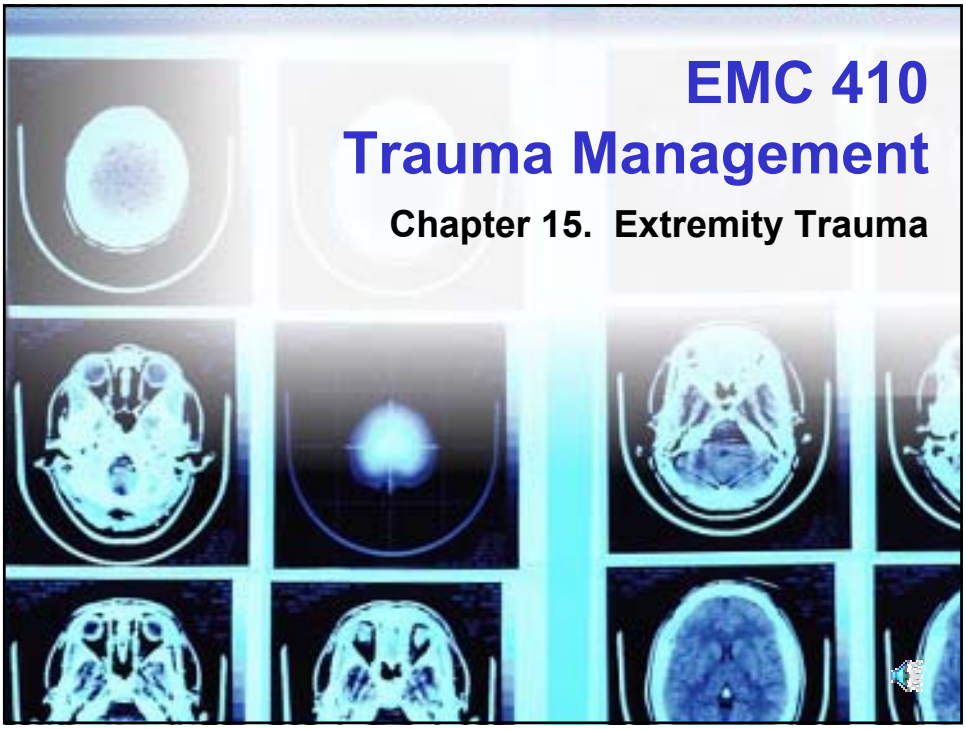


EMC 410
Trauma Management

Chapter 15. Extremity Trauma

Unit Objectives

- **Upon completion of this chapter, you should be able to:**
  - Describe the epidemiology and etiology of extremity trauma.
  - Describe the normal anatomy and physiology of the extremities.
  - Discuss the pathophysiology, assessment findings, and management of sprains, dislocations, fractures, and amputations.
  - Explain the techniques of assessment of extremity injuries.
  - Describe the general principles of splinting.

Unit Objectives

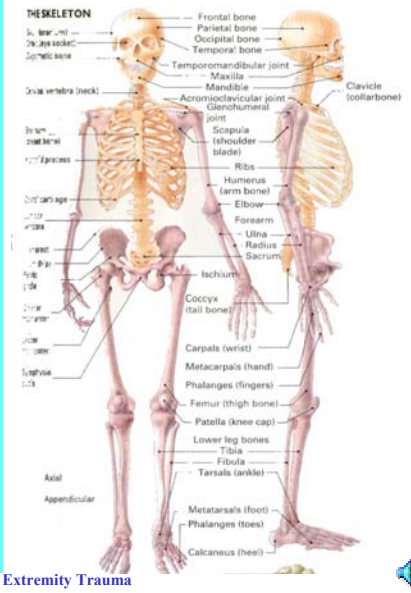
- List the complications of extremity injuries.
- List the associated blood loss of various fracture sites.
- Explain the healing process of fractures.
- List and describe the various types of fractures.

Epidemiology and Etiology

- Most common discharge diagnosis in 1991 survey was fracture, representing 37 percent of all patients.
- 53 percent of all injuries reported in the National Health Interview Survey from 1985 to 1988 involved the musculoskeletal system.
- Fractures are more common in males than females under the age of 44, but there is a dramatic reversal after that age.
- In the elderly aged 85 and older, fractures are four times more common in females than males.

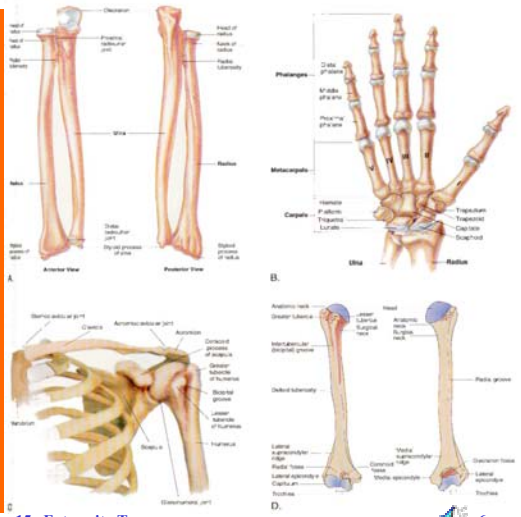
Anatomy and Physiology

- Musculoskeletal system is comprised of 206 bones and their joints, skeletal muscles, nerves, tendons, ligaments, and blood vessels.



