Lower Extremity Trauma

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LOWER EXTREMITY TRAUMA

I. PELVIC FRACTURES

- MVAs are the #1 cause.
- Often a marker of serious concomitant injuries
- 15% have associated injuries to intrapelvic structures (i.e. urethra, bladder, rectum, and vasculature)
- The most common cause of mortality from a pelvic fracture is hemorrhage

A. Diagnosis

1. Many patients present in shock due to associate retroperitoneal hemorrhage. A pelvic fracture presenting with hypotension carries a 50% mortality rate.
2. Grey Turner’s sign (ecchymosis of the abdomen or flanks) may be present with retroperitoneal hemorrhage.
3. With associated GU trauma, urine may extravasate into the scrotum, penis, abdominal wall or peritoneal cavity.
4. AP view of the pelvis will identify most fractures.
5. Inlet and outlet (tangential) views of the pelvis are helpful in diagnosing displaced fractures of pelvic arches, as well as SI joint disruptions and sacral fractures.
6. CT is helpful in determining the degree of pelvic instability and diagnosing retroperitoneal hematoma.
B. Classifications (multiple different classification schemes exist)

1. Fractures of individual bones without a break in the continuity of the pelvic ring (Type I fractures, i.e., avulsion fractures, isolated fractures of pubic rami, fractures of sacrum or coccyx).
   a. In general are stable injuries requiring bed rest only.
   b. Isolated fractures of a pubic ramus are the most common type of pelvic fracture.
   c. Sacral fractures may be associated with significant neurologic disability (bowel, bladder and sexual dysfunction).

2. Single break in the pelvic ring (Type II fractures, i.e., fractures of both ipsilateral rami, fractures near and sublux of the symphysis pubis or the SI joint).
   a. Are stable if non-displaced and treated primarily with bed rest.
   b. The presence of significant displacement implies a second disruption of the pelvic ring (an unstable fracture).
3. Double breaks in the pelvic ring (Type III fractures)
   a. Are unstable fractures with a high incidence of intraperitoneal
      and retroperitoneal injuries.
   b. Straddle fractures: up to one-third of the patients will have
      lower urinary tract damage.
   c. Malgaigne fractures:
      i. A double vertical fracture of the pelvis, anterior and
         posterior to the acetabulum.

4. Fractures of the acetabulum (Type IV fractures)
   a. These are frequently associated with hip
      dislocations.

C. Treatment and complications

   1. Hemorrhage (usually retroperitoneal) is of major concern
      a. Use of MAST trousers is controversial. They should be used
         only in the prehospital and ED setting. While useful for
         immobilizing fractures and compressing the pelvis, they
         decrease access to the abdomen and may cause compartment
         syndromes with prolonged use.
      b. Placement of an external fixator may be helpful, especially
         for displaced fractures of the anterior arch.
      c. ATLS recommends the use of a wrapped bed sheet for pelvic
         stabilization and support.
      d. Angiography with selective embolization of pelvic vessels.
2. Genitourinary
   a. Blood at the urethral meatus warrants retrograde urethrogram before catheter insertion.
   b. Retrograde cystogram is indicated in the presence of gross hematuria to rule out bladder rupture.
   c. A speculum exam may be needed to differentiate menses from vaginal lacerations.
3. Rectal injuries
   a. Broad spectrum antibiotics and diverting colostomy are indicated.
4. Nerve root injuries most commonly occur with sacral fractures and SI joint disruptions.
5. Intraabdominal injuries
   a. Closed peritoneal lavage is contraindicated. CT or open lavage should be done to avoid hitting retroperitoneal hematomas.

II. HIP & LOWER EXTREMITY

A. Avascular necrosis of the femoral head
   1. Ischemic bone death of the femoral head due to a compromise of its blood supply.
   2. Trauma is the #1 cause – usually after a femoral neck fracture or hip dislocation. Other causes include: chronic corticosteroid therapy, sickle cell disease, alcohol abuse, gout and lupus. Twenty percent of cases are idiopathic.
   3. Most common in relatively young males (30-50 years of age is the peak incidence) and bilateral approximately 50% of the time.
   4. Presents with increasing hip, thigh or knee pain with no recent history of trauma. Decreased range of motion is noted on physical exam.
   5. X-ray shows decreased bone density of the femoral head initially, followed by bone collapse and loss of head sphericity in the later stages.
   6. Treatment involves surgical removal of part of the core of the femoral head, or total hip arthroplasty in more advanced cases.

