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Injuries of the Lower Extremity: Knee, Ankle and Foot

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First Steps

• I need a volunteer or two who is willing to move up to the front of the room and help me a demonstration
• The rest of you come closer and arrange yourselves so you can talk amongst yourselves (No not because my lecture is going to be that boring)
Objectives

• To provide a review of common lower extremity injuries that present in an Emergency Department setting, focusing on those involving in the knee, ankle and foot
• To describe the epidemiology of these injuries
• To review the appropriate history and physical exam maneuvers in order to quickly evaluate and distinguish the different emergent injuries
• To review the diagnostic examinations available for further evaluation
• To describe the preliminary management of the in the emergent setting
Basic Anatomy of the Knee

- Large Hinge Joint
- Femur
- Tibia
- Fibula
- Patella
More Basic Anatomy

- Ligaments
- Medial Collateral Ligament (MCL)
- Lateral Collateral Ligament (LCL)
- Anterior Cruciate Ligament (ACL)
- Posterior Cruciate Ligament (PCL)
- Articular Cartilage
- Medial Meniscus
- Lateral Meniscus
Types of Knee Injuries

- Injuries to one or more of the ligaments of the knee (ACL, PCL, MCL, and LCL)
- Injuries to the bony structures (Patellar fractures, femur fractures, tibial fractures)
- Injuries to the meniscus and articulating surface
Key Pieces of History

- **Fracture**
  - High-velocity collision
  - Inability to immediately bear weight
  - "Pop" occurred with injury

- **ACL tear**
  - Cut or pivot mechanism of injury
  - Knee "gave way"
  - Inability to continue participation
  - "Pop" felt or heard with injury

- **PCL tear**
  - Blow to proximal tibia
  - Less instability than ACL tear

- **Meniscal tear**
  - Squat/kneel associated with a twist
  - Clicking
  - Locking
  - Pain with rotational movement

- **Overuse syndrome**
  - Occupational or recreational repetitive movement
Epidemiology of Knee Injuries

• All Knee injuries

• Subset of Ligamentous injuries

Source undetermined
Stepwise evaluation of the injured knee

- Palpate the knee and determine the areas of maximal tenderness
- Examine and note the presence and location of any effusion
- Evaluate the Range of Motion at the Knee
- Evaluate the movement and stability of the patella
- Perform specific ligamentous stability testing
- Perform Meniscal examination
- Examine for neurovascular compromise
Palpation

- Superior Patella Pole (Quadriceps Tendonitis)
- Inferior Patella Pole (Prepatellar Tendonitis)
- Anterior Patella (Prepatellar Bursitis)
Joint line (Meniscal Injury)

- Lateral
- Medial

mikebaird, flickr
Palpation in Adolescents

- Tibial Tuberosity (Osgood-Schlatter)
- Femoral or Tibial Epiphysis (Non displaced fracture through the physis)
DDX of Effusions

• Trauma
  ▫ Ligamentous injury
  ▫ Intra-articular fracture
  ▫ Patellar dislocation
  ▫ Meniscus injury

• Polyarthritis
  ▫ Reiter's syndrome
  ▫ Juvenile rheumatoid arthritis
  ▫ Rheumatoid arthritis

• Infection
  ▫ Gonorrhea
  ▫ Lyme disease
  ▫ Tuberculosis
  ▫ Brucellosis

• Gout
  ▫ Pseudogout (calcium pyrophosphate deposition disease)
  ▫ Osteoarthritis and overuse syndrome

• Tumor
  ▫ Malignant
    ▪ Hematologic
    ▪ Solid tumor
      ▪ Chondroblastoma
      ▪ Eosinophilic granuloma
      ▪ Giant cell tumor
      ▪ Ewing's sarcoma
      ▪ Osteosarcoma
      ▪ Synovial sarcoma
  ▫ Benign
    ▪ Aneurysmal bone cyst
    ▪ Fibrous cortical defect
    ▪ Fibrous dysplasia
    ▪ Osteochondroma
    ▪ Osteoid osteoma
    ▪ Pigmented villonodular synovitis
Range of Motion

- The knee should be able to range from hyperextension to 135 degrees of flexion
- Loss of active extension and inability to maintain passive extension are indicative of quadriceps and patellar tendon
Patellar Testing

- Examine the patella, with ROM testing, feeling for catches and grinding.