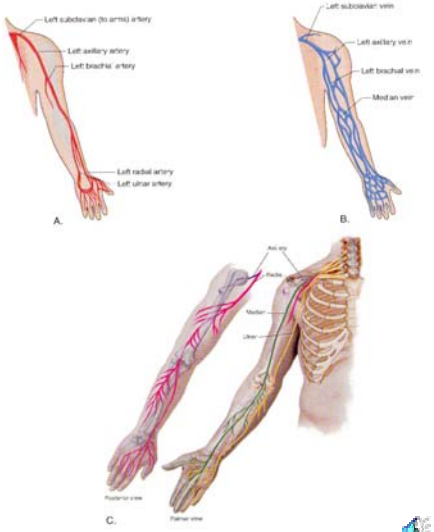
Anatomy and Physiology continued

- Upper extremity
  - Clavicle, scapula, humerus, radius, ulna, carpals, metacarpals, and phalanges



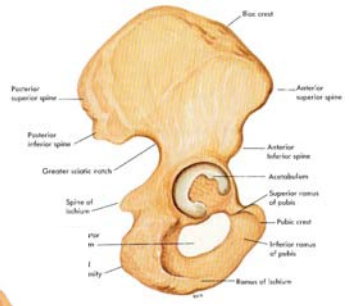
Anatomy and Physiology continued

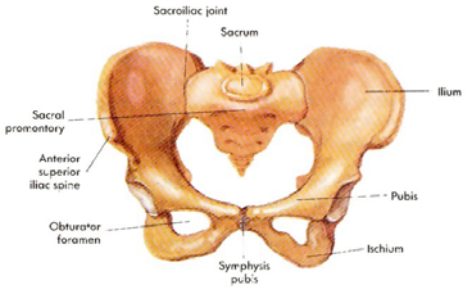
- **Upper extremity continued**
  - Subclavian, axillary, brachial, radial, median, and ulnar arteries
  - Radial, median, and ulnar nerves



Anatomy and Physiology continued

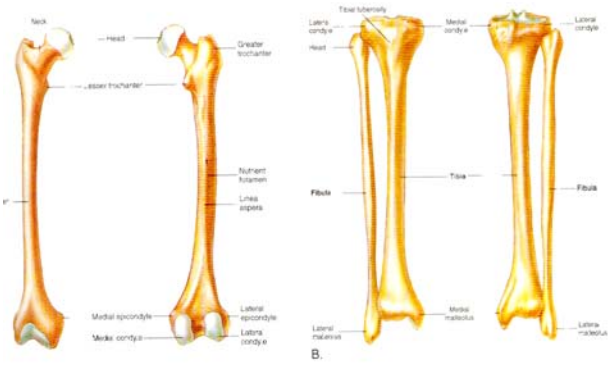
- Pelvis
  - Ilium, ischium and pubis
  - Sacrum
  - Acetabulum





Anatomy and Physiology continued

- **Lower extremity**
  - Femur, tibia, fibula, tarsals, metatarsals, phalanges
  - Femoral, popliteal, anterior tibial, posterior tibial arteries
  - Sciatic, tibial, and peroneal nerves



Focused Assessment

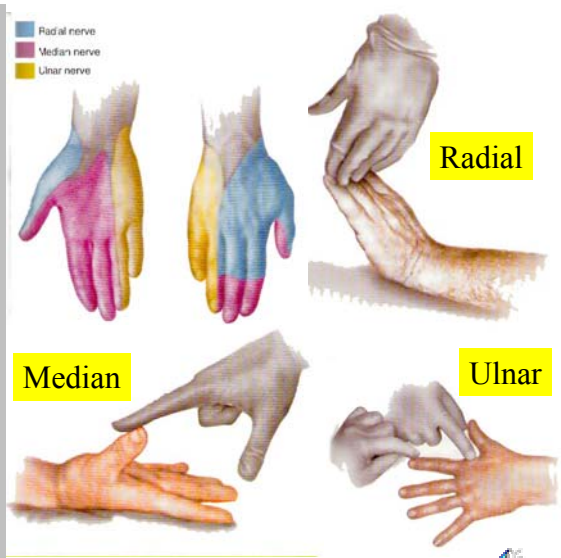
- **History**
  - Chief complaint
  - MOI
    - Magnitude, mechanism, and direction of forces
  - Patient position on arrival
- **Physical exam**
  - Inspection
    - Position, deformity, angulation, swelling, discoloration
  - Palpation
    - Deformity, tightness, crepitus, point tenderness, distal pulses, skin temperature, capillary refill
  - ROM - best left for emergency department