B. Soft tissue injuries of the hip and thigh
   1. Bursitis
      a. Several bursae surround the hip and may become inflamed due to overuse or excessive pressure. Treatment is with rest, heat and NSAIDs.
      b. Ischiogluteal bursitis often occurs in individuals who sit for prolonged period of time on hard surfaces. Tenderness is present over the ischial tuberosity. In addition to the usual
conservative therapy, these patients should be advised to use cushioned seating in the future.

2. Muscle injuries
   a. Are more common in athletes, poorly conditioned people engaging in strenuous exercise, and in cold weather.
   b. Partial tears present with swelling, ecchymosis, tenderness and a mild loss of strength.
   c. Specific muscle groups:
      i. Hamstring injuries are typically due to rapid acceleration while running and present with sudden, intense pain in the posterior thigh.
      ii. Quadriceps injuries occur when the muscles contract against the body’s weight (e.g., stumbling to avoid a fall) and present with pain or an inability to extend the knee.
      iii. Iliopsoas strain results from sudden hip flexion against resistance, and often presents with intraabdominal (lower quadrant) pain.
   d. Partial tears usually respond to conservative therapy (i.e., NSAIDs and rest). Complete tears may require surgical repair.

3. Tendon injuries of the hip (“groin pull”) result from a force to abduct the hip during contraction of the adducting muscles.
   a. Pain and tenderness is noted at the inferior pubic ramus and ischial tuberosity.
   b. Partial tears can be managed conservatively, complete tears often require surgery.

C. Hip dislocations

- The most common cause is motor vehicle accident.
- Approximately 50% are associated with fractures of the acetabulum or the femoral head.
- Need to reduce as soon as possible to decrease complications (avascular necrosis of the femoral head)
1. Anterior dislocations (10% of all hip dislocations)
   a. Patients present with hip flexed, abducted and externally rotated.
   b. May be anterosuperior (pubic) or anteroinferior (obturator).
   c. Damage to the femoral artery, vein or nerve may occur, but is unusual.
   d. Treat with closed reduction, usually under general anesthesia.

2. Central dislocations (relatively rare)
   a. Femoral head is dislocated medially, with a badly fractured acetabulum.
   b. Surgical repair is required (not surprisingly).

3. Posterior dislocations (80-90% of hip dislocations)
   a. The classic “dashboard injury”.
   b. Presents with hip flexed, adducted and internally rotated.
   c. Sciatic nerve injury occurs in approximately 10% of cases.
   d. Treatment is with closed reduction, preferably under general anesthesia.
4. Dislocation of hip prosthesis
   a. Most occur in the first 3 months postoperatively.
   b. Reduction may cause damage to the prothesis and should be attempted only after orthopedic consultation.

D. Fractures of the femur

1. Femoral head fractures

   ![Diagram of femur]

   a. Usually occur with hip dislocation (10-16% of posterior hip dislocations will have a femoral head fracture).
   b. Post-traumatic arthritis and aseptic necrosis of the femoral head are potential complications.

2. Femoral neck fracture
   a. Most common in elderly women, usually with relatively minor trauma.
   b. Some nondisplaced fractures may be subtle and require repeat films at 10-14 days or bone scan in 1-2 days for diagnosis.
   c. Avascular necrosis of the femoral head in 15% of nondisplaced fractures and 90% of completely displaced fractures.
   d. All displaced fractures will require surgery.
3. Intertochanteric fracture
   a. Fracture line is between the greater and lesser trochanter.
   b. Avascular necrosis is rare.
   c. The vast majority will require some form of internal fixation.

