

Bones of Forearm: Radius and Ulna

Competencies

AN8.1: Features of individual bones (upper limb): Identify the given bone, its side, important features and keep it in anatomical position.

AN8.2: Features of individual bones (upper limb): Identify and describe joints formed by the given bone.

AN8.4: Features of individual bones (upper limb): Demonstrate important muscle attachment on the given bone.

This chapter includes description of radius and ulna.

RADIUS

- Radius is the lateral bone in forearm (*radius* = ray, in Latin).
- Radius is homologous to the tibia (situated medially in the lower limb).

Parts (Fig. 4.1)

- Radius has upper end, shaft, and lower end.
- *Upper end* has disc-shaped head, narrow neck, and radial tuberosity.
- The *shaft* is long, convex laterally, and has sharp medial interosseous border.

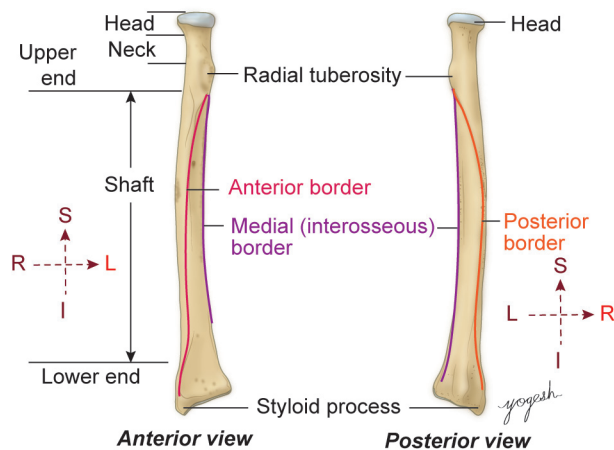


Fig. 4.1: Parts and borders of radius (right, anterior and posterior views)

- *Lower end* is expanded and has laterally directed prolonged styloid process and Lister's tubercle posteriorly.

Side Determination and Anatomical Position^{Viva}

Hold the bone in such a way that

1. Disc-shaped head is directed upward, and broad end is directed downward.
2. Concave surface of shaft faces anteriorly and Lister's tubercle at the lower end faces posteriorly.
3. Styloid process is directed laterally and will determine the side to which the bone belongs.

Features of Radius (Flowchart 4.1)

- Radius has upper end, shaft, and lower end (Figs 4.1–4.6).

Upper End

- The upper end of radius has head, neck, and radial tuberosity.

Head

- Head of the radius is disc-shaped.
- Its upper surface has concave articular facet covered by hyaline cartilage.
- *Articulation:* The upper surface of head articulates with capitulum of humerus to form *elbow joint* (humeroradial articulation).
- The circumference of the head is also smooth articular and covered by hyaline cartilage
- *Articulation:* The circumference of head articulates with the radial notch of ulna medially and annular ligament on all other sides. It forms *superior radioulnar joint*.

Neck

- Neck is the round, constricted part just below the head.

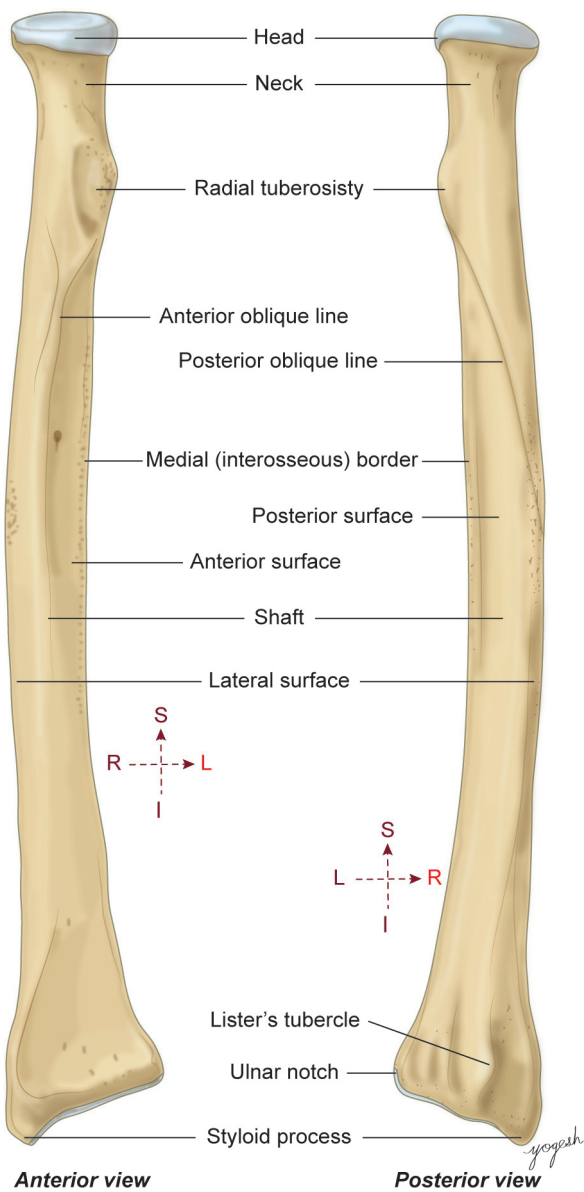


Fig. 4.2: Features of right radius (right, anterior and posterior views).

