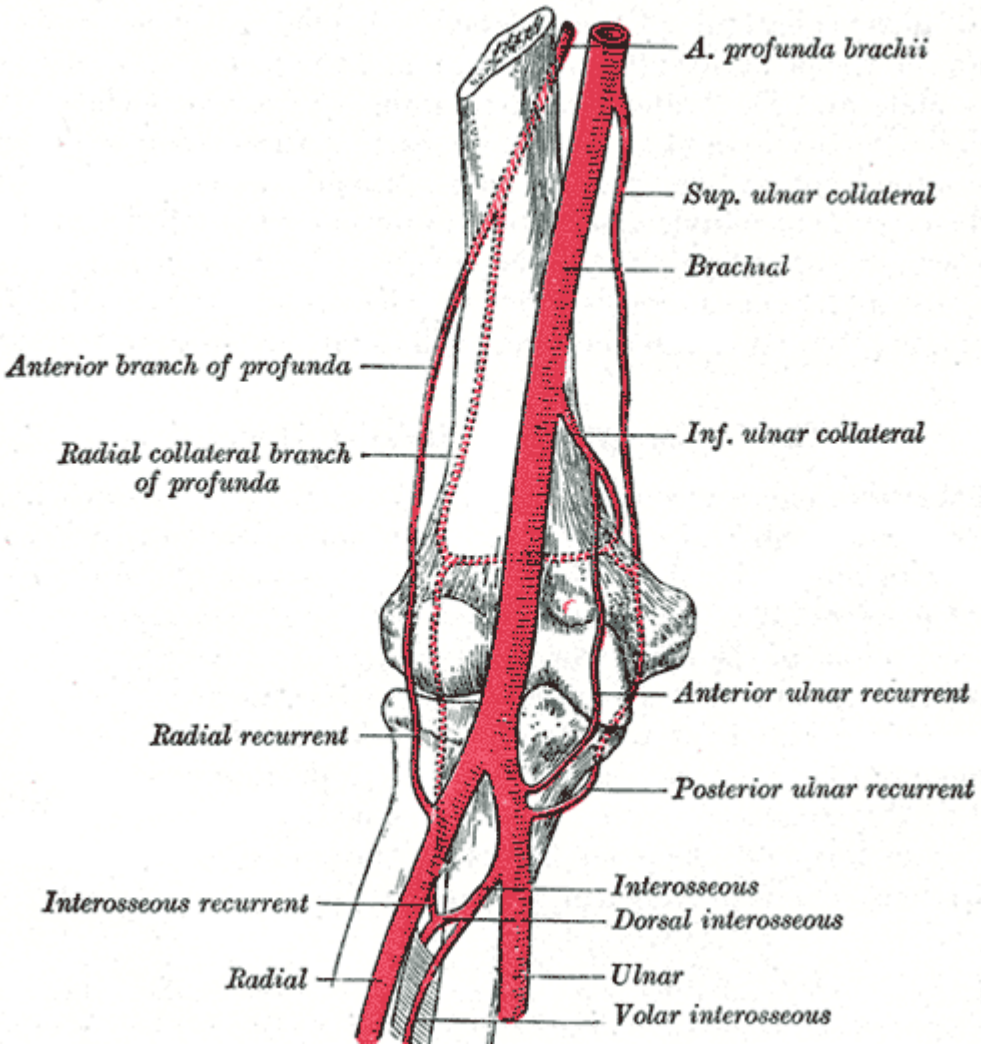
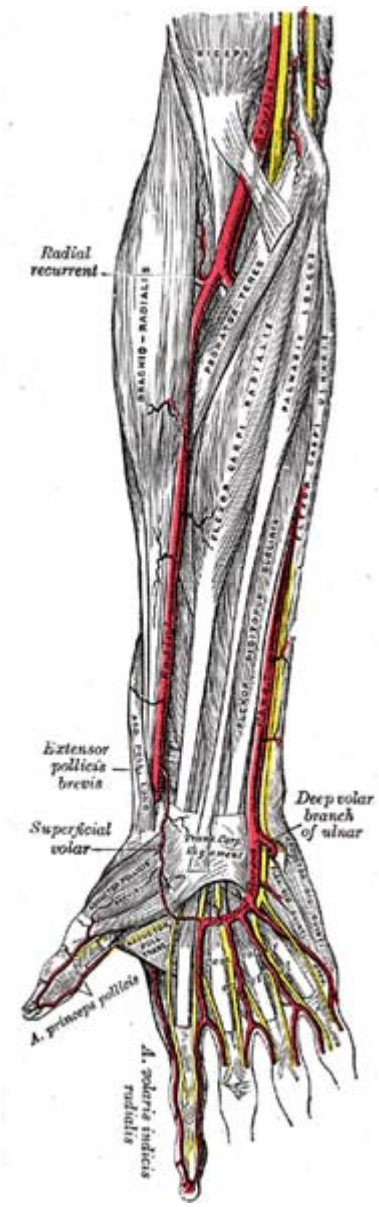
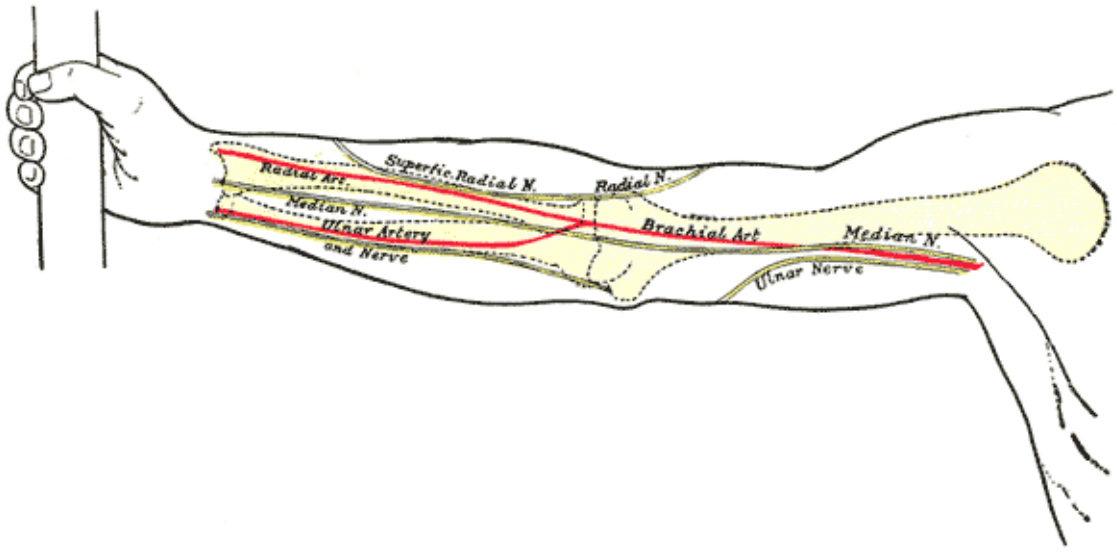