4. Trochanteric fractures
   a. Greater trochanter
      i. In the young, this is usually secondary to forceful contraction of the gluteus medius with epiphyseal separation.
      ii. In adults, this usually results from direct trauma to the area.
      iii. Usually treated conservatively with limited weight bearing.
      iv. Surgical fixation is indicated if displaced more than 1 cm.
   b. Lesser trochanter
      i. Usually occurs in young athletes.
      ii. Caused by powerful contraction of the iliopsoas.
      iii. Presents with pain and tenderness in the femoral triangle.
      iv. Most can be treated conservatively with gradual weight bearing.
      v. Surgical fixation is indicated if displaced > 2 cm
   c. Subtrochanteric and femoral shaft fractures
      i. These may cause significant blood loss with hematoma formation.
      ii. Shaft fractures are primarily in young patients who have sustained high energy trauma and have a high incidence of concomitant injuries.
      iii. Fat emboli syndrome is a concern with shaft fractures.
      iv. Treat initially with a traction splint and, ultimately, ORIF.
E. Knee injuries

1. Dislocations
   a. The knee joint
      i. A true orthopedic emergency.
      ii. The majority are anterior or posterior. Can also be lateral, medial or rotary.
      iii. 30–40% have popliteal artery injury. While there is no consensus as to the diagnostic approach to detect popliteal artery injury, some type of vascular assessment must be done (i.e., arteriography, ultrasound, arterial-brachial indicis, etc.)
      iv. 35% have peroneal nerve injury.
      v. Some dislocations will reduce spontaneously prior to presentation. Stress radiographs or arthograms may aid in the diagnosis.
      vi. Immediate reduction is indicated.
   b. The patella
      i. The vast majority are lateral.
      ii. Risk factors include a high riding patella (patella alta) and excessive genu valgum (“knock knees”).
      iii. The typical patient is an obese female who experiences a sudden twisting on an extended or slightly flexed knee.
      iv. Reduce with knee extended and hip flexed, and then immobilize the knee in full extension.
      v. Superior or intra-articular dislocations warrant orthopedic consultation.
2. Fractures
   a. The Ottawa Knee Rules: X-rays are necessary if one of the five conditions are present:
      i. Age older than 55 years.
      ii. Inability to transfer weight from one foot to the next, four times at the time of injury and in the emergency department.
      iii. Inability to flex the knee to 90 degrees.
      iv. Patellar tenderness with no other bony tenderness.
      v. Tenderness of the fibular head.
   b. Femoral condyle (supracondylar, intercondylar, unicondylar)
      i. Usually secondary to direct trauma.
      ii. Associated neurovascular injury is relatively uncommon.
   c. Tibial spine
      i. Usually present with associated damage to the cruciate ligaments.
      ii. Incomplete or nondisplaced fractures should be immobilized in extension. Completely displaced fractures require open reduction.
   d. Tibial tuberosity
      i. The insertion site for the quadriceps.
      ii. Caused by a sudden force to flex the knee while quadriceps is contracted.
      iii. If tubercle is incompletely avulsed, can immobilize extension. Complete avulsions require operative repair.
e. Tibial plateaus
   i. Caused by direct force (most commonly to the lateral knee that compresses the femoral condyle into the articulating surface of the tibia).
   ii. More common in the elderly.
   iii. 7–15% will have associated ligamentous injury.
   iv. Can be difficult to detect. Oblique views may be helpful. Sometimes only a fat-fluid level is present on X-ray.
   v. If fracture fragment is depressed 5 mm or more, surgery is indicated.

f. Patellar fractures
   i. Can be caused by direct trauma or contraction of the quadriceps during violent flexion of the knee.
   ii. X-ray findings can be confused with a secondary patellar ossification site (usually in the superolateral aspect). These anomalies are usually present bilaterally.
   iii. Other than small avulsion fractures of the rim, these are considered intra-articular fractures.
   iv. If overlying skin is open, these require debridement and irrigation in the OR.
   v. Non-displaced transverse fractures can be treated conservatively with immobilization in extension.
Displaced fractures require open reduction and internal fixation. Severely comminuted fracture may warrant total patellectomy.