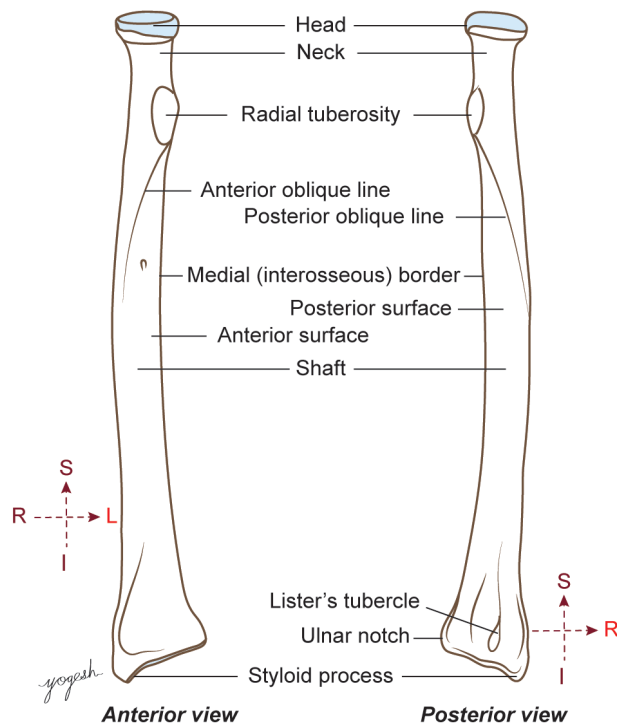


Fig. 4.3: Features of right radius (right, anterior and posterior views).

- Neck is embraced by the lower part of the annular ligament that provides stability to superior radio-ulnar joint.

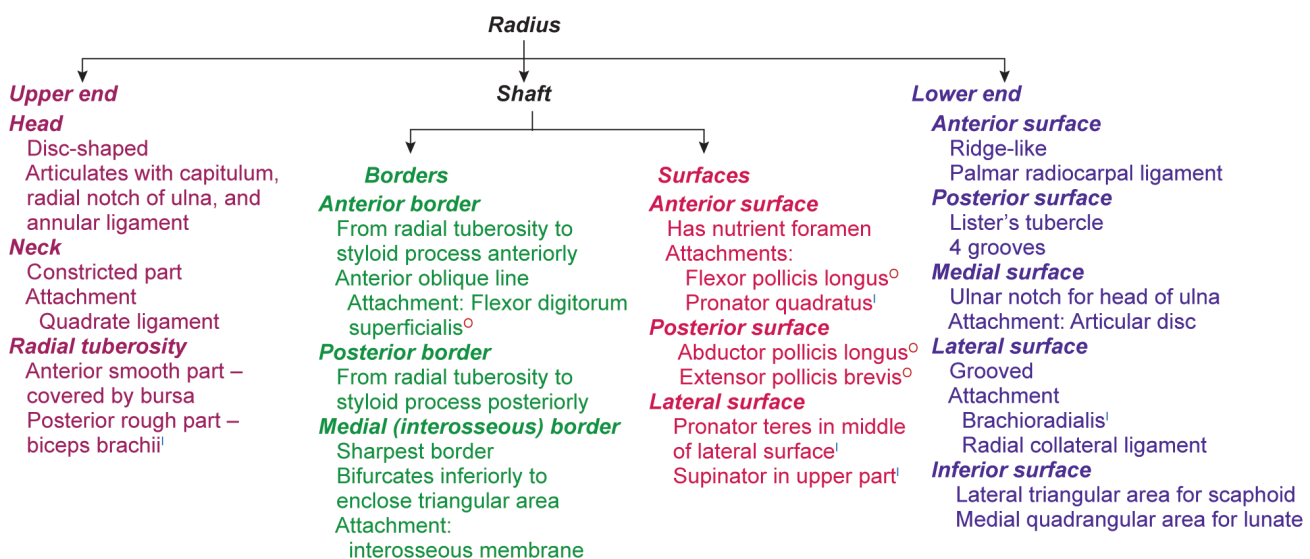
Attachments

- *Supinator* muscle: Insertion of supinator extends anteriorly, laterally, and posteriorly on the neck (in addition to shaft of the radius).
- *Quadratus ligament* is attached to the medial side of the neck.

Radial tuberosity

- It is a bony projection that lies just beneath the medial side of the neck.

Flowchart 4.1: Features of radius



Clinical integration: Fractures of radius (Colles', Smith's, Barton's, Chauffeur's fractures), pulled-elbow.

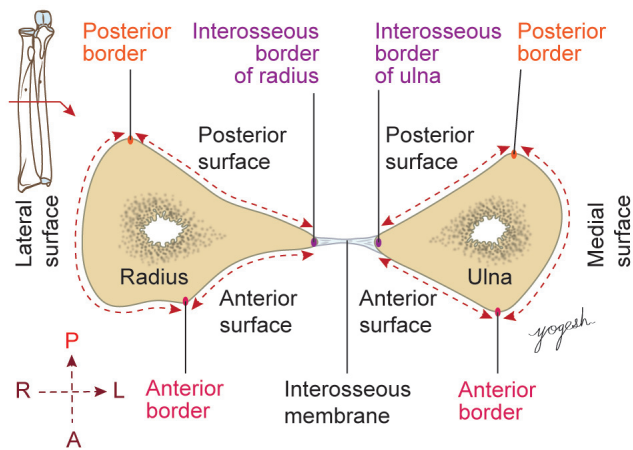


Fig. 4.4: Transverse section of radius and ulna showing borders and surfaces (right, superior view of cross-section, left upper corner part showing the plane of section passing through the shaft of radius and ulna).

