Leg and Ankle Anatomy

EID 424
Bioengineering Applications in Sports Medicine
Prof. Kremenic
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? ? ?

- What is the leg?

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The Foot

- Lots of bones
- Lots of very small moving parts
- Very hard for me to understand

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Of Note in the Foot

- Calcaneus
  - Heel bone
- Talus
  - Above calcaneus
- Plantar fascia
  - Tough tissue running along bottom of foot
  - Connects heel with toes
  - Helps support arch

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The Leg Bony Anatomy

- Tibia
  - Medial
- Fibula
  - Lateral
- Lateral/medial malleoli are your "ankle bones"

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Ankle Bony Anatomy

- Tibia
- Fibula
- Talus
- Form a mortise*
  - Works like a hinge for flexion-extension
- Calcaneus
  - Joint between talus and calcaneous allows foot to roll
    - Inversion/eversion
  - Subtalar joint

* Know your carpentry! Mortise and tenon joint

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Ankle Ligaments

- Lots of 'em
- Lateral
  - Anterior talofibular ligament
  - Posterior talofibular ligament
  - Calcaneofibular ligament
- Medial
  - Deltoid ligaments

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Leg Musculature -- Posterior

- Ankle plantar flexors
  - Soleus
  - Medial/lateral gastrocnemius
    - Also aid in knee flexion
- Toe flexors
- Foot inverters
  - Tibialis posterior

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Leg Musuculature –- Anterior and Lateral

- Anterior
  - Ankle dorsiflexors
    - Tibialis anterior
      - Also ankle evertor
  - Toe extensors
- Lateral
  - Peroneal muscles act as ankle evertors

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The Achilles Tendon

- Inserts onto calcaneous
  - Calcaneal tendon
- Connects to major ankle plantarflexors
- Largest tendon in human body
- Vital for locomotion
  - Stretched prior to foot hitting ground
  - Shortens as foot hits ground
    - Pulls heel up
  - Use of stored energy makes for efficient locomotion

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Common Injuries

- Turf toe
- Plantar fasciitis
- Ankle sprain
- High ankle sprain
- Achilles tendon-
  - itis
  - osis
- Compartment syndrome

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Turf Toe

- Hyperextension injury of the 1st metatarsophalangeal (MP) joint
  - Big toe
- Common in (American) football
  - Esp. on artificial turf

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Turf Toe

- Results in:
  - Decreased range of motion (ROM)
  - Loss of push off strength
- Grade I: stretched out
- Grade II: partial tear
- Grade III: full tear
  - Possible sesamoid bone fracture

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Turf Toe Treatment

- Rest
  - Ice
  - Compression
  - Elevation
- Taping
- Rigid shoe
- Cam walker
  - Ankle immobilizer with rocker bottom
- Cast

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Plantar Fasciitis

- Inflammation of plantar fascia
  - Painful!
  - Esp. early in day
- Causes
  - Flat/high arches
  - Sudden increase in:
    - Activity
    - Weight
  - Tight Achilles tendon

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Plantar Fasciitis Treatment

- Rest
  - Tough to rest foot
  - Ice
  - Anti-inflammatory
- Extra support
  - Shoes
  - Taping
  - Orthotics

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Plantar Fasciitis Treatment

- Stretching
  - Achilles tendon
    - Gastrocemius
    - Soleus
  - Intrinsic muscles of the foot
- Strengthening
  - Calf raises
  - Towel curls

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Ankle Sprains

- Most common sports injury
- *Lateral* ankle sprain
  - Typically occurs in landing from a jump, running, stepping
- Grade I
  - Mild pain, little swelling
  - Stretch or minor tear
  - Little loss of function
  - Return in a few days
    - Brace? Tape?

