

Virtual Anatomy Lab: Study notes

Week 1 - The hip, thigh, and bone marrow

OSTEOLOGY

A. The hip bone.

The **2 hip bones** form the pelvic girdle. They are formed by the fusion of the ilium, the ischium and the pubis.

The ilium: The ilium is the broad portion of the hip bone which forms the superior part of the hip bone. Anatomic landmarks include the iliac crest, the iliac spines (anterior superior, anterior inferior, posterior superior, posterior inferior), the iliac fossa, the articular surface for the sacroiliac joint, and the greater sciatic notch.

The inferior and anterior portion of the hip bone is formed by the **ischium** on the lateral sides and the **pubis** anteriorly. Together, these bones form a round to oval opening known as the **obturator foramen**. The anatomic landmarks of the **ischium** include the ischial tuberosity, the ischial spine, and the greater and lesser sciatic notches. For the pubis, note the pubic crest and the pubic tubercle.

The ilium, ischium and pubis contribute to the articular surface for the hip joint, a region known as the acetabulum. This shallow cup-like structure contains a lunate surface, a fossa and the acetabular notch and serves as the insertion point for the head of the femur.

B. The femur.

The superior extremity of the femur: The superior extremity of the femur is formed by the head and fovea capitis (fossa for ligament of head of femur), the neck with the retinacular foramina, the greater and lesser trochanters, the intertrochanteric line and the intertrochanteric crest.

Body or diaphysis. On the body of the femur, we can see the linea aspera on the posterior surface.

Clinical note: The following structures can be palpated: the iliac crest, the anterior superior iliac spine, the sacroiliac joint (corresponds to the dimple for the posterior superior iliac spine that can be noted in the medial part of the buttock), the ischial tuberosity (that we sit on) and the greater trochanter.

VASCULARIZATION OF THE FEMORAL HEAD AND NECK

The ligament of the head of the femur (round ligament) contains a branch of the obturator artery that provides only 0-20% of the blood supply of the head of the femur in an

adult. The **retinacular arteries** arise from the posterior branches of the medial circumflex femoral artery. These arteries pass primarily on the posterior surface of the neck of the femur with the capsule retinacula, then enter the retinacular foramina that are present in the neck of the femur close to the head (therefore these vessels are first **superficial** and then intramedullary). In the adult, these arteries, which are now intraosseous (**intramedullary**), cross the neck. They are responsible for vascularization of the head and neck of the femur and anastomose with the branch of the obturator artery present in the ligament of the head of the femur. In the child, the presence of epiphyseal cartilage (growth cartilage) prevents the retinacular arteries from vascularizing the head.

Clinical Significance

- In the case of a fracture of the neck of the femur with displacement, **avascular necrosis** of the head of the femur occurs due to an interruption of the superficial and intramedullary vessels.
- In the case of septic arthritis in children, increased intracapsular pressure causes compression of the superficial vessels on the surface of the neck of the femur. **Avascular necrosis** of the head of the femur results.

ANATOMY OF THE HIP JOINT

The hip joint is a multiaxial **ball-and-socket** synovial joint. To form the joint approximately 3/4 of the head of the femur articulates with the acetabulum of the hip bone. The **articular cartilage** covers both the head of the femur except in the region of the fovea capitis, and the lunate surface of the acetabulum. The **acetabular labrum (or lip)** is a fibrocartilaginous ring attached to the rim of the acetabulum; it deepens the cavity of the acetabulum.

The hip joint is stabilized by several ligaments.

- The **transverse acetabular ligament** closes the acetabular notch.
- The **ligament of the head of the femur (round ligament or ligamentum teres)** is surrounded by fat and a synovial membrane and contains a branch of the obturator artery. It connects the transverse ligament to the fovea capitis (and thus to the head of the femur).

The **fibrous capsule** is attached to the edge of the acetabulum and the transverse acetabular ligament. On the femur side, it attaches to the intertrochanteric line and to the middle of the dorsal surface of the neck of the femur (only half the neck is intracapsular). Certain fibers called **retinacula** are reflected along the neck; they contain **retinacular arteries** that penetrate the retinacular foramina of the neck of the femur to vascularize the head and neck of the femur.

