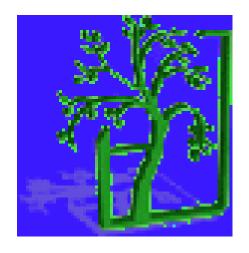
How to Triage Orthopaedic Care

David W. Gray, M.D.



OBJECTIVES:

- Define basic assessments skills needed to identify orthopedic injuries
- Differentiate when an orthopedic injury is a medical emergency
- Determine best level of care, when to refer to a higher level medical care, and which healthcare professional is the most appropriate (ER, UCC, PCP, or Specialist)

Skeletal Trauma

- 10 to 15 % of all Childhood Injuries
- Physeal Injuries are ~ 15% of all Skeletal Injuries

- Suspected Spinal Cord Injury
- Obvious Deformity extremity is bent or bowed
- Dislocation of Joint
- Open Laceration
- Neurologic Injury
- Vascular Injury be able to assess pulses and color of extremity

- Neurologic Injury especially loss of motor function
- Tingling or Numbness in a single extremity after injury is not an uncommon complaint - reassess and know how to do a Neurologic Exam of an Extremity - you have to develop your skills
- Assess by Doing a Motor and Sensory Examination
- Light touch, Pin prick (use a paper clip)

- Neurologic Injury
- Assess by Doing a Motor and Sensory Examination
- Light touch, Pin prick, and 2 point Discrimination
- Paper Clip helpful for Pin Prick and 2 point discrimination
- 2 Point Discrimination very helpful for hand injuries and lacerations

- Vascular Injury be able to assess pulses and color of extremity
- Capillary refill is variable
- If the environment is cold and having difficulty with vascular exam warm the extremity

- Compartment Syndrome is swelling with in a Muscular Compartment that closes off the capillary flow to the soft tissue of that compartment
- The Muscle Compartment is very firm, tense and painful to touch.
- This is a surgical emergency and needs immediate evaluation
- Can be associated with fractures, crush injuries or vascular injuries, or after extreme exertion

- This is a surgical emergency and needs immediate evaluation
- It can happen acutely within an hour of injury or develop over several hours after injury
- Most commonly seen in leg (below the knee) and forearm

- Compartment Syndrome
- Pain out of Proportion First sign is Pain on Passive Range of Motion
- Extreme Pain on Passive Motion of the Muscles in that Compartment - example severe pain on movement of fingers or toes after injury to the leg or forearm above
- Pulses are Intact early on!
- Neurologic Exam is Intact early on! (May have some some tingling)
- The Muscle Compartment is very firm, tense and painful to touch.

Delayed Referral for Medical Evaluation

- Persistent Swelling
- Persistent Loss of Range of Motion
- Difficulty with Ambulation
- Persistent Pain
- Constitutional Symptoms fever, weight loss

The History

- How, When and Where ?
- Swelling?
- Ability to Ambulate?
- Did you hear or feel a Pop?
- Did you Relocate an Injured part?

Extremity Examination

- Learn How to Examine an Extremity
- Know the Vascular and Neurologic Examination - Study
- Know the Extremity Anatomy Bone, Muscle, Ligament, Nerve, Vascular
- Dont be afraid to Reassess and Repeat your Examination
- Stay Calm

Physical Exam

- Visual Inspection for Swelling, Discoloration, Bruising, and Obvious Deformity?
- Open Laceration or Wound?
- Range of Motion can the injured area move - either with the patient moving it or examiner?
- Stability of the Joint may or may not be able to assess

Physical Exam

- Tenderness: Where is the maximal tenderness - over the Bone, Ligaments, Muscle or Joint?
- Is the Patient able to Weight Bear ?
- Neurovascular Exam of the Extremity
- Are they able to Move the Injured Area

The Physical Exam

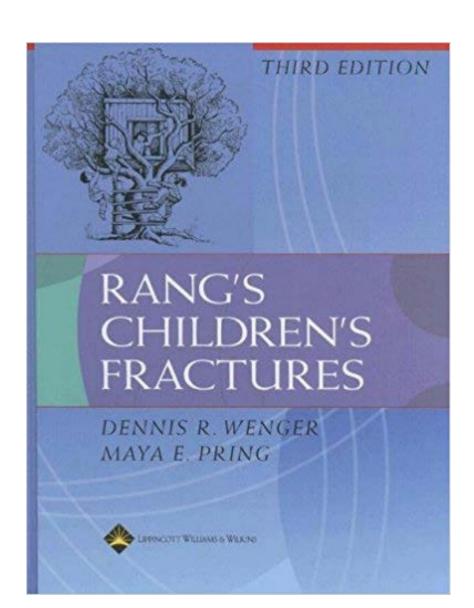
- Have the patient demonstrate the area of maximal tenderness
- Use one finger to localize tenderness
- Is the tenderness located over the bone or the soft tissues?
- Compare the 2 sides looking for swelling

Orthopaedic Assessment

- Palpate for Tenderness
- Deformity
- Evaluate Neurologic Status
- Evaluate the Vascular Status
- Assess the Soft Tissue Injury
- Understand the Mechanism of Injury

