The Foot and Ankle

Objectives:
After completion of this lab, you should be able to:
1. Identify bony landmarks and muscles around the ankle and foot
2. Measure and identify normal and abnormal ankle range of motion
3. Identify normal and abnormal strength and length of the ankle muscles
4. Identify the relationship of the foot and ankle motion during both open and closed kinematic chains
5. Identify the location and function of the support structures of the ankle and foot complex.

Equipment:
1. Marking pencil
2. Goniometer

Reading Materials:
Kendall, F. P., E. K. McCreary, P. G. Provance, M. M. Rodgers, and W. A. Romani, 5th Ed. 2005. Muscles, Testing and Function With Posture and Pain. Williams & Wilkins, Baltimore.
Chapter 7: Lower Extremity (pg. 402-415)

Procedure:
1. While your subject is in a sitting position, find and mark the following bony landmarks. Use a model of the ankle and foot to help you identify the bony structures.
   - **Anterior-medial surface of the tibia** draw the borders of the surface
   - **Fibular head** the bony landmark on the lateral aspect of the shank
   - **Medial and lateral malleoli,**
   - **Calcaneus**
   - **Talus** located in the area between the malleoli and the calcaneus.
   - **Navicular head** the apex of the medial arch of the foot.
   - **Cuboid** located on the lateral side of the foot.

2. Review your subject's standing posture. Focus your attention on the foot segment, ankle, and knee joint. Note the deviation observed and hypothesize the consequences of the deviation on subject's muscle length, strength, and stress placed on the supporting structures.

3. Identify the following soft tissue structures by using the bony landmarks to help you. Ligaments attach between two bones. Most of the time, the name of ligaments tell their attachments.
   - **Anterior talofibular, calcaneofibular and posterior talofibular ligaments**. They are located on the lateral side of the ankle and are sometimes called lateral collateral ligaments of the ankle joint. Among the three ligaments, the anterior talofibular ligament is the weakest. In contrast, the posterior talofibular ligament is the strongest. In a common inversion ankle sprain, the anterior talofibular and calcaneofibular ligaments are typically injured.
   - **Deltoid ligament** – It is located on the medial side of the ankle and is sometimes called the medial collateral ligament of the ankle. The name "deltoid ligament" implies its

triangular shape. The origin of the deltoid ligament is on the medial side of the medial malleolus. The insertion of the deltoid ligament is a continuous line from the medial side of the navicular bone, to the talus and calcaneus. This ligament mainly limits ankle eversion. Since this ligament is very strong, forceful eversion of the ankle may cause avulsion fraction of the medial malleolus instead of a sprain of the deltoid ligament.

4. Measure the range of motion of the ankle by using a goniometer:
   Place the stationary arm of a goniometer along the fibular bone and the moveable arm along the side of the foot. The axis of the goniometer is located at the intersection of the foot and the shank. The starting position is where the angle between the foot and shank is 90°.
   - Measure ankle **dorsiflexion range** while your subject is in:
     - Long sitting position with knee fully extended
     - Long sitting position with knee flexed (45 degrees)
   - Measure **ankle plantar flexion range** while your subject is in a long sitting position

Table 1. Range of Joint Motion and Range of Muscle length

Left Foot	Movement	Right Foot
	Ankle dorsiflexion with knee fully extended **(20°)**	
	Ankle dorsiflexion with knee flexed	
	Ankle plantar flexion **(45°)**	

In general, the ankle dorsiflexion range of motion should be the similar between measurements taken with and without knee flexion. However, if the subject is unable to fully dorsiflex his/her ankle without knee flexion but able to so with knee flexion, it indicates that the subjects has tightness of the gastrocnemius muscle.

5. Perform muscle testing of the following muscles according to the instruction given in the book. During muscle testing, please identify the border of muscles if possible.
   - **Tibialis anterior (Kendall, pg. 410)**
   - **Tibialis posterior (Kendall, pg 411)**
   - **Peroneus longus and brevis (Kendall, pg. 412)**
   - **Peroneus tertius (Kendall, pg. 409)**
   - **Soleus (Kendall, pg. 413-414)**
   - **Gastrocnemius (Kendall, pg. 415)**
   - **Extensor hallucis longus and brevis (Kendall, pg. 403)**
   - **Extensor digitorum longus and Brevis (Kendall, pg. 408-409)**
   - **Flexor hallucis longus (Kendall, pg. 402)**
   - **Flexor digitorum longus (Kendall, pg. 407)**

6. Test your hypotheses using information collected during range of motion and muscle test

Questions:

- Does your subject have a limited or excessive ankle dorsiflexion? If yes, what is the range?
- What structure (s) could potentially limit ankle dorsiflexion range of motion?
- Could weakness of the ankle dorsiflexors influence the ankle dorsiflexion range?
- Assume that your subject has limited ankle dorsiflexion, please design a stretching exercise program specific to your subject.
- Does your subject have a limited or excessive ankle plantar flexion? If yes, what is the range?
- What structure (s) could potentially limit ankle plantar flexion range of motion?
- Could weakness of the ankle plantar flexors influence the ankle plantar flexion range, and how?
- Assume that your subject has limited ankle plantar flexion, please design a stretching exercise program specific to your subject.
- When performing a standing calf stretch with knee fully extended, which muscles are stretched?
- When performing a standing calf stretch with knee slightly flexed, which muscle (s) is stretched?
- What are the functional differences of the tibialis anterior and tibialis posterior?
- What are the functions of the tibialis posterior during stance?
- Design an exercise to strengthen the tibialis posterior muscle.
- Deltoid ligament is very strong. During an eversion sprain, the ligament might not be severly injured; however, the abduction force may cause an avulsion fracture of the attachment of the deltoid ligament instead. Which attachment of the deltoid ligament is susceptible to injury during an eversion ankle sprain?

References:

Hoppenfeld, S. 1976. Physical Examination of The Spine and Extremities. Appleton-Century-Crofts, East Norwalk.

Kendall, F. P., E. K. McCreary, P. G. Provance, M. M. Rodgers, and W. A. Romani, 5th Ed. 2005. Muscles, Testing and Function With Posture and Pain. Williams & Wilkins, Baltimore.

Norkin, C. C., and D. J. White. 1985. Measurement of Joint Motion: A Guide to Goniometry. F.A. Davis Company, Philadelphia.

Sahrmann, S. A. 2002. Diagnosis and Treament of Movement Impairment Syndromes. Mosby, Inc., St. Louis.