The capsule is thick in 3 regions, formed by 3 capsular ligaments:

- (1) The **Iliofemoral ligament**. (Very strong). It is Y-shaped between the anterior inferior iliac spine and the intertrochanteric line. It limits hyperextension and lateral rotation.
- (2) The **Pubofemoral ligament** extends from the pubic part of the acetabulum to the inferior part of the intertrochanteric line. It limits abduction.
- (3) The **Ischiofemoral ligament** forms the posterosuperior part of the capsule and limits medial rotation.
NB: the postero-inferior part of the capsule is weak.

The **Synovial capsule** is formed by the synovial membrane which lines the interior of the fibrous capsule from the acetabular labrum, and covers the intracapsular part of the neck of the femur, the ligament of the head of the femur, and the fat that is found in the acetabular fossa. Between the iliofemoral and pubofemoral ligaments, the synovial capsule may communicate with the psoas bursa.

Compared to the shoulder joint, the acetabulum is deeper than the glenoid cavity due to the acetabular labrum. As a consequence the range of motion of the hip is less than that of the shoulder. However, the muscles and ligaments surrounding the hip are stronger than those of the shoulder and the fibrous capsule of the hip is thicker and less elastic than that of the shoulder, thereby reducing the risk of dislocation of the hip joint as compared to the shoulder.

MOVEMENTS OF THE HIP

Several groups of muscles act on the hip joint. They are divided here based on their action.

- (1) **Flexion:** The muscles whose action results in flexion of the hip are found in the anterior compartment of the thigh (exceptions are the 3 vastus muscles). The muscles of the anterior compartment of the thigh are the **iliopsoas**, the **sartorius**, and the **quadriceps femoris** (the rectus femoris, vastus lateralis, vastus medialis and

vastus intermedius). The muscles of the anterior compartment are innervated by the **femoral nerve**.
Clinical note: The **Thomas test** is used to detect a lesion of the iliopsoas muscle. For this test, the patient lies on his back (supine position) and the hip on the opposite side is completely flexed in order to obliterate lumbar lordosis. **Result:** flexion of the hip on the affected side and pain during passive extension.

- (2) **Extension:** The muscles whose action results in extension of the hip are the **gluteus maximus** and the **hamstring muscles**. The hamstring muscles of the posterior thigh muscles are the **biceps femoris**, the **semimembranosus**, the **semitendinosus** and the **hamstring part of the adductor magnus** (the adductor magnus is found in the medial compartment). The hamstring muscles are innervated by the **sciatic nerve**.
- (3) **Adduction:** The muscles whose action results in adduction of the hip are found in the medial compartment of the thigh. They are the **gracilis**, the **pectineus**, the **adductor longus**, the **adductor brevis** and the adductor part of the **adductor magnus**. The innervation of these muscles is provided by the obturator nerve.
- (4) **Abduction:** The muscles whose action results in abduction of the hip are the **gluteus medius**, the **gluteus minimus** and the **tensor fasciae latae**. These muscles are innervated by the **superior gluteal nerve**.
- (5) **Medial rotation:** Note that the muscles responsible for medial rotation of the hip and the same as those that execute abduction.
- (6) **Lateral rotation :** The muscles whose action results in lateral rotation of the hip are the **gluteus maximus** and the **6 short lateral rotators** of the hip (piriformis, obturator internus and externus, superior and inferior gemelli, quadratus femoris muscles).

GLUTEAL REGION

The gluteus maximus covers the following structures:

1. The **piriformis** muscle.
2. The **superior gluteal nerve** and vessels emerge from the suprapiriform space. The superior gluteal nerve passes between the gluteus medius and gluteus minimus muscles, innervates them and ends by supplying the tensor fasciae latae.

The functions of these muscles are: abduction and medial rotation of the hip. Additionally, these muscles **stabilize the pelvis on a supporting leg**, e.g., standing on just one foot. In this case, the origin of the 2 gluteus muscles is considered to be the greater trochanter and insertion is in the pelvis.