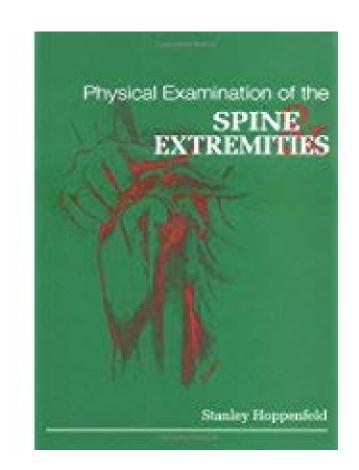
Orthopaedic Resources

Rang's Childrens Fractures



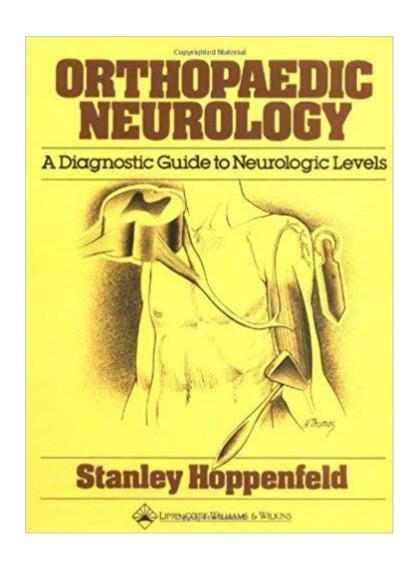
Extremity ExaminationResources

Hoppenfeld
 Physical
 Examination of
 Spine and
 Extremities



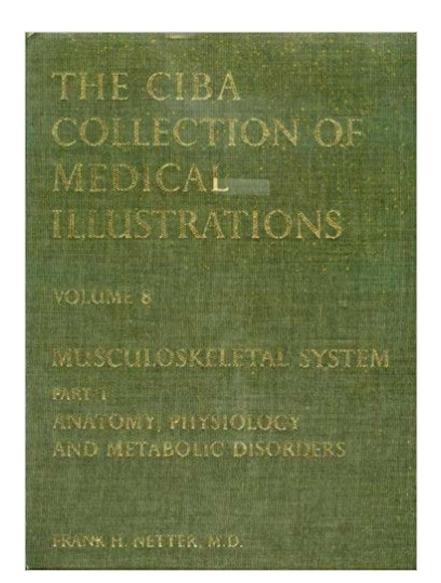
Extremity Examination Resources

 Hoppenfeld -Orthpaedic Neurology



Extremity Examination Resources

 Ciba Collection of Medical Illustrations Volume 8 Part 1 Anatomy, Physiology and Metabolic Disorders by Frank Netter



Skeletally Immature Patients

- Possess Unique Characteristics Compared to the Adults
- The Closer to Skeletal Maturity the more the Injury Patterns Mimic Adults

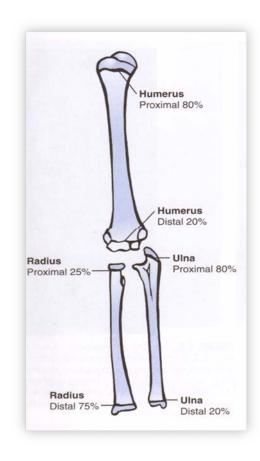
Unique Anatomy For Children and Implications for Injury

Physis ("Growth Plates")

Adds longitudinal growth of the bone

Peak height velocity occurs later in boys (13 to 14) than girls (11 to 12)

Periods of rapid growth put children at risk for injury as "growth plates" narrow near the end of growth



Orthopedic Anatomy

Parts of a growing bone

Epiphysis

Physis

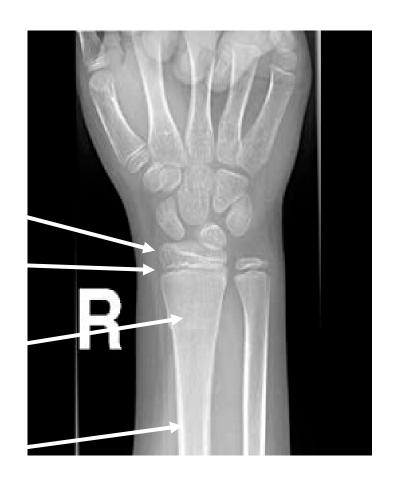
Metaphysis

Diaphysis



Anatomy

- Epiphysis
- Physis
- Metaphysis
- Diaphysis



Apophysis

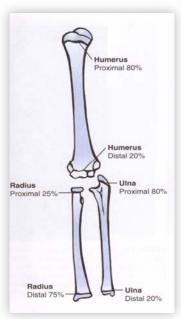
Apophysis

Growth Area of bone where a muscle tendon attaches

Highest risk of injury during peak growth rate

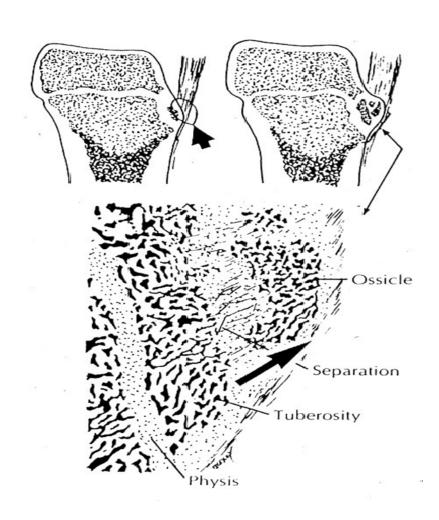
Best Known - Tibial Tubercle - Osgood Schlatter