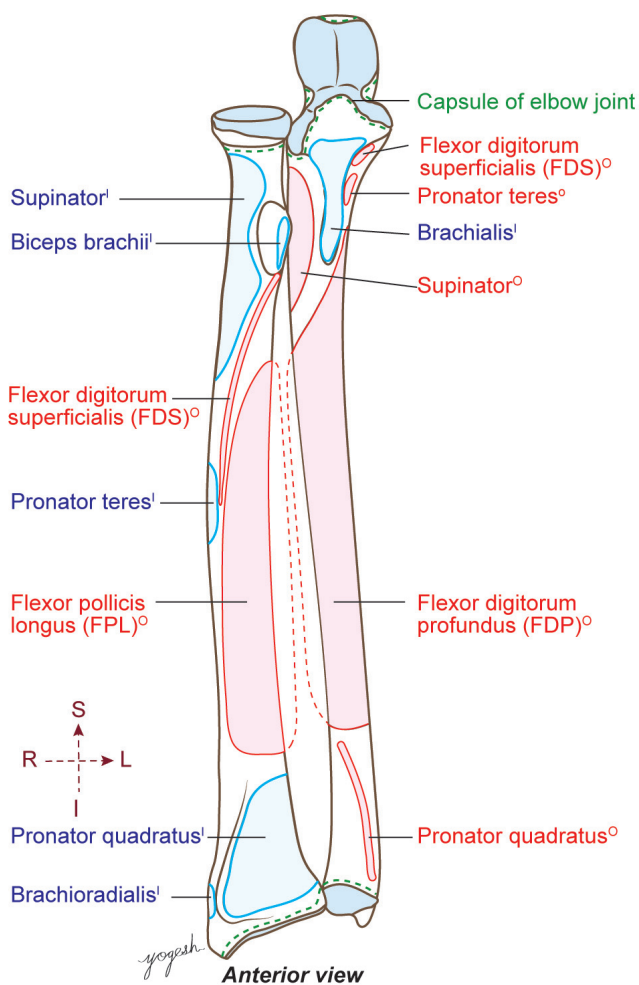


Fig. 4.5: Attachments of radius and ulna (right, anterior view)

- Parts
 - Radial tuberosity has two parts:
 1. Anterior smooth part – is covered by a small *synovial bursa* that separates tuberosity from the tendon of biceps brachii.
 2. Posterior rough part – gives insertion to the tendon of *biceps brachii*.^{Spotters}

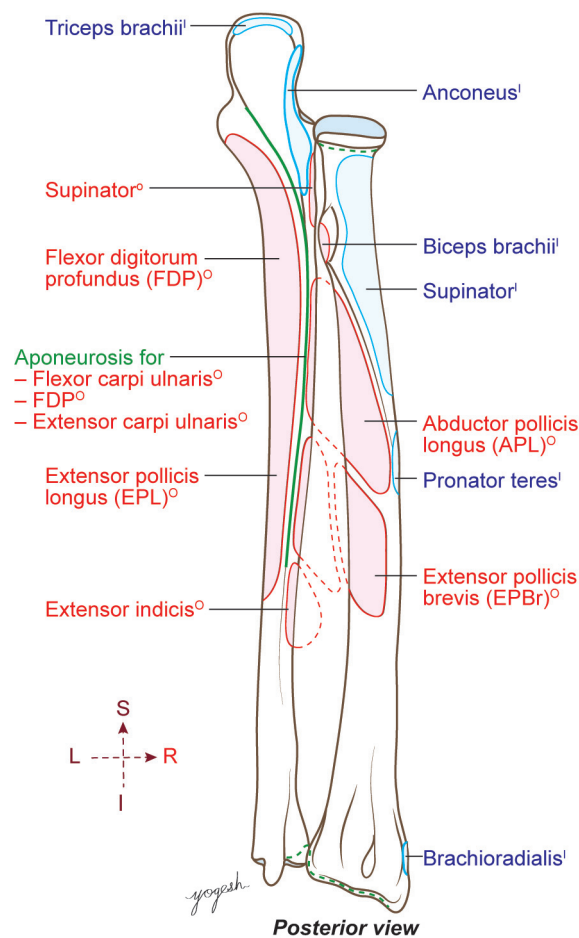


Fig. 4.6: Attachments of radius and ulna (right, posterior view)

Shaft (Fig. 4.4)

- Shaft of the radius is narrow and cylindrical above, and broader below.
- Shaft has
 - Three borders: Anterior, posterior, and medial (interosseous)
 - Three surfaces: Anterior, posterior, and lateral.

Borders

Anterior border

- It extends from anterolateral part of the lower end of radial tuberosity to the styloid process.
- *Anterior oblique line*
Anterior border descends obliquely downward and laterally in the upper part to form anterior oblique line.
- Lower part of anterior border is sharp, crest-like and can be felt subcutaneously.
- *Attachment*
 - *Radial head of flexor digitorum superficialis (FDS)* originates from anterior oblique line.

Posterior border

- Posterior border is well-defined only in its middle part.
- It extends from back of the radial tuberosity to styloid process.

- *Posterior oblique line* is the upper oblique part of the posterior border that runs obliquely downward and laterally.

Medial (interosseous) border

- Medial border is the sharpest border of radius.
- It begins from posteroinferior part of radial tuberosity.
- In its lower part, the medial border bifurcates to enclose a *triangular area* just above the ulnar notch of radius. [*Previous concept*: This small triangular area may be considered as medial surface of radius.]
- *Attachments*
 - *Interosseous membrane* is attached to the lower three-fourths of interosseous border and to the posterior border of the above-mentioned triangular area.
 - *Pronator quadratus* inserts on the lower-fourth of the anterior surface and triangular area on the medial side of the lower end of radius.

Surfaces

- Radius has three surfaces: Anterior, posterior, and lateral.

Anterior surface

- It lies between anterior and interosseous borders.
- It is narrow above and broader below.
- It is concave anteriorly.
- *Nutrient foramen* is present in the upper part of anterior surface. It is directed upward, as the lower end of radius is growing end.^{Viva}
- *Nutrient artery* of the radius is the branch of anterior interosseous artery.^{MCQ}
- *Attachments*
 - *Flexor pollicis longus* originates from upper two-thirds of anterior surface of radial shaft.
 - *Pronator quadratus* inserts on the lower-fourth of anterior surface and a small triangular area on the medial side of radius.