Diagram of the anastomosis around the elbow-joint.



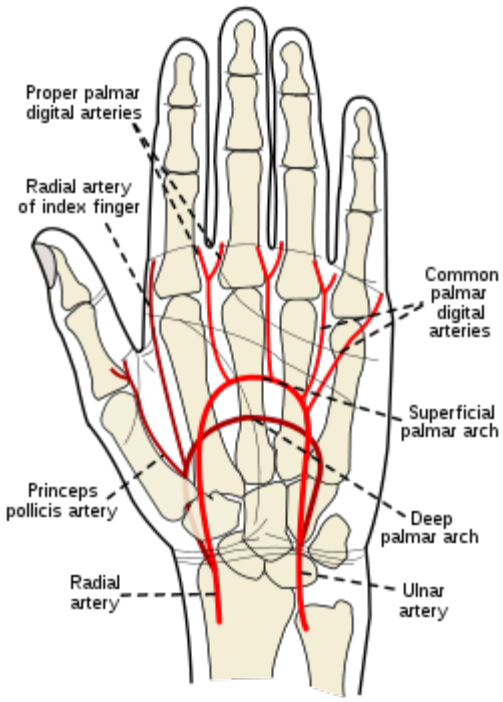
The radial and ulnar arteries.



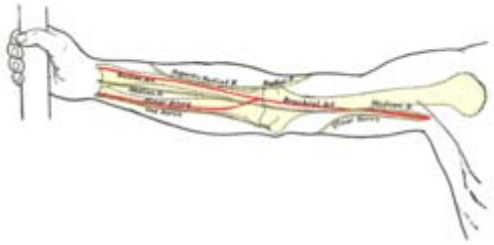
Front of right upper extremity, showing surface markings for bones, arteries, and nerves.

