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HEALTHCARE TRAINING

UPPER AND LOWER LIMB ASSESSMENT AND X-RAY INTERPRETATION

PRECOURSE WORKBOOK

JESHNI AMBLUM-ALMER

Jeshni Amblum-Almer is your course director for this programme. She has been a nurse for 30yrs, and has been a nurse practitioner and university lecturer for the past 16years.

Trained in South Africa as a midwife, psychiatric nurse and community nurse, I've worked mainly in A&E and community clinics. In England, I initially worked in the emergency department, before taking a site clinical manager post. Since 2006, I have worked part time in urgent care and my main role included the Minor Illness and Minor Injuries modules and teaching on various other courses including Prescribing, Interprofessional Problem Based Learning at St. Georges Medical School and pre reg nurses at Kingston University. More recently, I have been the Course Director for the RCN accredited MSc Advanced Practice at City University.

My main role now is reviewing the lectures, applying for accreditation and teaching on some of the courses.

I have recently been elected as the next President of the General Practice and Primary Care Section at the Royal Society of Medicine, the first nurse in its 200year history. I have been an external examiner for the MSc Advanced Practice programme at Glyndwr university in Wales and hold positions on various governing bodies. I also hold a Masters in Medical Law.

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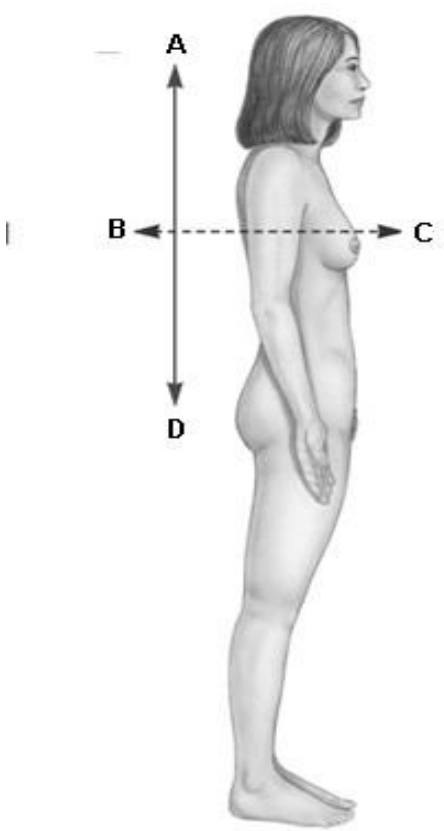
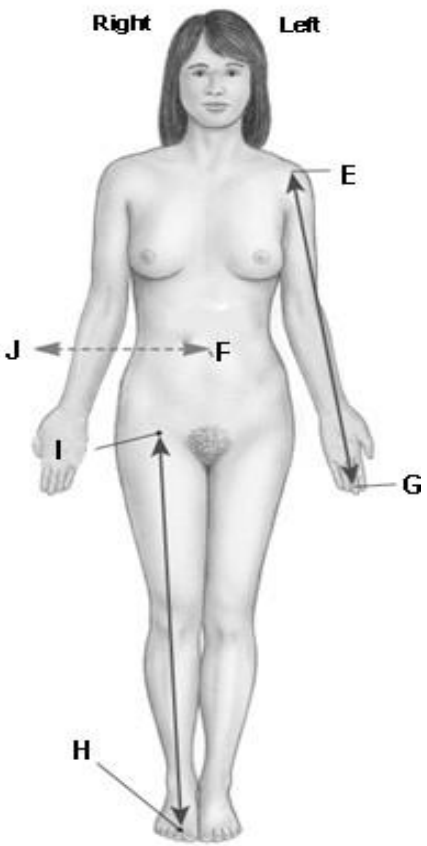
Terms Of Location

It is also important when documenting clinical findings, that you are able to specify the location of a laceration, contusion, abrasion, swelling or bony tenderness. This will also be able to allow other health care professionals who you may be referring to, or who may be reviewing your patients to know exactly the locations that you may have found positive or negative clinical findings.

Looking at the following list of anatomical locations, try to match the location to the description that relates to the adjective. You can also use the printed and web resources to assist you to match the adjective to the relevant term.





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Terms Of Location

Anterior	Towards the back of the torso
Posterior	Above, or towards the top of the body
Ventral	Away from the centre of the body, or another structure
Dorsal	Towards the armpit
Medial	Towards the outer surface of the body
Lateral	Towards the centre of the body, or another structure
Peripheral	Towards the front of the body
Inferior	Vertically, along the body
Superior	On or towards the palm of the hand
Proximal	On or towards the back of the hand, or top of the foot
Distal	Towards the front of the torso
Transverse	Towards the groin
Longitudinal	Towards the outside, or away from the midline of the body
Palmar	Below, or towards the bottom of the body
Planter	Towards the buttocks
Dorsal	Towards the back of the body
Axillary	Horizontally, across the body
Inguinal	On or towards the sole of the foot
Caudal	Towards the centre, or midline of the body

RECOMMENDED READINGS

Darwood,M. (2012) The Essential Tool for Emergency Practitioners. London:Radcliffe Publishers
Jarvis, C. (2008) Physical Examination & Health Assessment London : Elsevir Lumley, J. (2008)Surface Anatomy: The Anatomical Basis of Clinical Examination. 4th ed. Churchill :Livingstone
Purcell, D. (2010) Minor Injuries: A Clinical Guide for Nurses . 2ed. Edinburgh: Churchill Livingstone

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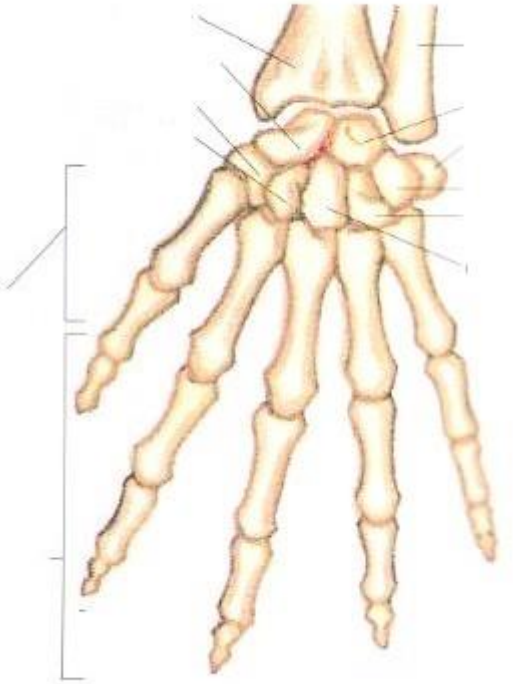
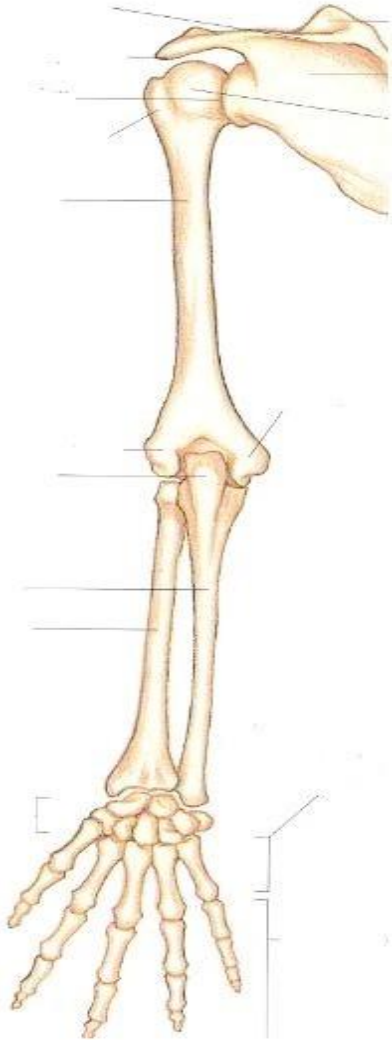
Upper Limb Assessment

Prior to discussion of the assessment and management of clinical presentations in class, you need to be aware of the relevant anatomy and physiology related to upper limb assessment.

Palmar Aspect Of The Hand



Posterior Arm



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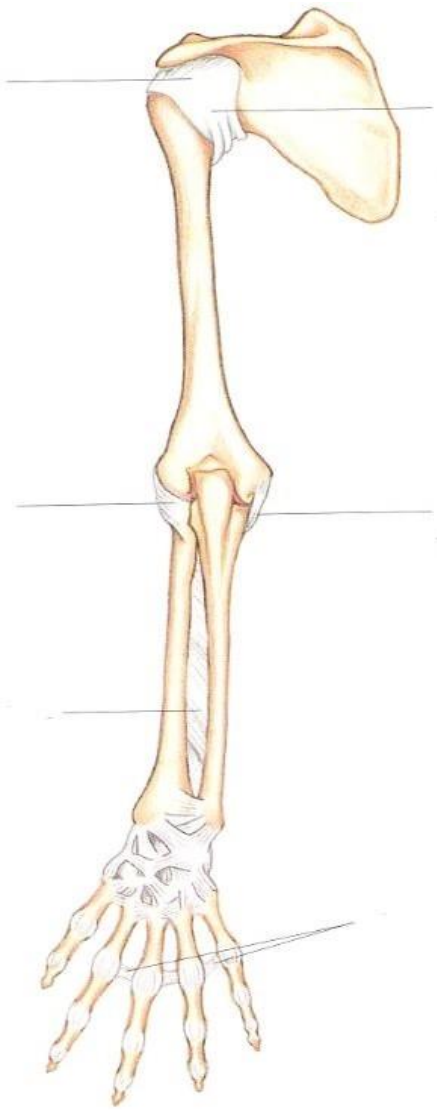
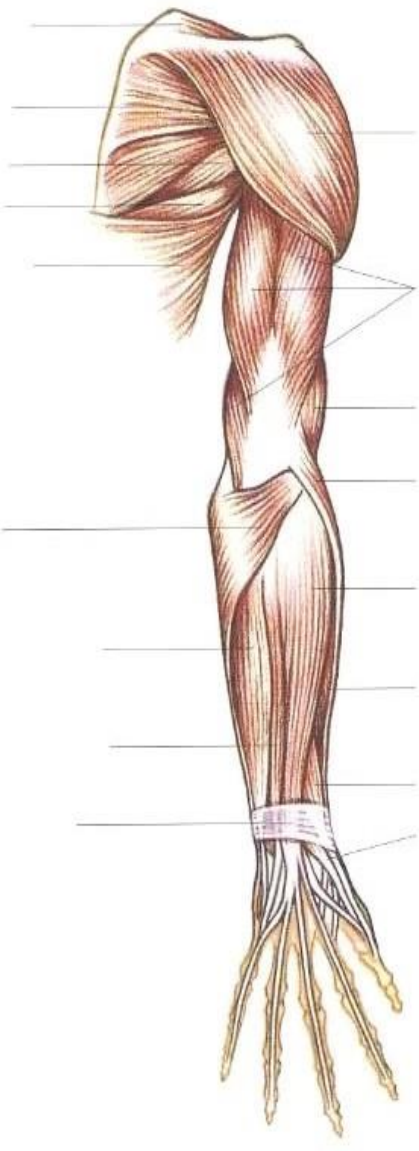
Upper Limb Assessment

Posterior Arm With Ligaments



Superficial Muscles Of Posterior Arm



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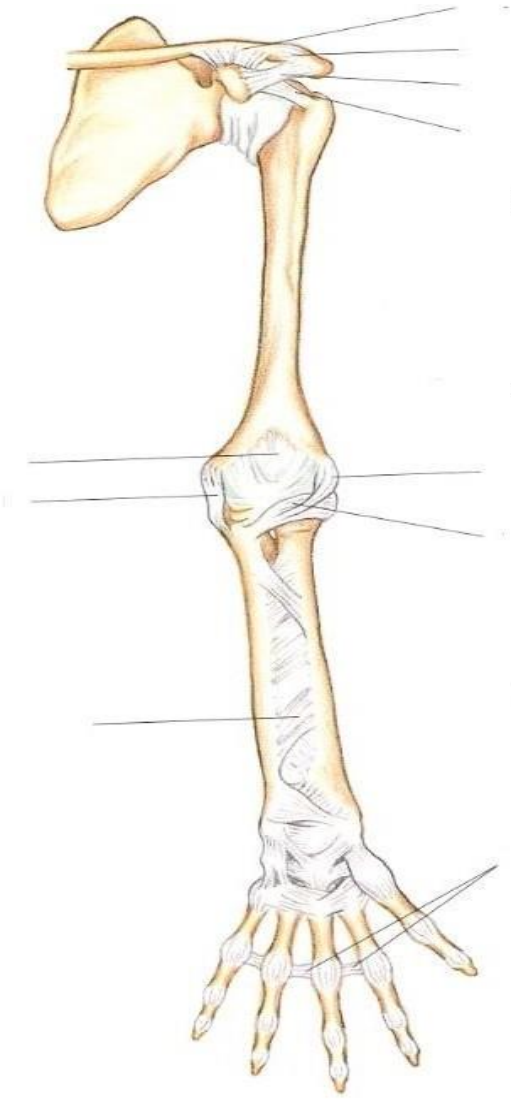
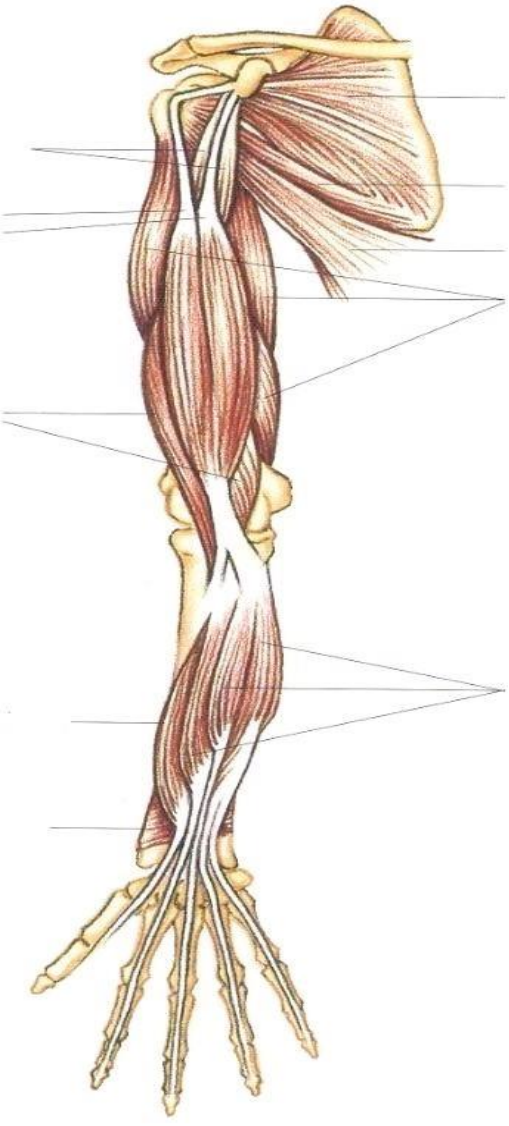
Upper Limb Assessment

Anterior Arm With Ligaments



Deep Muscles Of Anterior Arm



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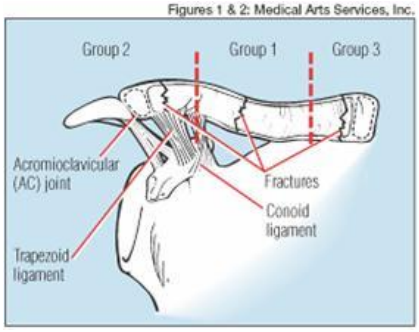
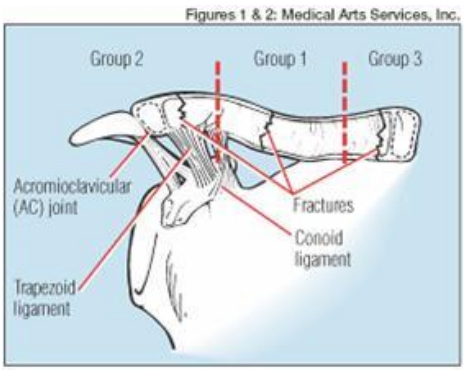
CLINICAL SHOULDER ANATOMY

The shoulder is the most mobile joint in the human body.

Ranges of Movement
- In which two of the following are we most mobile?
Flexion, Extension, Abduction, Adduction Internal Rotation, External Rotation

Clavicle
- o S-Shaped, double curved bone
- o Protects underlying brachial plexus and vascular structures.
- o Elevates along with upper limb elevation.





Most clavicular fractures occur between the lateral 1/3 and medial 2/3. What is the characteristic deformity that results from a fractured clavicle?

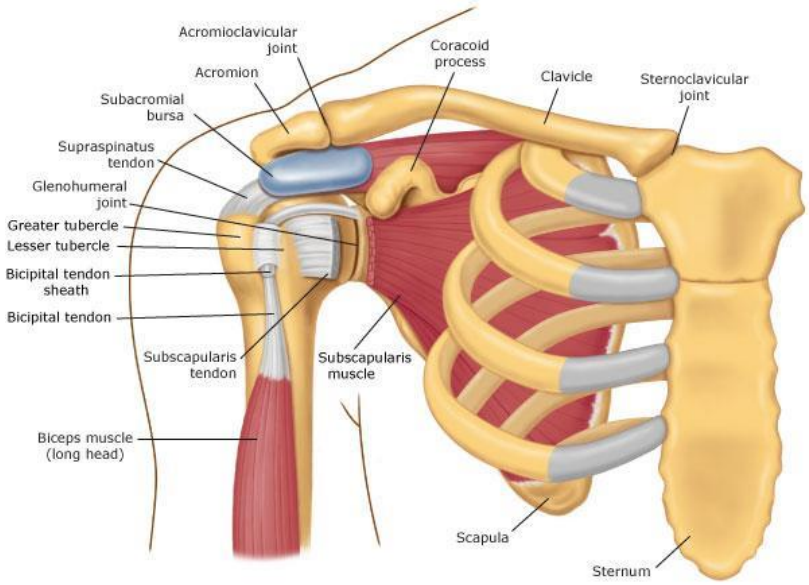
How does this affect mechanics of the shoulder?