Posterior surface

- It lies between posterior and interosseous borders.
- *Attachments*
 - *Abductor pollicis longus* and *extensor pollicis brevis* originate from the posterior surface of radius.

Lateral surface

- It lies between anterior and posterior borders.
- It is convex laterally. A rough oblique ridge is present in the middle of the posterior surface and marks the maximum convexity of the bone.
- Lateral surface is wider above and is continuous with the neck.
- *Attachments*
 - *Pronator teres* inserts in the middle of the lateral surface.
 - *Supinator* inserts on the upper part of the lateral surface.

Lower End

- Lower end of radius is broad and expanded.
- It has 5 surfaces: Anterior, posterior, medial, lateral, and inferior.

Anterior surface of lower end

- It has a thick ridge that separates the anterior surface of shaft of radius from inferior surface of lower end of radius.
- *Attachments*
 - *Palmar radiocarpal ligament* is attached to the ridge-like anterior surface of lower end.

Posterior surface of lower end

It is broad and has grooves and tubercle.

Dorsal tubercle of Lister: It is small pointed tubercle on the posterior surface of radius.^{Viva}

Grooves: Posterior surface shows four shallow grooves.

- Relations of grooves^{Viva, NEXT}
 1. Lateral most groove – through the groove on the posterior surface of styloid process, the tendons of abductor pollicis longus and extensor pollicis brevis are passing.^{NEXT}
 2. Second groove (between Lister's tubercle and styloid process) gives passage the extensor carpi radialis longus and extensor carpi radialis brevis tendon.^{NEXT}
 3. Oblique groove (medial to Lister's tubercle) gives passage to extensor pollicis longus tendon.^{Viva, NEXT}
 4. Fourth groove (on the medial side of oblique groove) gives passage to extensor digitorum, extensor indicis, posterior interosseous nerve, and anterior interosseous artery.

Medial surface of lower end

- It has *ulnar notch* for head of ulna to form inferior radioulnar joint.
- Smooth ridge that separates ulnar notch from inferior surface gives attachment to base of *triangular articular disc* of inferior radioulnar joint.

Lateral surface of lower end

- Lateral surface of the lower end forms *styloid process*.
- It projects downward beyond the rest of the bone.
- Lateral surface of styloid process has groove that gives passage to tendons of abductor pollicis longus and extensor pollicis brevis.^{Viva} Radial artery lies medial to the styloid process of radius.^{NEXT}
- *Attachments*
 - *Brachioradialis* inserts at the base of styloid process.^{NEXT}
 - *Radial collateral ligament* is attached to the tip of styloid process.

Inferior surface of lower end (Fig. 4.7)

- It is concave and triangular.
- It is covered by articular cartilage and participate in wrist joint.^{NEXT}

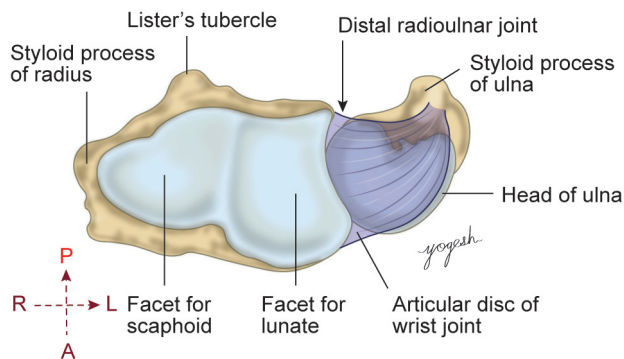
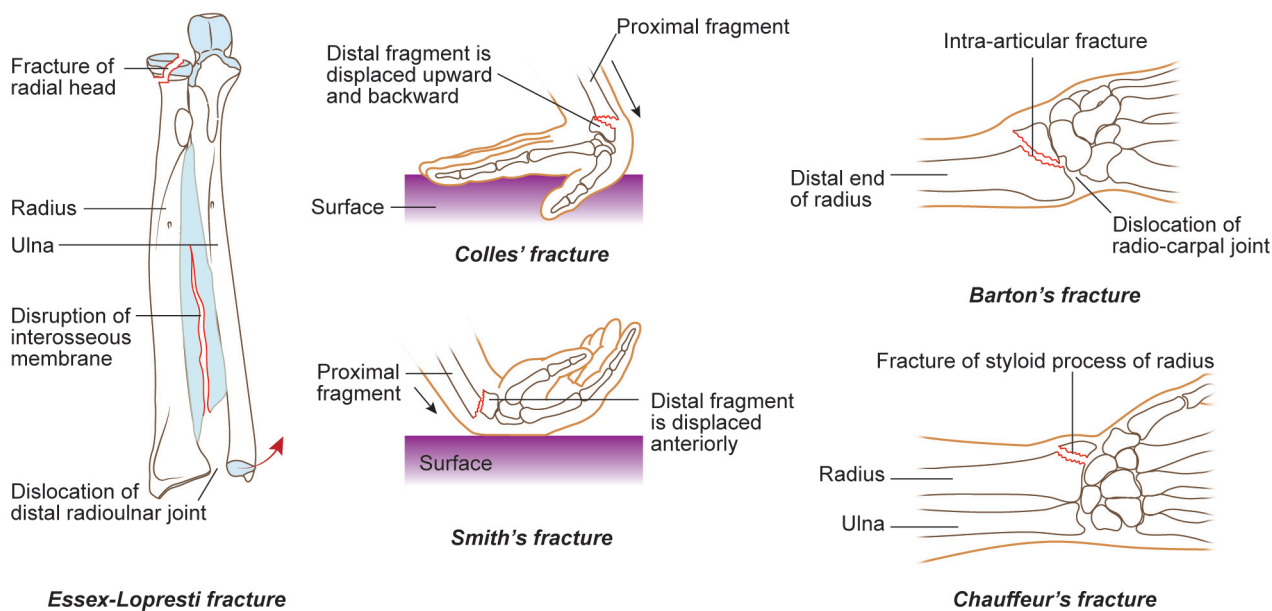


Fig. 4.7: Distal end of radius and ulna (right, inferior view)

- It is divided by a faint ridge into
 - Lateral triangular area that articulates with scaphoid.
 - Medial quadrangular area that articulates with lunate bone.
- **Attachment**
 - **Capsule of wrist joint** is attached to the anterior and posterior margins of the inferior articular surface.