- Next test the movement of the patella testing for lateral laxity (Patellar Dislocation)
ACL testing

• Anterior Drawer sign
  ▫ Performed at 90 degrees flexion
  ▫ Make sure the quadriceps muscles are relaxed
  ▫ Compare the amount of laxity of movement compared to unaffected side

• Lachman’s Test
  ▫ Performed at 20 to 30 degrees flexion
PCL Testing

- Posterior Drawer sign
  - Gold Standard
  - Performed similarly to Anterior drawer sign

Posterior Sag Sign
- Observe the lag at maximum muscle relaxation
- Compare to unaffected leg
MCL Testing

• Valgus stressing of the MCL at both 0 and 30 degrees
• Testing at 30 degrees removes the stabilization provided by the cruciate ligaments
LCL Testing

- LCL testing similar to MCL testing
- Varus stress testing
- Performed at 0 and 30 degrees
Meniscal Testing

- McMurray’s Test to evaluate for Meniscal injury
- Positive test is “clicking” along joint line along with pain during internal and external rotation
Ottawa Knee Rules

- OK break into groups and lets take 1 minute and list the criteria
- Hint: There are 5
Ottawa Knee Rules

- Age 55 years or older
- Tenderness at head of fibula
- Isolated tenderness of patella
- Inability to flex to 90°
- Inability to bear weight both immediately and in ED
Ottawa Knee Rules: The Numbers

- In one meta-analysis the decision rule had a sensitivity of 1.0 (95% confidence interval 0.96 to 1.0) in identifying clinically important fractures.
- In the same study the potential reduction in use of radiography was estimated to be 49%.
- The probability of fracture, if the decision rules were negative, was estimated to be 0% (95% CI 0% to 0.5%).
- Not worth a patient complaint.
Imaging Modalities

- Plain X-Rays
- CT
- Ultrasound
- Bone Scan
- MRI
Plain Films

- Traditional Standard of Care when concern for fracture
- Generally A/P and Lateral performed in ER
- Additional Useful images include a “Sunrise” view
Computer Tomography

- Useful in detecting tibial plateau fracture
- Usually performed when diagnosis is unclear
Ultrasound

- Often used to examine the musculature of a joint while in use
- Provides dynamic imaging for examining muscle tears, tendon ruptures, and other soft tissue injuries.
Magnetic Resonance Imaging

- Most useful for examination of meniscal injuries
- Can be used for evaluating for ligamentous injury
  - ACL has high sensitivity but poor sensitivity in determining complete versus partial tear
  - Very sensitive in PCL

Source Undetermined
Initial Management

• Or in the other words, after all of that what should we do?
Patellar Fractures

- If extension is possible without displacement
  - non operative management
  - Initially treated in knee immobilizer
  - Treated long leg cast 4-6 weeks
  - Operative management consists of ORIF
Patellar Dislocation

- Closed reduction may be attempted
  - Gentle extension of the leg with anteromedial pressure on the lateral aspect of the patella
  - Following reduction patient should be placed in a knee immobilizer for 3-6 weeks
  - 30-50% recurrence rate in properly treated primary dislocations
Distal Femur Fracture

- Usually secondary to MVC or significant fall
- After examination, the leg should be splinted
- If joint incongruity, Ortho consult and ORIF
- Patients are at risk for fat embolus
Tibial Plateau Fracture

- More common in the elderly
- Usually strong varus force as cause
- By definition are intrarticular
- Often with associated ACL or MCL injury (20-25%)
- Patient should be made non-weight bearing and placed in immobilization either with a long leg cast or immobilizer
- Patient may require ORIF in more serious or displaced fractures

Source Undetermined
Epiphyseal Fracture

- Constitute a fracture through an open growth plate
- Anatomic reduction
- Ice, elevation, immobilization with a long leg splint
- Early orthopedic consultation
Osteochondritis Dissecans (OCD)

- Unknown etiology, thought to be related to chronic or acute trauma
- Occurs mostly in adolescent males
- Usually seen on plain films
- In patients with open growth plates, treat with protected weight bearing
- Poor prognosis if closed
- If loose piece, may require OR

Kristin M Houghton, [Wikimedia Commons](https://commons.wikimedia.org/wiki/User:Kristinmho)
Meniscal Injuries

- Crescent shaped semilunar fibrocartilaginous structures
- Diagnosis via MRI after clinical suspicion
- Unless locking, initial management is NSAIDs, ice, knee immobilization, non-weight bearing, and orthopedic referral
- Ultimate management is determined often secondary to associate ligamentous injury