CLINICAL SHOULDER ANATOMY

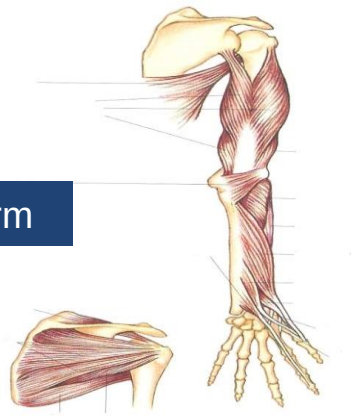
Clavicular Joints
- Sternoclavicular joint
- Acromioclavicular joint
- Coracoacromial ligament

What is the role of the acromion and coracoacromial ligament in maintaining glenohumeral stability?

Scapula
- Glenoid fossa
- Spine
- Acromion
- Coracoid process
- Supraglenoid tubercle
- Infraglenoid tubercle
- Supraspinous fossa
- Infraspinous fossa
- Subscapular fossa
- Scapular notch



Deep Muscles Of Posterior Arm



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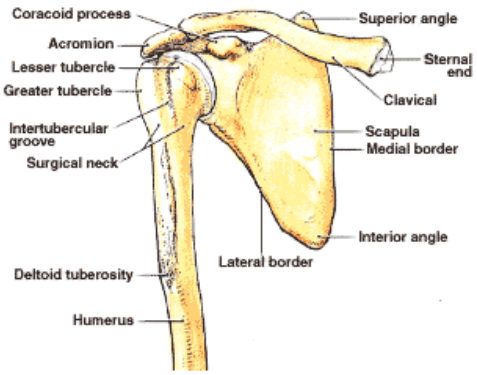
CLINICAL SHOULDER ANATOMY

Scapulothoracic Articulation
Provides the following movements:
Protraction, Retraction, Elevation, Rotation (during shoulder abduction):

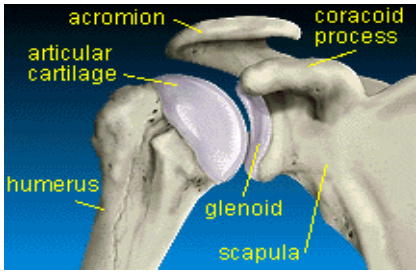
Proximal Humerus
- Head
- Anatomical neck
- Surgical neck
- Greater tubercle
- Lesser tubercle
- Intertubercular sulcus (bicipital groove)
- Deltoid tuberosity
- Spiral groove

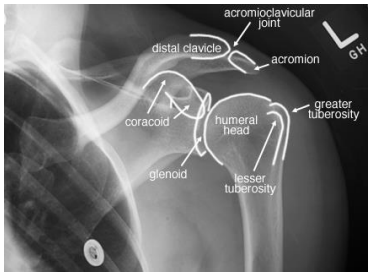


Glenohumeral Joint
- Glenoid fossa

- Glenoid labrum

Extends the depth of the glenoid fossa to confer more stability.





SLAP Tear
- Detachment of Superior Labrum with Anterior-Posterior extension can occur from repetitive overhead activities or a sudden pull on the arm or compression (fall on outstretched arm).

- **Fibrous capsule of the glenohumeral joint**
  - Which part of the fibrous capsule is most loose?
  - How does it tighten with various shoulder movements?

  Abduction:
  Internal rotation:
  External rotation:

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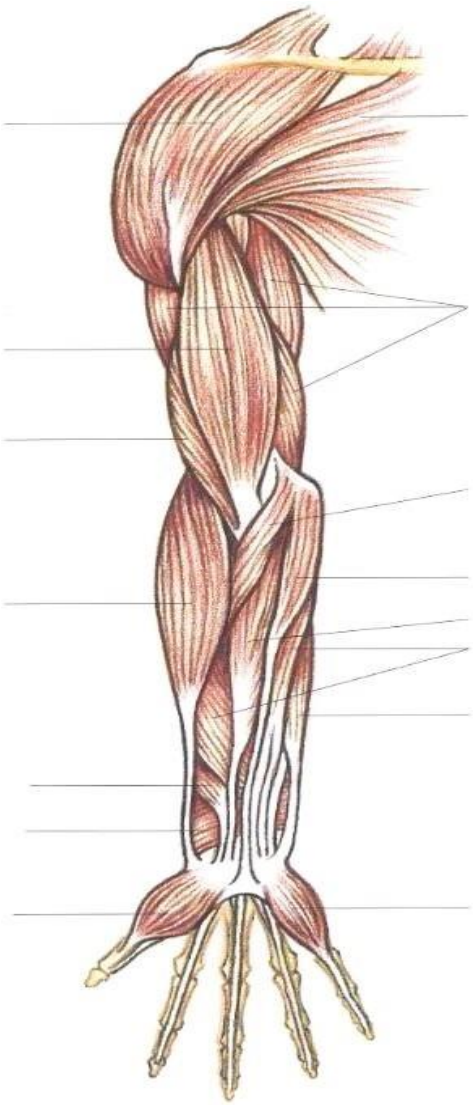
Upper Limb Anatomy

Superficial Muscles Of Anterior Arm



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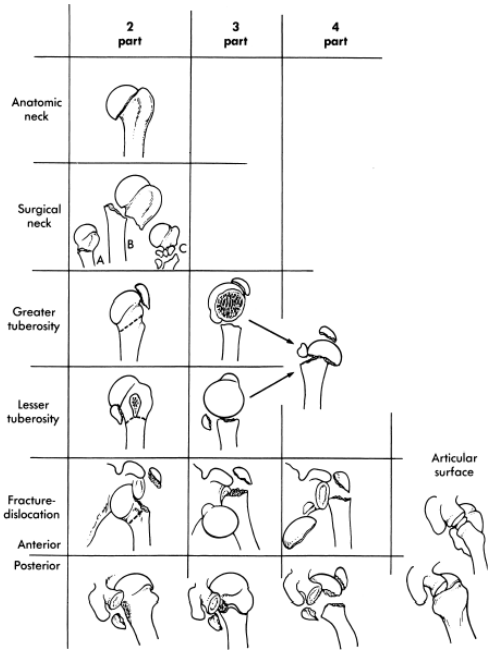
PROXIMAL HUMERUS FRACTURES: NEER CLASSIFICATION

2-part fractures

- May be Tx'd conservatively if:
  - Displaced < 1 cm
  - Angulation < 45 °
  - No dislocations
  - Good reduction
  - No intraarticular involvement
  - Anatomic neck intact
- Otherwise: surgical evaluation

All else: surgical evaluation



SHOULDER FRACTURES

Neer classification 3-part proximal humerus fracture involving:

- Surgical neck
- Lsr tuberosity

Tx: surgical eval

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SHOULDER MUSCULATURE

Outermost Layer

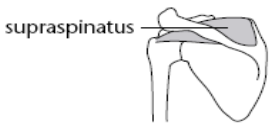
- Deltoid
  - Action:

- Pectoralis major
  - Sternocostal head
    - Action:
  - Clavicular head
    - Action:

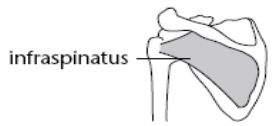
- Pectoralis minor
  - Action (including breathing):

Deep Layer

- Rotator Cuff (SITS)
  - Supraspinatus
    - Action:

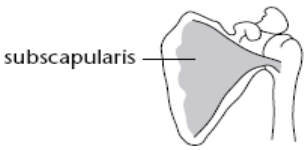


  - Infraspinatus
    - Action:



  - Teres Minor
    - Action:

  - Subscapularis
    - Action:



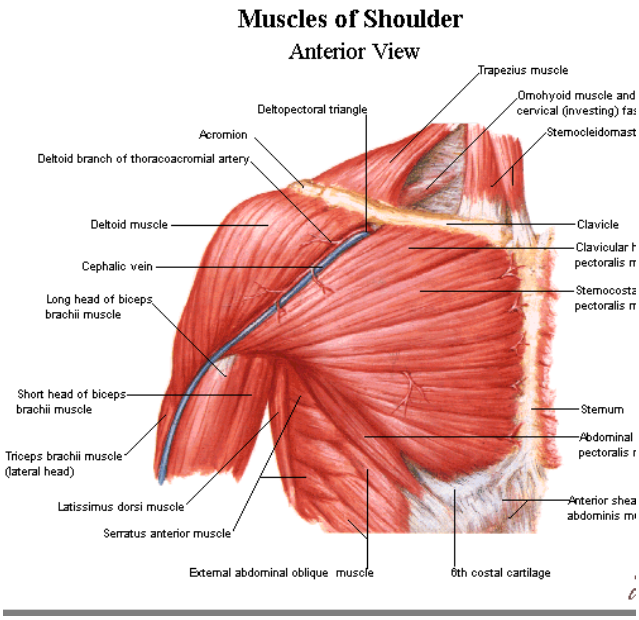
To which common structure do these muscles attach?

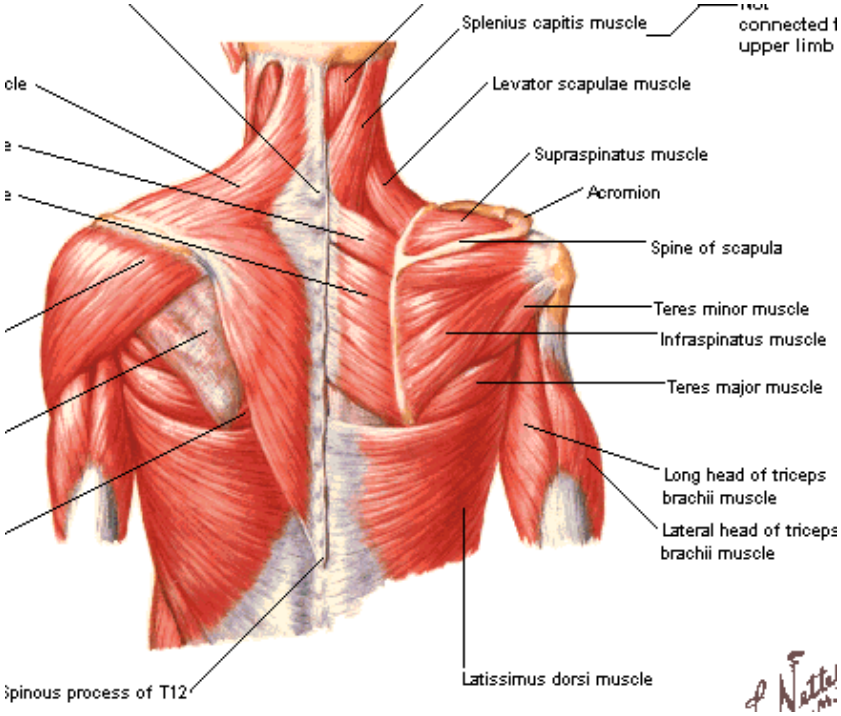
What is the combined movement of these muscles?

SHOULDER MUSCULATURE

Accessory Muscles

- Trapezius
  - Action:
- Levator Scapulae
  - Action:
- Rhomboid Major/Minor
  - Action:
- Latissimus Dorsi
  - Action:
- Teres Major
  - Action:
- Biceps Brachii
  - Action:





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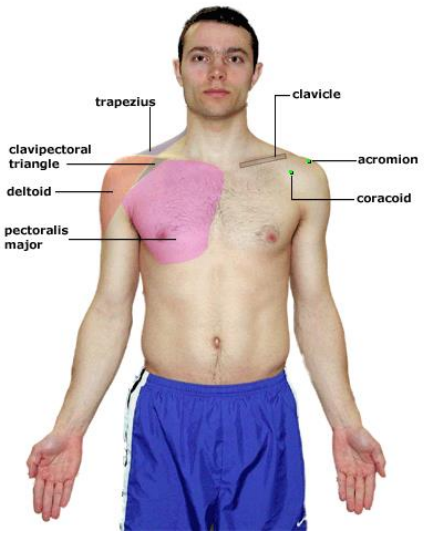
PALPATION

Surface Anatomy (Anterior)

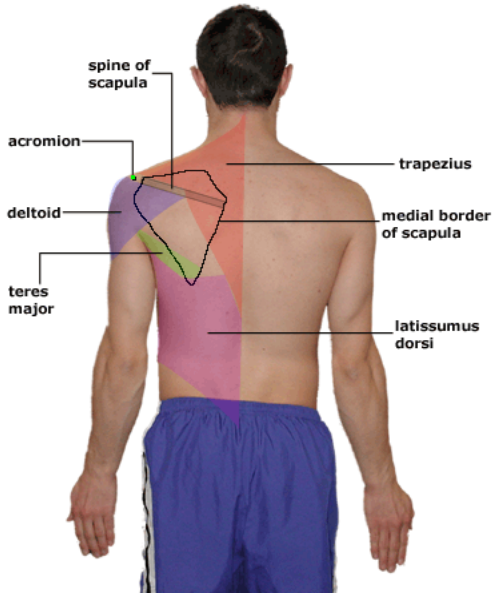
- Clavicle
- SC Joint
- Acromion process
- AC Joint
- Deltoid
- Coracoid process
- Pectoralis major
- Trapezius
- Biceps (long head)



PALPATION

Surface Anatomy (Posterior)

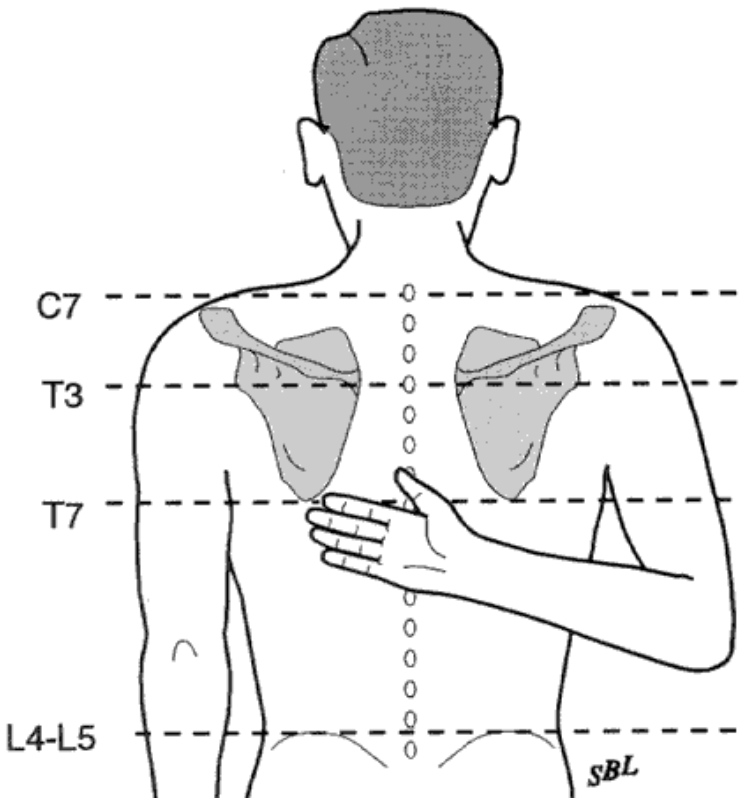
- Scapular spine
- Acromion process
- Supraspinatus
- Infraspinatus
- Deltoid
- Trapezius
- Latissumus dorsi
- Scapula
  - Inferior angle
  - Medial border



SHOULDER MOVEMENTS

Abduction

1st Group:	Agonist: Supraspinatus Synergist: Deltoid (Anterior, Middle portion) A-P Stabilisation: Trapezius (Inferior portion), Serratus Anterior
2nd Group:	Agonist: Trapezius (Medial portion) A-P Stabilisation: Infraspinatus, Long head of biceps brachii
3rd Group:	Agonist: Trapezius (Superior portion) A-P Stabilisation: Deltoid (Posterior head), Pectoralis major (Clavicular portion)
4th Group: > 110o	Agonist: Pectoralis major (Clavicular portion) Antagonist: Latissimus dorsi, triceps brachii (long head)



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SHOULDER MOVEMENTS

Adduction

Agonist: Latissimus dorsi
Synergist: Pectoralis major (sternal and clavicular heads), Teres major, Coracobrachialis, Triceps brachii (long head)

Flexion

Agonist: Deltoid (Anterior, Middle portion)
Synergist: Coracobrachialis, biceps brachii (short head), pectoralis major (Clavicular portion)
Antagonist: Latissimus dorsi

Extension

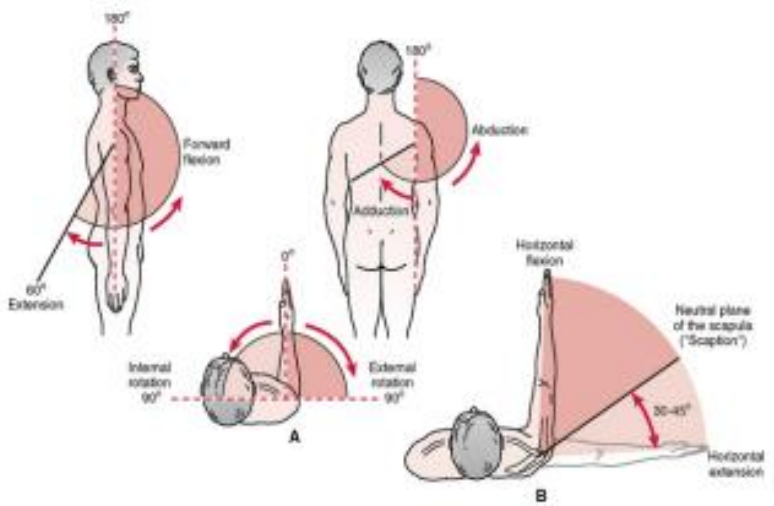
Agonist: Latissimus dorsi Deltoid (Posterior portion)
Synergist: Deltoid (Posterior portion), pectoralis major (sternal head), teres major, triceps brachii (long head)

