

Virtual Anatomy Lab: Study notes

Week 2 - The knee and leg

OSTEOLOGY

A. The femur.

The inferior extremity of the femur presents the medial and lateral condyles; the medial and lateral epicondyles; the patellar surface, the intercondylar fossa. The popliteal surface is found in the shaft of the femur below the linea aspera.

B. The tibia.

The superior extremity of the tibia presents the plateau, the medial and lateral condyles, the anterior and posterior intercondylar areas, the intercondylar eminence and the tibial tuberosity.

C. The patella.

The posterior aspect of the patella is articular; the anterior aspect is non-articular.

Clinical note: In the knee region, you can palpate: the epicondyles of the femur, the condyles of the femur and the tibia, the tibial tuberosity and the patella.

THE KNEE JOINT

The knee joint is a modified hinge, uniaxial synovial joint. The articular surfaces are covered by **articular cartilage**. These include the condyles of the femur and the tibia, the posterior aspect of the patella and the patellar surface of the femur.

The fibrous capsule:

Posteriorly, the fibrous capsule attaches to the margins of the articular surfaces of the condyles of the femur and the tibia. It is strengthened by 2 capsular ligaments: the oblique popliteal ligament, and the arcuate popliteal ligament present above the tendon of the popliteus muscle where it passes out of the joint

Medially & laterally, it attaches to the margins of the articular surfaces of the condyles of the femur and the tibia. It is strengthened by **2 collateral ligaments**; these ligaments are lax when the knee is flexed, and are stretched during extension of the knee.

- (1) Tibial collateral ligament.** The tibial collateral ligament is shaped like a broad flat bandage. It attaches to the medial epicondyle of the femur and the medial condyle of the tibia and is fused to the fibrous capsule and the medial meniscus. The function of this ligament is to prevent abduction. A lesion of this ligament occurs during violent

abduction.

Clinical note. Examination of the ligament: place one hand on the lateral aspect of the knee. The other on the medial aspect of the distal part of the leg. Apply **valgus force**.

- (2) Fibular collateral ligament.** The fibular collateral ligament is cord shaped. It attaches to the lateral epicondyle of the femur and the head of the fibula. The tendon of the popliteus muscle separates it from the lateral meniscus. Its function is to prevent adduction. A lesion of this ligament occurs during violent adduction.

Clinical note. Examination of the ligament: place one hand on the medial aspect of the knee. The other on the lateral aspect of the distal part of the leg. Apply varus force. The exam is performed with the knee extended and with the knee flexed 20°-30°.

Anteriorly, and above the patella, the fibrous capsule is absent. It is replaced by the tendon of the quadriceps femoris muscle. Below the patella, the **“patellar ligament”** strengthens the capsule. It joins the apex of the patella to the tibial tuberosity. Beside the patella are the **medial and lateral retinacula of the patella** (continuation of the vastus medialis and the vastus lateralis muscles), attached to the margins of the patella and the condyles of the tibia respectively.

INTRA-ARTICULAR STRUCTURES

Cruciate Ligaments

- 1. Anterior Cruciate Ligament.** The anterior cruciate ligament attaches to the anterior intercondylar area of the tibia and extends upwards and to the back. It attaches to the medial side of the lateral condyle of the femur and prevents hyperextension of the knee and anterior displacement of the tibia.
- 2. Posterior Cruciate Ligament.** The posterior cruciate ligament attaches to the posterior intercondylar area of the tibia and extends upwards and to the front. It attaches to the lateral side of the medial condyle of the femur and prevents posterior displacement of the tibia.

Clinical note: Cruciate Ligament Tests

a. Anterior cruciate ligament test:

Pull the tibia anteriorly.

b. Posterior cruciate ligament test:

Push the tibia posteriorly.

- If the knee is flexed 90°, the test is called the “drawer test”.
- If the knee is flexed 30°, the test is called the “Lachman test”. This test is more useful especially in cases of acute lesions where it is impossible to flex 90° without causing pain.

In cases of downhill skiing accidents, the anterior cruciate ligament can be torn, especially with skiing today because the boots are high and stiff (therefore less shock absorption at the ankles). With these skiers, the quadriceps are overdeveloped because the skier sits back. Without opposition by the hamstring muscles, the quadriceps pull the tibia anteriorly and tear the anterior cruciate ligament.