3. Ligamentous injuries
   a. Most present with hemarthroses.
   b. 1$^{\text{st}}$ degree sprain: no instability but pain with stress testing.
   c. 2$^{\text{nd}}$ degree sprain: pain and mild instability.
   d. 3$^{\text{rd}}$ degree sprain: marked instability (complete ligament disruption)

   e. Medial Collateral Ligament (MCL)
      i. Caused by a valgus force to knee.
      ii. If laxity is felt with valgus stress with knee in 30 degree flexion, check for laxity while in full extension. If this is present, damage to other structures (i.e., cruciate ligaments) is present.
      iii. The “terrible triad”: rupture of ACL and MCL with tear of the medial meniscus.
f. Lateral Collateral Ligament (LCL)
   i. Isolated injuries to this are uncommon.
   ii. Caused by a varus stress.
   iii. May have associated common peroneal nerve injury.
g. Anterior Cruciate Ligament (ACL)
   i. Usually a non-contact injury. Often caused by stopping abruptly or making a sharp turn while running.
   ii. Patients frequently hear a “pop,” then knee gives out.

h. Posterior Cruciate Ligament (PCL)
   i. Not a commonly torn ligament.
   ii. Usually caused by pretibial trauma to the hyperflexed knee (as in the “dashboard injury”).
   iii. Diagnosed by a positive posterior drawer sign.
i. Isolated ligament injuries can be treated as follows:
   i. First degree: ice, compressive wrap, non weight bearing.
   ii. Second degree: ice, immobilization, non weight bearing.
   iii. Third degree: orthopedic consultation, some may not require immediate intervention.

4. Meniscal injuries
   a. Can occur primarily or with associated ligamentous injuries.
   b. May present with locking of the joint during flexion or extension, clicking or popping during activity or effusion after activity.
   c. A positive McMurray or Apley test may be present.
   d. Arthroscopy or MRI is used for definitive diagnosis.
5. Quadriceps/patellar tendon rupture
   a. Caused by forceful contraction of quadriceps or falling on a flexed knee.
   b. Risk factors include chronic steroid use, hyperparathyroidism, and long-term dialysis.
   c. Complete ruptures require surgical repair.

F. Distal leg

1. Fractures of the tibial shaft
   a. Have a high rate of open fractures and healing complications.
   b. All displaced fractures require hospitalization for circulatory observation due to high incidence of compartment syndromes.
   c. Closed fractures with minimal or no displacement (e.g., a spiral fracture secondary to excessive rotation while skiing) can initially be managed with a long leg splint with 10 to 20 degrees of knee flexion.

2. Fractures of the fibular shaft
   a. Isolated fractures of the fibular shaft are uncommon.
   b. Usual mechanism is a direct blow.
   c. Fracture of head or neck may injure common peroneal nerve.
   d. Treatment is symptomatic. A short leg walking cast may be used for comfort.
   e. Maisonneuve fracture
      i. Rupture of deltoid ligaments of the ankle or distal tibial fracture with a proximal fibular fracture.
      ii. Caused by forceful external rotation of the foot.
      iii. Most can be treated with cast immobilization. Any ankle instability warrants operative repair.
G. The ankle

1. Inversion injuries typically cause sprains, while eversion injuries characteristically cause fractures.
   a. 75% of all ankle injuries are sprains and 90% of these involve the lateral ligaments. The anterior talofibular ligament is the most commonly injured lateral ligament.
   b. Standard X-ray views include AP, lateral and mortise (15 degree of internal rotation) views.
   c. The ankle can be thought of as a ring consisting of the tibia, fibula and talus bound together by medial (deltoid) ligaments, lateral ligaments and tibiofibular ligaments. Any two breaks in the ring (e.g., a fracture of both malleoli, a malleolus and a ligament, or two ligaments) leaves the joint unstable.
2. Ligamentous injuries
   a. Lateral collateral ligaments
      i. Usually injured by internal torsion.
      ii. Laxity on anterior drawer testing of the ankle indicates tear of the anterior talofibular ligament.
      iii. Laxity noted with inversion testing indicates a tear of the anterior talofibular and canaeofibular ligaments.
   b. Medial collateral ligaments
      i. Usually injured by eversion stress
      ii. Almost always associated with fracture of the fibula (Maisonneuve) or separation of the tibiofibular syndesmosis.
   c. Treatment
      i. 1st degree sprains can be treated with rest, ice, compression dressing and elevation.
ii. 2nd degree sprains require immobilization and non weight bearing.
iii. 3rd degree sprains warrant immobilization and orthopedic consultation.