Ossification

- Radius ossifies from one primary and two secondary centers as follows:
 1. One primary center appears in 8th week of IUL – for shaft.
 2. One secondary center appears in 1st year – for lower end and fuses with shaft by 17th–19th years.
 3. One secondary center appears in 5th year – for upper end and fuses with shaft by 14th–17th years. Thus, lower end of radius is growing end.



Essex-Lopresti fracture

Clinical Integration

Fractures of radius (Fig. 4.8)

- Fractures of radius can be grouped as fractures of proximal end, shaft fractures, and distal end fractures.
- **Essex-Lopresti fracture:** It is a fracture of radial head with dislocation of distal radioulnar joint and disruption of interosseous membrane [Prefer Essex-Lopresti, British orthopedic surgeon, 1916–1951].
- Distal end fractures are classified as Colles' fracture and Smith's fracture.

Colles' fracture

- Distal end of radius gets fractured 2 cm above the lower end, and the distal fragment is displaced upward and backward [Abraham Colles, Irish surgeon 1773–1843].^{Viva}
- Cause: Fall on outstretched hand.
- **Dinner-fork (bayonet-like) deformity:** Upward and backward displacement of distal segment of radius creates a dinner-fork deformity, lateral view of wrist looks similar to dinner-fork.

Smith's fracture

- Distal end of radius is fractured, and distal fragment is displaced anteriorly (reverse of Colles' fracture) [Robert William Smith, Irish surgeon, 1807–1873].^{Viva}

Barton's fracture

- It is an intra-articular fracture of distal end of radius with dislocation of radiocarpal joint [John Rhea Barton, American orthopedic surgeon, 1794–1871].

Chauffeur's fracture or Hutchinson fracture

- It is a fracture of styloid process of radius caused by compression of scaphoid bone against the styloid process [Chauffeur's were appointed as drivers].

Pulled elbow (subluxation of head of radius)^{Viva}

- It occurs due to sudden powerful jerk on the hand of a child.

ULNA

- Ulna is the medial bone of the forearm (radius is the lateral bone).
- Ulna is homologous to the fibula (lateral bone of the leg).
- Ulna is a long bone.

Parts (Fig. 4.9)

- Ulna has upper end, shaft, and lower end.
- Upper end of the ulna is expanded, and it shows
 - Hook-like *olecranon process*
 - Smooth articular *trochlear notch*
 - Crest-like *coronoid process* (bracket-like)
- Shaft is cylindrical and has sharp lateral or interosseous border.
- Lower end has head and styloid process. *Styloid process* that projects posteroinferiorly from the head.

Side Determination and Anatomical Position^{Viva}

Hold the bone vertically in such a way that

1. Hook-like olecranon process projects upward.
2. Trochlear notch faces forward.
3. Sharp interosseous border faces laterally and will help to determine the side of the bone (interosseous border of right ulna faces to the right).

Some Interesting Facts

Function of ulna

- **Stabilization:** It stabilizes the forearm by gripping the lower end of humerus in its trochlear notch.
- **Weight transmission:** It transmits the weight from forearm to the humerus.

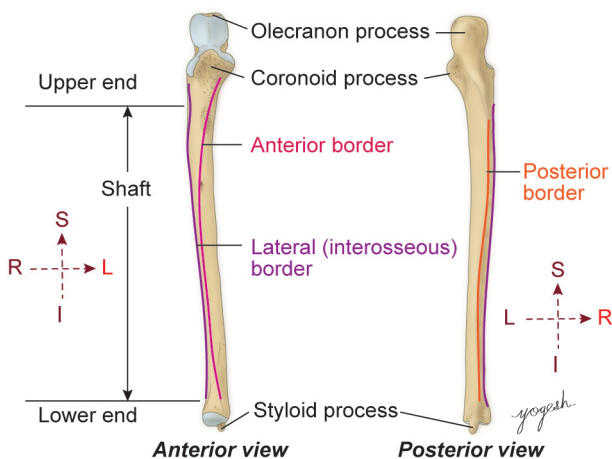


Fig. 4.9: Parts and borders of ulna (right, anterior and posterior views)

Features of Ulna (Figs 4.5, 4.6, 4.10, 4.11)

- Role in pronation and supination: Ulna forms the foundation on which radius moves in supination and pronation.
- Ulna has upper end, shaft, and lower end.