External Rotation

Agonist: Infraspinatus
Synergist: Deltoid (Posterior fibres), Teres Minor

Internal Rotation

Agonist: Subscapularis
Synergists: Pectoralis major (sternal and clavicular heads), Latissimus dorsi, Teres Major, Deltoid (Anterior fibres)



SCAPULOTHORACIC MOVEMENTS

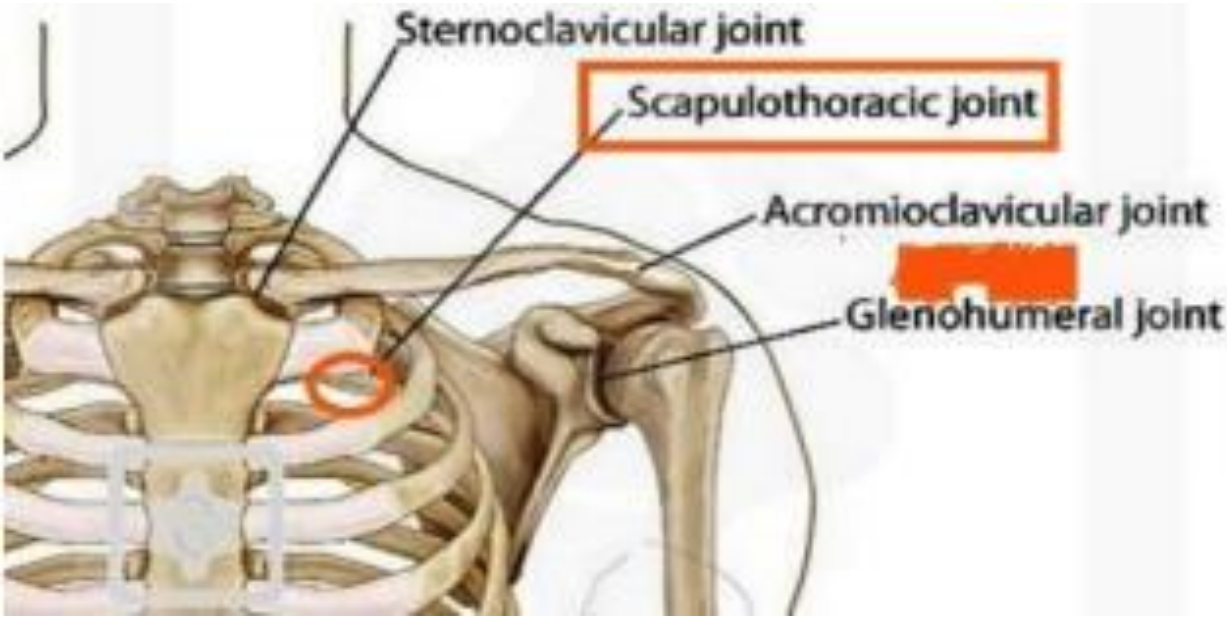
Protraction
- Serratus anterior, Pectoralis minor

Retraction
- Rhomboid major and minor, Trapezius (Middle portion)

Elevation
- Levator scapulae, Trapezius (Superior portion)

Depression
- Trapezius (Inferior portion), Latissimus dorsi

Scapular Rotation
- Upper is a combination of elevation and protraction
- Lower is a combination of depression and retraction



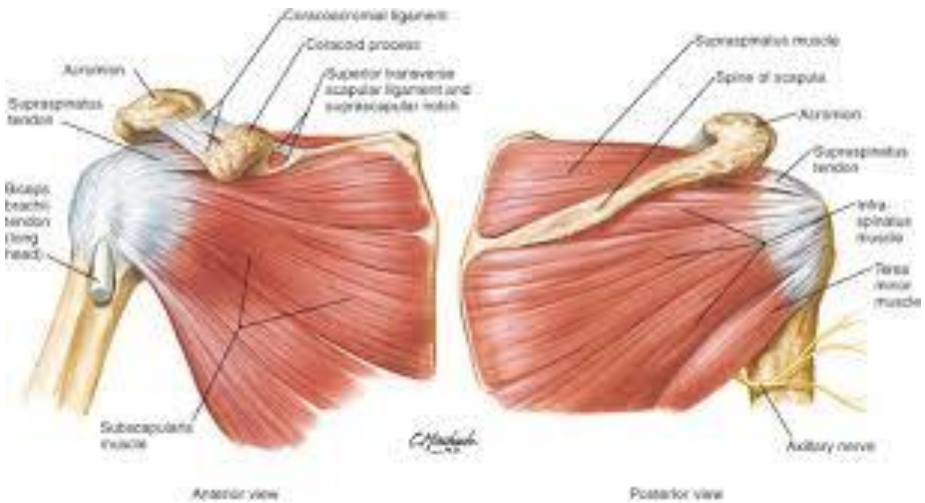
SHOULDER PATHOLOGIES

Common Pathologies:

- External Primary Impingement
- Rotator Cuff Tears

- Adhesive Capsulitis (idiopathic frozen shoulder)
- Anterior Instability

- Posterior Instability



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CLINICAL TESTS

- Active tests to be done before passive tests, with most painful test done last (increases sensitivity). This is important for all clinical tests.

- Muscle vs. Capsular tests
  - Ask patient to contract muscles acting in opposite direction 10-20% maximum voluntary contraction and then relax.
  - Then attempt to move the limb further into range. If range increases, problem is muscular not capsular.

Apley's Scratch Test
- Tests: Internal rotation and adduction on one limb, and external rotation and abduction on the other.
- Ask patient to touch hands behind back.

Scapular Winging

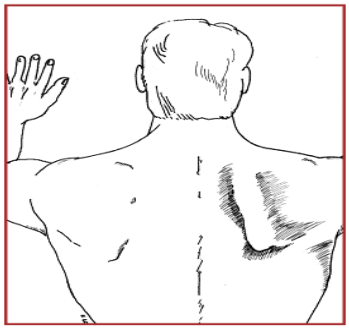


FIGURE 6. Scapular winging caused by long thoracic nerve injury. Scapular abduction, such as pushing against a wall, accentuates the protuberance of the medial scapular edge.

Jobe's Apprehension Test
- Doesn't require patient pain, can be performed with patient stood or sat.
- Rotate humerus posteriorly

Surprise Test
- Greater sensitivity and specificity than Jobe's
- Can cause pain due to sudden release of tension

Anterior Instability
- Empty Can Test (thumb neutral)
- Full Can Test (thumb up)

Lift off sign
- Tests for subscapularis lesion

FUNCTIONAL TESTS

Forearm supinated, resting on table
- Wrist flexion
- 0kg nonfunctional, 0-1kg functionally poor, 1-2kg functionally fair, 2.5kg+ functional
- Forearm pronated, resting on table
- Wrist extension lifting 0.5-1kg
- 0 reps nonfunctional, 1-2 reps functionally poor, 3-4 reps functionally fair, 5-6 reps functional

Forearm between supination and pronation resting on table
- Radial deviation lifting 0.5-1kg
- Thumb flexion with resistance from rubber band around thumb
- 0 reps nonfunctional, 1-2 reps functionally poor, 3-4 reps functionally fair, 5+ reps functional

Forearm resting on table, rubber band around thumb and index finger
- Thumb extension from rubber band around thumb
- Thumb abduction against resistance of rubber band
- 0 reps nonfunctional, 1-2 reps functionally poor, 3-4 reps functionally fair, 5+ reps functional

Forearm resting on table
- Thumb adduction, lateral pinch of piece of paper
- Thumb opposition, pulp to pulp pinch of piece of paper
- Hold 0s nonfunctional, Hold 1-2s functionally poor, Hold 3-4s functionally fair, Hold 5+s functional

Finger flexion, patient grasps mug or glass using cylindrical grasps and lifts off table
- 0 reps nonfunctional, 1-2 reps functionally poor, 3-4 reps functionally fair, 5+ reps functional

Patient attempts to put on rubber glove keeping fingers straight
- 21+s nonfunctional, 10-20s functionally poor, 4-8s functionally fiar, 2-4s functional

Patient attempt to pull fingers appart (abduction) resistance of rubber bands and
- Hold 0s nonfunctional, Hold 1-2s functionally poor, Hold 3-4s functionally fair, Hold 5+s functional

Patient holds piece of paper between fingers whilst examiner pulls on paper
- Hold 0s nonfunctional, Hold 1-2s functionally poor, Hold 3-4s functionally fair, Hold 5+s functional

PERIPHERAL NERVE NEUROPATHIES

Nerve: Suprascapular (C5,6)
Muscle Weakness: Supraspinatus, infraspinatus
Sensory Alteration: Top of shoulder from clavicle to spine of scapula. Pain in posterior shoulder radiating into arm.
Mechanism of Injury: Compression in suprascapular notch. Stretching into scapular protraction with horizontal adduction. Direct blow, space occupying lesion (i.e. Ganglion).

Nerve: Axillary (C5,6)
Muscle Weakness: Deltoid, teres minor
Sensory Alteration: Deltoid area, anterior shoulder pain
Mechanism of Injury: Anterior glenohumeral dislocation or fracture of surgical neck of humerus. Surgery for instability.

Nerve: Radial Nerve (C5-8, T1)
Muscle Weakness: Triceps, wrist extensors, finger extensors (shoulder/wrist/hand extension)
Sensory Alteration: Dorsum of hand
Mechanism of Injury: Fracture of humeral shaft. Pressure (i.e. crutch Palsy).

Nerve: Long Thoracic Nerve (C5-7)
Muscle Weakness: Serratus anterior
Sensory Alteration: None
Mechanism of Injury: Direct blow, traction, compression against internal chest wall (rucksack injury), heavy effort above shoulder height, repetitive strain.

Nerve: Musculocutaneous (C5-7)
Muscle Weakness: Coracobrachialis, biceps brachialis
Sensory Alteration: Lateral aspect of forearm
Mechanism of Injury: Compression muscle hypertrophy. Direct blow. Fracture (clavicle and humerus). Dislocation (anterior). Surgery

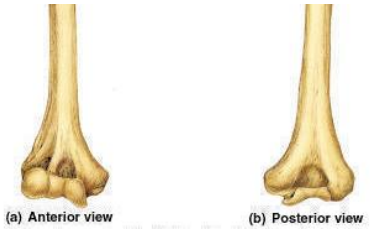
Nerve: Spinal Accessory Nerve (Cranial nerve XI, C3,C4)
Muscle Weakness: Trapezius
Sensory Alteration: Brachial plexus symptoms possible due to shoulder drooping. Shoulder aching.
Mechanism of Injury: Traction (shoulder depression and neck rotation to opposite side), biopsy.

CLINICAL ELBOW ANATOMY

Ranges of Movement

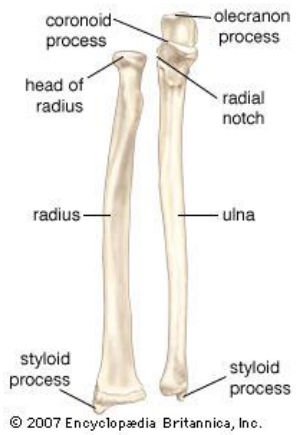
In which anatomical areas do the following movements take place:
Flexion/Extension, Pronation/Supination

Distal Humerus
- Capitulum
- Trochlea
- Coronoid fossa
- Radial fossa
- Olecranon fossa
- Lateral epicondyle
- Medial epicondyle



Radius
- Head and neck of radius
- Radial tuberosity

This serves as an attachment point for which muscle?

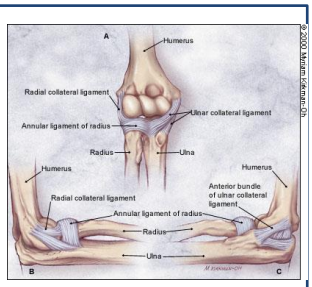


Ulna
- Olecranon
- Coronoid process
- Radial notch
- Trochlear notch

What is the anatomical relationship between the epicondyles and olecranon process in elbow extension? In elbow flexion?

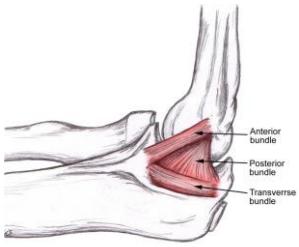
Humeroulnar Joint
- Ulnar (medial) collateral ligament

SPECIAL TESTS



Humeroradial Joint
Radial (lateral) collateral ligament
Annular ligament

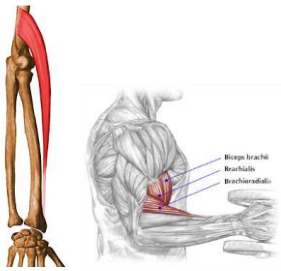
Fibrous Capsule:
- Is loose both anteriorly and posteriorly (to permit movement)
- Is strengthened elsewhere by ligaments (to provide stability).



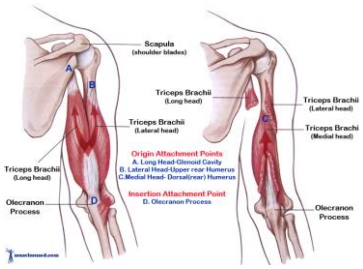
Ligaments:
- Ulnar (medial) collateral ligament
- Radial (lateral) collateral ligament
- Annular ligament

ARM MUSCULATURE AND ELBOW MOVEMENTS

- The arm extends from the shoulder to the elbow.
- There are two muscular compartments in the arm; the anterior flexor compartment and the posterior extensor compartment.



Anterior Compartment (Flexion):
- Brachialis
- Brachioradialis
- Biceps brachii
- Extensor carpi radialis



Posterior Compartment (Extension):
- Triceps brachii

How is triceps brachii similar to the quadriceps?
- Anconeus
- Flexor carpi ulnaris

Supination:
- Supinator
- Biceps brachii

Pronation:
- Pronator Quadratus
- Pronator Teres

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ELBOW ASSESSMENT IN CHILDREN

Distal to the humerus are the growth centers of the proximal end of the olecranon (age1), the head of the radius (ages5-7), and occasionally, the radial tuberosity which appears at puberty. To make things even more confusing, **the capitellum and trochlea fuse to form one epiphysis at ages 13-15.** The epicondyles usually fuse to the shaft of the humerus independently. Thus you can see it is necessary to have knowledge of these centers in order not to misinterpret one of them as a fracture. Of course one of the oldest aids to the inexperienced eye is to take a radiograph of the normal side to compare. Note the position of the normal growth centers in figure 5 above and in the illustration in figure 6 below.

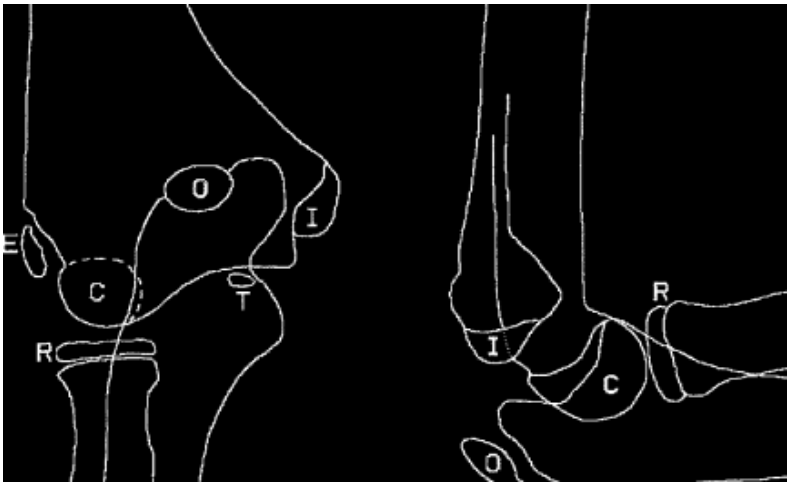


Figure # 7 (above). The normal growth centers of the elbow. They can be remembered in order of appearance by the mnemonic CRITOE.
Key:
C-capitellum R-radial head
I-internal epicondyle T-trochlea
O-olecranon
E-external epicondyle

Illustration courtesy of Alson S. Inaba, MD, author and Loren Yamamoto, MD, web page author, U of Hawaii via the Internet www2.hawaii.edu/medicine/pediatrics

Occasionally one of the growth centers may be fractured or subluxated. This is not likely to happen without the secondary signs of interarticular hemorrhage discussed above (fat pad displacement), but even so it's always wise to splint the joint and obtain follow up films after a period of immobilization if there is any doubt clinically

ASSESSMENT: CRITOE

CRITOE
Ossification Centres
6 osification centres around elbow joint, appear and fuse at different ages.
Order of appeareance specified in CRITOE (Capitelum, Radius, Internal/Medial epicondyle, Trochlea, Olecranon, External/Lateral epicondyle).
As a general guide remember 1-2-5-7-9-11 years.