Ulnar artery

Artery: Ulnar artery



Palm of left hand, showing position of skin creases and bones, and surface markings for the volar arches.



Front of right upper extremity, showing surface markings for bones, arteries, and nerves.

Latin	*A. Ulnaris*
Gray's	*subject #152 595*
Source	brachial artery
Branches	anterior ulnar recurrent artery posterior ulnar recurrent artery common interosseous artery (volar, dorsal) muscular artery volar carpal dorsal carpal deep volar superficial volar arch
Vein	ulnar vein
MeSH	*Ulnar+Artery*

The **ulnar artery** is the main blood vessel, with oxygenated blood, of the medial aspect of the forearm. It arises from the brachial artery and terminates in the superficial palmar arch, which joins with the superficial branch of the radial artery. It is palpable on the anterior and medial aspect of the wrist.

Along its course, it is accompanied by a similarly named vein or veins, the ulnar vein or ulnar veins.

The ulnar artery, the larger of the two terminal branches of the brachial, begins a little below the bend of the elbow in the cubital fossa, and, passing obliquely downward, reaches the ulnar side of the forearm at a point about midway between the elbow and the wrist. It then runs along the ulnar border to the wrist, crosses the transverse carpal ligament on the radial side of the pisiform bone, and immediately beyond this bone divides into two branches, which enter into the formation of the superficial and deep volar arches.

Relations

Forearm

In its upper half, it is deeply seated, being covered by the Pronator teres, Flexor carpi radialis, Palmaris longus, and Flexor digitorum superficialis; it lies upon the Brachialis and Flexor digitorum profundus.

The median nerve is in relation with the medial side of the artery for about 2.5 cm. and then crosses the vessel, being separated from it by the ulnar head of the Pronator teres.

In the lower half of the forearm it lies upon the Flexor digitorum profundus, being covered by the integument and the superficial and deep fasciæ, and placed between the Flexor carpi ulnaris and Flexor digitorum superficialis.

It is accompanied by two venæ comitantes, and is overlapped in its middle third by the Flexor carpi ulnaris; the ulnar nerve lies on the medial side of the lower two-thirds of the artery, and the palmar cutaneous branch of the nerve descends on the lower part of the vessel to the palm of the hand.

Wrist

At the wrist the ulnar artery is covered by the integument and the volar carpal ligament, and lies upon the Flexor retinaculum of the hand. On its medial side is the pisiform bone, and, somewhat behind the artery, the ulnar nerve.

