Musculoskeletal Biomechanics
BIOEN 520 | ME 527

Mini-Lab 1
Basic Anatomy
Anatomy: General

- Planes of the body
- Directional terms
- Joint motion/position
- Primary musculoskeletal structures
Anatomy: Foot and Ankle

- Foot and ankle anatomy (emphasizing the musculoskeletal system – no nerves or vessels)
- Dissection video(s)
- Practical examination
Planes of the body

• **Coronal Plane (Frontal Plane)** - A vertical plane running from side to side; divides the body or any of its parts into anterior and posterior portions.

http://training.seer.cancer.gov/anatomy/body/terminology.html
Planes of the body

- **Sagittal Plane (Lateral Plane)** - A vertical plane running from front to back; divides the body or any of its parts into right and left sides.

http://training.seer.cancer.gov/anatomy/body/terminology.html
Planes of the body

• **Axial Plane** *(Transverse Plane)* - A horizontal plane; divides the body or any of its parts into upper and lower parts.

http://training.seer.cancer.gov/anatomy/body/terminology.html
Planes of the body

- **Median plane** - Sagittal plane through the midline of the body; divides the body or any of its parts into right and left halves.

http://training.seer.cancer.gov/anatomy/body/terminology.html
Directional terms

- Directional terms describe the positions of structures relative to other structures or locations in the body.

http://training.seer.cancer.gov/anatomy/body/terminology.html
Directional terms

• **Superior or cranial** - toward the head end of the body; upper (example, the hand is part of the superior extremity).

http://training.seer.cancer.gov/anatomy/body/terminology.html
Directional terms

• **Inferior or caudal** - away from the head; lower (example, the foot is part of the inferior extremity).

http://training.seer.cancer.gov/anatomy/body/terminology.html
Directional terms

- **Anterior or ventral** - front (example, the kneecap is located on the anterior side of the leg).

http://training.seer.cancer.gov/anatomy/body/terminology.html
Directional terms

• **Posterior or dorsal - back** (example, the shoulder blades are located on the posterior side of the body).

http://training.seer.cancer.gov/anatomy/body/terminology.html
Directional terms

• **Medial** - toward the midline of the body (example, the middle toe is located at the medial side of the foot).

http://training.seer.cancer.gov/anatomy/body/terminology.html
Directional terms

• **Lateral** - away from the midline of the body (example, the little toe is located at the lateral side of the foot).

http://training.seer.cancer.gov/anatomy/body/terminology.html
Directional terms

- **Proximal** - toward or nearest the trunk or the point of origin of a part (example, the proximal end of the femur joins with the pelvic bone).

http://training.seer.cancer.gov/anatomy/body/terminology.html
**Directional terms**

- **Distal** - away from or farthest from the trunk or the point or origin of a part (example, the hand is located at the distal end of the forearm).

[Image: http://training.seer.cancer.gov/anatomy/body/terminology.html]
Joint motion: flexion/extension

(a) Joints between atlas and occipital bone and between cervical vertebrae
(b) Shoulder joint
(c) Elbow joint
(d) Wrist joint
(e) Hip joint
(f) Knee joint

http://classroom.sdmesa.edu/eschmid/chapter7-zoo145.htm
Joint motion: abduction/adduction

(a) Shoulder joint  (b) Wrist joint  (c) Hip joint

http://classroom.sdmesa.edu/eschmid/chapter7-zoo145.htm
Joint motion: rotation

(a) Atlanto-axial joint  (b) Shoulder joint  (c) Hip joint

Joint motion: circumduction

(a) Shoulder joint

(b) Hip joint

http://classroom.sdmesa.edu/eschmid/chapter7-zoo145.htm
Joint motion: special motions

(a) Temporomandibular joint  (b)  
Elevation  Depression

(c) Temporomandibular joint  (d)  
Protraction  Retraction

(e) Intertarsal joints  (f)  
Inversion  Eversion

(g) Ankle joint

(h) Radioulnar joint  (i)  
Palm posterior  Palm anterior

Opposition

(h) Radioulnar joint  (i)  
Palm posterior  Palm anterior

Opposition

http://higheredbcs.wiley.com/legacy/college/tortora/0470565101/hearthis_ill/pap13e_ch09_illustr_audio_mp3_am/simulations/hear/synovial_joint_special_movements.html
Joint position: varus/valgus


http://bikedynamics.co.uk/fit01.htm
Primary Musculoskeletal Structures

- Bone
- Muscle
- Ligament
- Tendon
- Cartilage
- Others: (disc, meniscus, labrum, plantar fat)
Foot: motion