Arthroscopist, Wikimedia Commons
Ligamentous Injuries

- ACL injuries
- PCL injuries
- MCL injuries
- LCL injuries
ACL injuries

- 50% of ACL injuries are associated with meniscal injuries
- Often associated with bleeding and thus immediate swelling
- Grade I and II should be managed conservatively with pain meds and range of motion exercises
- Patient should be made non weight bearing
- If possible, patient should not be placed in a knee immobilizer if an isolated injury
PCL injuries

• Hyperflexion and Dashboard injuries when isolated injury
• Generally managed non-operatively
• Treated long term with quadriceps strengthening
MCL injuries

- Often due to a direct blow to the lateral aspect of the knee
- Should be placed in knee immobilizer and allowed to “scar” down
- Long term management is generally non operative in isolated injury
LCL injury

- Less common than others, due to protection provided by other leg
- Management the same as with MCL
  - Non-operative management
  - Knee immobilization
Tibial Femoral Knee Dislocation

- Limb Threatening Injury
- Half of all Dislocations reduce spontaneously
- 2/3 From MVCs
- 2 ligament injuries
- Neurovascular injury

[Image: Tibial Femoral Knee Dislocation, Hellerhoff, Wikimedia Commons]
Tibial Femoral Knee Dislocation

- Longitudinal Reduction should be attempted immediately after documentation of neurovascular status
- Recheck of neurovascular status post reduction
- Arteriogram should be performed in any patient not immediately going to the OR if there is any concern of vascular injury
- Prompt vascular surgery involvement is a must
Demonstration and Review
Ankle Anatomy

- Bony anatomy
  - Calcaneus/talus (dome)
  - Tibia (medial malleolus)
  - Fibula (lateral malleolus)

- Composed of 2 joints:
  - True Ankle joint
  - Subtalar joint

- True ankle joint contains the tibia, fibula, and talus
- Allows for dorsiflexion and plantar flexion
Ankle Anatomy

Subtalar Function

- Subtalar joint consists of the talus and the calcaneus
- Allows for inversion and eversion

[Images of eversion and inversion]

Grook Da Oger, Wikimedia Commons
Ankle Lateral Ligaments

- Anterior talofibular
- Posterior talofibular
- Calcaneofibular
- Anterior tibiofibular
- Posterior tibiofibular

Quadell, Wikimedia Commons
Ankle Medial ligament (Deltoid)
Ankle Ring

- Integrity of the ring necessary for stability of the ankle

- Consists of the following:
  - Tibial plafond,
  - Medial malleolus,
  - Deltoid ligaments,
  - Calcaneus,
  - Lateral collateral ligaments
  - Lateral malleolus
  - Syndesmotic ligaments
Ankle Injuries

• Types of injuries
• Ankle sprain/Ligamentous injury
• Ankle fracture/Bony injury
• Joint Dislocation
Ankle Injury Pathophysiology

- Excessive inversion stress (85%) is the most common cause of ankle injuries for two reasons:
  - Medial malleolus is shorter than the lateral malleolus, allowing the talus to invert more than evert.
  - Deltoid ligament stabilizing the medial aspect is stronger.
- However, given the above when eversion injuries occur there is often substantial damage.
Ankle examination

- Look at the ankle for signs of deformity, redness, or swelling
- Feel for tender areas, systematically checking:
  - 1. the anterior joint line
  - 2. the lateral gutter and lateral ligaments
  - 3. the syndesmosis
  - 4. the posterior joint line
  - 5. the medial ligament complex
  - 6. the medial gutter
- Feel for an effusion, synovitis, deformity, bony prominence and loose bodies.
- Examine for neurovascular compromise
Ankle Joint Testing

• Drawer and Talar tilt examination techniques are used to assess ankle instability

• Anterior talofibular ligament
  ▫ Anterior drawer test

• Calcaneofibular ligament
  ▫ (Talar Tilt) Inversion stress test

• Deltoid ligament
  ▫ (Talar Tilt) Eversion stress test

• Use of these techniques in acute injuries can be limited by pain, edema, and muscle spasm

Grook Da Oger, Wikimedia Commons
Anterior Drawer Test

Talar Tilt Inversion Stress Test

openmichigan, YouTube

openmichigan, YouTube
Ottawa Ankle/Foot Rules

- OK break into groups one more time and lets take 1 minute and list the criteria
Ottawa Ankle Rules