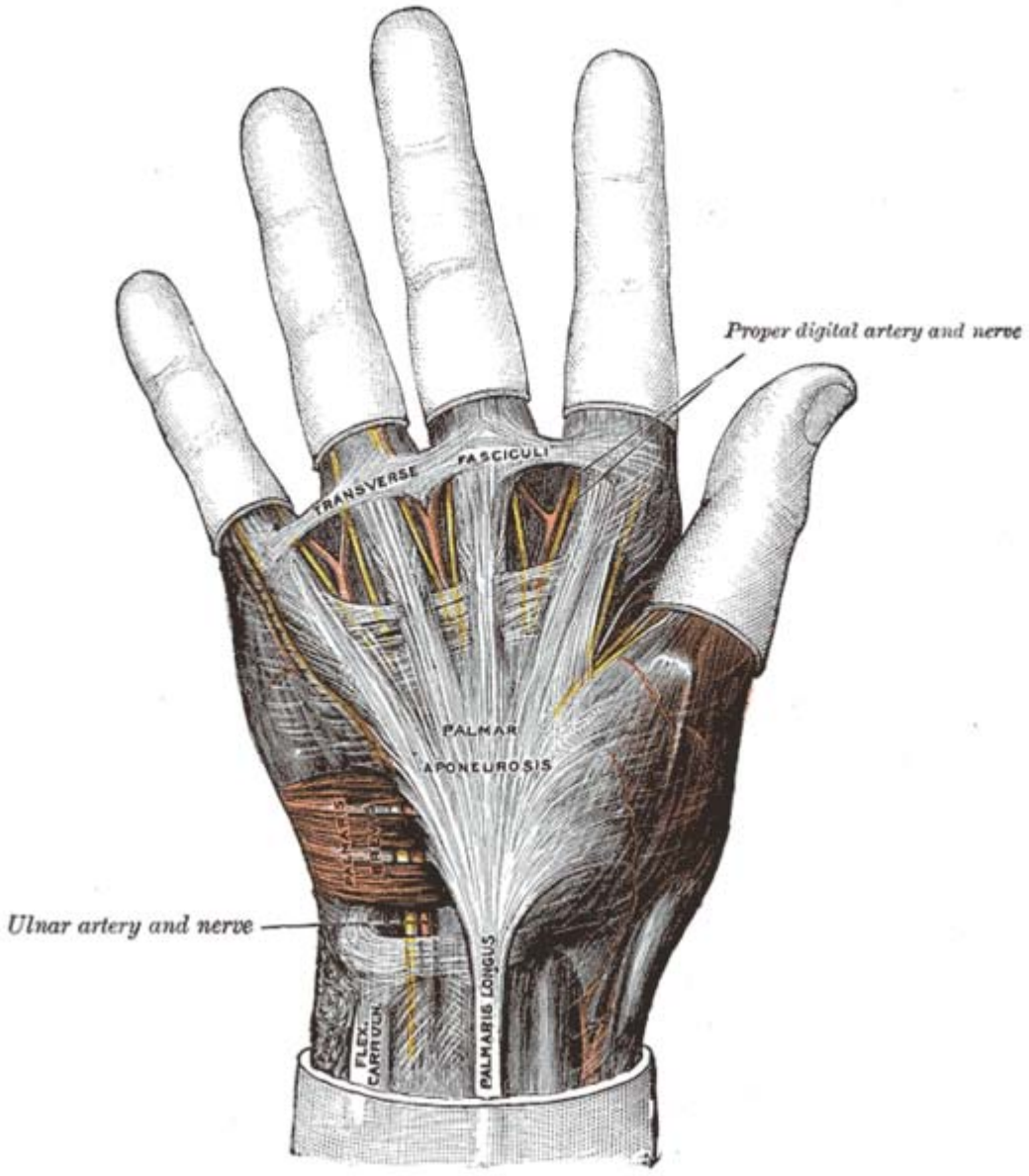
Peculiarities

The ulnar artery varies in its origin in the proportion of about one in thirteen cases; it may arise about 5 to 7 cm. below the elbow, but more frequently higher, the brachial being more often the source of origin than the axillary.

Variations in the position of this vessel are more common than in the radial. When its origin is normal, the course of the vessel is rarely changed.

When it arises high up, it is almost invariably superficial to the Flexor muscles in the forearm, lying commonly beneath the fascia, more rarely between the fascia and integument.

In a few cases, its position was subcutaneous in the upper part of the forearm, and subaponeurotic in the lower part.



The palmar aponeurosis.