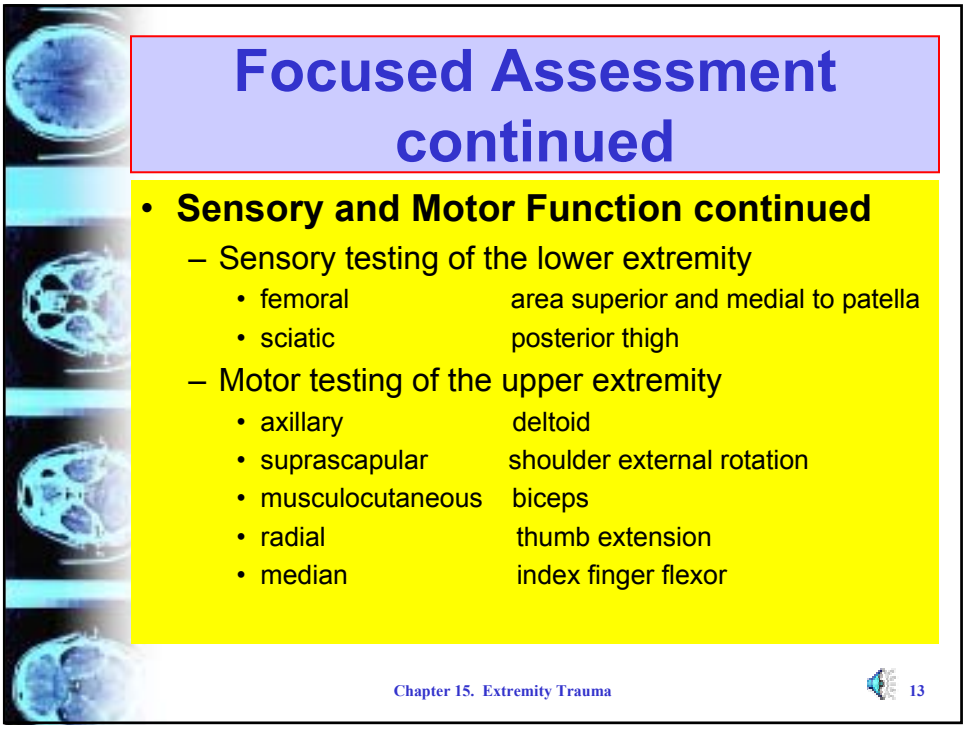
Focused Assessment continued

- **Circulation**
  - Mechanisms
    - Direct laceration, stretching, platelet aggregation with delayed occlusion
  - Assess
    - Nail bed color, warmth of the skin, pulse strength
    - Auscultation for bruits
    - Doppler assessment for blood flow

Focused Assessment continued

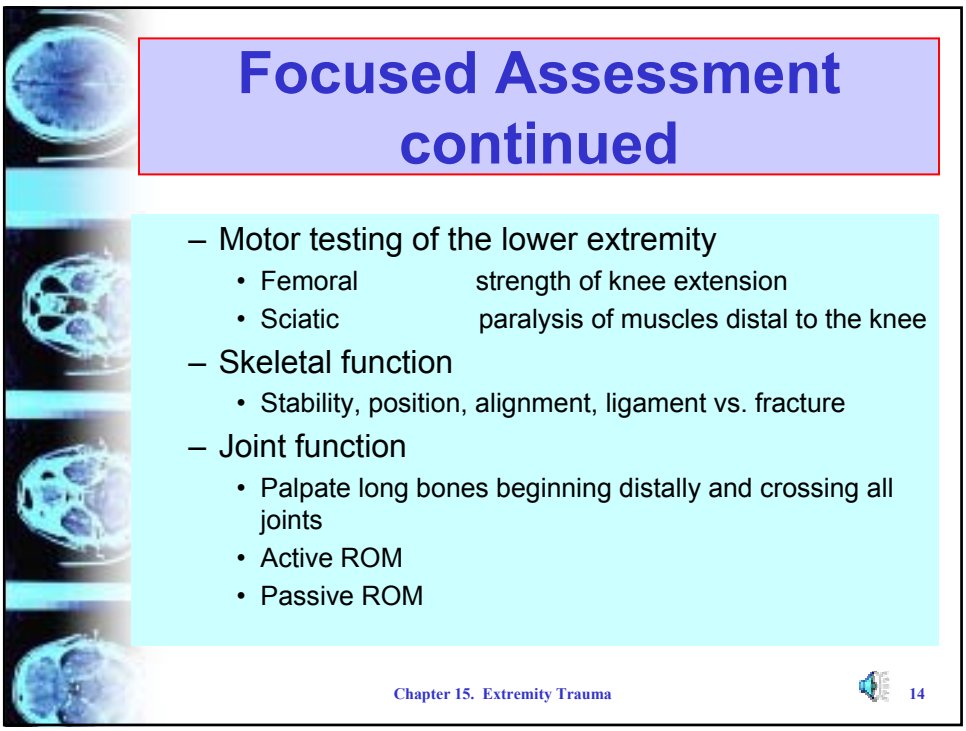
- **Sensory and motor function**
  - Evaluate before and after any intervention
  - Sensory function
    - Light touch and two point discrimination (5 mm normal)
  - Sensory testing of upper extremity
    - Axillary nerve lateral arm
    - Musculocutaneous lateral forearm
    - Radial thumb
    - Median index fingertip
    - Ulnar little fingertip





Focused Assessment continued

- **Sensory and Motor Function continued**
  - Sensory testing of the lower extremity
    - femoral — area superior and medial to patella
    - sciatic — posterior thigh
  - Motor testing of the upper extremity
    - axillary — deltoid
    - suprascapular — shoulder external rotation
    - musculocutaneous — biceps
    - radial — thumb extension
    - median — index finger flexor

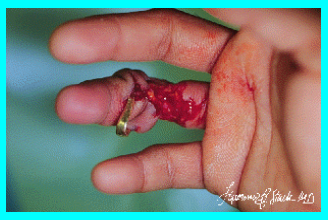


Focused Assessment continued

  - Motor testing of the lower extremity
    - Femoral — strength of knee extension
    - Sciatic — paralysis of muscles distal to the knee
  - Skeletal function
    - Stability, position, alignment, ligament vs. fracture
  - Joint function
    - Palpate long bones beginning distally and crossing all joints
    - Active ROM
    - Passive ROM

Pathophysiology

- **Amputations**
  - Arteries usually spasm and occlude unless a crushing injury.
  - Tourniquets rarely required.
  - Amputated tissue usually viable for reimplantation 14-18 hours post injury.
  - Treat the patient then the amputation.
  - Place amputated tissue in watertight bag and then on ice.
  - Do not allow tissue to freeze or frostbite.