THE MENISCI (medial and lateral)

The menisci are crescent-shaped fibrocartilaginous structures above the condyles of the tibia. They deepen the tibial plateau. The tibial collateral ligament of the knee is fused to the medial meniscus; it limits movement of the meniscus. A tear in the ligament is often accompanied by a torn meniscus.

OTHER STRUCTURES IN THE KNEE

- the tendon of the popliteus muscle
- a fat pad posterior to the patellar ligament

SYNOVIAL MEMBRANE OR CAPSULE

The synovial membrane lines the fibrous capsule and is reflected on the bones at the margins of the articular surfaces. It is attached to the margins of the menisci and the patella, and covers the cruciate ligaments except posteriorly. Below the patella, it forms a median infrapatellar synovial fold. On both sides of the median fold, there are alar folds. Superiorly, it continues with the **suprapatellar bursa** that separates the quadriceps tendon from the femur.

MOVEMENTS OF THE KNEE.

- (1) Extension.** The **quadriceps femoris**. (The **rectus femoris** and the **vastus intermedius** muscles have their insertions in the base of the patella and via the patellar ligament in the tibial tuberosity. The **vastus medialis** and **vastus lateralis** muscles have their insertions in the margins of

the patella and via the retinacula of the patella in the condyles of the tibia. The **gluteus maximus** muscle and the **tensor fasciae latae**, through the **iliotibial tract**, maintain extension of the knee.

- (2) Flexion.** Muscles responsible for the flexion of the knee are the following:

- The Pes anserinus (Crow’s foot): sartorius, gracilis and semitendinosus muscles have their insertion on the medial aspect of the medial condyle of the tibia.
- The semimembranosus muscle has its insertion on the posterior aspect of the medial condyle of the tibia.
- The biceps femoris muscle has its insertion on the head of the fibula.
- The popliteus muscle and the 2 heads of the gastrocnemius muscle.

POPLITEAL FOSSA

The popliteal fossa is a diamond-shaped fossa located posterior to the knee.

Boundaries:

1. **Superolaterally:** biceps femoris muscle.
2. **Inferolaterally:** lateral head of the gastrocnemius muscle.
3. **Superomedially:** semimembranosus and semitendinosus muscles.
4. **Inferomedially:** medial head of the gastrocnemius muscle.
5. **Roof:** fascia lata and the small saphenous vein.
6. **Floor:** the popliteal surface of the femur, the capsule of the knee and the popliteus muscle.

Contents:

1. **The popliteal artery** is the continuation of the femoral artery at the adductor hiatus. It is found on the floor and ends at the inferior border of the popliteus muscle where it divides into the anterior and posterior tibial arteries. It gives off 5 genicular arteries.

NB: To palpate the pulse of the popliteal artery, the knee must be flexed in order to

relax the muscles and the fascia lata.

2. **The popliteal vein, which receives the small saphenous vein.**
3. **The tibial nerve:** this is one of the 2 terminal branches of the sciatic nerve. It crosses the popliteal fossa from the superior angle to the inferior angle. The branches of the tibial nerve in the popliteal fossa are the **sural nerve** that accompanies the small saphenous vein on the posterior aspect of the leg and the lateral aspect of the foot. It is the **cutaneous nerve** for these 2 regions; the **muscular branches** supply gastrocnemius, popliteus and soleus muscles; and the **articular branches** for the knee.
4. **The common peroneal nerve:** this is the other terminal branch of the sciatic nerve. It crosses the popliteal fossa from the superior angle to the lateral angle and is found **medial to the biceps; it winds around the neck of the fibula (where it can be palpated)**. It divides in 2: the superficial peroneal nerve and the deep peroneal nerve.
Clinical note: The nerve can be damaged by a cast that starts under the knee and extends down to the toes if the upper edge of the cast is too high or if it does not have sufficient padding. The result is “**drop foot**” due to paralysis of the muscles of the anterior and lateral compartments of the leg and numbness as well as tingling on the anterolateral surface of the leg and on the dorsal surface of the foot and toes.