Sagittal plane

Dorsiflexion

Neutral

Plantar flexion
Foot: motion

- Eversion or valgus
- Inversion or varus
- Frontal plane
Foot: motion

transverse plane

abduction or external rotation

neutral

adduction or internal rotation
Foot: motion

• Pronation
  ▪ dorsiflexion
  ▪ abduction/external rotation
  ▪ eversion/valgus
  ▪ flat foot

• Supination
  ▪ plantar flexion
  ▪ adduction/internal rotation
  ▪ inversion/varus
  ▪ high arched foot

• issues with pronation and supination:
  - works well for hand, but not for foot due to 90° ankle
  - neutral position vs. anatomic position
  - in some texts, refers to pure frontal plane motion
  - in flat foot (hyperpronated foot or pes planus), forefoot actually supinated relative to hindfoot
Foot and ankle anatomical terms

• Discuss the foot with ankle at 90° (i.e., neutral position) and not with the ankle plantar flexed (i.e., anatomical position), except if we are taking about the toes.

• Avoid use of pronation/supination (see last slide); instead discuss motion/position in specific cardinal planes.

• Coronal rather than frontal (minor point)
Foot and ankle anatomical terms

• Sagittal plane motion at all joints is referred to as dorsiflexion/plantar flexion.

• Hindfoot (calcaneus to tibia, calcaneus to talus, talus to tibia) ankle at 90°
  ▪ coronal plane motion = inversion/eversion (and position varus/valgus)
  ▪ transverse plane motion = adduction/abduction or internal/external rotation
Foot and ankle anatomical terms

- Forefoot to hindfoot (first metatarsal to talus) ankle at 90°
  - coronal plane motion = inversion/eversion (and position varus/valgus)
  - transverse plane motion = adduction/abduction or internal/external rotation

- Hallux to first metatarsal
  - coronal plane motion = inversion/eversion
  - transverse plane motion = varus/valgus
    - hallux valgus = bunion
Foot and ankle anatomical terms

• Use hindfoot not rearfoot

• Use neutrally aligned not rectus

• Can not say “pes planus foot type”, as that literally means “foot flat foot type”. Say “pes planus” or “planus foot type”.
Foot: bony anatomy

*medial column*: calcaneus, talus, navicular, medial cuneiform, first metatarsal
Foot: bony anatomy

lateral column: calcaneus, cuboid, fifth metatarsal
Coach Mike Holmgren said Monday that a bone scan revealed Alexander sustained a "small crack" and "displaced fracture" on a non-weight-bearing bone in his foot sometime during the Seahawks' 42-30 win over the New York Giants on Sunday.
Foot: bony anatomy
Foot: bony anatomy

POND DE GARD (South of France)

http://www.technologystudent.com/struct1/arch1.htm
Foot: bony anatomy

medial/lateral X-ray

Radiographic Anatomy of the Skeleton, Michael L. Richardson, M.D.
http://www.rad.washington.edu/radanat/Foot.html
Foot: bony anatomy

medial / lateral X-ray

Radiographic Anatomy of the Skeleton, Michael L. Richardson, M.D.
http://www.rad.washington.edu/radanat/Foot.html
Foot: bony anatomy

anterior/posterior or dorsal/plantar X-ray

Radiographic Anatomy of the Skeleton, Michael L. Richardson, M.D. http://www.rad.washington.edu/radanat/Foot.html
Foot: bony anatomy

anterior/posterior
or dorsal/plantar
X-ray

Radiographic Anatomy of the Skeleton,
Michael L. Richardson, M.D.
http://www.rad.washington.edu/radanat/Foot.html
Foot: bony anatomy

oblique X-ray

Radiographic Anatomy of the Skeleton, Michael L. Richardson, M.D.
http://www.rad.washington.edu/radanat/Foot.html
Foot: bony anatomy

oblique
X-ray

Radiographic Anatomy of the Skeleton,
Michael L. Richardson, M.D.
http://www.rad.washington.edu/
radanat/Foot.html
Foot: bony anatomy (n=28)