Pathophysiology continued

- **Compartment syndrome**
  - Locally increased tissue pressure impedes circulation.
  - Usually result of crushing injuries, burns, electrocution, fractures, snake bites and encapsulated hematomas.
  - Lower leg and forearm are the most common sites.
  - S&S
    - Severe pain out of proportion to the injury
    - Tight muscle compartment
    - Applied pressure, passive stretch, and active contraction increases pain
    - Pain, paresis, paralysis, puffiness, pallor, pulselessness
  - Treatment
    - Emergency fasciotomy

Pathophysiology continued

- **Crush Injury and Crush Syndrome**
  - Weight applied to tissue for several hours
  - Muscle tissue releases myoglobin, potassium and phosphorous
  - Results in hypovolemia and renal failure.
  - Treatment
    - Release pressure
    - 500 cc/hr NaCl
    - Sodium Bicarbonate

Pathophysiology continued

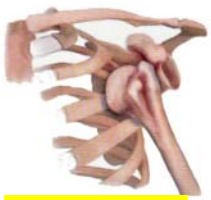
- **Dislocations and sprains**
  - Sternoclavicular joint
    - Rarely injured
    - May be anterior or posterior
    - May result from direct blow or from blow to the shoulder
    - Deformity usually palpable
    - Posterior dislocations usually associated with life-threatening chest trauma
    - Patients present with arm supported tightly against the body
    - Complain of pain with movement or palpation of joint
    - Treatment is figure-of-eight splint

Pathophysiology continued

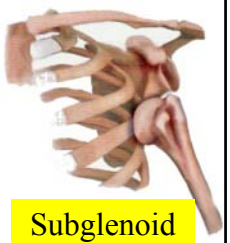
- **Dislocations and sprains continued**
  - Acromioclavicular joint (shoulder separation)
    - Most commonly result from MVC, contact sports and falls
    - Usually result from direct blow to the point of the shoulder or a fall onto an outstretched arm
    - May be relatively asymptomatic with no external evidence of injury or may present with sever pain, deformity, and adduction of the arm close to the body.
    - Treatment is immobilization with sling and swathe

Pathophysiology continued

- **Dislocations and sprains continued**
  - Glenohumeral joint (shoulder dislocation)
    - Most frequently dislocated major joint
    - May dislocate anteriorly, posteriorly, inferiorly, or superiorly
    - Regardless of type, treated with sling and swathe
    - Anterior
      - Severe pain with arm abducted and externally rotated with prominent acromion process
      - Neurovascular damage occurs in up to 12 percent of cases



Subcoracoid

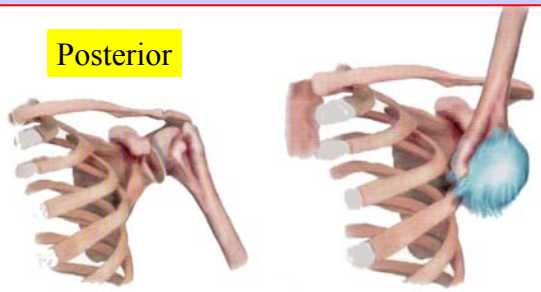


Subglenoid

Subclavicular

Intrathoracic

Pathophysiology continued

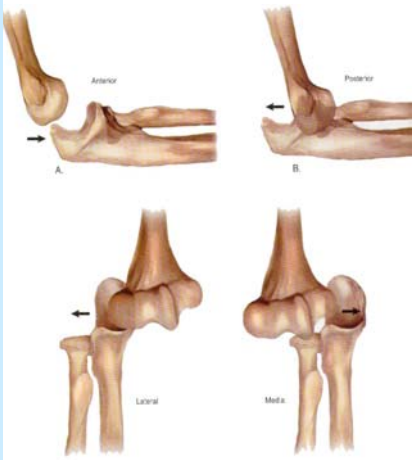


•Dislocation and sprains continued

- Glenohumeral dislocation continued
  - Posterior
    - Severe pain, adduction and internal rotation, prominent acromion and coracoid processes
    - Palpable humeral head
  - Inferior
    - Arm locked overhead with elbow flexed and hand either on or behind the head

Pathophysiology continued

- **Dislocations and sprains continued**
  - Elbow
    - Mostly posterior dislocations, although anterior, medial or lateral are possible
    - 40 percent are associated with fractures of adjacent bony structures
    - Patient presents with elbow locked in flexion, shortening of the forearm, and marked prominence of the olecranon
    - Neurovascular injury occurs in up to 21 percent of patients
    - If distal neurocirculatory function intact, immobilize in the position found with board or wire ladder splint



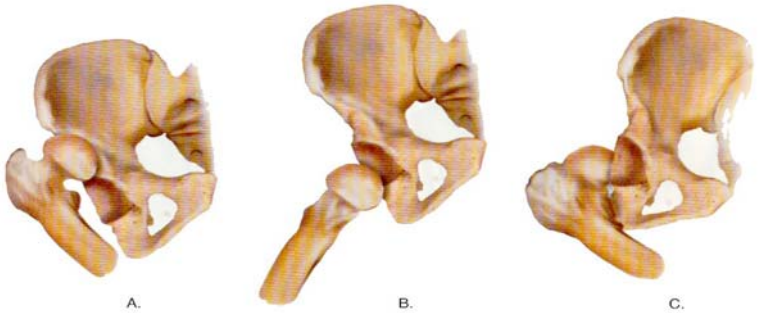
Pathophysiology continued

- **Dislocations and sprains continued**
  - Radiocarpal dislocation (wrist)
    - Usually results from fall onto a dorsiflexed wrist, although falls onto palmar flexed wrist are also possible.
    - All bones in the wrist are readily palpable and tenderness and swelling indicate fracture or dislocation.
    - Important to assess neurovascular function as these structures are very superficial and prone to injury.
    - Use splint of choice followed by sling and swathe.