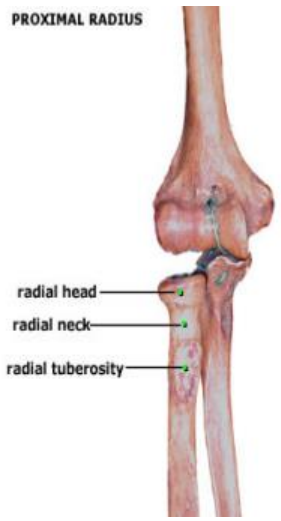
CLINICAL ELBOW ASSESSMENT

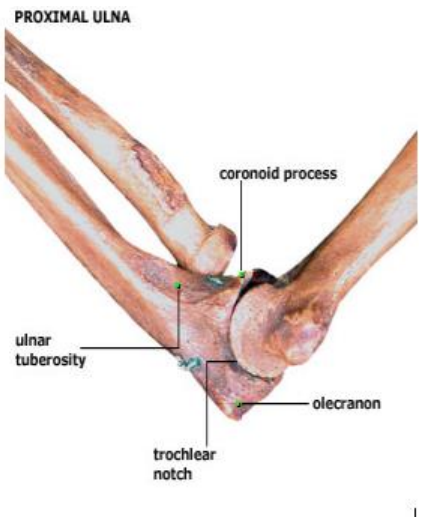
- Functional Tests:
    - Sitting
        - Bring hand to mouth lifting weight.
            - 0kg nonfunctional, 0.5-0.9kg functionally poor, 1.4-1.8kg functionally fair, 2.3-2.7kg functional

- Standing 90 cm from wall, leaning against the wall
    - Push arms straight
        - 0 reps nonfunctional, 1-2 reps functionally poor, 3-4 reps functionally fair, 5-6 reps functional
            - Standing facing closed door
    - Open door starting with palm down (supination)
    - Open door starting with palm up (pronation)
    - 0 reps nonfunctional, 1-2 reps functionally poor, 3-4 reps functionally fair, 5-6 reps functional

Ligamentous valgus instability test

- Stabilise patient's arm with one examiner's hands at the elbow and the other hand above the patient's wrist.
- An abduction or valgus force at the distal forearm is applied to test the medial collateral ligament whilst the ligament is palpated
- Note any laxity, decreased mobility, or altered pain





BELMATT
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SPECIAL TESTS

Ligamentous varus instability test
- Patients elbow slightly flexed, and stabilised as above. An adduction or varus force applied to distal forearm to test lateral collateral ligament whilst the ligament is palpated.
- Normally examiner feels ligament tense when stress is applied.
- The examiner applies the force several times with increasing pressure whilst noting any alteration in pain or ROM.
- If excessive laxity is found or a soft end feel is felt, it indicates injury to the ligament and may indicate posterolateral joint instability.

Posterolateral elbow instability
- Most common pattern of elbow instability in which there is displacement of the ulna on the humerus.
- Ulna supinates or laterally rotates away from the trochlea

Epicondylitis
- Palpate epicondyles whilst resisting either flexion or extension.

Elbow flexion test
- Fully flex patient's elbow. Extend wrist and abduct and depress shoulder (waiter's position).
- Hold for 3-5 mins for ulnar nerve impingement symptoms.

PERIPHERAL NERVE NEUROPATHIES

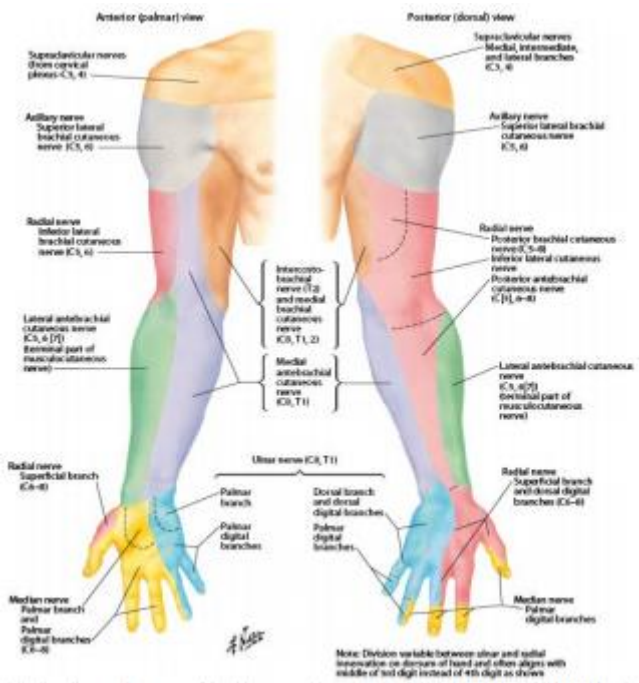
Nerve: Median (C6-8, T1)
Muscle Weakness:
Pronation (pronator teres, pronator quadratus).
Wrist flexion (flexor carpi radialis, palmaris longus).
Digit flexion (flexor digitorum superficialis, lateral half of flexor digitorum profundus)
Thumb (flexor pollicis longus, thenar eminence (AOF)
Lateral two lumbricals

PERIPHERAL NERVE NEUROPATHIES

Sensory Alteration: Palmar aspect of hand with thumb, index, middle, and lateral half of ring finger. Dorsal aspect of distal 1/3 index, middle, and lateral half of ring finger.
Functional Loss: Pronation weak or lost. Weak wrist flexion and abduction. Radial deviation at wrist lost. Inability to oppose or flex thumb. Weak thumb abduction. Weak grip. Weak or no pinch.

Nerve: Ulnar (C7-T1)
Muscle Weakness: Wrist flexion (flexor carpi ulnaris). Digit flexion (medial half of FDP). Thumb (adductor pollicis). Hand (hypothenar eminence, medial two lumbricals, all interossei).
Sensory Alteration: Dorsal and palmar aspect of little and medial half of ring finger.
Mechanism of Injury: weak wrist flexion. Loss of ulnar deviation. Loss of distal flexion of little finger. Loss of abduction and adduction of fingers. Inabilty to extend 2nd-3rd phalanges of little and ring fingers (hand of benediction)

Nerve: Radial(C5-8, T1)
Muscle Weakness:
Elbow extension (anconeus)
Elbow flexion (brachioradialis)
Wrist extension (extensor carpi radialis longus, carpi ulnaris)
Sensory Alteration: Palmar aspect of hand with thumb, index, middle, and lateral half of ring finger. Dorsal aspect of distal 1/3 index, middle, and lateral half of ring finger.
Functional Loss: Pronation weak or lost. Weak wrist flexion and abduction. Radial deviation at wrist lost. Inability to oppose or flex thumb. Weak thumb abduction. Weak grip. Weak or no pinch.



ELBOW ASSESSMENT

When assessing the elbow, you need to be systematic in your assessment as the elbow and wrist are the most frequently injured joints.

1. FAT PADS
2. RADIAL HEAD
3. GROWTH CENTERS
4. HUMERUS AND ULNA

Displacement of the flexor fat pad of the elbow is a reliable sign of joint effusion, and in the case of trauma almost always indicates interarticular haemorrhagea. If both the flexor and extensor fat pads are displaced the joint effusion is quite large as seen frequently in severe transcondylar fractures. Oft times the fat pad displacements are the only signs of fracture, and it behooves the attending physician to then immobilize the joint and obtain a follow up film in seven to ten days. Note the normal position of the flexor fat pad as seen in the lateral projection in figure 1.

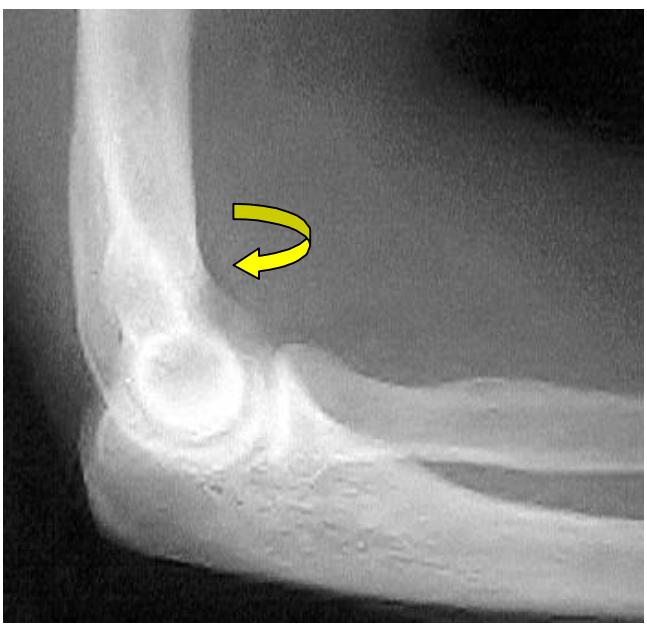


Figure # 1 (right). Yellow arrow points to the normal position of the flexor fat pad of the elbow. Note its position adjacent to the anterior cortex of the distal humerus. You must look for this fat pad on every elbow examination because its displacement signifies fluid (such as hemorrhage) in the joint.

FAT PADS IN THE ELBOW

The extensor fat pad is usually not visible in a normal elbow joint. If you see it as shown in figure 2, it almost always indicates fluid or haemorrhage in the joint. Also note in figure 2 the anterior displacement of the flexor fat pad when compared to the normal position in figure 1.

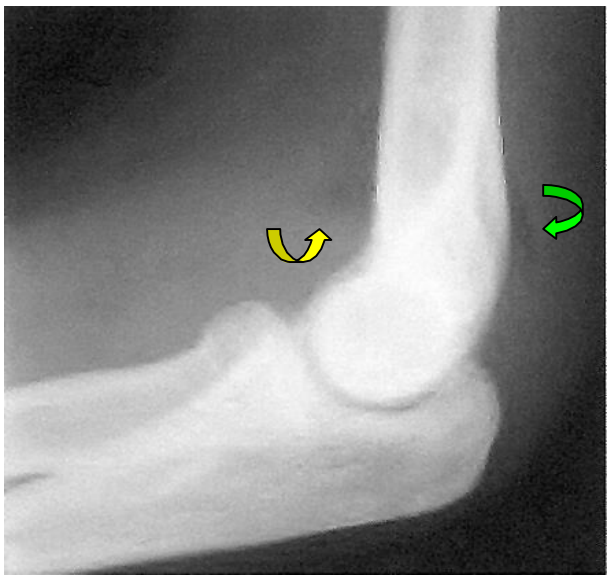
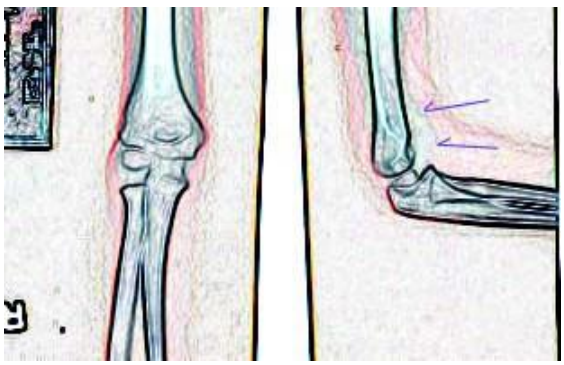


Figure # 2 (left). Green arrow shows the extensor fat pad in this patient with an elbow injury. The yellow arrow shows an elevated flexor fat pad which is better seen on the original radiograph, but you can get an idea of what to look for by referring to another case with an accompanying edge-enhanced sketch below.

Figures # 3(below left) and # 4 (below right). Another case of interarticular hemorrhage showing displaced fat pads (arrows).



ELBOW: RADIUS AND ULNA

The fat pads of the elbow should be the first things you look for when evaluating the joint. If they are displaced, chances are there is a fracture somewhere (in trauma cases). In these cases you should immobilize the joint and obtain follow up films in 7 to 10 days, which will often show evidence of a healing fracture such as periosteal new bone formation or early callus.

The radial head evaluation includes its position in relation to the ulna as well as a look for fractures.
Even experienced radiologists or orthopedic surgeons may miss a dislocated radial head if they focus on an obvious fracture of the ulna. The combination of fracture of the shaft of the ulna and a dislocated radial head is known as a Monteggia fracture. The head of the radius should superimpose the ulna in all projections and a line drawn along the long axis of the radius should intersect the capitellum (refer back to the normal position in figure 1). Note its position in a patient with Monteggia's fracture in Figure 4.

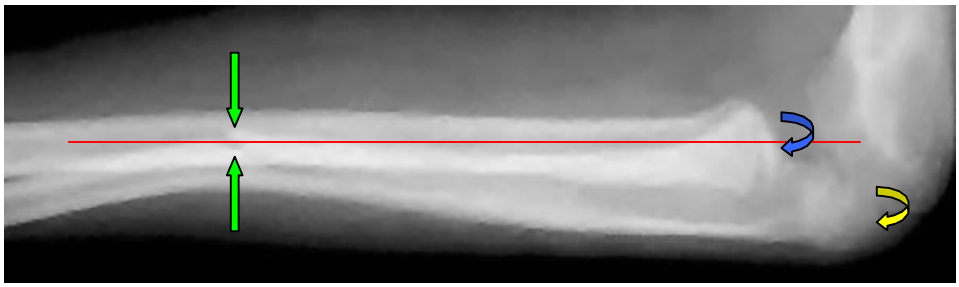


Figure # 4(above). A line (red) drawn along the long axis of the radius misses the capitellum (yellow arrow) indicating a dislocated radial head (blue arrow) in this patient with a Monteggia's fracture (green arrows). Courtesy of Lynette L. Young, MD U. of Hawaii via the internet. www2.hawaii.edu/medicine/pediatrics

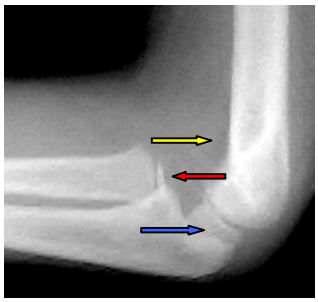


Figure # 5(left). Here's another look at the elbow in the case of Monteggia's fracture above. Note the fat pad is adjacent to the bone (yellow arrow). The radial head, in this case the epiphysis (red arrow) does not point at the capitellum (blue arrow).
Compare the position to the normal in figure 205.
www2.hawaii.edu/medicine/pediatrics

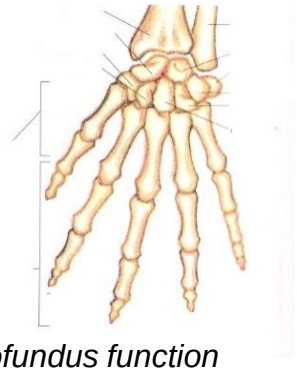
Figure # 6 (above). Normal elbow in a seven year old male. Note the alignment of the radial head (epiphysis) and shaft (long red arrows) with the capitellum (blue C). Also all of the growth centers of the elbow are visible in the radiographs above. Can you identify them? Radiographs courtesy of Alson S. Inaba, MD, author and Loren Yamamoto, MD, web page author, U of Hawaii via the Internet. www2.hawaii.edu/medicine/pediatrics

The growth centers of the elbow can be very confusing to the student. There are usually six and sometimes seven of them that appear at various ages. The capitellum (also spelled capitulum) and lateral part of the trochlea appear at 1 to 1 1/2 years of age and I for one am always getting them confused. One way to remember which side the capitellum is on is to think of the radial head as having a CAP. The lateral, also called the external, epicondyle is just above (cephalad) and lateral to the capitellum and appears at about age 14. It is the site of frequent inflammatory episodes called tennis elbow but the radiographs taken for this clinical diagnosis are usually negative. The medial, also called the internal, epicondyle appears at about age 8 or 9 (earlier in females).

FOREARM MUSCULATURE

- 2 flexors (plus palmaris longus if you've got it) and 3 extensors are the motors of the wrist
  Can you identify them:
- 4 additional muscles control pronation/ supination of the forearm
  Can you identify them:

FOREARM MUSCULATURE



- **Anterior Compartment** (from medial to lateral, superficial then deep)

- Which principle movements occur in this compartment?

- Flexor carpi radialis
- Flexor digitorum superficialis
- Flexor digitorum profundus

How would you test flexor digitorum superficialis and flexor digitorum profundus function independently of each other?

- Palmaris longus (if present)
- Flexor carpi ulnaris
- Flexor pollicis longus
- Pronator quadratus

Posterior Compartment (from lateral to medial, superficial then deep)
- Which principle movements occur in this compartment?

- Brachioradialis
- Extensor carpi radialis longus
- Extensor carpi radialis brevis
- Extensor digitorum
- Extensor digiti minimi
- Extensor carpi ulnaris
- Abductor pollicis longus
- Extensor pollicis brevis
- Extensor pollicis longus
- Extensor indicis
- Supinator

- In 10% of people, the tip of the thumb and index finger always function simultaneously. Are you with the majority?

HAND AND WRIST

Ulna
- Styloid process
- Triangular fibrocartilage complex
    - Allows ulnar articulation with lunate and triquetrum.

Radius
- Articulating surface for the scaphoid and for the lunate.

Identify the distal radioulnar joint.
Which parts of the radius and ulna form this joint?

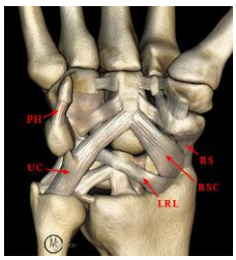
- Colles' fracture, a complete transverse fracture within the distal 2cm of the radius is the most common fracture in the forearm. The distal fragment is displaced dorsally and results from forced dorsiflexion of the hand, usually as a fall by outstretching the upper limb.
- Colles' fracture causes a dinner fork deformity named for the 'jog' that occurs just proximal to the wrist (produced by posterior displacement and tilt of distal radius fragment).

Carpals
- Carpals are organised into a moveable proximal row and an immovable distal row.
- You can use the following mnemonic to remember them:**S**ome **L**overs **T**ry **P**ositions **T**hat **T**hey **C**an't **H**andle

Proximal Row
- Scaphoid
- Lunate
- Triquetrum
- Pisiform

    - Located within flexor carpi ulnaris tendon to enhance mechanical advantage.

Distal Row
- Held immobile by strong interosseous ligaments.
- Trapezium
- Trapezoid
- Capitate
- Hamate



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WRIST JOINTS

- Radiocarpal Joint
- Midcarpal Joint
    - Between Proximal and Distal Rows
- Intercarpal Joints
    - Between adjacent carpals.

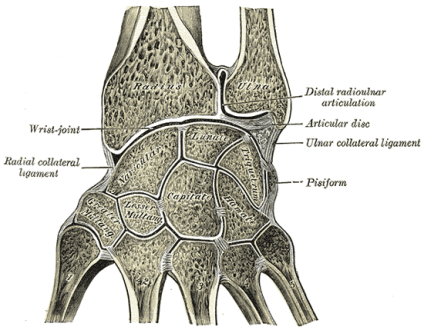
What is the relationship between the distal ulna and the carpals?

What movements occur at the radiocarpal joint? Radioulnar joint?

WRISTS

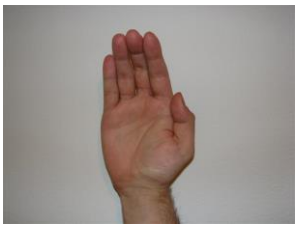
Ligaments

- Important for intracarpal alignment and load transmission.