Tibial Tubercle is an Apophysis- Osgood Schlatter is inflammation of the tibial tubercle - Apophysitis



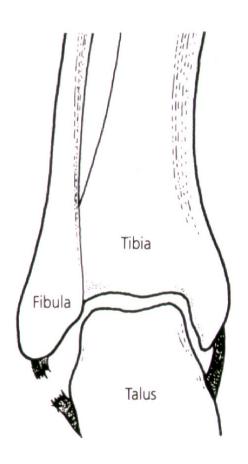


Injury Terms: Fractures

- Fracture Broken, Break, Crack etc.
- Open soft tissue envelope open allowing contamination of bone to dirt and bacteria
- Closed soft tissue envelope intact no communication to outside world
- Comminuted multiple pieces
- Compound we do not use this term it was primarily used to indicate an open fracture in older literature

Injury Terms:

Sprain vs Strain





Sprains

Severity:

Grade I - min. structural disruption

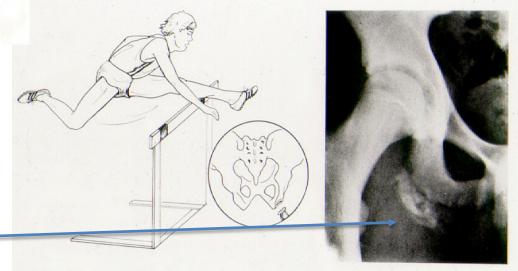
Grade II - partial disruption

Grade III - complete disruption

Strain vs. Avulsion Fracture

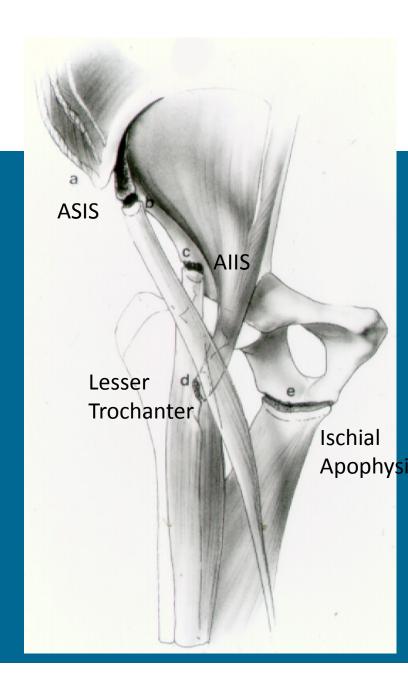


Ischial ApophysisAvulsion - pulled awayby Hamstring Origin



Pelvic Avulsion Fractures

- » Often preceding symptoms
- » Multiple Apophyseal Sites in the Pelvis
- » Sometimes occult
- » Disabling and can be slow to heal



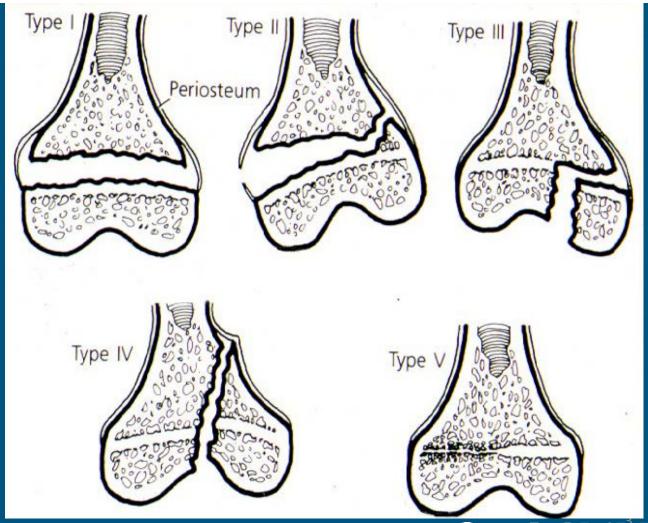
Anterior Inferior Iliac Spine (Apophysis) Pelvic Avulsion Fracture

the Rectus Femoris Muscle has its origin here - one of the 4 muscles that constitute the Quadriceps



cookChildren's.

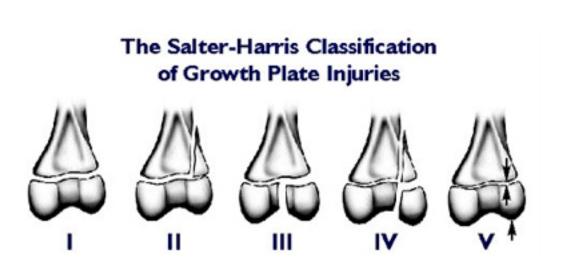
Physeal Fracture Patterns



CookChildren's.