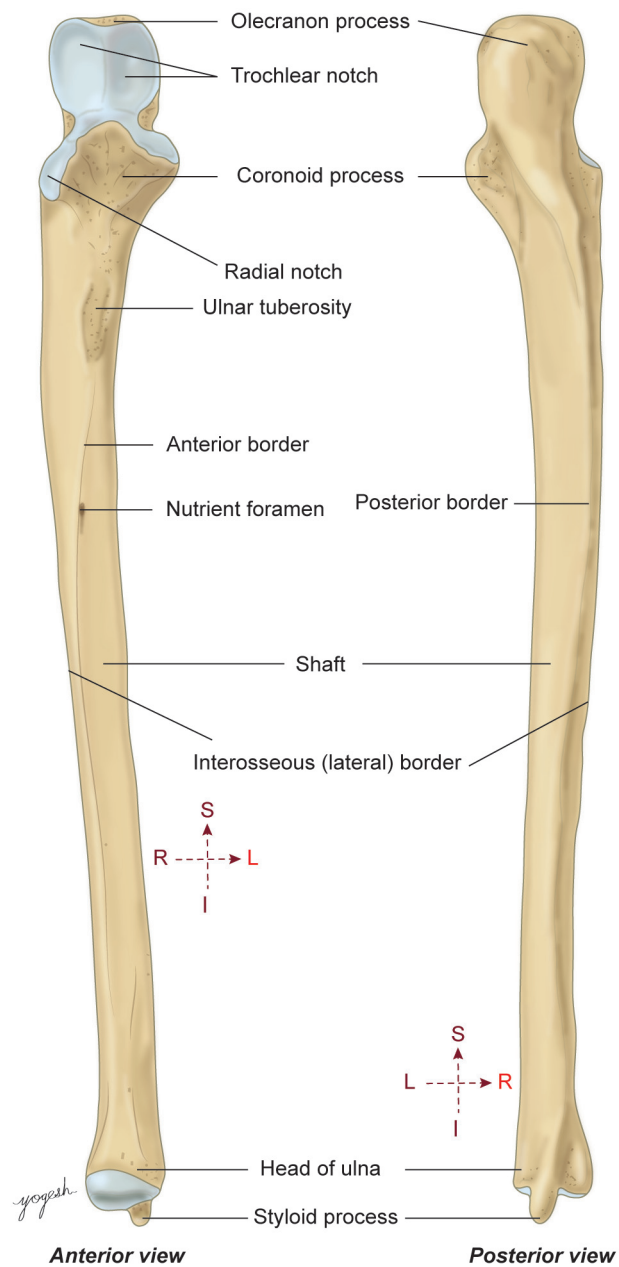


Fig. 4.10: Features of right ulna (right, anterior and posterior views).

Upper End (Fig. 4.12, Flowchart 4.2)

- Upper end of ulna has coronoid and olecranon processes, trochlear and radial notches.

Processes

Olecranon process

- It is a beak-like upward projection at the upper end of the ulna.
- It has five surfaces: Superior, inferior, anterior, lateral, and medial.
- **Anterior surface:** It is concave and covered by hyaline cartilage. Together with upper surface of coronoid process, it forms a *trochlear notch*.

Articulation

It articulates with trochlea of humerus to form humeroulnar part of elbow joint.

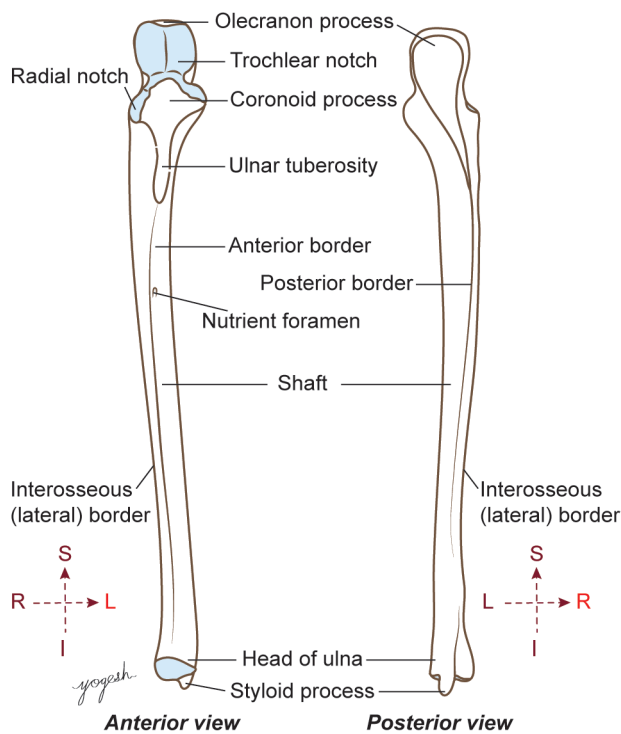


Fig. 4.11: Features of right ulna (right, anterior and posterior views).

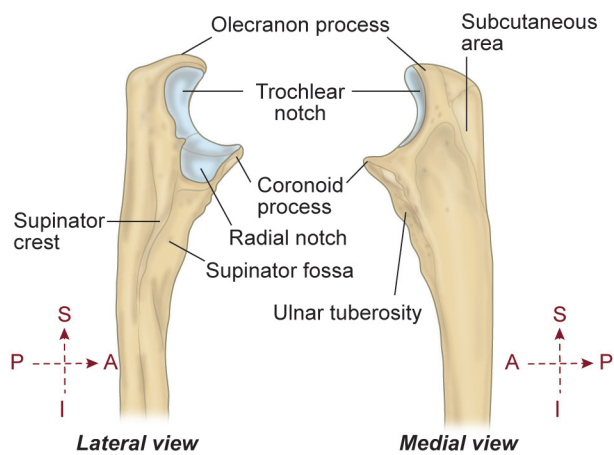
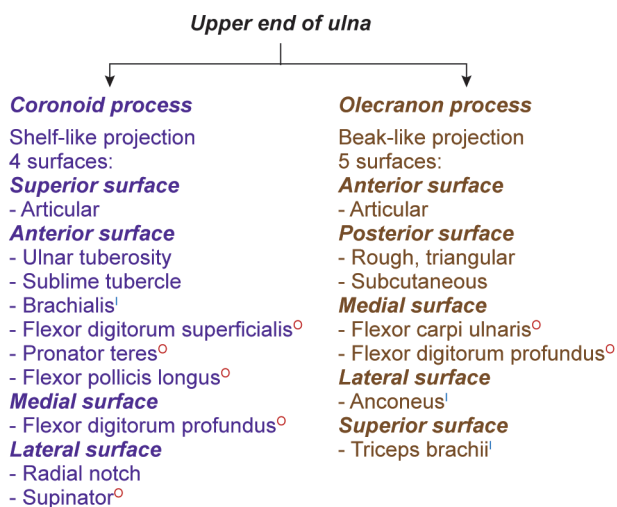


Fig. 4.12: Proximal end of ulna (right, medial and lateral views).