- Palmar (volar) ligaments
    - Thick and strong.
- Dorsal ligaments
    - Thin and fewer in number.
- Extrinsic ligaments
    - Palmar:
        - Radial collateral ligament (superficial and deep layers)
        - Ulnar ligament complex
            - Ulnolunate ligament (palmar border of triangular fibrocartilage with lunate)
            - Ulnar collateral ligament
    - Dorsal
        - Radiocarpal ligament (3 bands: radioscaphoid, radiolunate, radiotriquetral).

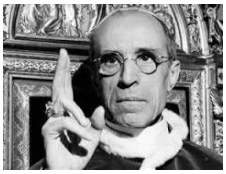
CLINICAL WRIST AND HAND PATHOLOGIES



Common Pathologies:

Ape hand deformity
- Wasting of the thenar eminence as a result of median nerve palsy.
- Thumb falls back in line with the fingers as a result of extensor muscle pulling.
- Patient unable to flex or oppose the thumb.

Hand of Benediction
- Wasting of hypothenar muscles, interossei, and two medial lumbricals due to ulnar nerve palsy.



Drop-Wrist deformity
- Radial nerve palsy and extensors not functioning.

Dupuytren contracture
- Progressive genetic disease-conracture of the palmar fascia
- Fixed flexion deformity of MCP and PIP joints
- Usually seen in ring or little finger-skin often adherent to fascia.

Swan Neck Deformity
- Flexion of MCP and DIP, extension of PIP
- Result of contracture of intrinsic muscles
- Often seen in rheumatoid arthritis or following trauma

Trigger Finger
- Thickening of flexor tendon sheath causing sticking of tendon when patient attempts to flex finger.
- As condition worsens, the finger won't let go and fixe flexion deformity occurs.
- Usually occurs in 3rd-4th finger.
- Associated with rheumatoid arthritis- worse in the morning

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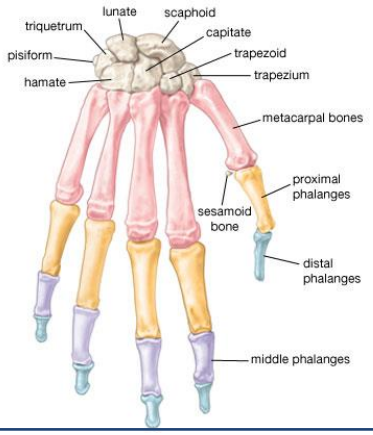
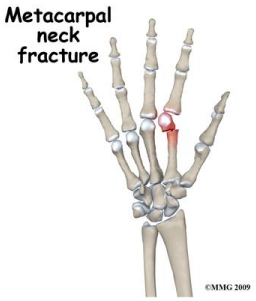
HAND

Metacarpals
- I-V
- Head
- Neck

Phalanges
- Proximal
- Intermediate
- Distal





JOINTS

- Metacarpophalangeal (MCP) Joints
- Interphalangeal Joints
    - Proximal interphalangeal joints (PIP joints)
    - Distal interphalangeal joints (DIP joints)

All digital articulations are designed to function in flexion.

LIGAMENTS AND TENDONS

- Retinacular system
    - Restrain joints, tendons, skin, nerves, and blood vessels

- Palmar (volar) Plate
    - Attached to base of proximal phalanx and palmar (volar) surface of the metacarpal neck.
    - Prevent flexor tendon impingement during metacarpophalangeal MCP flexion.
    - Limit MCP hyperextension

LIGAMENTS AND TENDONS

- Digital Extensor Assembly System
  - Long extensor tendons held over MCP by sagittal bands
  - Allow release of distal phalanx.
  - Lateral bands slack during PIP flexion. This allows active flexion, but no active extension of DIP.

Try it- I bet you can't do it!

- Digital Flexor Tendon Sheath Pulley System
  - Most tendons restrained by tendon sheaths to limit bowstringing across joints.
  - Pulley system:
    - 5 annular pulleys (A1-A5) and three inner cruciform pulleys (C1-C3).
    - Pulleys allow for smooth a smooth curve to limit local points of high pressure.

- Digital Collateral Ligaments
  - MCP Collateral Ligaments
    - Oblique from dorsolateral MCP to palmolateral base of proximal phalanx.
    - Dorsal portions provide restraining force during MCP flexion (ligaments are taught during MCP flexion)
    - Palmar portions limit MCP extension (ligaments slack during extension).
    - Fingers cannot be abducted unless hand is extended.

Try it- I bet you can't do it!

WRIST MOVEMENTS

Which muscles are used to perform the following actions?

Supination:

_____

Pronation:

_____

Wrist flexion:

_____

Wrist extension:

_____

Wrist ulnar deviation (adduction):

_____

Wrist radial deviation (abduction):

_____

Proximal interphalangeal flexion:

_____

Distal interphalangeal flexion:

_____

HAND MUSCULATURE

- Extrinsic Muscles (cross wrist)
  - Allow larger and stronger gross movements for grasping and pinching.
- Intrinsic Muscles
  - Position digits for motion (either powerful grip, or delicate motor tasks).

The intrinsic muscles associated with the first digit (thumb, pollex) and the fifth digit (little finger, digiti minimi) are generally arranged on the palmar surface of the hand into two eminences – the thenar and hypothenar eminences.

- Thenar eminence:
  - Abductor pollicis brevis
  - Opponens pollicis
  - Flexor pollicis brevis

- Adductor pollicis
  - Is located neither in the thenar or hypothenar eminence.

- Hypothenar eminence:
  - Opponens digiti minimi
  - Flexor digiti minimi
  - Abductor digiti minimi

These muscles can be remembered with the acronym A OF A OF A (abductor pollicis brevis, opponens pollicis, flexor pollicis brevis-thenar muscles- adductor pollicis- opponens digiti minimi, flexor digiti minimi, abductor digiti minimi-hypothenar muscles)

DEEP MUSCULATURE

- Lumbricals
- Palmar interossei
- Dorsal interossei

How are the interossei and lumbricals used in writing?

Which muscles are tested by performing a “pincer grip” with thumb and index finger?

HAND MUSCULATURE

Innervation

- Radial Nerve
    - Wrist and digit extensors.
    - Impairment causes wrist drop, impedes hand grasp

Try it!

- Median Nerve
    - Wrist and Hand extrinsic flexors
    - Critical to fine motor hand function
- Ulnar Nerve
    - Power source for grasping
    - Intrinsic hand musculature

Loss of extensors severely weakens grip. Why?

EVALUATION OF THE HAND AND WRIST

Evaluation of the hand and wrist usually does not cause problems to the untrained eye because fractures and dislocations are usually obvious. Occasionally, however, subtle lesions can be missed, and we will therefore give you a system to reduce the chance of a miss, leaving interpretation of more complex processes such as the arthridities to the radiologist, rheumatologist and orthopedic surgeons. Remember to always splint the affected part in cases of trauma, and you will have acted properly.

A system for looking at the bones of the hand and wrist includes: Sam's Cortices

1. Soft tissues
2. Arcs
3. Mnemonic
4. Styloid processes 5-Cortices

Those not trained in trauma often ignore soft tissues, but radiologists will frequently look at soft tissue outlines first, if for nothing else to use as a clue to the site of injury. See if you can zero in on the site of injury in some of the following presentations.

EVALUATION OF THE HAND AND WRIST

The wrist has three curves, two of which are concave and one that is convex as seen in the AP projection. Refer to figure 7.

Figure # 8 (right). Look for the three arcs or curves of the wrist on your initial evaluation of the AP view. Any disruption of one of these arcs may signal a dislocation. The radial-carpal arc (red) should align the navicular, lunate, and triquetrum with the natural curve of the radius-articulating surface. The intercarpal curve is shown in blue, and the carpal- metacarpal arc in black.

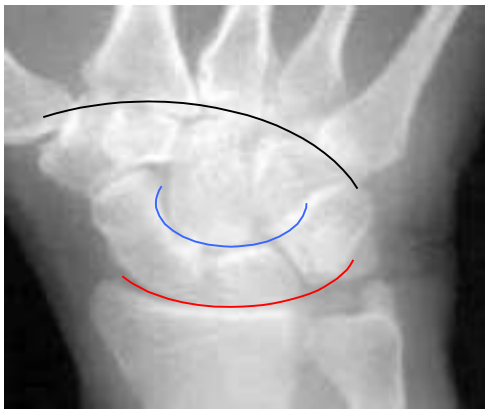
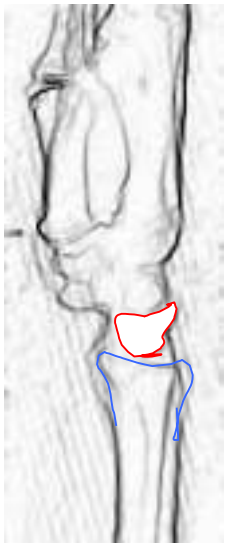


Figure # 208 (left). Lateral view of a normal wrist. Note the position of the lunate in relation to the articulating surface of the distal radius. See drawing in figure 209 (right).

Figure # 209 (right). The lunate, outlined in red, should always align with the distal articulating surface of the radius, outlined in blue.



Any break in the curves is a red flag for a subluxation or dislocation. In evaluating positions the curves are important as well as the position of the lunate in the lateral view. Note the position of the normal lunate in relation to the articulating surface of the radius in figures 8 and 9 on the previous page.

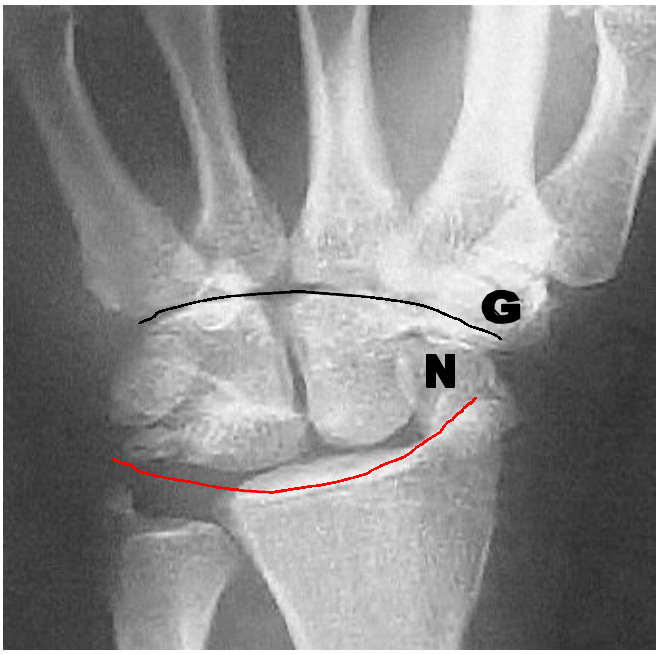


Figure # 9 (left). Note that you can draw the radial-carpal arc (red) and the carpal- metacarpal arc (black), but the intercarpal curve is not apparent. Also note the navicular (N) superimposes the radial styloid process in this AP view, and the greater multangular (G) is displaced distal to the black curve. This trauma patient has a trans-carpal dislocation as confirmed in the lateral view (figure 211) below.

Figure # 10 (right). Lateral view of the same patient. Note that although the lunate remains aligned with the distal radius, the remainder of the carpal bones are dislocated dorsally. Films courtesy of the EMBBS library via the Internet. www.embbs.com

It is also easy to miss a subtle scaphoid-lunate dissociation, so I look specifically for widening of the space between the two. Note the normal relationship in figure 212.

Figure # 11 (left). Note the normal width of the navicular (also called the scaphoid) – lunate space (arrows). This is the same radiograph as seen in figure 207.

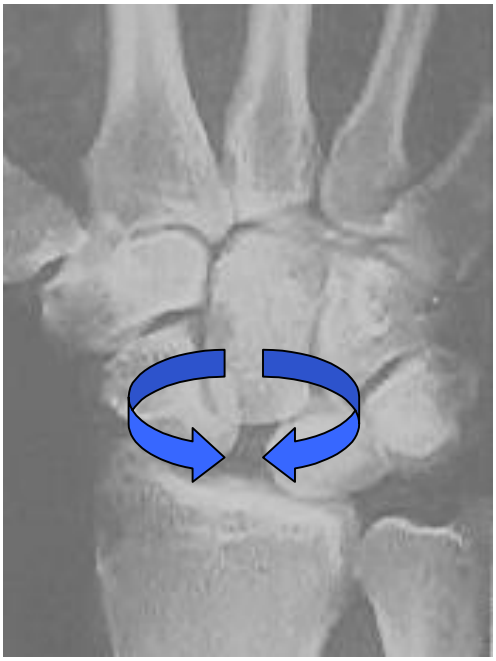


Figure # 12 (right). Note the widened space (blue arrows) between the scaphoid (navicular) and the lunate in this patient with a ruptured scaphoid-lunate ligament. The gap between these carpal bones is called the “Terry Thomas Sign” or “David Letterman Sign” after the famous gaps in their front teeth. Wrist arthrography (invasive) or MRI (non-invasive) can confirm the diagnosis.

Even after years of looking at small parts like the bones of the hand and wrist, I still take the time to look at each bone with a magnifying glass while reciting the famous (or is it infamous?) mnemonic, "never lower Tillie's panties, grandma might come home", to identify each of the carpal bones. For you youngster's who are not familiar with it, each first letter of the mnemonic stands for the first letter of one of the bones, i.e. Navicular, Lunate, Triquetum (or triangular), Pisiform, Greater multangular, Multangular (lesser), Capitate (or cunate), and Hamate. This process forces me to evaluate each carpal bone for position, possible fractures etc. Therefore, the third word in your system should be mnemonic

EVALUATION OF THE HAND AND WRIST

One of the common fracture injuries is that of the carpal navicular, and if the ordering physician or PA is astute he or she will request a magnified view if there is tenderness in the anatomic snuffbox. Appreciate how easy it is to diagnose a fracture of the navicular with a magnified view as shown in figure 14.

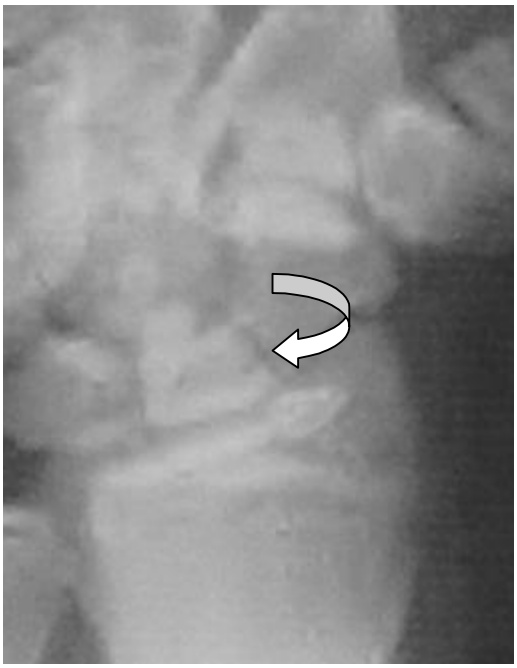


Figure # 13 (left). Even though this magnified view of the navicular did not reproduce well, it is still relatively easy to see the fracture line (arrow).

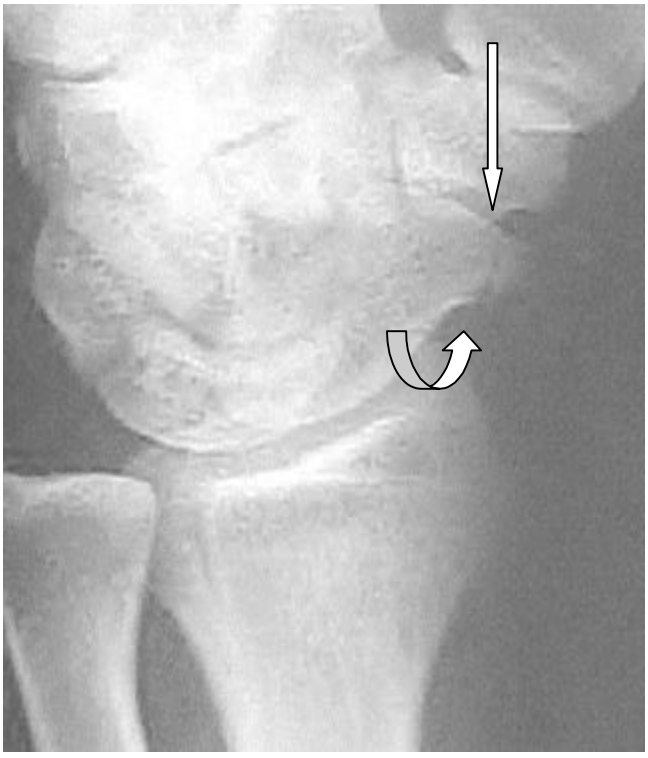


Figure # 14 (right). Here's another magnified view with the hand in ulnar deviation. This fracture (arrows) might not have been seen without special views.

We target the radial and ulnar styloid processes specifically because fractures are so common in these locations. Sometimes all that can be discerned is a small wrinkle in the cortex which is why the cortices are included in the system. Also the cortices of the distal radius are subject to greenstick injuries known in the trade as torus fractures. These lesions are demonstrated in figures 16 and 17. The torus fracture in figure 17can be classified as an Aunt Minnie.

Torus fractures are often seen in paediatric x-rays. Childrens bones are more malleable and torus fractures can be easily missed. If clinically tender, consider ingtreat as a fracture.

Figure # 15 (left) Looking at the styloid processes, in this case the ulnar styloid, often yields a fracture diagnosis as shown here (arrow). Let's see how sharp you are; what else is wrong with this wrist?