Salter Harris Classification System

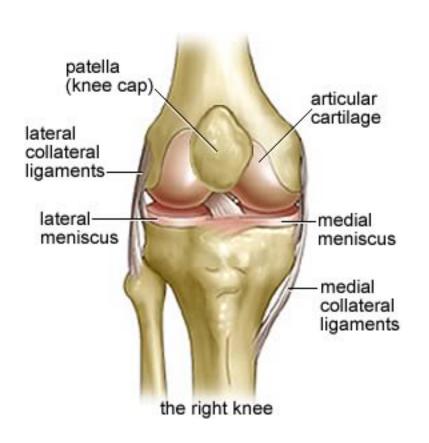
- I. Separation
- II. Above
- III. Lower (beLow)
- IV. Through
- V. EveRything Ruined

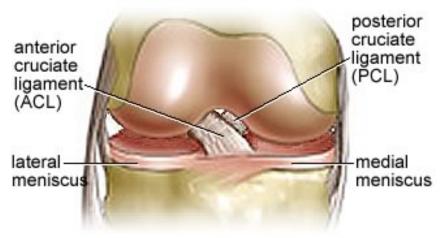


Salter II Fracture Distal Radius

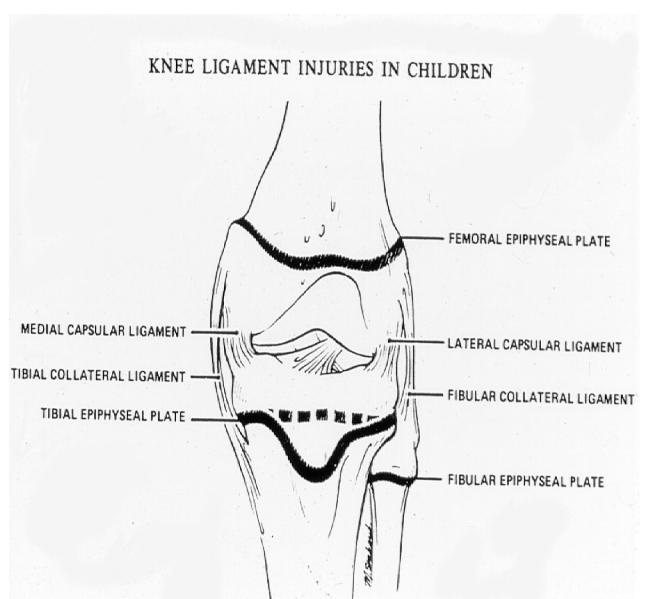


Knee Anatomy





Physeal Anatomy and Knee Ligaments Insertion Sites in Children May Create Unique Injuries



Salter I Fracture Distal Femur





Fracture at Distal Femoral
Physis (Growth Plate)
as seen on Stress Film the Physis Failed in this case
instead of the Medial
Collateral Ligament Tearing

Salter I Fracture Distal Femur





How would you know to refer?

Exam will show Swelling at the Joint - Large Joint Effusion

Tender on the Femur - Directly on the Bone

Unable to bear weight

Radius and Ulna Fractures



Deformity - Bowing of Arm
Open area that may represent an Open
Fracture

Radius and/or Ulna Fractures



- » This was an open fracture
- » Immediate Referral
- Often will see DarkBlood and FatGlobules in the BloodOozing from Wound
- » Splint and Send

Supracondylar Fractures

- » Most common type is Fall on Outstretched Elbow
- » Marked Swelling around the Elbow
- » Splint with long arm splint with comfortable position.



Supracondylar Humerus Fracture

- » Marked Swelling around Elbow
- » May Have Ecchymosis Anteriorly from the Proximal humerus tearing thru the Brachialis Muscle and Coming up to the Skin
- » May even have "Dimpling" or "Puckering" of the Skin which has been pulled back into the fracture
- » Refer Immediately
- » Splint in Position of Slight Flexion 20 to 45 degrees



Supracondylar Humerus

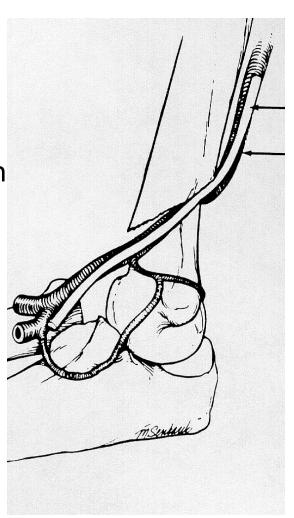
» General

- Typical age range 1-10 years
- Males > females by 2:1
- Peak incidence: 5 to 8 years
- Approximately 1% are open
- concurrent forearm fractures in ~



Supracondylar Humerus

- » Arterial Injury:
 - Pink hand
 - —Be highly suspicious of entrapmen especially if:
 - Anterior puckering
 - Anterior medial ecchymosis
 - Median nerve injury