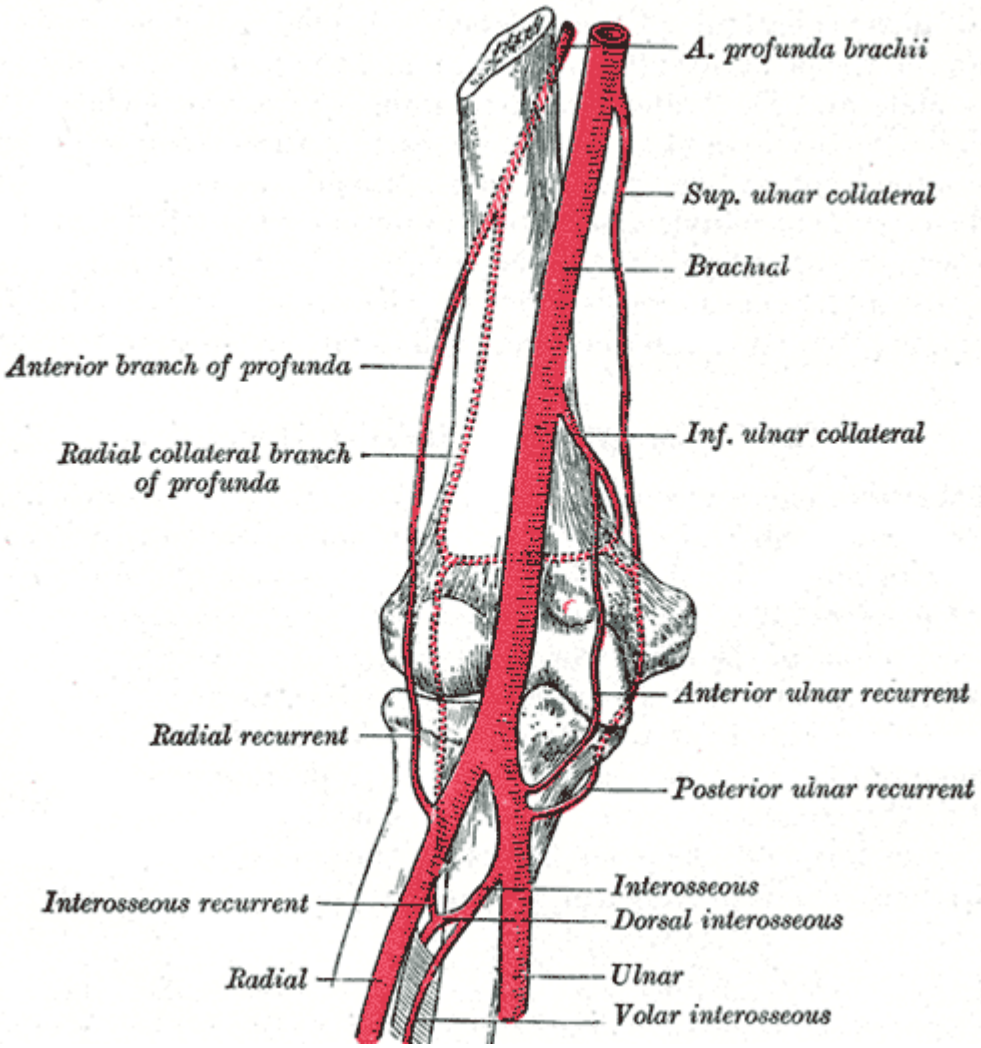
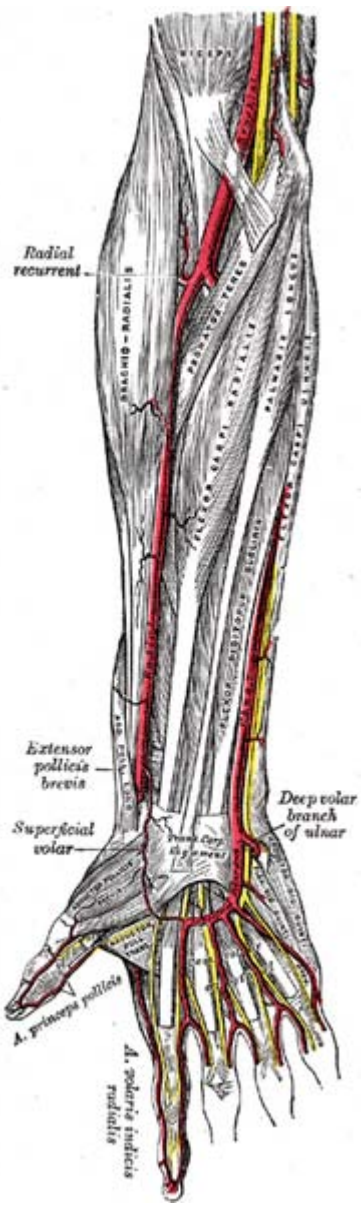
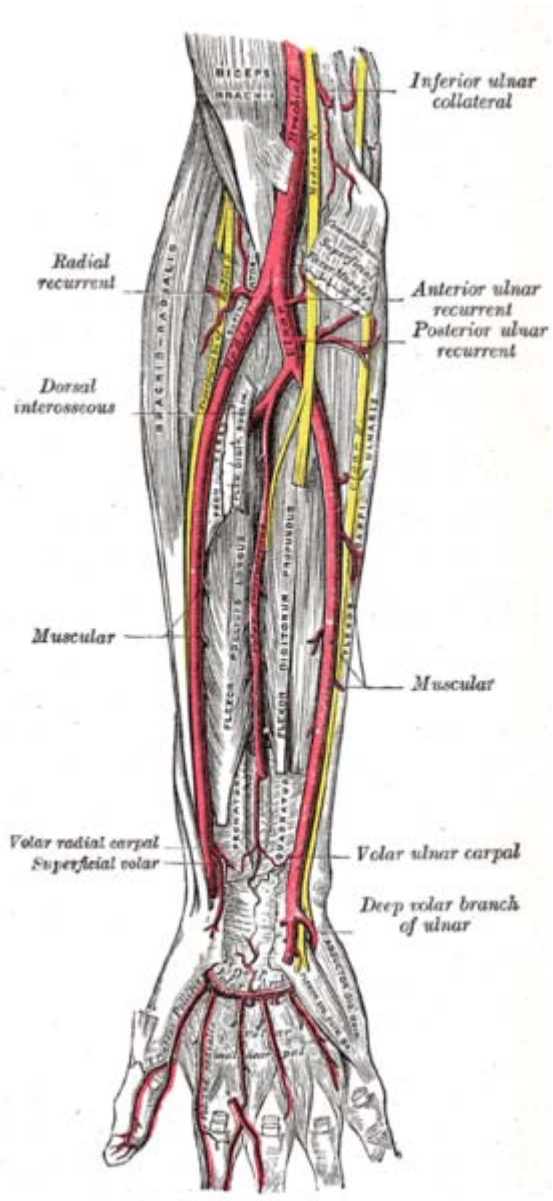