- hindfoot: calcaneus, talus, (tibia, fibula)
- midfoot: navicular, cuboid, and medial, intermediate and lateral cuneiform
- forefoot: metatarsals (n=5) and phalanges (n=14)
- ¼ of bones in the body (n=206)
Foot: joints (n=19 major, n=57 total)

- talocrural (ankle)
- talocalcaneal (subtalar)
Foot: joints (n=19 major, n=57 total)

- talonavicular (Chopart’s)
- calcaneocuboid (Chopart’s)
Foot: joints (n=19 major,)

- tarsometatarsal (Lisfranc’s)
- first metatarsophalangeal
Foot: ligaments (n=108)

medial ligaments: deltoid

Frank Netter, Atlas of Human Anatomy
Foot: ligaments (n=108)

lateral ligaments: lateral collateral ligament

Frank Netter, Atlas of Human Anatomy
Foot: ligaments (n=108)

plantar ligaments: long plantar and spring

Gray’s Anatomy, www.bartleby.com/107/
Foot: extrinsic muscles (n=12)

anterior extrinsic muscles (extra credit)
  tibialis anterior
  extensor hallucis longus
  extensor digitorum longus
  peronius brevis
  peronius longus
  peronius tertius

Gray’s Anatomy, www.bartleby.com/107/
posterior extrinsic muscles (extra credit)

- soleus
- gastrocnemius
- tibialis posterior
- flexor hallucis longus
- flexor digitorum longus
- plantaris

Gray’s Anatomy, www.bartleby.com/107/
Foot: retinaculum

- Flexor retinaculum
- Extensor retinaculum
- Peroneal (Fibular) retinaculum
Foot: retinaculum
Foot & Ankle: anatomy

Schilling Tendon Procedure
From Wikipedia, the free encyclopedia.

The Schilling Tendon Procedure is a temporary surgical procedure developed by Boston Red Sox team physician William Morgan, MD to stabilize the peroneus brevis tendon so that it is prevented from anterior displacement with ankle flexion. If the peroneal retinaculum is torn, the peroneal tendons are no longer stabilized. This allows the peroneal brevis tendon to move untethered over the lateral malleolus, creating pain. During pitching mechanics, the snapping of the tendon over the bone is painful and distracting to the pitcher.

The procedure involves the placement of three sutures through the skin anterior to the path of the peroneus brevis tendon and into the underlying deep connective tissue. These sutures provide a temporary barrier, preventing the tendon from moving anteriorly over the malleolus. The procedure is performed with local anaesthetic, about 24 hours before the player begins to pitch. The stitches must be removed immediately following the cessation of play, and indications are that the stitches may tear during the course of a game.

The procedure is named for Major League Baseball pitcher Curt Schilling, who required the surgery to be able to pitch for the Boston Red Sox in Game 6 of the 2004 American League Championship Series and Game 2 of the 2004 World Series. Schilling was the winning pitcher in both games, and his blood-soaked sock gave a new meaning to the term Red Sox during the team's improbable run towards their first world championship in 86 years.

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Foot: intrinsic muscles (n=20)

intrinsic muscles - layer 1

Gray’s Anatomy, www.bartleby.com/107/
Foot: intrinsic muscles (n=20)

intrinsic muscles - layer 2
Foot: intrinsic muscles (n=20)

intrinsic muscles - layer 3

Gray’s Anatomy, www.bartleby.com/107/
Foot: intrinsic muscles (n=20)

intrinsic muscles - layer 4

Gray’s Anatomy, www.bartleby.com/107/
Foot: plantar aponeurosis
Foot: plantar aponeurosis

medial/lateral view

http://www.medicalmultimediagroup.com/pated/foot/heel spur/heel spur.html
Foot: plantar aponeurosis

medial/lateral X-ray

http://www.jointenterprise.co.uk/heel_pain_or_plantar_fasciitis.htm
Foot in Art
Foot in Art
Foot in Art
Foot in Art