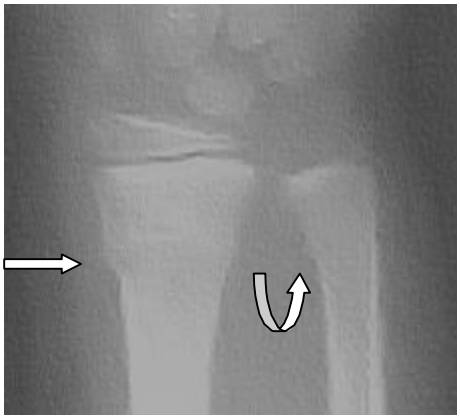


Figure # 16 (right). The torus fractures of the radius and ulna demonstrated here by the wrinkles in the cortex (arrows) are "Aunt Minnies". You should never miss one.

.

Figure # 17 (right). See figure 22

We target the radial and ulnar styloid processes specifically because fractures are so common in these locations. Sometimes all that can be discerned is a small wrinkle in the cortex which is why the cortices are included in the system. Also the cortices of the distal radius are subject to greenstick injuries known in the trade as torus fractures. These lesions are demonstrated in figures 16 and 17. The torus fracture in figure 17can be classified as an Aunt Minnie.

Figure # 18 (left). A short ulna or ulna minus deformity is a variation of Madelung's deformity as shown here.

Figure # 19 (right). Here's a kind of neat Aunt Minnie. The beak-like bony structure (arrow) extending from the anterior cortex of the distal humerus is called a supracondylar process. It is a vestigial structure analogous to a rooster's spur. The brachial artery often divides around this structure. It usually does not have any clinical implications.

Finally, a word or few about the Salter-Harris classification of fractures through the epiphysis and physis is in order.

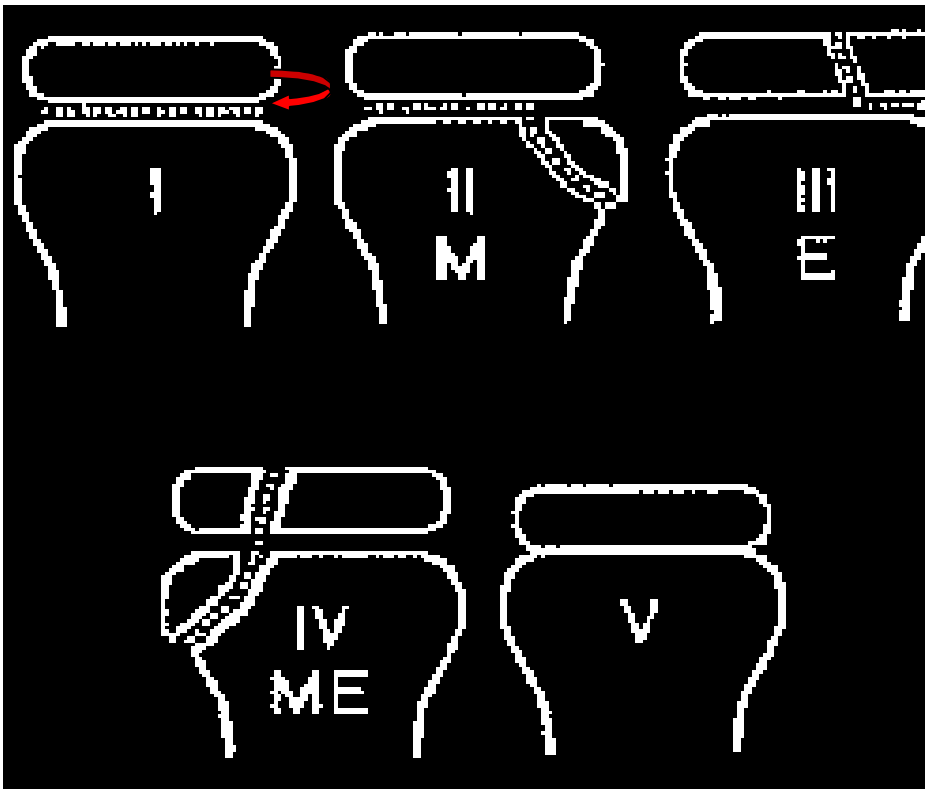


Figure # 20 (up). Salter-Harris classification of fractures is shown here courtesy of Drs. Chung, Inaba, and Yamamoto as noted above. The curved red arrow points to a dotted line indicating a fracture through the physis, classified as a Salter-Harris type I. The physis may or may not be widened, and therefore the injury may or may not be visible on the radiograph initially. The type II lesion shows an obvious fracture through the metaphysis, but again the physis may or may not be widened. Likewise for the physis in a type III fracture through the epiphyseal plate. A type IV fracture is usually associated with a widened physis. A type V injury is rare, where the physis is jammed or compacted into the metaphysis. There are often displaced fragments in the type II, III, and IV injuries. www2.hawaii.edu/medicine/pediatrics

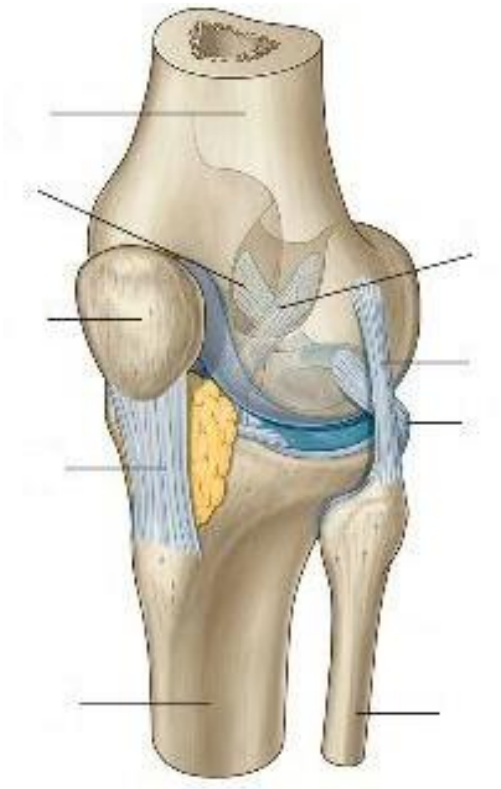
LOWER LIMB

Lower Limb Assessment

Prior to discussion of the assessment and management of clinical presentations in class, you need to be aware of the relevant anatomy and physiology related to lower limb assessment.

Using published and web resources to assist you, label the following series of diagrams related to lower limb assessment

The Knee

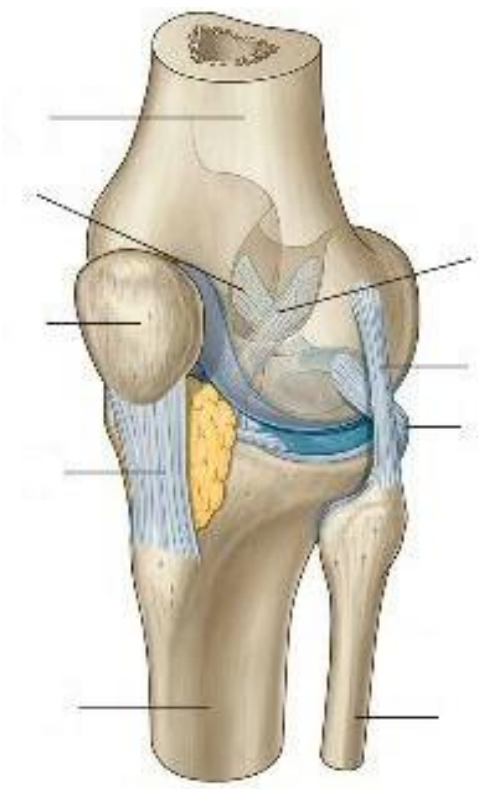


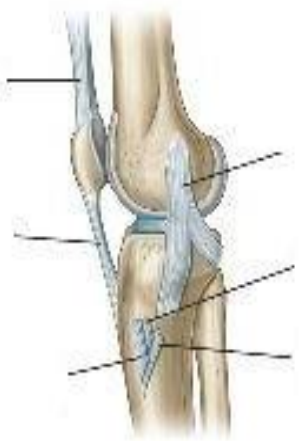
BELMATT
HEALTHCARE TRAINING

Lower Limb Anatomy

Label the diagrams

The Knee





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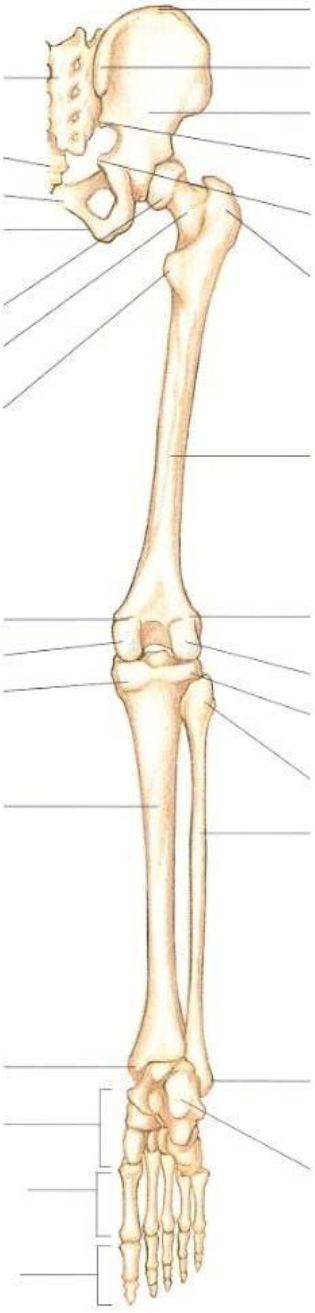
Lower Limb Anatomy

The Knee



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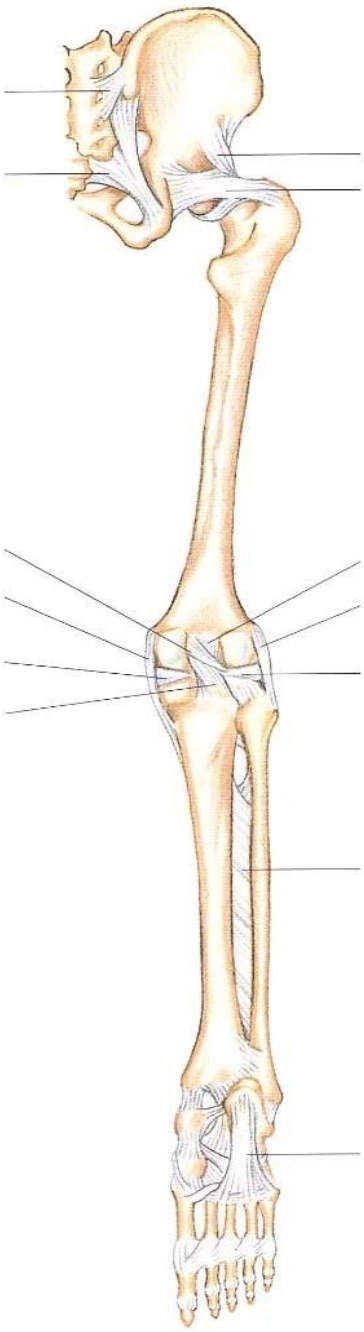
Lower Limb Assessment

Posterior Leg With Ligaments



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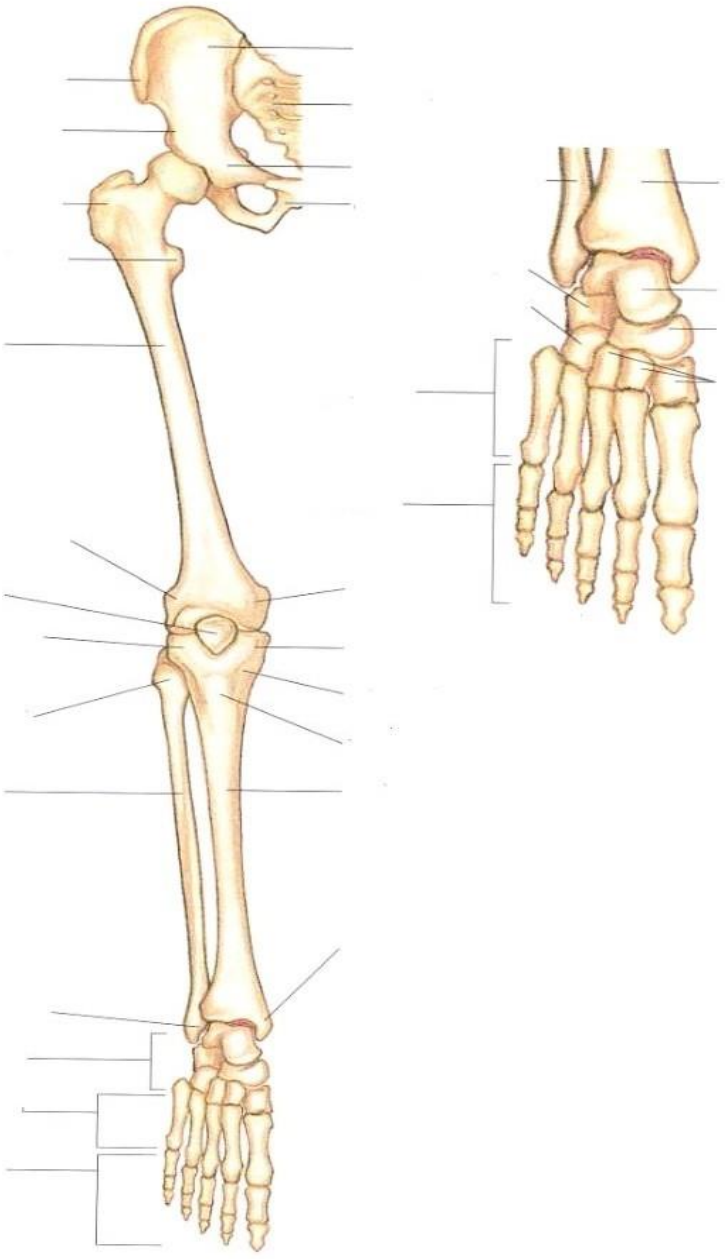
Lower Limb Assessment



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Lower Limb Assessment

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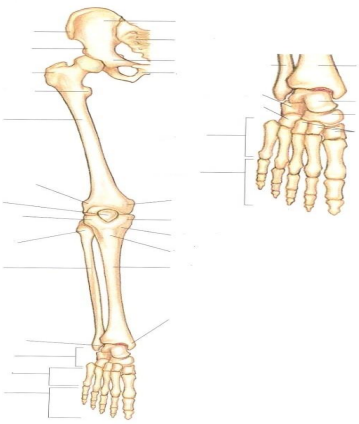
CLINICAL KNEE ANATOMY:

• Distal femur:
o Femoral condyles
§ Medial vs. Lateral
o Patellar surface
§ Patellofemoral pain syndrome
o Femoral epicondyles

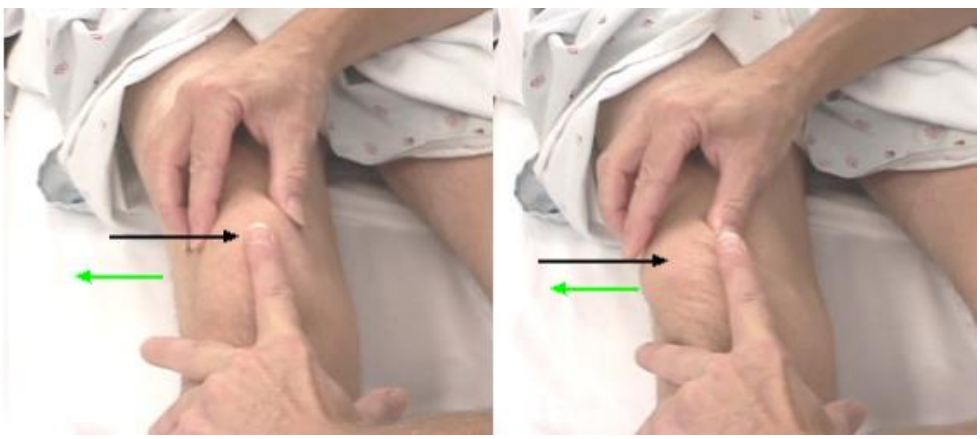
• Meniscus
o Why are tears of the medial meniscus more common than tears of the lateral meniscus?

• Tibia:
o Tibial condyles
o Tibial plateau
o Intercondylar eminence
o Tibial tuberosity

• Patella:
o Articular surface
o Patellar ligament vs. Quadriceps tendon



Patellar Apprehension Test

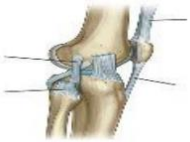


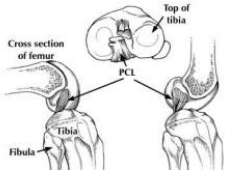
CLINICAL KNEE ANATOMY:

• Genu Varum and Genu Valgum
o Genu varum (bowleg) is characteristic in certain conditions such as rickets. Excessive pressure is taken by the medial side of the knee joint in this condition.

o Genu valgum (knock knee) is normal in children under the age of six. Excessive pressure is taken by the lateral side of the knee joint in this condition
o If either of these conditions are not corrected in the adult, they can lead to the development of osteoarthritis.

LIGAMENTS





Anterior cruciate ligament
o Restraint to anterior tibial displacement.
• Posterior cruciate ligament

o Restraint to posterior tibial displacement.
• Medial (tibial) collateral ligament

o Resists valgus
o Stronger than LCL (LCL reinforced by iliotibial band).
• Lateral (fibular) collateral ligament

o Primary restraint to varus load.
o More mobile than MCL
• If a force applied against the knee when the foot cannot move, ligament injuries are likely.
• Tearing of the medial collateral ligament may also tear the medial meniscus due to their firm attachment. This often results from twisting the knee whilst flexed.
• Additionally, an “unhappy triad” may occur when the anterior cruciate ligament is also ruptured. What specific movements cause the unhappy triad?