Diagram of the anastomosis around the elbow-joint.



Arteries of the right forearm - anterior view.

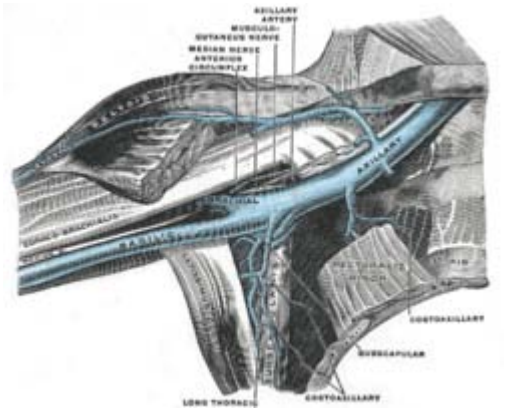


Ulnar and radial arteries. Deep view.

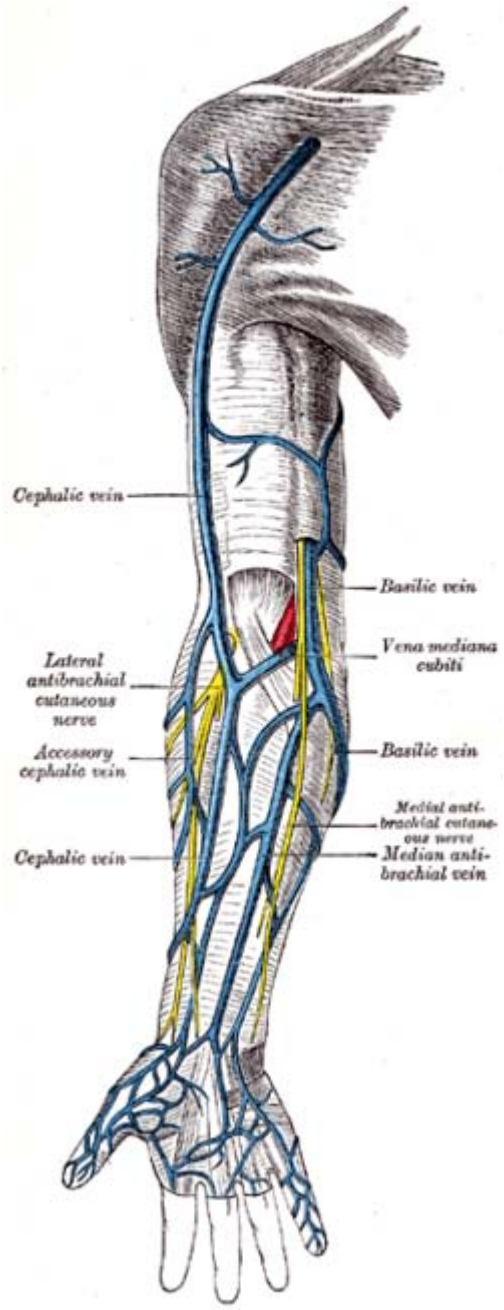
Chapter 18

Basilic Vein

Vein: Basilic vein



The veins of the right axilla, viewed from in front.