Supracondylar Humerus Fracture

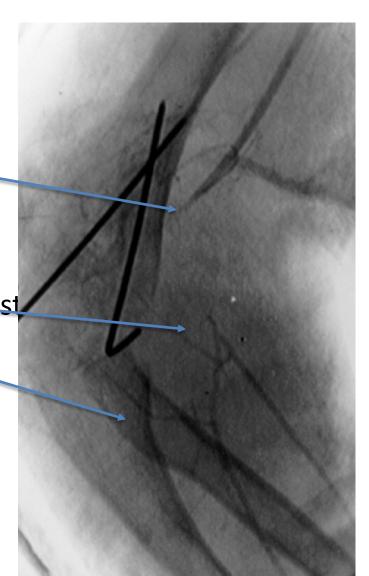
» Examination

- Always check for <u>palpable</u> pulses (Doppler pulse may be present in spite of complete of occlusion of the brachial artery)
- Check compartments
- Surgeons should Always document detailed neurovascular examination before any treatment
 !!

Supracondylar Humerus Type III

- » Arterial Injury
- » Brachial Artery Occluded

» Reconstituted Flow by Collaterals Dist



Supracondylar Humerus Fracture

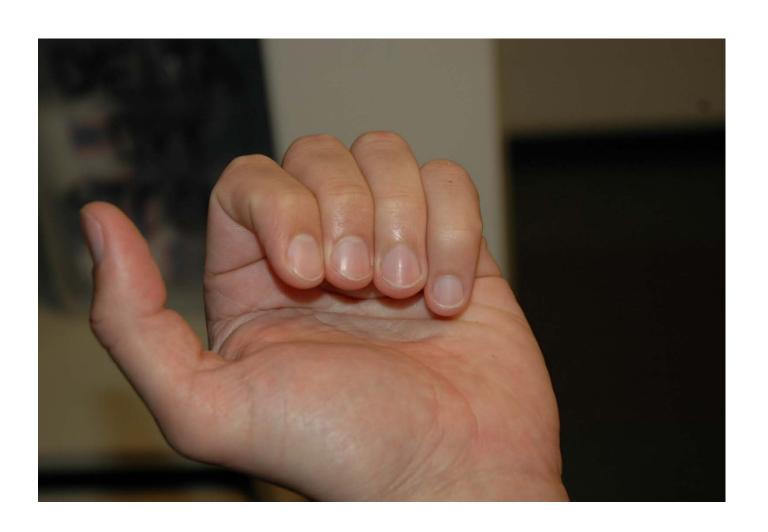
- » Neurologic Examination
 - Nerve injury is present in about 8%
 - Of this 8%
 - Radial nerve 40%
 - Median nerve (complete) 35%
 - Ulnar nerve 22% (but most common with flexion supracondylar)
 - Anterior interosseous nerve is actually the most common (but requires detailed neuro exam)

Deformity

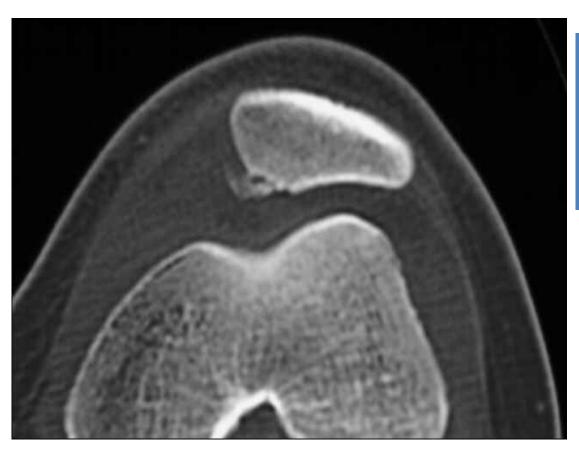
- This is a Femoral Shaft Fracture
- Note the Bowing of the Thigh
- Splint the Extremity
- If there are No Pulses and there is an Obvious Deformity Gently Straighten the Extremity and Splint prior to Transport
 - For Example if the Extremity is Rotated more than 90 degrees
 - For Example if the extremity is Bent more than 45 degrees and "Floppy" (Unstable)