Pathophysiology continued

- **Dislocations and sprains continued**
  - Hip
    - Requires tremendous force, usually the result of MVC
    - Posterior
      - Most common (90%) and usually result of MVC with down-and-under pathway
      - Shortened, flexed, adducted, and internally rotated extremity
      - 50% accompanied by fractures

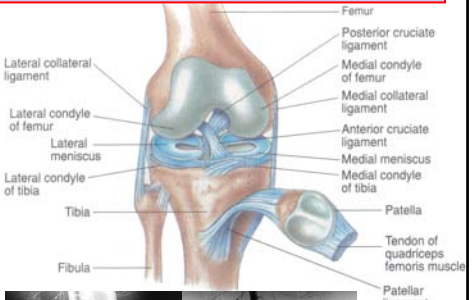
Pathophysiology continued



- **Sprains and dislocations continued**
  - Hip
    - Anterior
      - Superior iliac, superior pubic, and inferior obturator
      - External rotation and abduction with slight flexion
      - Femoral head is palpable in the anterosuperior iliac spine or below the femoral artery
      - Splint in the position found if neurovascular function intact

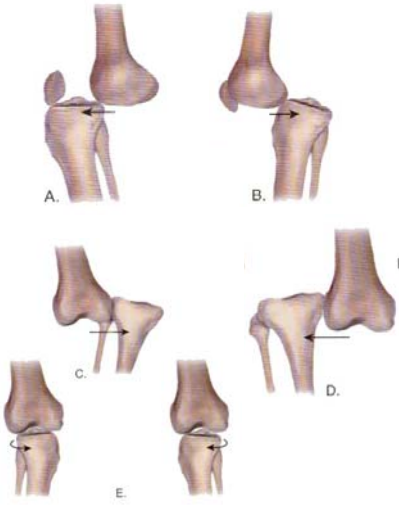
Pathophysiology continued

- **Dislocations and sprains continued**
  - Knee
    - Hinge joint with a ROM of 0 degrees in full extension to 130 degrees in full flexion
    - Injury can be produced by only moderate amounts of energy
    - Knee is inherently unstable; All stability is provided by surrounding ligaments
    - Dislocation is a true orthopedic emergency because of the high rate of associated neurovascular injury
      - Vascular damage occurs in up to 40% of dislocations
      - Half of these will result in amputation



Pathophysiology continued

- **Dislocations and sprains continued**
  - Knee continued
    - 5 types of dislocation based upon resting position of tibia relative to femur
      - Anterior dislocations are most common; Usually result from hyperflexion
      - Posterior dislocations require great force and usually result from MVC
      - Medial dislocations require varus (toward the midline) forces
      - Lateral dislocations require valgus forces that tear the cruciates and medial ligaments
      - Rotary dislocations result from the femur twisting while the foot remains firmly planted



Pathophysiology continued

- **Dislocations and sprains continued**
  - Knee continuted
    - Patellar dislocations
      - Usually occur as a result of a twisting injury
      - Rarely results in neurovascular injury
    - Some knee dislocations spontaneously reduce; History is very important
    - Splint in position found if distal neurocirculatory function is intact.

Pathophysiology continued

- **Dislocations and sprains continued**
  - Knee continued
    - Medical collateral ligament (MCL) sprain
      - Usually result from blow to outer part of the knee
      - Valgus stress tears MCL
      - Patient complains of medial knee pain and joint instability
      - To test the MCL, grasp the ankle and the knee and apply opposing forces (medial against the knee and lateral against the ankle) while visualizing and palpating the medial joint space.
      - A gap in the joint space or "clunk" when opposing forces are relived indicates MCL injury

Pathophysiology continued

- **Dislocations and sprains continued**
  - Knee continued
    - Lateral collateral ligament (LCL) sprain
      - Rarely injured
      - Results from varus stress
      - Patient complains of tenderness over the head of the fibula with lateral instability
      - To text the LCL, reverse the hand position used to test the MCL

Pathophysiology continued

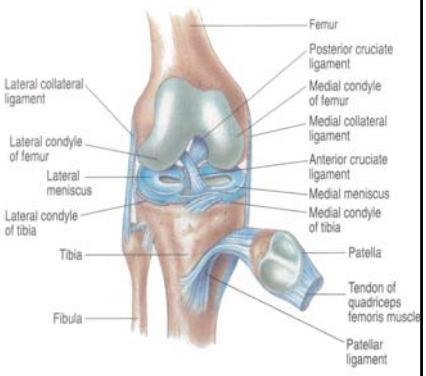
- **Dislocations and sprains continued**
  - Knee continued
    - Anterior cruciate ligament (ACL)
      - Most commonly inured ligament of the knee.
      - Usually results in non-contact sports when the foot is planted while running and the direction of travel is abruptly changed. May also result when a ski binding fails to release.
      - Patient will report a “pop” followed by joint instability.
      - Pain is variable as there are few pain fibers in the area.
      - When present, pain is located in the posteriolateral area.
      - Testing of the ACL is the same as for PCL except the direction of force is reversed.