Flowchart 4.2: Upper end of ulna



- **Posterior surface**
It is a triangular rough area, the apex of which is directed downward.

It is subcutaneous (can be felt) and covered by *subcutaneous olecranon bursa*.

- **Medial surface:** It is smooth and is continuous with medial surface of the body.

Attachment

- Medial surface gives attachments to *capsular ligament of elbow*, *posterior and oblique bands of ulnar collateral ligament* and origin of *flexor carpi ulnaris* and origin of *flexor digitorum profundus*.

- **Lateral surface:** It is smooth and continues with posterior surface of the shaft.

Attachment

Lateral surface gives attachments to (before backward)

- Capsular ligament
- Radial collateral ligament
- Insertion of *anconeus*^{Spotters}

- **Superior surface:** It has a rough posterior surface and sharp anterior margin.

Attachments

- *Triceps brachii* inserts on the rough posterior part of superior surface.
- *Capsular ligament* is attached to the anterior margin.
- *Synovial bursa* separates tendon of triceps from the joint capsule.

Coronoid process

- It is a shelf-like process that projects forward from the upper part of the shaft (*coronoid* = crow's beak in Greek).

- It has four surfaces: Superior, anterior, medial, and lateral.

- **Superior surface:** Together with anterior surface of olecranon process, it forms *trochlear notch*.

- **Anterior surface:** It is triangular.

Ulnar tuberosity: Rough lower part of a surface forms ulnar tuberosity

Sublime tubercle: It is a tubercle on the medial margin of anterior surface.

Attachments

- *Brachialis* inserts on anterior surface of coronoid process.

- Medial margin of coronoid process provides the following attachments:

Anterior and oblique band of *ulnar collateral ligament*

Flexor digitorum superficialis (origin)

Pronator teres (origin)

Flexor pollicis longus

- **Medial surface:** It is continuous with medial surface of shaft.

Attachment

Origin of *flexor digitorum profundus*

- **Lateral surface:** Lateral surface has oval-shaped articular fossa called *radial notch* in upper part.
Articulation: It articulates with the head of radius.
Attachments: *Annular ligament* is attached to the anterior and posterior borders of radial notch.
Supinator fossa: It is a depressed lower part of the lateral surface. It is posteriorly bounded by *supinator crest*.
Attachments: Deep fibers of *supinator* muscle originates from supinator fossa supinator crest.

Shaft of Ulna (Flowchart 4.3)

- It is cylindrical and narrows above downward.
- It has three borders – anterior, posterior, and lateral (interosseous) and three surfaces – anterior, posterior, and medial.

Borders

Anterior border

- It extends from ulnar tuberosity to the base of styloid process.
- **Attachments**
 - *Flexor digitorum profundus* originates from upper three-fourths of anterior border.

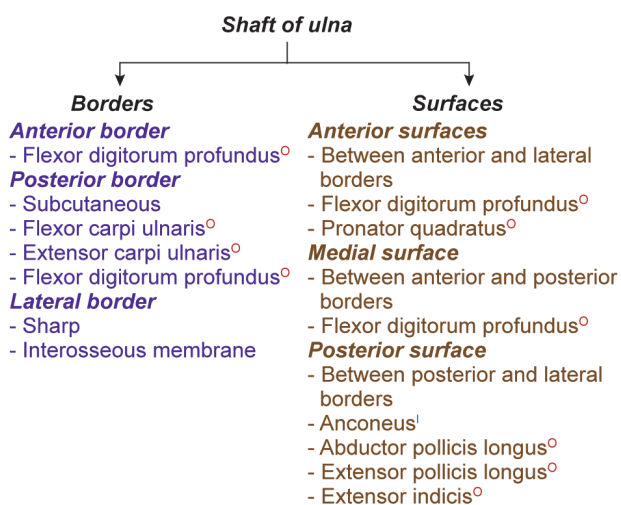
Posterior border

- It extends from apex of the triangular posterior surface of olecranon process to the back of styloid process.
- As the entire posterior border is subcutaneous, it can be palpated (felt). *Clinical integration*
- **Attachments:** Posterior border gives origin to
 - *Flexor carpi ulnaris*
 - *Extensor carpi ulnaris*
 - *Flexor digitorum profundus*
- All these muscles attach to the posterior border through a common aponeurosis.

Lateral (interosseous) border

- It is sharp in upper part and ill-defined in lower part.

Flowchart 4.3: Shaft of ulna



- **Extent:** It extends as continuation of supinator crest to the medial side of the styloid process.
- **Attachments**
Interosseous membrane is attached to interosseous border.

Surfaces

- Ulna has three surfaces – anterior, posterior, and medial.

Anterior surface

- It lies between anterior and interosseous borders.
- *Nutrient foramen* is present in the upper part of anterior surface. It is directed upward as the lower end of ulna is a growing end.
- Oblique ridge is present in the lower one-fourth of this surface.
- **Attachments**
 - *Flexor digitorum profundus* arises from upper three-fourths of the anterior and medial surfaces of ulnar shaft.
 - *Pronator quadratus* originates from ridge in the lower one-fourth of anterior surface.

Medial surface

- It lies between anterior and posterior borders.
- **Attachments**
 - *Flexor digitorum profundus* originates from upper three-fourths of medial surface.