Symmetric Hand Closure

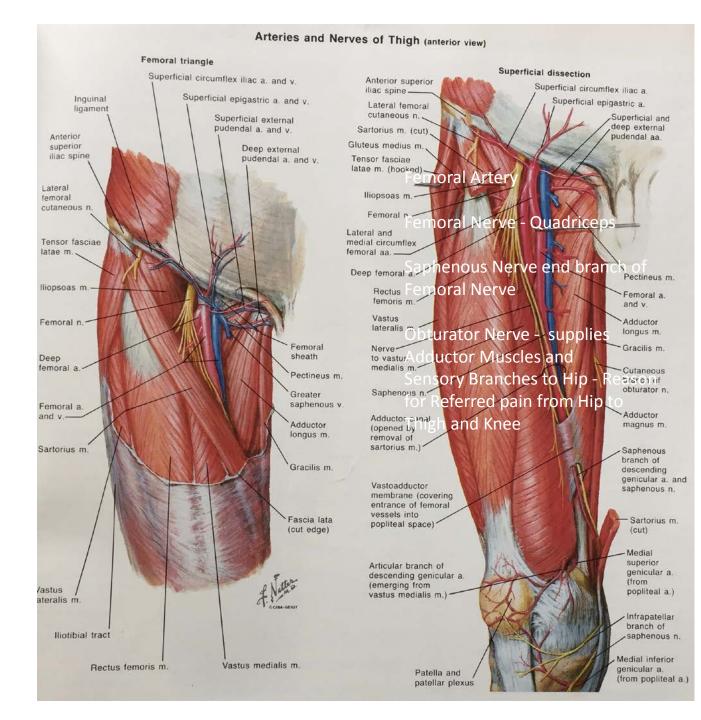


Patellar Dislocation



Referral Needed to Assess for any occult Fractures that are Intra- Articular Referral Does not have to be Immediate if the Patella is Reduced

Anterior Thigh

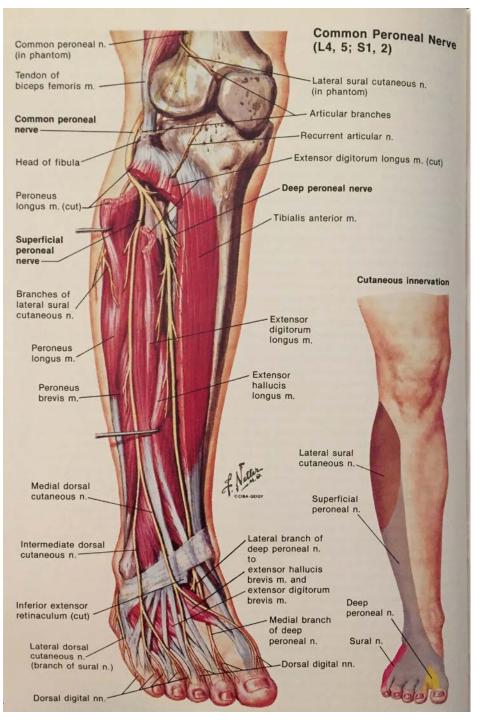


Obturator Nerve (L2, 3, 4) Iliohypogastric n. -Lumbar plexus Ilioinguinal n.-Genitofemoral n. Lumbosacral trunk Lateral femoral cutaneous n.-Femoral n. Obturator nerve Posterior branch -Articular branch-Obturator externus m. Anterior branch-Adductor brevis m. Adductor longus m. Posterior (divided) branch -Adductor magnus m. (partly supplied Cutaneous branchby sciatic n.) Gracilis m. Articular branch to knee joint. Hiatus of adductor canal Cutaneous innervation Note: only muscles innervated by obturator nerve are shown

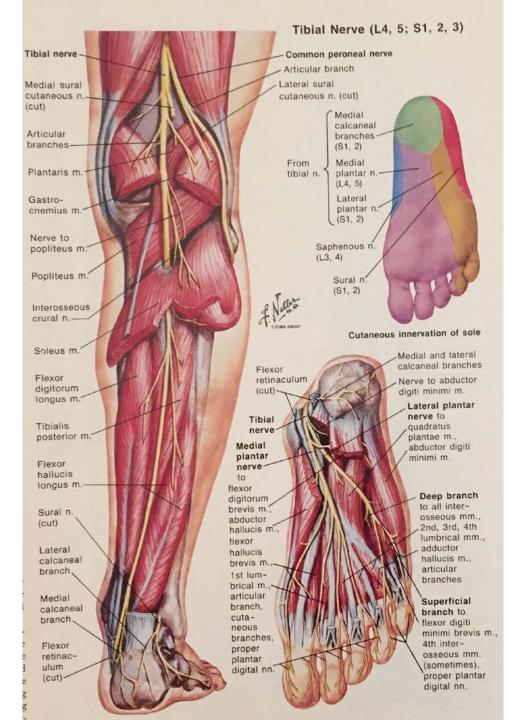
Medial Thigh

Arteries and Nerves of Thigh: Deep Dissection (posterior view) Superior cluneal nn Gluteal aponeurosis and gluteus medius m. (cut) Gluteus maximus m. (cut) Superior gluteal a. and n. Middle cluneal nn.-Gluteus minimus m. Inferior gluteal a. and n. Tensor fasciae latae m. Piriformis m. Pudendal n. Gluteus medius m. (cut) Nerve to obturator internus and superior Superior gemellus m. gemellus mm. -Obturator internus m. Sacrotuberal ligament -Greater trochanter Posterior femoral Inferior gemellus m. cutaneous n.-Gluteus maximus m. Ischial tuberosity (cut) Quadratus femoris m. Inferior cluneal nn. (cut)-Medial circumflex Adductor magnus m./ femoral a. Vastus lateralis m. Gracilis m. and iliotibial tract Sciatic n. Adductor minimus portion of adductor magnus m. Semitendinosus m. 1st perforating a. (retracted)-Adductor magnus m. Semimembranosus m. 2nd and 3rd perforating aa. Sciatic n.-4th perforating a. Articular branch -(termination of deep femoral a.) Adductor hiatus-Long head (retracted) Popliteal v. and a .femoris m. Short head Medial superior genicular a.-Lateral superior genicular a. Adductor tubercle of femur-Common peroneal n. Tibial n. Plantaris m. Gastrocnemius m. (lateral head) Gastrocnemius m. (medial head) Lateral sural Medial sural cutaneous n. cutaneous n. Lesser saphenous v.