Superficial veins of the upper limb.

Gray's	*subject #172 662*
Source	dorsal venous network of hand
Drains to	axillary vein

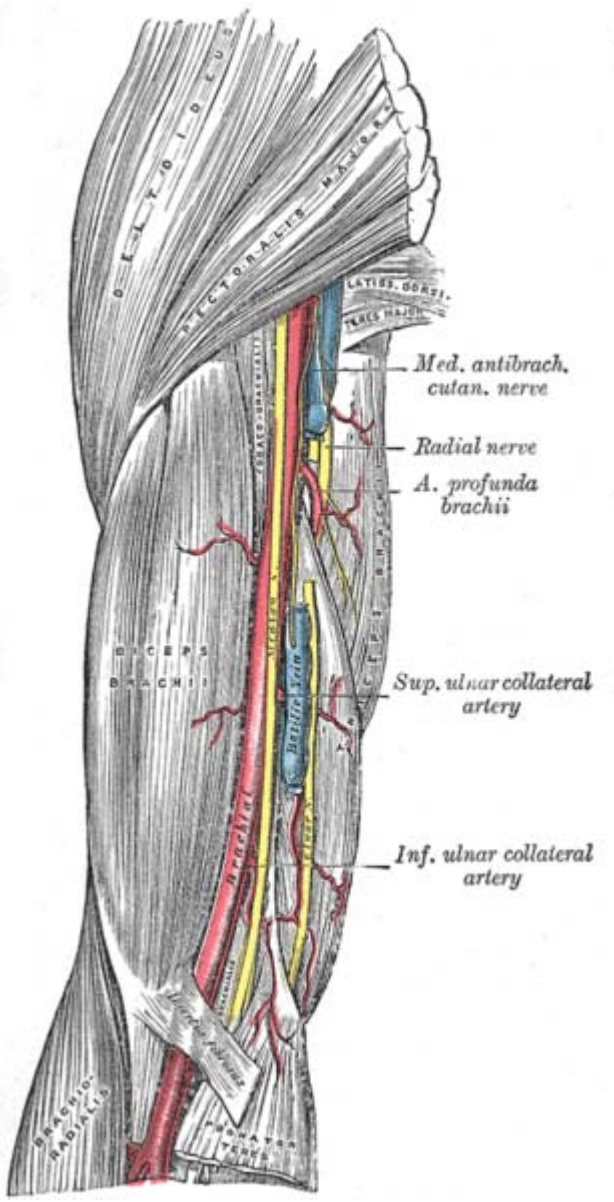
In human anatomy, the **basilic vein** is a large superficial vein of the upper limb that helps drain parts of hand and forearm. It originates on the medial (ulnar) side of the dorsal venous network of the hand, and it travels up the base of the forearm and arm. Most of its course is superficial; it generally travels in the subcutaneous fat and other fasciae that lie

superficial to the muscles of the upper extremity. Because of this, it is usually visible through the skin.