Posterior surface

- It lies between posterior and interosseous borders.
- **Subdivisions**
 - Oblique line extending from supinator crest to the posterior border divides the posterior surface into:
 - Smaller upper area
 - Larger lower area
 - A vertical ridge divides larger lower area into:
 - Medial area (adjoining to the posterior border)
 - Lateral area (adjoining to the border)
- **Attachments**
 - *Anconeus* inserts on the lateral surface of olecranon process and upper one-fourth of the posterior surface of ulna shaft.
 - *Abductor pollicis longus*, *extensor pollicis longus*, and *extensor indicis* originate from above downward from larger lateral part of posterior surface.

Lower End

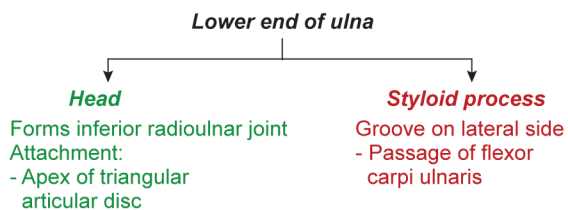
- It is slightly expanded.
- It has head and styloid process.

Head

Head of ulna presents

- Articular surface (smooth convex) on the lateral side.
Articulation: It articulates with ulnar notch of lower end of radius to form *inferior radioulnar joint*.
- Inferior surface has
 - Semilunar area laterally that articulates with superior surface of triangular articular disc.

Flowchart 4.4: Lower end of ulna



- Rough groove medially that gives attachment to the tip of triangular articular disc.
- Anterior and posterior margins of head groove attachment to the *capsular ligament* of wrist joint.

Styloid process of ulna

- It projects downward from posteromedial aspects of lower end.
- *Relation*
 - Tendon of *extensor carpi ulnaris* is passing through the groove that lies posterior between the head and styloid process. NEXT
- *Attachments*
 - *Ulnar collateral ligament* of wrist joint is attached to the tip of the styloid process.

Ossification

- Ulna ossifies from one primary and two secondary centers.
- Primary center: For shaft appears during 8th week of intrauterine life.
- Secondary centers
 - One for upper end (at olecranon process) appears during 9th year – fuses with shaft by the 18th year.
 - One for lower end appears by 6th year and fuses with shaft by the 20th year.

Thus, the lower end of ulna is the growing end.

Clinical Integration

Fractures of ulna

- **Nightstick fracture:** It is the fractured shaft of ulna without any other fracture. It occurs due to direct hit on shaft of ulna, may occur when watchman raises his arm against trauma (Fig. 4.13).
- **Monteggia fracture:** It is the fracture of upper one-third of ulna with dislocation of the head of radius [Giovanni Battista Monteggia, Italian surgeon, 1762–1815] (Fig. 4.13).
- **Hume fracture:** It is a fracture of olecranon with anterior dislocation of head of radius.
- **Previous concept:** The *3 point bony relationship* of the elbow: In an extended elbow, tip of olecranon

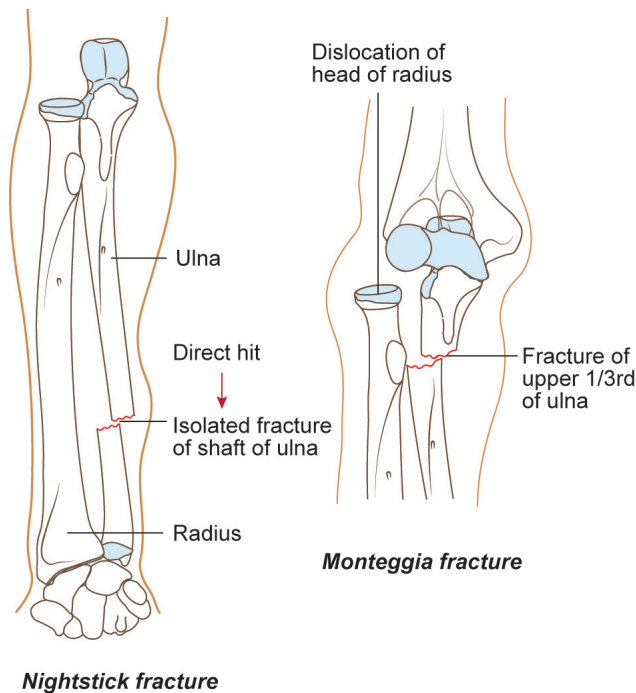


Fig. 4.13: Nightstick fracture and Monteggia fracture of ulna

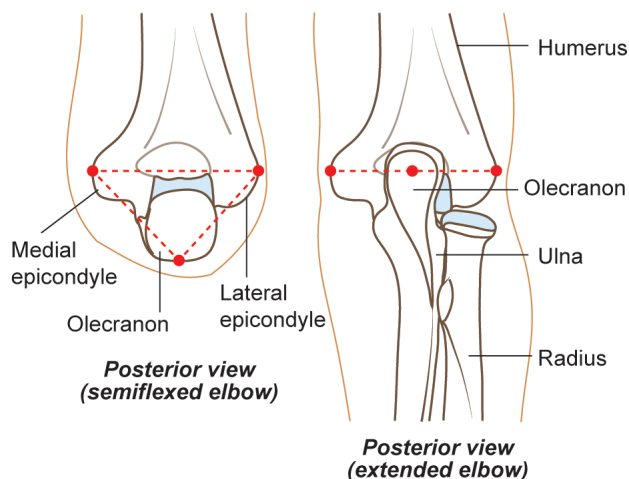


Fig. 4.14: Three-point bony relationship of the elbow

lies in a horizontal line passing through the medial and lateral epicondyles of humerus. In flexed elbow, these points form equilateral triangle (Fig. 4.14).

Recent concept: This triangle may not be equilateral and may not have same measurements in both elbows.

- **Madelung's deformity:** It occurs due to delayed closure of lower epiphysial line of radius. It results in defective development of ulna, increase interosseous space, bowing of radius, and subluxation of distal radioulnar joint [Otto Wilhelm Madelung, German surgeon, 1846–1926].