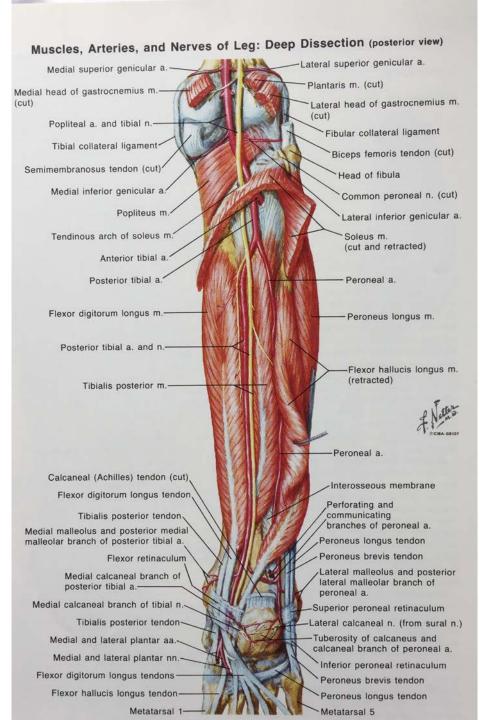
Posterior Thigh



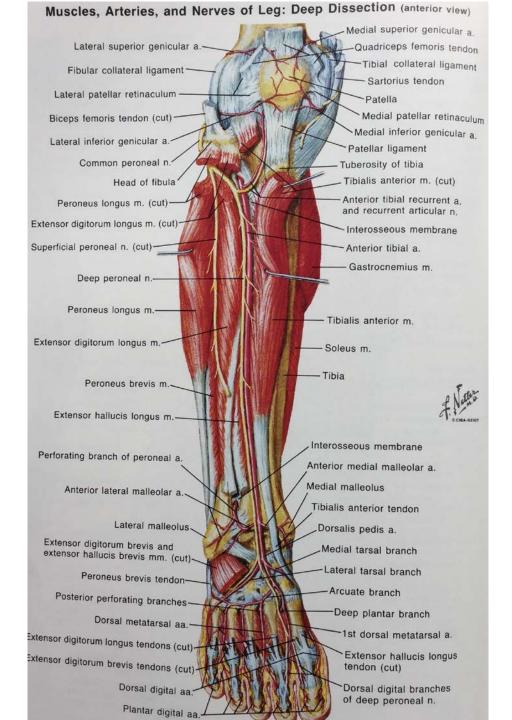
Anterior Lateral Leg



Posterior Leg



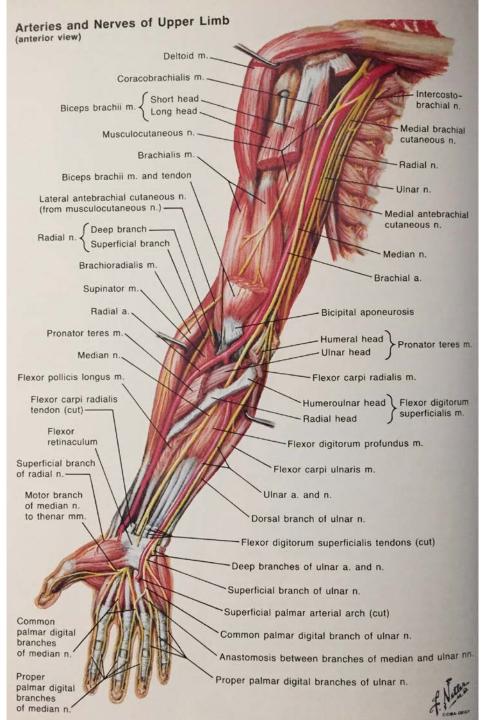
Posterior Leg



Anterior Leg

Partial dissection Tibial n. Common peroneal n. (cut) Adductor magnus tendon-Medial sural cutaneous n. (cut) Popliteal a. and v.-Lateral superior Medial superior genicular a. genicular a. Plantaris m. Fibular collateral Medial head of ligament gastrocnemius m. (cut)-Lateral head of gastrocnemius m. Tibial collateral ligament -Biceps femoris Semimembranosus tendon (cut) tendon (cut)-Lateral inferior genicular a. Medial inferior genicular a.-Head of fibula Popliteus m. Common peroneal n. (cut) Tendinous arch Nerve to of soleus m .soleus m. Plantaris tendon Peroneus longus m. Soleus m. Gastrocnemius m. (cut)-Soleus m. inserting into calcaneal (Achilles) tendon-Peroneus longus Tibialis posterior tendon tendon Flexor digitorum Peroneus brevis longus tendontendon Posterior tibial a. and v.-Peroneal a. Medial malleolus Lateral malleolus Tibial n. Superior peroneal Flexor hallucis retinaculum longus tendon Tuberosity of Flexor retinaculum calcaneus Calcaneal (Achilles) tendon