3. Fractures
   a. The Ottawa Ankle Rules: X-rays are necessary if there is pain in the malleolar region and any of the following findings:
      i. Bone tenderness at the posterior edge of the distal 6 cm or the tip of the lateral malleolus.
      ii. Bone tenderness at the posterior edge of the distal 6 cm or the tip of the medial malleolus.
      iii. The patient is unable to bear weight for at least four steps both immediately after the injury and in the emergency department.
   b. Often occur with associated ligamentous injury.
   c. Definitive treatment (open versus closed) is variable with the primary goal being stability of the talus within the joint.

4. Dislocations (not a common injury)
   a. May be posterior (most common), anterior, lateral or superior.
   b. Most are associated with malleolar fractures and almost half are open dislocations.
   c. Emergent reduction is indicated.
   d. There is a relatively high incidence of vascular injury and avascular necrosis of the talus.

5. Achilles tendon rupture
   a. Most commonly in middle-aged men engaging in athletics.
   b. May be due to forceful dorsiflexion of the ankle or direct blows to a taut tendon.
   c. Often described as being “kicked in the back of the leg”.
   d. Even with complete rupture, some active plantar flexion may be present.
   e. A Thompson’s test (calf squeeze) aids in the diagnosis.
   f. Complete ruptures should be repaired surgically.

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**Calf-Squeeze Test to Determine Achilles Tendon Rupture or Avulsion**

1. Patient is asked to kneel with the knee on the injured side supported by the examining table.
2. Examiner squeezes the calf on the injured side.
3. Squeezing the calf causes a contraction of the calf muscle and plantar flexion of the ankle and foot if the Achilles tendon is intact.
4. If there is no plantar-flexion response to the calf-squeeze test, this indicates that the Achilles tendon has been avulsed and generally requires surgical repair.
H. The foot

1. The forefoot: phalanges and metatarsals.
2. The midfoot: the cuneiforms, cuboid and navicula.
3. The hindfoot: calcaneus and talus.

4. Calcaneal fractures
   a. Usually secondary to a fall from a height.
   b. Bilateral 10 – 20% of the time. Associated lumbar spine injuries 10% of the time and other injuries to the involved extremity 26% of the time.
   c. Most fractures are through the body.
   d. May see a decrease in Bohler’s angle on lateral film, and special calcaneal views may aid in the diagnosis.
   e. Notoriously difficult to treat, often with long term morbidity.

5. Talus fractures
   a. Often secondary to hyperdorsiflexion of the foot.
b. The lateral view of the foot is most helpful.
c. At risk for avascular necrosis, especially if fracture through neck with dislocation of the body.
d. Usually require early reduction if any displacement is present.

**LATERAL VIEW**
1. Displaced vertical fracture through the neck of the talus.
2. Body of the talus is displaced into equinus and posteriorly.
3. Os calcis is displaced anteriorly with the next and body of the talus.

6. Midfoot fracture
   a. A rare occurrence. Usually involve the navicula.
   b. Usually due to direct trauma (crush injuries).
   c. Non displaced fractures can be treated with a walking cast; displaced fractures require orthopedic consultation.

7. Tarsometatarsal (Lisfranc) fracture/dislocations
   a. Can be caused by direct (car running over foot) or indirect (excessive axial load onto plantar flexed foot) trauma.
   b. Very often associated with fracture of the base of the second metatarsal (this is where forefoot “locks into” the mid foot).
   c. Most reliable radiographic finding is separation of the first and second metatarsals.
   d. Notoriously difficult to reduce.
   e. Admission for observation for circulatory compromise of the foot (a major complication) is indicated.

8. Metatarsal fractures
   a. Stress fractures of the 2nd and 3rd metatarsals occur with frequent “pushing off” (i.e., “the march fracture”) since they are subjected to the greatest stress during this activity.
   b. Other fractures are secondary to direct blows or twisting type injuries.
c. Can usually be treated conservatively with a short leg splint and non weight bearing.

9. Fractures of the base of the 5th metatarsal
   • The most common type of metatarsal fracture
   a. Tuberosity fracture
      i. Secondary to inversion, with avulsion of the peroneus brevis insertion.
      ii. Can be treated conservatively with immobilization and non weight bearing.
   b. Jones fracture
      i. Now thought \textit{not} to be an avulsion fracture.
      ii. Fracture line is \textit{distal} to the insertion of the peroneus brevis.
      iii. Usually treated with screw fixation.