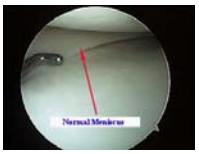
Pathophysiology continued

- **Dislocations and sprains continued**
  - Knee continued
    - Posterior cruciate ligament (PCL) sprain
      - Usually the result of sports injuries or MVC and accompanied by injury to other ligaments
      - Patient complains of posterior knee pain and may walk with knee flexed to avoid full extension
      - Ecchymosis and swelling may be observed in the posterior popliteal space
      - To test the PCL place the knee in a flexed position with the foot held flat against the ground. Grasp the knee below the patella and push the tibia backwards.
      - The PCL is probably damaged if the tibia slides backward on the femur

Pathophysiology continued

- **Dislocations and sprains continued**
  - Knee continued
    - Meniscus injury
      - Menisci are 2 semilunar cartilages in the capsule of the knee joint which act as shock absorbers
      - Medial meniscus is more commonly injured than the lateral
      - The usual MOI is a twisting motion.
      - Because of their limited blood supply, menisci do not heal well even when repaired.
      - Damaged menisci lead to arthritic joint changes.
      - Patient will complain of medial or lateral joint line tenderness with exacerbation of the pain at the extremes of normal knee motion.
      - Often swelling is delayed and the joint remains stable, prompting the patient to continue activity immediately following the injury.
      - If the meniscus is severely torn and becomes incarcerated within the joint space, the knee is locked in position.





Pathophysiology continued

- **Dislocations and sprains continued**
  - Ankle
    - Almost always accompanied by fractures of both malleoli.
    - 4 types: posterior, anterior, upward, and lateral
    - One of the most common musculoskeletal injuries.
    - Anterior drawer test: firmly stabilize the tibia with one hand while pulling the foot forward with the other. Movement forward signifies a grade 3 disruption.
    - Splint the foot and ankle in the position found if neurovascular function is intact.

Pathophysiology continued

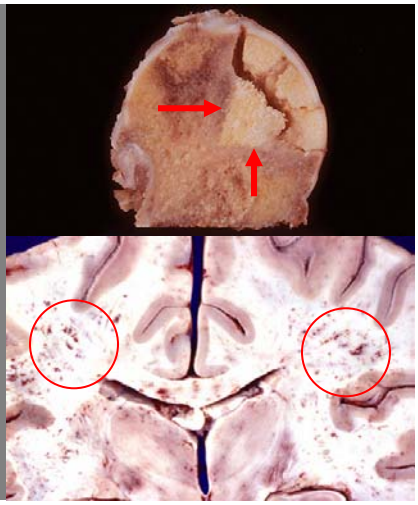
- **Dislocations and sprains continued**
  - Hindfoot
    - Occurs infrequently, usually the result of a fall
    - Calcaneus may be dislocated medially or laterally relative to the talus
  - Midfoot
    - Occur with axial loading of the foot in maximum plantar flexion
    - Usually normally aligned with significant swelling and tenderness
  - Toes
    - Uncommon, but can occur to the large toe with moderate force
    - May result from crush injuries
    - Generally dislocated laterally or medially

Pathophysiology continued

- **Fractures**
  - Bone is highly vascular and virtually all fractures will bleed.
  - Fractures are almost always painful.
  - Fractures may be open or closed.
    - Open fractures usually the result of bone ends puncturing the skin but may also be the result of a soft tissue injury that overlies a fracture (e.g., GSW)
  - Fracture healing
    - Begins with a hematoma that bridges the bone ends, progresses to an inflammatory phase, and ends with remodeling.
    - Rate of healing is affected by the type of bone, degree of fracture, and systemic states

Pathophysiology continued

- **Fractures continued**
  - Complications of fractures
    - Hemorrhage
    - Nerve injury
    - Compartment syndrome
    - Contractures
    - Avascular necrosis
    - Fat embolism
    - DVT
    - Wound infection



Pathophysiology continued

- **Fractures continued**
  - Scapula
    - Well protected by muscle and soft tissue, thus requiring substantial force to fracture.
    - Because of the amount of force required to produce scapular fracture, should be alert to chest and vertebral injury.
    - Usually lacks deformity.
    - S&S include ecchymosis, swelling, tenderness, difficulty raising the arm, and some respiratory difficulty with pleuritic pain on the side of injury.
    - Splint with sling and swathe and spinal immobilization may be indicated.

Pathophysiology continued

- **Fractures continued**
  - Clavicle
    - Most frequently fractured bone.
    - Usually results from forces applied to the lateral aspect of the shoulder causing fracture of the middle third of the clavicle.
    - Fractures to the lateral third result from a direct blow to the top of the shoulder.
    - Fractures to the proximal third are relatively rare and are typically associated with direct blows to the chest.
    - The patient presents with the arm held close to the body with complaints of pain over the site.
    - Pain will increase with motion of the arm or shoulder.
    - Gentle palpation should identify the location of tenderness and thus, the fracture site.
    - Pneumothorax, brachial plexus or vascular injury may accompany the fracture.
    - Splint with figure-of-eight or sling and swathe.

Pathophysiology continued

- **Fractures continued**
  - Humerus
    - Proximal fracture
      - Usually result from direct forces or axial loads onto the elbow or outstretched arm.
      - Difficult to distinguish from a shoulder dislocation.
      - Patient presents with arm held closely to the body with pain, deformity, and crepitus.
      - Splint with board splint on posterolateral aspect of upper arm and sling and swathe.

Pathophysiology continued

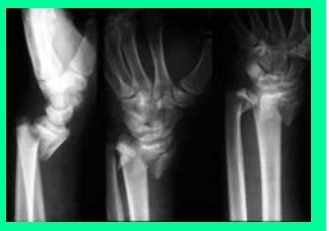
- **Humerus continued**
  - Midshaft fracture
    - Usually result from direct trauma from falls and MVC.
    - Usually have greater degree of deformity than proximal fractures.
    - Patient presents with pain, diminished ROM, shortening and rotation.
    - Splint with padded board or wire ladder with the elbow at 45 or 90 degrees of flexion, and sling and swathe.