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Ankle Sprains

- Grade II
  - Moderate/severe pain, swelling, stiffness
  - Partial tear of ligament(s)
  - Some loss of function
  - 2-3 month recovery
- Grade III
  - Severe pain, swelling, stiffness
  - Complete rupture of ligaments
  - Requires period of immobilization (brace, cast)
  - Crutches
  - Surgery?
  - Can be four months or more for complete return of function

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Ankle Sprains

- Rehabilitation
  - We'll discuss this at a later date

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Ankle Sprains -- Sample Rehab

- Immobilize 2-4 wks (splint, cast)
- 2-6 wks:
  - Removable brace
  - Weight bearing as tolerated (WBAT)
  - Active range of motion (AROM) exercises
  - No inv/add
- 6-12 wks
  - Sports brace
  - Strengthening
  - Proprioception
- 3-6 mos
  - Cutting and pivoting
  - Sports-specific exercises

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High Ankle Sprain

- Sprain of syndesmotic ligaments
  - Anterior/posterior tibiofibular ligaments
  - Interosseus ligament
    - Large "ligament" between tibia and fibula
- Outward twisting injury
- Painful
- Rest/brace
  - Surgery (screws) if unstable

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Achilles Tendonitis

- Most common in runners
  - Beware the middle-aged runner
- Overuse injury
  - Tight calf muscles
  - Training errors
    - Sudden change in amount/type of running

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Achilles Tendonosis

- Degenerative issue
  - Tendon is damaged
- Lack of/improper treatment can lead to tear of Achilles tendon
- Beware the middle-aged runner
- Beware Cipro!

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Achilles Tendon Repair

- After tendon torn
- Stitch together torn ends of tendon
  - "Mop ends"
  - Shortens tendon?
- Controversies
  - What kind of knot?
  - How many strands?
  - Reinforcement?
  - Percutaneous?
  - Rehab?
    - When to walk?
    - Brace?

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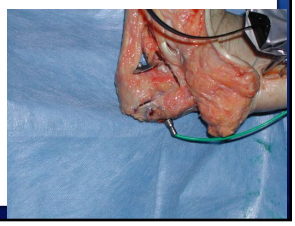
Achilles Tendon Forces

- Implant force transducer
- Fiber optics
  - Work of Paavo Komi



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Compartment Syndrome

- Compartments
  - Groups of muscles surrounded by tough connective tissue called fascia
  - Fluid/swelling can fill a compartment
  - This is bad
  - Increase in pressure reduces blood flow to muscle
    - Pain
    - Eventual tissue death
- Acute
- Chronic

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Acute Compartment Syndrome

- Caused by
  - Trauma
  - Dislocation
  - Vascular injury
- This is an emergency!

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Chronic Exertional Compartment Syndrome

- Pain occurs during repetitive exertion
  - Running
- Usually goes away rapidly with rest
- Usually no permanent effects
- Diagnosed by measuring pressure
  - Subject exercises (e.g., run on treadmill)
  - Large needle stuck in offending compartment to measure pressure
- Treatment via surgery
  - Fasciotomy

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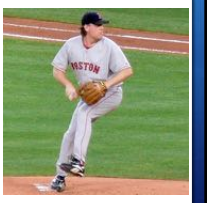
Ankle Injury Case Study: Curt Schilling



- Major-league baseball pitcher
  - Philadelphia Phillies
  - Arizona Diamondbacks
  - Boston Red Sox
  - 216-146, 3.46 ERA
- Won World Series with Arizona, Boston
  - Dominant in post-season play later in career…
  - …one of 103? [pure conjecture]

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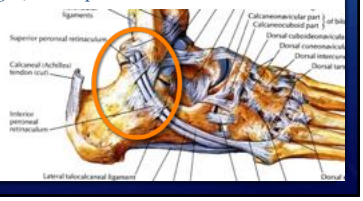
Ankle Injury Case Study: Curt Schilling

- 2004 Playoffs/World Series
  - Tore peroneal retinaculum (see anatomy handouts) in game 1 of division series
    - Retinaculum: band of fascial tissue that helps hold a tendon in place
  - Pitched terribly in game one of AL championship series
  - Team orthopod (Morgan) came up with an idea…



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Ankle Injury Case Study: Curt Schilling

- …surgical stabilization [temporary]!
  - Throw a few sutures in through the skin to hold things in place
    - Tried it in a cadaver, seemed to work
  - Won game 6 of ALDS
    - First time team came back from 3-0 deficit to win series
  - Won game 2 of World Series
    - Red Sox swept series
  - Repeated images of bloody sock on TV
    - Sock in Baseball Hall of Fame

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Ankle Injury Case Study: Curt Schilling

- Lessons learned
  - Pro athletes willing to do anything to be on the field
    - Record after injury (3 seasons):
      - 32-23
      - 4.30 ERA
      - Avg 149 IP (192 IP over prev 15 seasons)
  - Team docs willing to try just about anything to get them there

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