THE LEG

- (1) **Anterior Crural Compartment.** The anterior crural compartment contains 4 muscles, the **tibialis anterior** muscle, the **extensor hallucis longus** muscle, the **extensor digitorum longus** muscle and the **peroneus tertius** muscle. All of these muscles are innervated by L5, S1 except the tibialis anterior muscle, which is innervated by L4,5. These muscles perform **dorsiflexion of the ankle**. In addition the tibialis anterior muscle causes inversion of the foot, the peroneus tertius muscle causes eversion of the foot, the extensor digitorum longus muscle causes extension of the lateral 4 toes and the extensor hallucis longus muscle causes extension of the big toe.

All of the muscles of the anterior crural compartment are innervated by the **deep peroneal nerve**, one of the two terminal branches of the common peroneal nerve. It is situated between the tibialis anterior muscle and the extensor digitorum longus and extensor hallucis longus

muscles. In the foot, it is cutaneous for the skin in the first space (between the first and second toes). **The anterior tibial artery** is one of the 2 terminal branches of the popliteal artery. It pierces the interosseous membrane and accompanies the deep peroneal nerve. It continues as the dorsalis pedis artery. The arteries of the leg are found between 2 venae comitantes.

- (2) **Lateral Crural Compartment.** The lateral crural compartment contains 2 muscles, the **peroneus longus** and the **peroneus brevis** muscles. They are innervated by L5, S1. The peroneus muscles perform **eversion of the foot**. Since they pass behind the lateral malleolus, they also perform **plantar flexion of the foot**.

The **superficial peroneal nerve** passes between the 2 peroneal muscles (peroneus longus and brevis), innervates them, and then becomes cutaneous for the skin on the inferior 1/3 of the anterior surface of the leg, and the dorsal surface of the foot and the toes (exception is the first space between the toes).

- (3) **Posterior Crural Compartment.** The posterior crural compartment contains the following muscles. The superficial muscles are the **triceps surae muscle** that consists of the **soleus muscle** and the **gastrocnemius muscle**. The gastrocnemius muscle has 2 heads, one medial and the other lateral. These 2 muscles form the Achilles tendon that attaches to the calcaneus. Note the plantaris muscle may be absent. The deep muscles are the popliteus muscle, the muscles covered by the soleus muscle (the tibialis posterior, the flexor digitorum longus and the flexor hallucis longus muscles). The tibialis posterior muscle is innervated by L4,5. The triceps surae muscle is innervated by S1,2. The flexor muscles of the 5 toes are innervated by S2,3. All the muscles produce plantar flexion at the ankle except the popliteus muscle. Additionally, the popliteus and gastrocnemius muscles flex the knee, the tibialis posterior muscle produces inversion of the foot, the flexor hallucis longus muscle flexes the big toe and the flexor digitorum longus muscle flexes the lateral four toes.

Clinical note. Method to stretch the triceps surae (gastrocnemius-soleus) muscle. Stretch the soleus muscle with passive dorsiflexion at the ankle and slight flexion at the knee. Stretch the gastrocnemius muscle with passive dorsiflexion at the ankle and extension at the knee because the gastrocnemius muscle is bi-articular.

The tibial nerve. In the posterior compartment, it is found between the soleus muscle and the deep muscles. It ends posterior to the medial malleolus where it divides

into the medial and lateral plantar nerves. It innervates all the muscles in the posterior compartment of the leg.

The posterior tibial artery. It is one of the terminal branches of the popliteal artery and is found between 2 venae comitantes. It accompanies the tibial nerve in the posterior compartment of the leg and ends posterior to the medial malleolus where it divides into the medial and lateral plantar arteries. It gives off the peroneal artery. The pulse of the posterior tibial artery can be palpated midway between the medial malleolus and the Achilles tendon.

The saphenous veins.

(1) The great saphenous vein has its origin in the medial side of the dorsal arch of the foot. It courses anterior to the medial malleolus to the medial side of the leg, then posterior to the medial condyles of the tibia and femur, then to the medial side of the thigh into the saphenous opening in the fascia lata into the femoral vein. The saphenous nerve is a cutaneous branch of the femoral nerve that passes through the adductor canal to below the knee where it accompanies the great saphenous vein. It innervates the skin and medial surface of the leg and foot.

(2) The small saphenous vein has its origin in the lateral side of the dorsal arch of the foot. It courses posterior to the lateral malleolus, then posterior aspect of the leg to the popliteal vein. The small saphenous vein is accompanied by the sural nerve which is a cutaneous branch of the tibial nerve. It innervates the skin on the posterior surface of the leg and the lateral surface of the foot.