Pathophysiology continued

- **Fractures continued**
  - Humerus continued
    - Distal fracture
      - Usually result from fall onto an outstretched hand or direct blow to the elbow.
      - Patient presents with pain, tenderness, swelling, exaggeration or absence of the normal olecranon prominence, abnormal position, and crepitus.
      - Immobilize with padded board or wire ladder and sling and swathe.

Pathophysiology continued

- **Fractures continued**
  - Radius
    - Usually results from direct blow to the forearm.
    - Fracture involving the distal radius with dorsal displacement of the distal radius is referred to as Colles fracture.
    - Smith fracture has volar displacement and may also be referred to as a "reverse Colles" fracture.
    - Immobilize with a padded board splint or wire ladder splint, followed by a sling and swathe.
  - Ulna
    - Proximal fracture
      - Result from fall onto the posterior elbow.
      - Palpable gap may be located at the olecranon and an open fracture may be present.
      - Splint with hand in position of function.
    - Ulnar shaft fracture
      - Frequently associated with fractures of the radius at the same level.



Pathophysiology continued

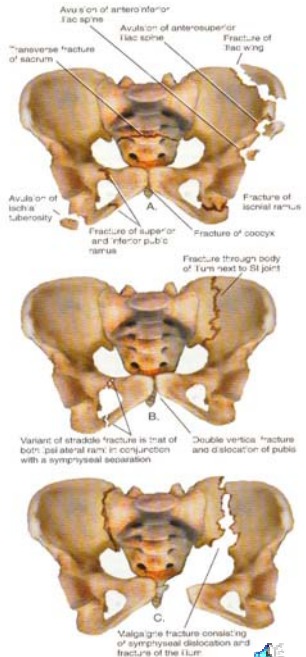
- **Fractures continued**
  - Carpal (wrist)
    - Occur because of significant rotational force or from falls on the hand.
    - Pain, swelling, and decreased ROM are usual complaints.
    - Splint with padded board, wire ladder, or pillow.
    - Immobilize in the position found.
  - Metacarpals
    - Occurs from crushing injuries or direct blows.
    - Tenderness, crepitus, and occasionally deformity are present.
    - If adjacent digits are uninjured, splint by taping to adjacent digit.
  - Phalanges
    - Result from crushing injuries or when digits are caught in equipment.
    - Deformity and crepitus make these injuries obvious.
    - Splint by taping to uninjured neighboring digits.

Pathophysiology continued

- **Fractures continued**
  - Pelvis
    - Generally associated with falls (30%) and MVC (60%).
    - Mortality ranges between 6% - 19%, but may be as high as 50% when associated with hypotension. Thus, hemorrhage should be suspected with any pelvic fracture.

Pathophysiology continued

- **Fractures continued**
  - Pelvis continued
    - Type I fractures
      - Generally stable, do not disrupt the pelvic ring, have the lowest incidence of associated injuries, and heal rapidly with bed rest.
    - Type II fractures
      - Involve a single fracture of the pelvic ring
      - Mobility at the symphysis pubis allows single fracture; if completely rigid, would have fractures in 2 or more places.
    - Type III fractures
      - Involve 2 or more fracture sites and are usually unstable.
      - Frequently associated with retroperitoneal hemorrhage, intraperitoneal injuries, and injury to the urinary bladder and urethra.
    - Type IV fractures
      - Involves the acetabulum and are associated with hip dislocations or fractures.



Pathophysiology continued

- **Fractures continued**
  - Pelvis continued
    - Associated injuries
      - Hemorrhage is the major cause of death in pelvic injuries, accounting for 65% of deaths from pelvic fractures.
      - Hemorrhage most frequently occurs with type III fractures and results from lacerations to the rich vascular network of the pelvis.
      - Veins of the pelvis are thin-walled and lack the ability to constrict to slow blood loss.
      - Bladder injuries may result depending upon the magnitude of blunt force applied, volume of urine within he bladder, and whether a pelvic fracture exists.
      - Urethral injury commonly associated with pelvic fracture.
      - Bowel and rectum may also be injured by bony fragments of the pelvis.

Pathophysiology continued

Type I- Fracture of individual bones without disruption of ring

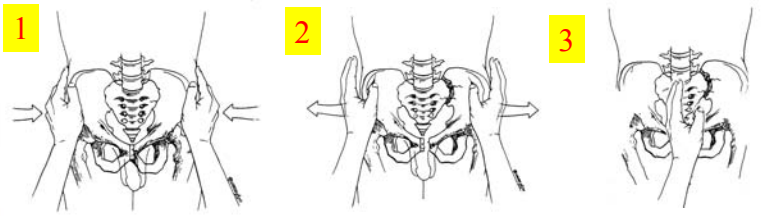
Type II – Single break in pelvic ring

Type III – Double break in pelvic ring

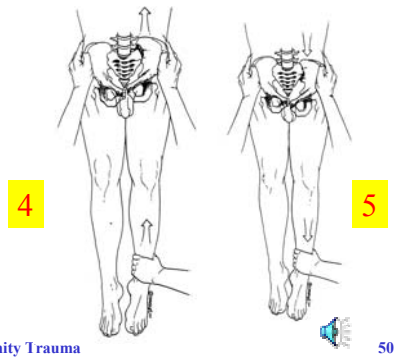
Pathophysiology continued

- **Fractures continued**
  - Pelvis continued
    - S&S
      - Pain
      - Instability
      - Crepitus
      - Deformity
      - Swelling
      - Ecchymosis, shortening of the leg on the affected side
      - Because pelvic fractures may also injure the cauda equina, the lower extremities should be evaluated for abnormal sensation and motor weakness.
      - Cauda equina injuries may also result in loss of bowel and bladder control and loss of innervation to the sex organs.
      - Priapism
      - Rectal bleeding or blood around the urethral meatus