- X-rays are only required if:
- There is any pain in the malleolar zone and:
- Bone tenderness along the distal 6 cm of the posterior edge of the tibia or tip of the medial malleolus
- Bone tenderness along the distal 6 cm of the posterior edge of the fibula or tip of the lateral malleolus
- An inability to bear weight both immediately and in the ED

http://www.bmj.com/content/326/7386/417.full
Ottawa Ankle Rules: The Numbers

- In a meta-analysis the pooled negative likelihood ratios for the ankle and mid-foot were 0.08 (95% confidence interval 0.03 to 0.18) and 0.08 (0.03 to 0.20)

- Applying these ratios to a 15% prevalence of fracture gave a less than 1.4% probability of actual fracture

- Sensitivity of almost 100%

- Reduce the number of unnecessary radiographs by 30-40%
Ankle Sprain Classification

• Grade 1: Ligament stretching with microscopic tearing but not macroscopic tearing.
  ▫ Little swelling is present
  ▫ Little or no functional loss and no joint instability
  ▫ Able to fully or partially bear weight.

• Grade 2: Partial tear
  ▫ Moderate-to-severe swelling, ecchymosis
  ▫ Moderate functional loss, and mild-to-moderate joint instability
  ▫ Difficulty bearing weight

• Grade 3: Complete rupture of the ligament
  ▫ Immediate and severe swelling and ecchymosis
  ▫ Moderate-to-severe instability of the joint
  ▫ Cannot bear weight without experiencing severe pain.
Ankle Ligamentous Injury Types

- ATFL is the most likely component of the lateral ankle complex to be injured in a lateral ankle sprain.
- In forced dorsiflexion, the PTFL can rupture.
- External rotation can disrupt the deep deltoid ligament on the medial side.
- Forced adduction in neutral and dorsiflexed positions can disrupt the Calcaneofibular (CFL).
Syndesmosis Sprains

- Account 10% of all ankle sprains and as high as 18% of football players
- Excessive external rotation of the talus or forced dorsiflexion causes the talus to place pressure on the fibula
- Results in spreading of the distal syndesmosis as well as damage to anterior or posterior tibiofibular ligament
Ankle Sprain Treatment

• PRICES
  • Protection
  • Relative rest
  • Ice
  • Compression
  • Elevation
  • Support

• Good return instructions also a must as always
Ankle Sprain Prognosis

• Most report full recovery at 2 weeks to 36 months (36-85%)
  ▫ Independent of the initial grade of sprain
  ▫ Most recovery occurs within the first 6 months

• After 12 months, the risk of recurrent ankle sprain returns to pre-injury levels

• Re-sprains occur in up to 36% of patients, athletes are at increased risk
Isolated Malleolar Fracture (Unimalleolar)

- ED Docs describe based off number fractures
  - unimalleolar, bimalleolar, trimalleolar
- Distal fibula or less common tibial fracture
- Fractures below the Tibiotalar line (T-t, distal to the tibial plafond) are usually stable

http://www.wheelessonline.com/image7/ank120.jpg
Bimalleolar fracture

- Involves the lateral and medial malleolus
- ED Treatment involves fracture reduction and realignment
- Initial ED management is usually followed by surgical fixation
- Ortho consult in ED

Source Undetermined
Trimalleolar Fracture

- Involves the lateral malleolus, medial malleolus, and the distal posterior aspect of the tibia
- Unstable, loss of lateral control
- Surgical repair is required
- Ortho consult in ED

Ankle Fracture Classifications

- Danis-Weber classification often used by Ortho
  - Some correlation with need for operative stabilization
  - Lauge-Hansen alternative classification system

- Type A: Transverse fibular avulsion fracture, occasionally with an oblique fracture of the medial malleolus
  - From internal rotation and adduction
  - Usually stable fractures

- Type B: Oblique fracture of the lateral malleolus with or without rupture of the tibiofibular syndesmosis and medial injury
  - From external rotation
  - May be unstable

- Type C High fibular fracture with rupture of the tibiofibular ligament and transverse avulsion fracture of the medial malleolus
  - From adduction or abduction with external rotation
  - Usually unstable and require operative repair
Pilon Fracture

- Fracture of the distal tibial metaphysis combined with disruption of the talar dome.
- Result of an axial loading mechanism drives the talus into the tibial plafond
  - Foot braced against a floorboard in an auto collision.
  - Skiers coming to an unexpected sudden stop
  - Free fall from heights
- Fractures often open and can be associated with lumbar spine injuries