10. Phalangeal fractures
    a. Usually secondary to direct (crushing) trauma.
    b. If displaced, can usually be reduced after digital anesthesia.
    c. Fractures of the big toe may require more immobilization (i.e., walking boot cast) given its increased role in weight bearing.

11. Soft tissue injuries
    a. Plantar fasciitis is an overuse syndrome caused by repetitive stretching of the plantar fascia, commonly occurring in runners.
       i. Presents with pain in arch or heel worsened by stair climbing and tenderness along medial edge of fascia.
       ii. Usually responds to rest, NSAIDs and possibly padded heel cups.
    b. Turf toe is a sprain or tear of the first MTP joint capsule caused by repetitive pushing off from a hard surface (i.e., repeated hyperextension of the great toe.)
       i. Initial treatment is conservative and the use of a supportive shoe to lessen the hyperextension.

12. Calcaneal spurs
    a. Occur on the plantar aspect of the calcaneus at the attachment of the plantar aponeurosis.
    b. Presents as heel pain with walking or standing and local tenderness to palpation.
    c. Treated with rest, NSAIDs and padded heel cups
13. Puncture wounds
   a. 8 – 15% progress to cellulitis or localized abscess.
   b. Associated osteomyelitis is due to pseudomonas aeruginosa 93% of the time.
   c. Surgical debridement and parenteral antipseudomonal antibiotics are indicated if osteomyelitis is present.
LOWER EXTREMITY TRAUMA

PEARLS

1. Pelvic fractures frequently present with associated genitourinary, gastrointestinal and vascular injuries.

2. The most common cause of mortality from a pelvic fracture is hemorrhage (usually retroperitoneal).

3. Non-displaced pelvic fractures with a single break in the pelvic ring are stable.

4. Any double break in the pelvic ring or single break with significant displacement is unstable and has a high incidence of intraperitoneal and retroperitoneal injuries.

5. 80 – 90% of hip dislocations are posterior and often secondary to motor vehicle accidents. A significant percentage (10%) of these will have associated sciatic nerve injury.

6. Femoral head fractures commonly occur with hip dislocations.

7. Trauma (usually femoral neck fracture or hip dislocations) is the #1 cause of avascular necrosis of the femoral head.

8. Femoral shaft fractures can cause a large amount of blood loss and hematoma formation.

9. A high percentage of knee dislocations have an associated popliteal artery injury. Arteriography after knee dislocation is generally warranted.

10. Most patellar dislocations can be reduced with the knee extended and hip flexed.

11. Tibial plateau fractures depressed 5 mm or more require surgical repair.

12. Tears of medial collateral ligament are frequently associated with concomitant injury to the anterior cruciate ligament and the medial meniscus.

13. Isolated injuries to the anterior cruciate ligament are often non-contact injuries.
14. Any patient unable to actively extend their knee after falling on it while flexed, should be evaluated for possible quadriceps/patellar tendon rupture.

15. Fractures of the tibial shaft have a high incidence of compartment syndromes and healing complications.

16. A Maisonneuve fracture is a rupture of the deltoid ligaments of the ankle or a fracture of the distal tibia with a proximal fibular fracture.

17. Inversion ankle injuries typically cause ligament sprains, while eversion injuries characteristically cause fractures.

18. The majority of ankle injuries are ligament sprains, and the vast majority of these involve the lateral ligaments.

19. Ankle dislocations have a relative high incidence of vascular injury and avascular necrosis of the talus.

20. Even with complete Achilles tendon rupture, the patient may have some active plantar flexion.

21. Calcaneal fractures are often bilateral (10 – 20%), associated with lumbar spine injuries (10%) and other injuries to the involved extremity (26%).

22. Tarsometatarsal (Listranc) fracture/dislocations are very often associated with a fracture of the base of the second metatarsal. Frequently, a separation of the first and second metatarsals is seen on X-ray.

23. A tuberosity fracture of the base of the fifth metatarsal is due to avulsion of the peroneus brevis insertion.

24. A Jones fracture of the fifth metatarsal is distal to the peroneus brevis insertion and is not thought to be an avulsion fracture.

25. Metatarsal stress fracture (i.e., “March fractures”) usually involves the second or third metatarsals.

26. Osteomyelitis in the foot secondary to puncture wounds is caused by Pseudomonas aeruginosa the majority of the time.
REFERENCES


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