Pathophysiology continued



- **Fractures continued**
  - Pelvis continued
    - Assessment
    - Treatment
      - Spinal immobilization
      - PASG
      - Scoop stretcher
      - Avoid log roll



Pathophysiology continued

- **Fractures continued**
  - Proximal femur
    - Usually the result of falls, MVC, and GSW
    - Fractures of the neck usually produce little swelling or deformity around the hip.
    - Pain with movement.
    - Shortening and external rotation.
  - Femoral shaft
    - Pain, deformity, crepitus are usually present.
    - Open fractures associated with significant hemorrhage.
  - Distal femur
    - Frequently intraarticular with impacted condyles
  - Treatment
    - Traction splint (generally contraindicated in open fracture or high proximal or low distal fractures that may involve the joint)
    - PASG

Pathophysiology continued

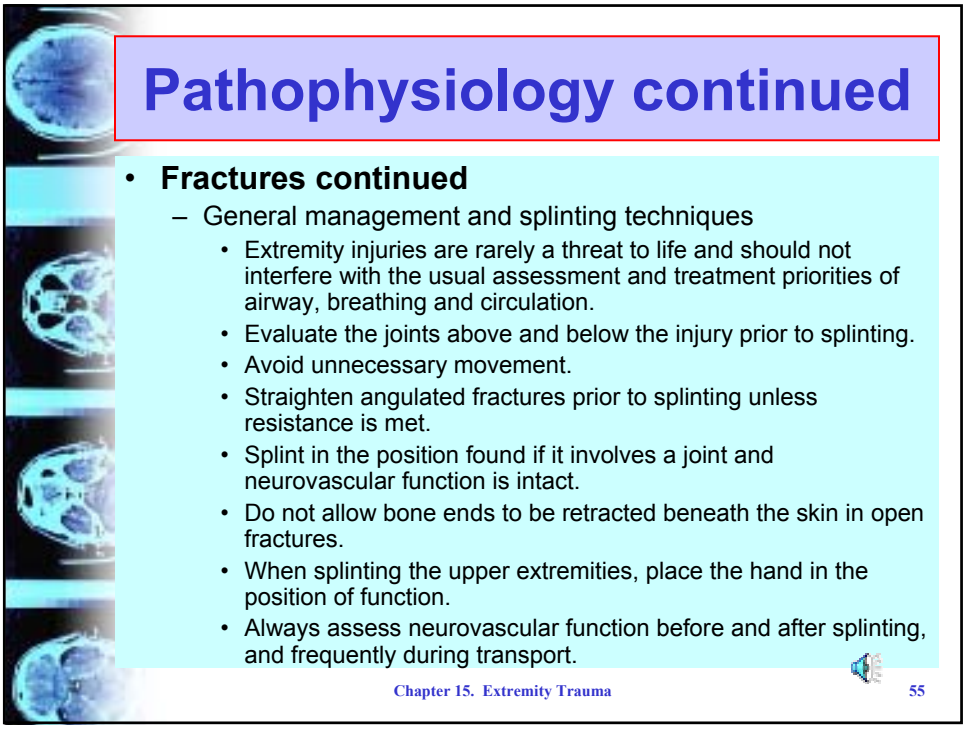
- **Fractures continued**
  - Tibia and Fibula
    - Most frequently injured from MVC, falls and jumps
    - Pain, swelling and deformity are usually obvious
    - These fractures bleed profusely causing rapid onset of joint edema.
    - Tibial plateau may be injured with knee dislocations.
    - Tibial shaft fractures usually accompanied by fibular shaft fractures.
    - May result in compartment syndrome.
    - Realign and splint with padded board splint.

Pathophysiology continued

- **Fractures continued**
  - Ankle
    - The distal tibia, medial malleolus, distal fibula, or any combination may be involved in an ankle fracture.
    - Generally produced by large amounts of torsion around a fixed foot.
    - May also result from a fall or jump.
    - Should be realigned and splinted. Pillow splint works well.
  - Tarsals
    - Calcaneus and talus are most often fractured during jumps or falls when the patient lands on his feet.
    - Patient presents with heel pain, tenderness, swelling, and crepitus.
    - Splint as with ankle fracture.

Pathophysiology continued

- **Fractures continued**
  - Metatarsal
    - Often occur in combination with midfoot dislocation.
    - Occur from axial loading of the foot.
    - Patient complains of midfoot pain, swelling, crepitus, and tenderness.
    - Splint with pillow, vacuum splint, or air splint.
    - Do not allow patient to walk as further injury and swelling may result.
  - Phalanx
    - Usually result from crush injuries.
    - Splint by taping the toe to an adjacent toe



Pathophysiology continued

- **Fractures continued**
  - General management and splinting techniques
    - Extremity injuries are rarely a threat to life and should not interfere with the usual assessment and treatment priorities of airway, breathing and circulation.
    - Evaluate the joints above and below the injury prior to splinting.
    - Avoid unnecessary movement.
    - Straighten angulated fractures prior to splinting unless resistance is met.
    - Splint in the position found if it involves a joint and neurovascular function is intact.
    - Do not allow bone ends to be retracted beneath the skin in open fractures.
    - When splinting the upper extremities, place the hand in the position of function.
    - Always assess neurovascular function before and after splinting, and frequently during transport.