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MUSCLES

Anterior Compartment
- primarily extension of the knee
• Tensor fasciae latae
o Lateral knee stabilisation.
• Vastus lateralis
• Vastus intermedius
• Vastus medialis
• Linea aspera
- Quadriceps:
o Predominate at all times during knee motion.
o Generate most of the muscle force on the knee

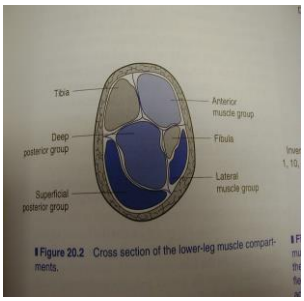
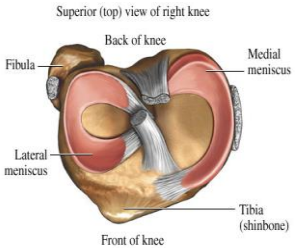
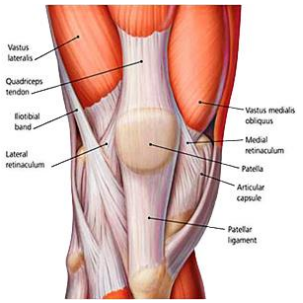


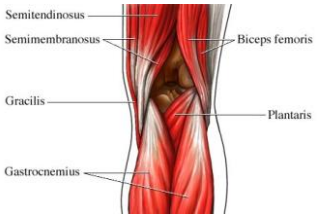
Figure 20.2 Cross section of the lower-leg muscle compartments.





Posterior Compartment
- Primarily knee flexion
• Biceps femoris
• Semitendinosus and Semimembranosus
• Plantaris
• Popliteus

Medial Compartment
• Gracilis
• Sartorius

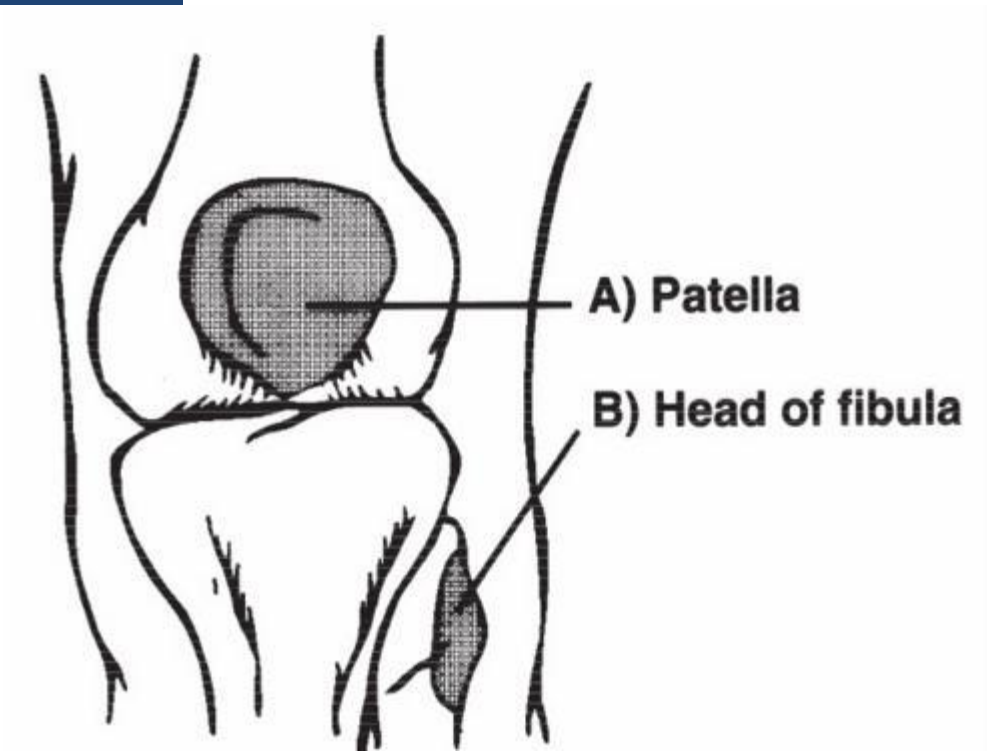


Pes Anserinus (“goose’s foot”)
o The insertion of Sartorius, gracilis, and semitendinosus.
o Irritation of the underlying bursa from overuse or injury can cause inflammation.

CLINICAL KNEE ASSESSMENT

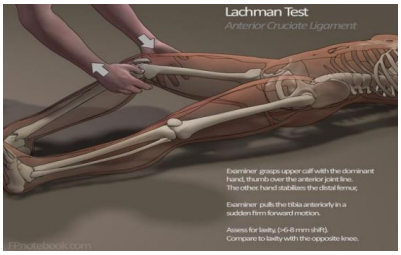
Ottawa Knee Rules:
- Xrays are only required if the following are present:
o Isolated bony tenderness of the patella
o Bony tenderness of fibula head
o Patient cannot flex knee to 900
o Patient cannot weight bear (4 steps) after injury or in A&E

Ottawa Knee Rules



COMMON MECHANISMS OF INJURY

Varus/valgus contact without rotation
Injured structures:
Collateral ligament, epiphyseal fracture, patellar dislocation
Varus/valgus contact with rotation
Injured structures:
Collateral and cruciate ligaments, patellar dislocation, meniscus tear

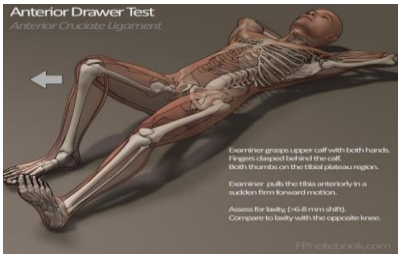


Hyperextension
- Injured structures:
    - ACL, PCL, posterior capsule

Hyperflexion
- Injured structures:
    - Meniscus (posterior horn), ACL

Forced internal rotation
- Injured structures:
    - Lateral meniscus

Forced external rotation
- Injured structures:
    - Medial meniscus, MCL, ACL

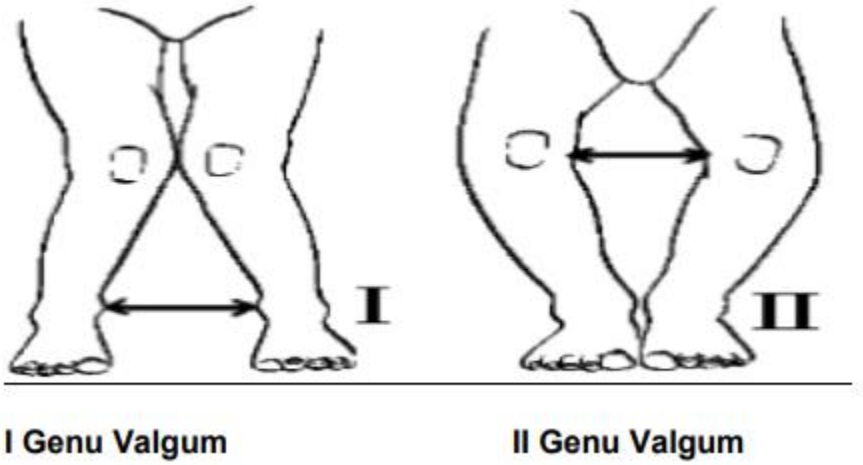


Genu valgum
- Possible correlated motions:
    - Pes planus
    - Excessive subtalar pronation
    - Lateral patellar subluxation
    - Excessive hip adduction
    - Ipsilateral hip excessive internal rotation
    - Lumbar spine contralateral rotation
- Possible compensatory motions:
    - Forefoot varus, excessive subtalar supination (allow lateral heel to contact ground), in-toeing (decrease lateral pelvic sway during gait), ipsilateral pelvic lateral rotation.

COMMON MECHANISMS OF INJURY

Genu varum
Possible correlated motions:
- Excessive lateral angulation of the tibia in the frontal plane; tibial varum. Medial tibial torsion, ipsilateral hip lateral rotation. Excessive hip abduction

Possible compensatory motions:
- forefoot valgus, excessive subtalar pronation to allow the medial heel to contact the ground, ipsilateral pelvic medial rotation.



I Genu Valgum II Genu Valgum

SPECIFIC TESTS

- Joint line tenderness (meniscal pathology)
- Childress sign (duck squat- meniscus)
- Anterior/Posterior drawer tests
- Lachman's test
- McMurray test (no longer recommended)
    - Low sensitivity, reliabilty, and pain.

KNEE MUSCLES AND REFERRED PAIN

Tensor fasciae latae:
- Lateral aspect of thigh

Sartorius:
- Over course of muscle

Quadriceps:
- Anterior thigh, patella, lateral thigh, and knee (vastus lateralis)

Adductor Longus/Brevis
- Superior anterolateral thigh, anterior thigh, proximal to patella and sometimes down anteriomedial leg.

Gracilis
- Medial thigh (midportion)

Semimembranosus/semitendinosus
- Ischial tuberosity, posterior thigh, posteromedial calf

Biceps femoris
- Posterior knee up posterior thigh

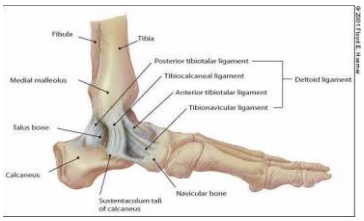
Gastrocnemius
- Posterior knee, posterolateral calf, posteromedial calf to foot instep

ANKLES AND FEET

Evaluation of the ankles and feet does not require a great deal of detail since the principles are similar to other small parts studies, which we have already discussed. Thus we will limit our discussion to a few salient points.

A system to memorize might include:

1. Soft tissues
2. Ankle mortise width
3. Base of the 5th metatarsal 4-cortices



CLINICAL ANKLE AND FOOT ANATOMY

Tibia

- Medial malleolus

Fibula:

Tarsals:

- Talus
- Calcaneus
    - Forms the “heel” of the foot and consequently receives the ground reaction forces during the heel strike portion of initial contact.
- Navicular
- Cuboid
- Medial, middle and lateral cuneiform
- Metatarsals and phalanges

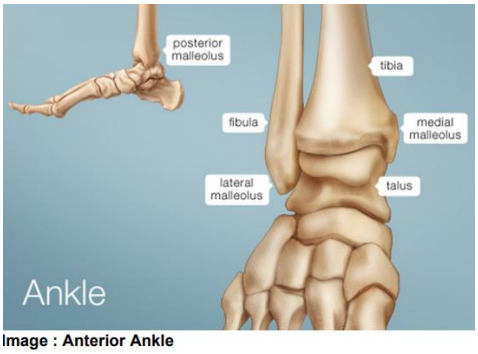
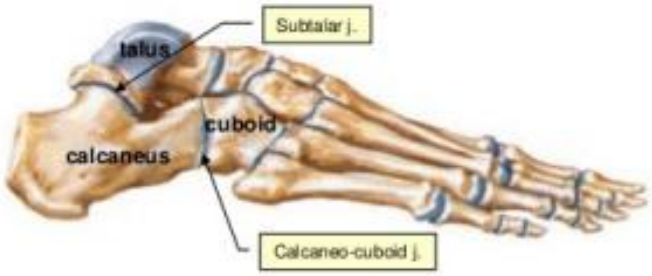
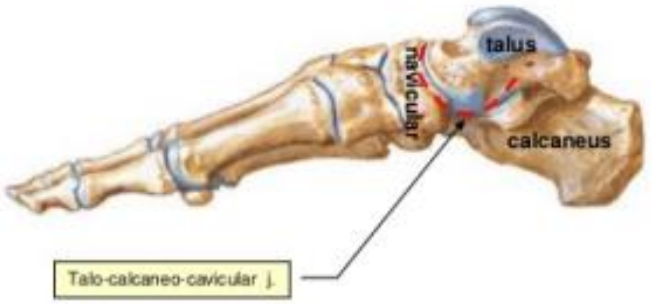


Image : Anterior Ankle

Joints of inversion and eversion: anatomical classification

- **Subtalar joint**
  - Synovial joint between the inferior surface of the body of the talus and the superior surface of the calcaneus.
- **talocalcaneonavicular joint**
  - Synovial joint between the head of the talus on one side and the posterior surface of the navicular, superior surface of the spring ligament, and the sustentaculum tali of the calcaneus on the other side.
- **calcaneocuboid joint**
  - Synovial joint between the anterior surface of the calcaneus and the posterior surface of the cuboid.





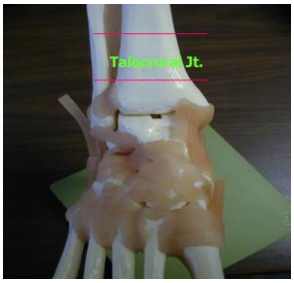
THE ANKLE (TALOCRURAL JOINT)

The ankle joint is a synovial hinge joint and is formed between the distal tibia, distal fibula and the talus.

Ankle Movements

- Dorsiflexion: 10-20o
- Plantarflexion: 40-55o

- These movements allow forward progression during locomotion.



Ligamentous Support of Talocrural Joint.

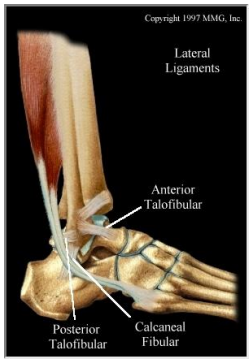
- Approximately 90% of all ankle sprains are supination injuries.

Lateral Ligaments

- Resist supination

- Anterior talofibular ligament
    - Resists ankle inversion during plantar flexion
    - Most commonly sprained

- Calcaneofibular
    - Resists ankle inversion during dorsiflexion
    - Second most commonly sprained ankle ligament



Medial Ligaments

- Deltoid
    - Resist pronation

Syndesmotic Ligaments

- Maintain stability between distal fibula and tibia.

- Anterior tibiofibular
- Posterior tibiofibular
- Transverse tibiofibular ligament
- Interosseous membrane

PARTS OF THE FOOT

- The foot can be divided into hindfoot, midfoot, and forefoot.

Hindfoot
- Comprises the talus and calcaneus
- Includes the subtalar joint
- Includes heel pad
    - U-shaped and consists of vertical fat-filled columns reinforced by elastic transverse and diagonal fibres to produce a honeycomb effect.
    - Designed to absorb shock.
    - ~ 11,610 heel impacts per mile of walking.

Subtalar Joint
- Includes the talus and calcaneus bones.

Subtalar Movements:
- Equal amounts of inversion/eversion
    - To assess, grasp calcaneus and rock it side to side
- Equal amounts of abduction/adduction
- Limited dorsi/plantar flexion
- Subtalar movement never occurs in isolation to midfoot motion.

Midfoot
- Comprises cuboid, navicular, and cuneiform bones.
- No significant dislocation of metatarsals or cuneiforms can occur unless bone is broken.
    - Fractures through or around 2nd metatarsal base are most common causes of mid tarsal movement.
    - Movements:
- Hindfoot movement never occurs in isolation to midfoot motion.

INTERTARSAL JOINTS

- Are closely congruent and exhibit minimal movement amongst each other.

- **Cuneonavicular joint**
  - Plantar calcaneonavicular (Spring) ligament
    - Helps to maintain medial longitudinal arch of the foot.
    - Bears the major portion of body weight by supporting the head of the talus.
    - Disruption of this ligament contributes to talar vertical tilt and hindfoot valgus.

- **Cuneocuboid joint**
  - Calcaneocuboid ligaments
    - Maintain the arch of the foot
    - Short Plantar and Long Plantar Ligaments

TARSOMETATARSAL (LISFRANC) JOINTS

- Intrinsically stable due to an arch-like configuration.
- 2nd metatarsal joint rigidity is the central structure of the medial longitudinal arch.
  - It provides a rigid lever for push-off in late stance.
- Motion of 1st, 4th, and 5th joints greater than 2nd and 3rd.
  - 1st tarsometatarsal joint ~10o plantar flexion.

HINDFOOT (SUBTALAR)-MIDFOOT (TRANSVERSE TARSAL) RELATIONSHIP

- Subtalar pronation/supination give flexibility to transverse tarsal joint.
- Subtalar eversion: both longitudinal and oblique axes are parallel.
  - This allows a ‘loose packed’ condition for the transverse tarsal joint which allows motion.
- Subtalar inversion: locks the transverse tarsal joint.
  - This provides rigidity in the midfoot.
  - Transverse tarsal joint is in a “closed packed” position.

FOOT ARCHES

Medial Longitudinal Arch
Components

- Main characteristic is its elasticity.
- Weakest part is talonavicular joint, though the plantar calcaneonavicular (spring) ligament reinforces.
- Calcaneonavicular (spring) ligament blends with deltoid ligament and is supported inferiorly by tibialis posterior tendon.
- Plantar aponeurosis also supports the medial longitudinal arch.
- Three most important contributors to arch stability
    - Plantar Fascia
    - Long/Short Plantar ligaments
    - Calcaneonavicular (spring) ligament

Lateral Longitudinal
Components

- Principle joint is calcaneocuboid joint. This joint is able to lock and allow limited movement.
- Reinforced by short and long plantar ligaments.

MUSCLE CONTROL OF ANKLE

Posterior Compartment
- Primarily plantar flexion

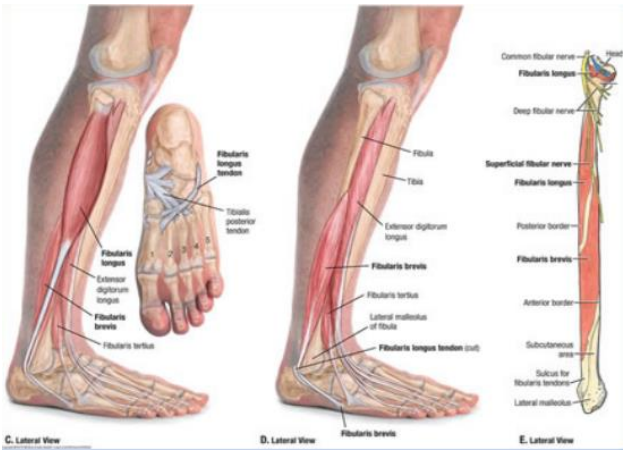
- Gastrocnemius
- Soleus

- Soleus and gastrocnemius both contribute to the calcaneal tendon (Achilles tendon) and through it attach ro the calcaneus.