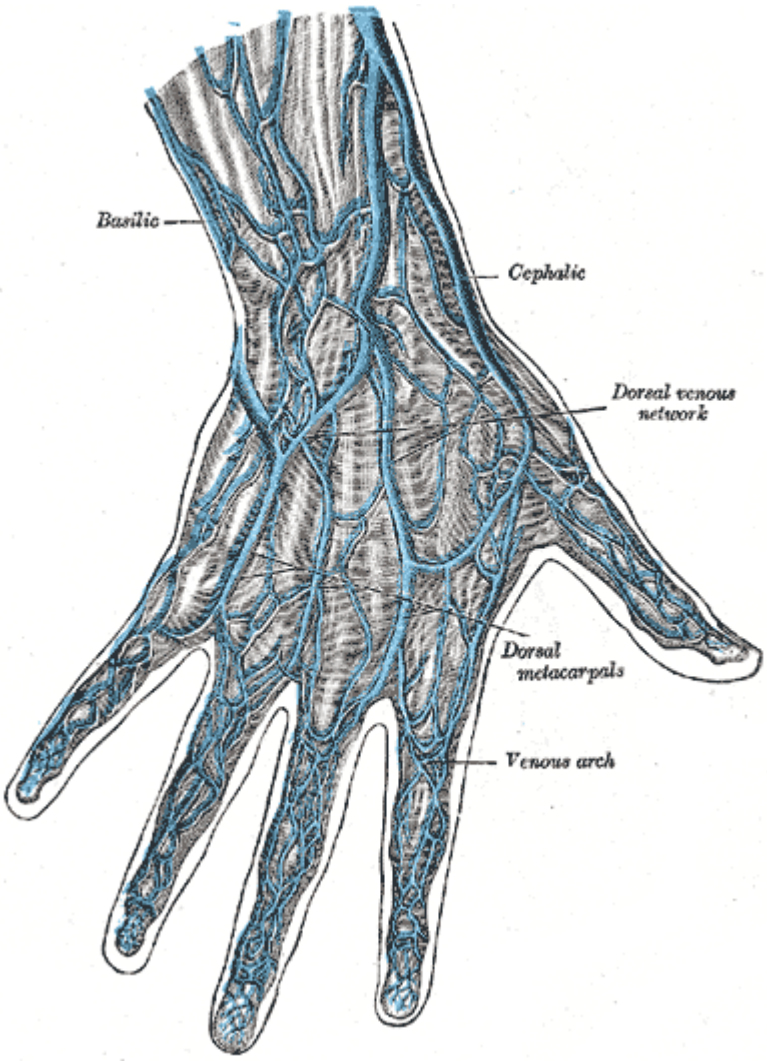
Near the region anterior to the cubital fossa, in the bend of the elbow joint, the basilic vein usually connects with the other large superficial vein of the upper extremity, the cephalic vein, via the median cubital vein. The layout of superficial veins in the forearm is highly variable from person to person, and there are generally a variety of other unnamed superficial veins that the basilic vein communicates with.

About halfway up the arm proper (the part between the shoulder and elbow), the basilic vein typically goes deep, travelling under the muscles. There, around the lower border of the teres major muscle, the anterior and posterior circumflex humeral veins feed into it, just before it joins the brachial veins to form the axillary vein.

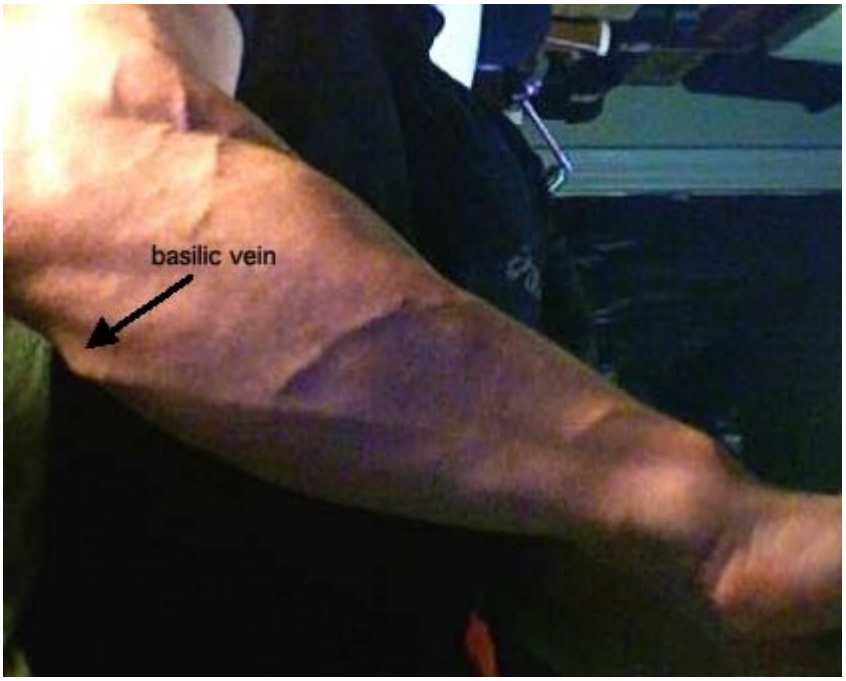
Along with other superficial veins in the forearm, the basilic vein is a possible site for venipuncture.



The brachial artery.



The veins on the dorsum of the hand.



Basilic vein on the forearm of a muscular adult male.