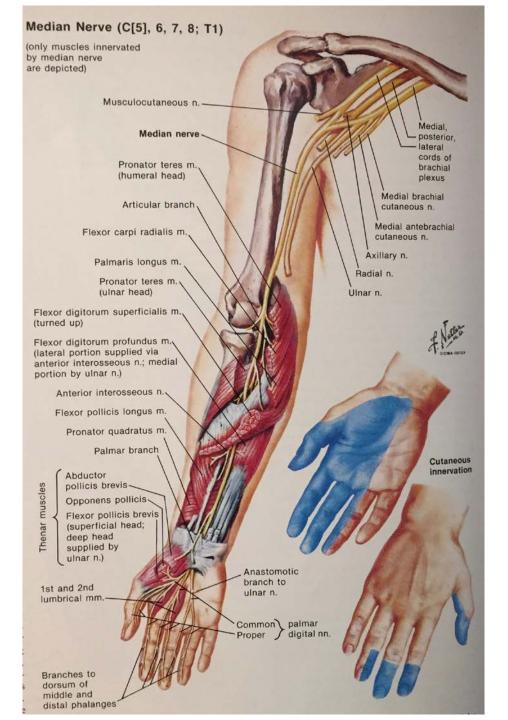
Posterior Leg



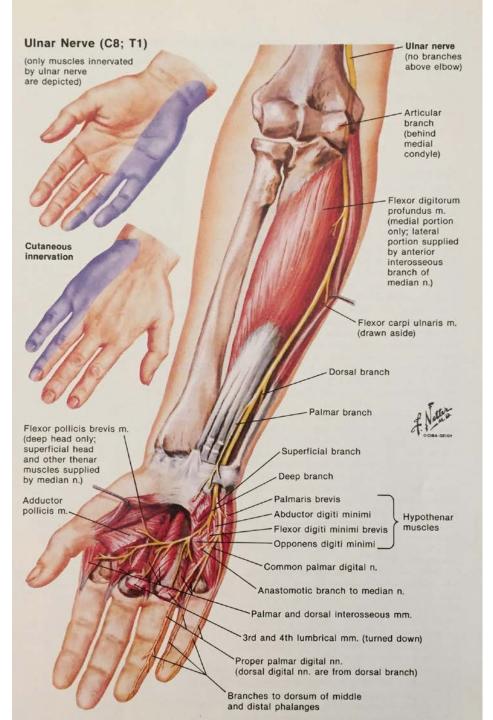
Upper Extremity

Radial nerve Radial Nerve in Forearm (C5, 6, 7, 8; T1) - Superficial branch (viewed from behind and Deep terminal branch slightly laterally) Lateral epicondyle Anconeus m. -Brachioradialis m. Extensor carpi radialis longus m. Supinator m. Extensor carpi radialis brevis m. Extensor-Extensor carpi ulnaris m. supinator group of Extensor digitorum m. and muscles extensor digiti minimi m. Extensor indicis m. Extensor pollicis longus m. Abductor pollicis longus m. Extensor pollicis brevis m. Posterior interosseous n. (deep branch of radial n. distal to muscular branches) Superficial branch of radial n. Superior From lateral axillary brachial nerve cutaneous n. Inferior lateral brachial cutaneous n. Posterior brachial From cutaneous n. radialnerve Posterior antebrachial cutaneous n. -Superficial branch of radial n.-Dorsal digital nn. **Cutaneous innervation from** radial and axillary nerves

Dorsal Forearm

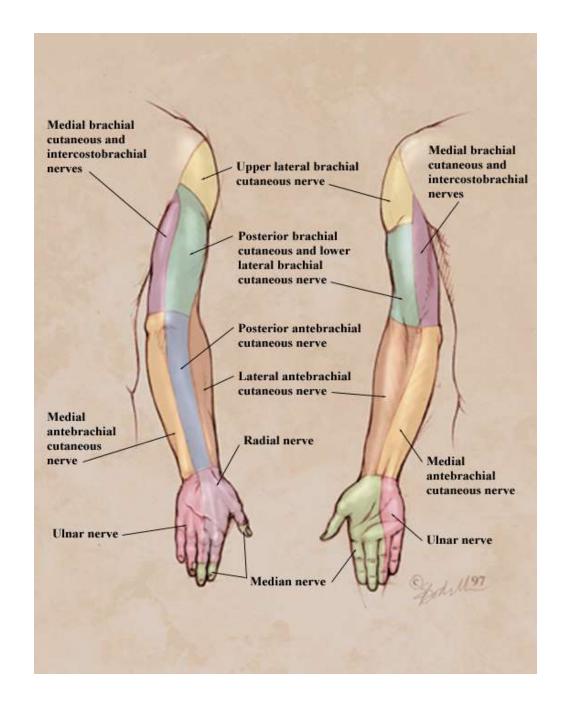


Volar Forearm



Volar Forearm

Hand and Finger Assessment



Hand Sensory Innervation