Maisonneuve fracture

- Proximal fibular fracture coexisting with a medial malleolar fracture or disruption of the deltoid ligament
- Associated with partial or complete disruption of the syndesmosis
- Important to perform a physical exam or x-rays to assess for this in ankle injuries

http://www.wheelessonline.com/image7/mason1.jpg
Tillaux fracture

- Salter-Harris (SH) type III injury of the anterolateral tibial epiphysis
- Caused by extreme eversion and lateral rotation
- Incidence is highest in adolescents because the fracture occurs after the medial aspect of the epiphyseal plate closes but before the lateral

http://emedicine.medscape.com/article/824224-clinical#showall
Ankle Dislocation

- Associated fractures are the rule rather than the exception with ankle dislocations
- Neurovascular injury is the principal concern
- Tented skin may be subject to ischemic necrosis
- Immediate reduction in the ED is often required
Demonstration and Review
Foot Anatomy

- Phalanges
  - proximal, middle, distal
- Metatarsals
- Tarsals
  - Calcaneus
  - Talus
  - Navicular
  - Cuboid
  - Cuneiforms
- Medial/lateral longitudinal and transverse metatarsal arches

Medial arch

Lateral arch

Rob Swatski, [flickr](https://www.flickr.com/photos/robswatski/)
Ottawa Foot Rules

- X-ray series is indicated if there is any pain in the midfoot zone and any one of the following:
- Bone tenderness at the base of the fifth metatarsal (for foot injuries)
- Bone tenderness at the navicular bone (for foot injuries)
- An inability to bear weight both immediately and in the emergency department for four steps.

http://www.bmj.com/content/326/7386/417.full
Foot Injuries

- Toe Injuries
- Metatarsal fracture
- Jones’ fracture
- Lisfranc fracture
- Navicular fracture
- Calcaneal fracture
Toe fractures

- Buddy tape the broken toe to an adjacent, uninjured toe
- Apply a rigid flat-bottom orthopedic shoe
- Union of fracture segments occurs in 3-8 weeks
- Symptoms usually improve much earlier
- Irreducible fractures sometimes require open reduction and internal fixation
First metatarsal fracture

- Least commonly fractured metatarsal
- Bears twice the weight of other metatarsal heads.
- Treat minimally displaced or nondisplaced fractures with immobilization without weight bearing
- Displaced fractures usually require open reduction and internal fixation

http://www.mdmercy.com/footandankle/conditions/trauma/fractures_metatarsals.html
Internal metatarsal fracture

- Nondisplaced and displaced fractures usually heal well, with weight bearing as tolerated, in a cast or rigid flat-bottom orthopedic shoe.

- Elastic support bandages may be equivalent or superior to casts

- Must look for Lisfranc Injury as this is a game changer

- March fracture is a stress fracture of the second or third metatarsal that occurs in joggers.
Jones’ fracture

- Transverse fracture of the 5th metatarsal
- Must be at least 15 mm distal to proximal end
- High rate of malunion
- As above contact Ortho

- Pseudo-Jones: avulsion fracture of tuberosity at 5th metatarsal

Lucien Monfils, Wikimedia Commons
Lisfranc fracture

- Site of articulation between the midfoot and forefoot
- Dislocation at the TMT joint
- Result of direct blow to the joint or by axial loading along the metatarsal, either with medially or laterally directed rotational forces
- Fracture at the base of second metatarsal should raise concern for this type of injury
- Often need weight bearing films to see displacement
Lisfranc fracture: Xrays

http://www.aafp.org/afp/980700ap/burrough.html

http://www.aafp.org/afp/980700ap/burrough.html
Navicular Fracture

- Avulsion fracture most common
- Type 1: coronal fracture with no dislocation
- Type 2: dorsolateral to plantomedial fracture with medial forefoot displacement
- Type 3: comminuted fracture with lateral forefoot displacement
- Most patients are placed in a non-weight-bearing cast for 6 weeks
- All navicular body fractures with 1 mm or more of displacement require open reduction and internal fixation.

http://www.aafp.org/afp/2003/0101/p85.html
Calcaneal fracture-Bohler’s angle

- Calcaneus fractures most often occur in males 5:1
- Peak age: between 30 and 50 years.
- Associated injuries (Lumbar spine vertebral compression fractures)
- Treatment: Operative vs Casting
- Ortho Consult
When to call Ortho for foot injuries

- Talus fractures
- Calcaneus fractures
- Navicular fractures, especially if intraarticular
- Cuboid fractures
- Lisfranc injuries
- Metatarsal shaft fractures with > 3 mm displacement or 10 degrees angulation
- Metatarsal head and neck fractures
- Jones fractures
Questions?
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