- **Plantaris**
    - Absent in 10-20% of people.
    - Similar in form and function to palmaris longus
- **Flexor digitorum longus**
- **Flexor hallucis longus**
- **Tibialis posterior**
    - Medial ankle stabilisation.

MUSCLE CONTROL OF ANKLE

Lateral Compartment
This is the smallest of the muscular compartments of the leg and contains two muscles:
- Fibularis (peroneus) longus
- Fibularis (peroneus) brevis



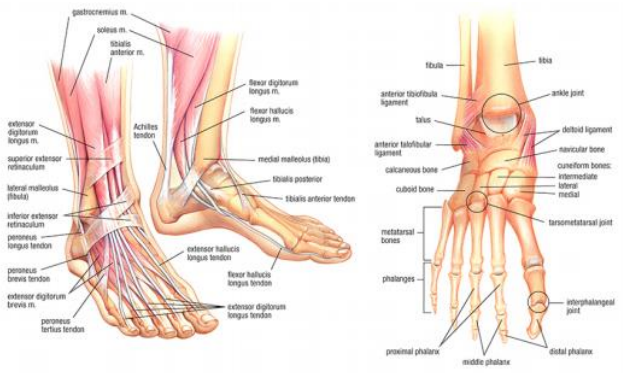
Anterior Compartment
- primarily dorsi flexion
- Tibialis anterior
- Extensor digitorum longus
- Extensor hallucis longus
- Fibularis (peroneus) tertius

Muscle Control of the Foot
- Extensor digitorum brevis
- Extensor hallucis brevis
- Plantar aponeurosis

INITIAL CONTACT DURING RUNNING

Hindfoot running
- Initial ground contact occurs at the hindfoot
- Similar kinematic pattern to normal walking.

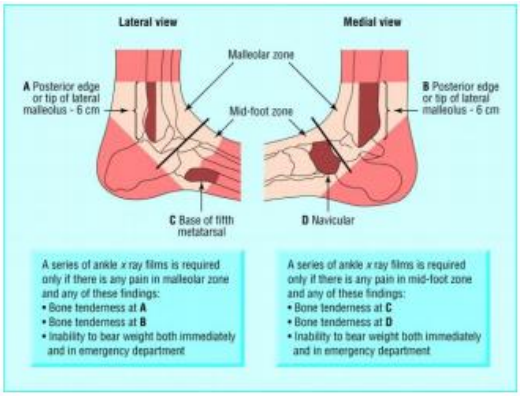
Midfoot running
- Initial contact occurs at heel and forefoot simulteaneously.
- Decreased ankle dorsiflexion.
- Toes extended



Forefoot running
- No heel strike
- Ankle plantarflexed and toes extended
- Foot slightly inverted (supinated)
- Contact occurs on lateral aspect just posterior to metatarsal heads.
- Ankle dorsiflexes and heel comes in contact prior to mid-stance.
- After heel contacts ground, normal kinematic pattern.
- Foot experiences 275% body weight during running

CLINICAL FOOT AND ANKLE ASSESSMENT

Ottawa foot and ankle rules
Xrays only obtained for the following:
- Bone tenderness is present over the lateral or medial malleolus.
- If patient is unable to weight bear for 4 steps both immediately postinjury and in A&E.



Do not order Xrays for the following:
- Patients younger than 15 or older than 60
- Intoxicated patients
- Multiple painful injuries
- Pregnancy
- Head injury
- Or diminished sensation due to neurologic deficit.
- Patients who exhibit laxity of the ATFL without other clinical findings.

Common Mechanisms of injury (malalignment):

- Rearfoot varus (calcaneal varus)
  - Possible correlated motions:
    - Tibial, femoral and pelvic lateral rotation
  - Possible compensatory motions:
    - Excessive internal rotation, hallux valgus, plantar flexed first ray, functional forefoot valgus, prolonged midtarsal pronation.

- Rearfoot valgus(calcaneal valgus)
  - Possible correlated motions:
    - Tibial, femoral and pelvic internal rotation, hallux valgus.

- Possible compensatory motions:
- Excessive external rotation, functional forefoot varus

Mnemonic: (Soft tissue ABC's)

The soft tissue evaluation frequently includes use of the bright light because of the technical difficulties of displaying all parts in good exposure. It also includes a specific look for a positive teardrop sign, which is another displaced fat pad as seen in the lateral view. The "teardrop" is actually a small bursa, which fills with fluid or hemorrhage following injury much the same as the fat pad signs in the elbow. Note the normal position of the anterior fat pad of the ankle as seen in figure 223, and the replacement of fat density by water density in the form of a teardrop as seen in an injured patient in figure 224

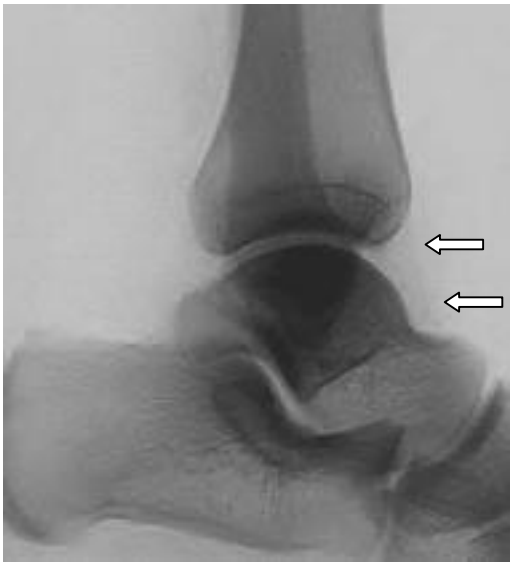


Figure # 21 (left). Note the normal position of the anterior fat pad of the ankle as demonstrated by the arrows in this radiographic negative. Figure #223a (below) shows the area of the fat pad and the location to look for it as outlined in white.

Mnemonic: (Soft tissue ABC's)

Figures #'s 22 (left above) and 22a (above). It takes a little imagination on these reproductions to see the positive teardrop sign of an injured ankle. It's usually much easier on well exposed films, but many times you will have to use the bright light. Do it!

All injured ankles require evaluation of the mortise joint width because disruption of the supporting ligaments is a severe injury sometimes requiring surgical intervention, even if a fracture is not associated. Occasionally stress views are necessary to demonstrate a widened joint. Compare the normal width of the mortise joint in relation to the medial and lateral malleoli in figures 25 and 25a to the widened joint due to a ruptured deltoid ligament.

Figures # 23 and 23a (left & right).
The AP (anterior-posterior) view on the left is an adolescent's ankle. The red arrows indicate the normal width of the mortise joint in the AP view. The oblique or mortise view on the right gives a better perspective of the ankle mortise joint and the normal width as indicated by the blue arrows in this adult patient.

Mnemonic: (Soft tissue ABC's)

Figure # 24 (left). Note the widening of the medial portion of the mortise joint (red arrow) due to a rupture of at least a part of the deltoid ligament.

The base of the fifth metatarsal is the most frequently fractured bone in the foot, so we have learned over the years to look specifically in this area in all cases of trauma to the foot or ankle. To the untrained eye the apophysis at the base of the fifth can be confused with a fracture. However, it's really very easy to tell the difference simply by knowing that the growth center line is parallel to the shaft of the fifth metatarsal and practically all fractures of the fifth are in a transverse plane as demonstrated in figures 27-29.

Figure # 25 (left). The growth center of the proximal fifth metatarsal (red arrow) is oriented near parallel to the proximal cortex (blue and green lines). Whereas a fracture at the base of the fifth is usually oriented transversely as shown by the blue arrow in Figure # 228 (right),

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Mnemonic: (Soft tissue ABC's)

Figure # 26 (left). Note the transverse or horizontal orientation of the fracture at the base of the fifth metatarsal (yellow arrow) as opposed to the vertical orientation of the apophysis as seen in figure 227 on the previous page. Case courtesy of Wheeless Textbook of Orthopedics on line. www.medmedia .com

Occasionally there may be soft tissue swelling over the apophysis at the base of the fifth metatarsal along with a question of possible separation or avulsion. In this case it is not possible to differentiate an avulsion fracture of the apophysis from a soft tissue injury until a follow up radiograph shows healing periosteal new bone. Obviously the prudent thing to do is to treat the patient as if it were fractured until a follow up film either proves or disproves the case.

Figure # 27 (left). Sometimes the apophysis appears to be separated from the proximal cortex at the base of the fifth metatarsal (yellow arrow). Don't mistake this for an avulsion fracture. Avulsions can occur at this location but they are rare and almost always associated with soft tissue swelling and clinical point tenderness. Note that there is no soft tissue swelling here.

Mnemonic: (Soft tissue ABC's)

There are also other sesamoids or ununited apophyseal growth centers in the region of the ankle or foot that sometimes cause confusion. These have been well demonstrated in the reference texts listed in the first chapter of this book. However it is worth mentioning that sesamoids and growth centers have a smooth, rounded cortex, whereas avulsion fractures usually have sharp Finally, as in all small parts evaluation, look at the cortices of each bone before declaring the study negative in your mind, and it is always prudent to await the consulting radiologist's report before telling the patient your interpretation. Lord knows even experienced things once in awhile! Two or three pairs of eyes are always better than one, and remember that you have the advantage of the patient who the radiologist seldom sees face to face, so be sure to provide that third side of the diagnostic triangle-history!edges. A case in point is demonstrated in this next case as shown in figure 3

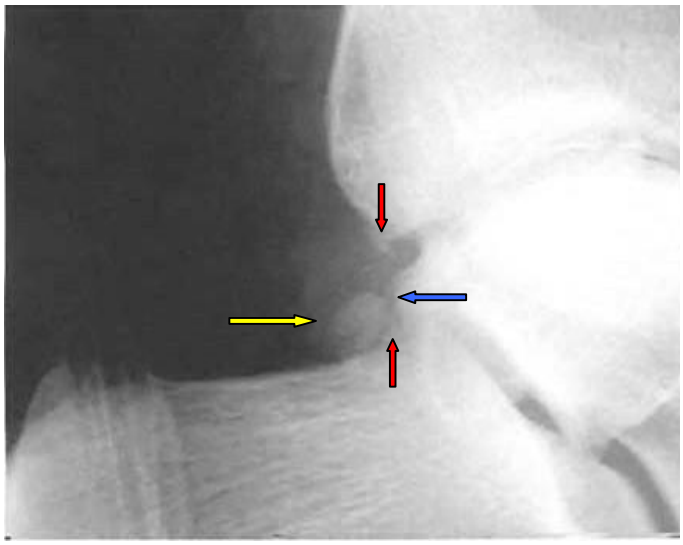

Figure # 28 (above). There is indeed a fracture demonstrated in the above radiograph. Can you spot it? The yellow arrow points to the os trigonum, a normal sesmoid seen in about 50% of the population. Some have postulated that the os trigonum represents an ununited apophysis of the posterior process of the talus. Note the smooth rounded edges typical of a sesmoid bone. Also note the ragged edge of the posterior process of the talus (blue arrow). This area is likely the origin of the two small avulsion fragments (red arrows) demonstrated in this patient with a Sheppard's fracture, i.e. a fracture of the lateral tubercle of the posterior process of the talus (also called the astragulus). Case courtesy of Wheeless Textbook of Orthopedics on line. www.medmedia .com

CASE STUDY 1

A 35 yr old baseball pitcher comes in with a history of gradual onset shoulder pain. States he had to stop pitching because of pain and weakness, especially during abduction and lateral rotation of arm. On examination he has supraspinatous tenderness near greater tubercle of humerus. An MRI reveals a tear in his rotator cuff.

What is the rotator cuff of the shoulder?

_____

_____

What usually causes rotator cuff strain ?

_____

_____

Which part of the rotator cuff usually tears?

_____

_____

Do these injuries occur only in baseball pitchers?

_____

_____

Which shoulder movement is weak and causes pain?

_____

_____

CASE STUDY 2

During a pickup game of football on artificial turf, a 38yr old ball carrier was slammed to the ground by a linebacker. He landed on his right shoulder and indicated he felt moderate pain that becomes worse when he attempts to raise his arm. During examination, there appears to be slightly superior displacement of the acromial end of his clavicle. Inferior pressure on clavicle revealed tenderness and some mobility of the clavicle when it articulates with the acromion. Abduction of the arm beyond 90 degrees causes severe pain and abnormal movement of the acromion and clavicle at the AC joint.

Which part of the AC joint hit the hard artificial turf?

_____

_____

What injury do you think resulted from the fall on his shoulder?

_____

_____

Which ligaments do you think would be disrupted and torn?

_____

_____

Would the articular capsule be injured?

_____

_____

If the player had fumbled and landed on his open hand, which bone might have been fractured?

_____

_____

Which shoulder movement is weak and causes pain?

_____

_____

CASE STUDY 3

A 52yr old woman was riding her bike along a gravel path when she lost her balance and fell on her outstretched upper arm. She states she heard a distinct cracking noise and felt sudden pain in her shoulder region. She has a deformity of her clavicle at the lateral and intermediate third and her shoulder is slumped inferomedially. Medial aspect of clavicle is elevated and patient is walks in holding arm.
Where does the clavicle commonly fracture?

Are clavicular fractures more common in adults than in children?

_____

_____

Why did her shoulder slump inferiomedially?

_____

_____

Why did her clavicle fracture without disrupting her AC joint?

_____

_____

Why did her clavicle fracture rather than her wrist.

_____

_____

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CASE STUDY 4

A 25 year old male falls on his elbow. Upon examination there is concentrated triceps contraction pulling the elbow apart.

Could this be an avulsion fracture?

_____

_____

If undisplaced, what is the best treatment (cast or sling)?

_____

_____

If an avulsion fracture, is surgery indicated due to traction of triceps muscle?

_____

_____

CASE STUDY 5

A 4 year old girl presents with pain and tenderness about her left elbow. A brief history reveals her left arm to have been pulled and pronated as her childminder attempted to bring her near.

Which ligament is likely affected?

_____

_____

Does this show radiographically?

_____

_____

Which movements help reduce this?

_____

_____

CASE STUDY 6

38 year old male got his right ring finger caught in a player's shirt while playing touch football
Felt pop in his finger and developed pain
Now in your clinic 4 hours later

What are the possibilities?

_____

_____

Jersey Finger?

_____

CASE STUDY 7

26 year old sergeant playing basketball and "jammed" his left middle finger
Pain and swelling of middle finger PIP joint (global)
Pain with resisted flexion and extension
What are the possibilities?

_____

_____

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CASE STUDY 8

A 17 year old male football player presents by stating that his knee feels unstable. He says during his last game, he twisted to challenge a player, and felt a ‘pop’ in his knee.

1. What soft tissues could be affected?

_____

_____

2. How would you test for each soft tissue?

_____

_____

3. Would you order an Xray?

_____

_____

CASE STUDY 9

A 10 year old boy presents to you with anterior knee pain that gets worse with exercise.

1. Describe your assessment.

_____

_____

2. Do you order an Xray?

_____

_____

3. What do you do next?

_____

_____

CASE STUDY 10

A 72 year old woman notes that her left knee has recently begun to swell. She has had pain in the medial aspect of the knee for several years but only recently did she notice fullness around the knee. She fell several weeks ago and supposes that the fall may have caused the buildup of fluid. The knee hurts her all day long but feels worse going down stairs, especially early in the morning and late in the day. She finds paracetamol helpful, but the pain relief is not adequate for her to be fully active.

1. Describe your assessment.

_____

_____

2. Do you order an Xray?

_____

_____

3. What do you do next?

_____

_____

CASE STUDY 11

How are the structures of the foot and leg affected by wearing high-heeled shoes or boots?

_____

_____

What surface anatomical structures would you expect to change when a person puts on this type of footwear?

_____

_____

CASE STUDY 12

On the death of her husband, a 50yr old female decided to earn her living by becoming an office cleaner. Part of her work involved scrubbing a flight of stone steps. After 3 weeks she noticed a painful swelling in front of the lower part of the left knee. **What is the diagnosis?**

_____

_____

_____

_____

CASE STUDY 13

You arrive at an accident scene and find a young gentleman lying on the group. He states he was knocked by a car and is now unable to stand. On examination ABC intact. However, you note that his left leg is shortened and externally rotated. What is the possible diagnosis?

_____

_____

_____

_____

CASE STUDY 14

A 28 year old female presented with pain in both lower legs on the inside of her shinbones radiating approx. 6 inches above her ankle. She was training for her first half marathon. She explained how when she first set out on a run her legs would be fine but after only five minutes the pain became so severe that she had to stop and walk home.

1. What passive movements would make her symptoms worse?

_____

_____

2. What muscles are associated with those movements?

_____

_____

3. Do you order an Xray?

_____

_____

4. What do you do for the patient?

_____

_____

CASE STUDY 15

A 63 year old male presented with a ‘turned ankle.’ He mentions that he was running and lost his balance and turned his ankle. He felt a searing pain in the outer surface of his right ankle. He has swelling, and bruising about the ankle but has been treating himself with R.I.C.E. since the incident.

1. Which two ligaments are likely involved?

_____

_____

2. How would you test each of the ligaments?

_____

_____

3. Do you order an Xray?

_____

_____

4. What treatment is given for the patient?

_____

_____

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CASE STUDY 16

A 42 year old female presents with continual pain upon walking in any shoes other than her sandals. When she wears shoes she finds moderate pain about the base of her big toe. As she works in a hospital environment she is worried about how this affects her ability to continue her job.

1. Which joint is likely affected? What is the diagnosis?

_____

_____

2. Do you order an Xray?

_____

_____

3. What tests might you do?

_____

_____

4. What treatment options may be available?

_____

_____

CASE STUDY 17

38 year old male got his right ring finger caught in a player's shirt while playing touch football
Felt pop in his finger and developed pain
Now in your clinic 4 hours later

What are the possibilities?

_____

_____

Jersey Finger?

_____

CASE STUDY 18

26 year old sergeant playing basketball and "jammed" his left middle finger
Pain and swelling of middle finger PIP joint (global)
Pain with resisted flexion and extension
What are the possibilities?

_____

_____

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