3. The **inferior gluteal nerve** and vessels emerge from the infrapiriform space. The inferior gluteal nerve innervates the gluteus maximus muscle.

The stability of the hip joint when standing on one foot depends on the following factors:

- (1) The gluteus medius and the gluteus minimus muscles must be normal.
- (2) The head of the femur must be found in the acetabulum.
- (3) The neck of the femur must be intact. Thus the angle between the neck and the body of the femur must be normal (around 160° in a child and 125° in an adult).

NB : **Coxa valga** means the angle is increased.
Coxa vara means the angle is decreased.

Clinical note: Normally, if a person stands on just one foot, the gluteus medius and gluteus minimus muscles stabilize the pelvis and maintain it in a horizontal position (the greater trochanter being considered as the origin and the pelvis as the insertion of the muscles). A **positive Trendelenberg sign** means the pelvis sags on the opposite side to the supporting leg, as in the following cases: Paralysis or weakness of the gluteus medius and gluteus minimus, (e.g. in cases of poliomyelitis or a lesion of the superior gluteal nerve), dislocation of the hip, or fracture of the neck of the femur.

The **sciatic nerve** emerges from the infrapiriform space, passes behind the hip joint (posterior dislocation of the hip can damage the sciatic nerve). The **sciatic nerve innervates the hamstring muscles**. In the buttocks region, it is covered by the gluteus maximus muscle. In the posterior compartment of the thigh, it is covered by the hamstring muscles. Normally, it terminates in the inferior 1/3 of the thigh where it divides into the **tibial nerve** and the **common peroneal nerve**.

The site of an injection in the buttocks is in the **superolateral quadrant**, far from the nerves. An injection in the sciatic nerve causes **Pain** and **numbness** of the skin of the leg and foot, except their medial surfaces (all the skin of the leg and foot is innervated by the tibial nerve and the common peroneal nerve, except the skin on the medial surface which is innervated by

the saphenous nerve, which is a branch of the femoral nerve) and **weakness** of the muscles innervated by the sciatic, tibial and common peroneal nerves.

THE FEMORAL TRIANGLE

Boundaries. The **base** of the femoral triangle is formed by the inguinal ligament (attached to the anterior superior iliac spine and the pubic tubercle). The **lateral boundary** is formed by the medial border of the sartorius muscle. The **medial boundary** is formed by the medial border of the adductor longus muscle. The **floor** is formed by the adductor longus, pectineus, iliopsoas muscles. The **roof** is formed by the superficial fascia containing the superficial inguinal nodes and the great saphenous vein, deep fascia (fascia lata).

Contents. The contents of the femoral triangle are as follows:

- (1) **Femoral nerve** located outside the femoral sheath (adventitia of the femoral vessels).
- (2) **Femoral artery:** continuation of the external iliac artery, posterior to the middle of the inguinal ligament. It runs towards the apex of the femoral triangle to enter the adductor canal. The femoral sheath surrounds the superior 4 cm of the femoral vein and artery. The profunda femoris artery is the main branch of the femoral artery. It gives rise to the lateral and medial circumflex femoral arteries.
- (3) **Femoral vein:** is found in the femoral sheath, medial to the artery. The profunda femoris vein and the great saphenous vein drain into the femoral vein
- (4) **Deep inguinal nodes.**

ADDUCTOR CANAL (or Subsartorial Canal)

Boundaries. The adductor canal is found in the middle 1/3 of the medial side of the thigh. The **roof** is formed by the sartorius muscle. The **lateral wall** is formed by the vastus medialis muscle. The **floor** is formed by the adductor longus and adductor magnus muscles.

The canal begins at the apex of the femoral triangle and ends at the adductor hiatus where the femoral artery forms the popliteal artery.

Contents.

- (1) Femoral vein and artery.
- (2) Nerve to the vastus medialis muscle

(3) Saphenous nerve.

Clinical note: Method for examining bi-articular muscles.

The functions of the **rectus femoris muscle** are flexion of the hip and extension of the knee. Therefore to stretch the muscle, you must lie on your stomach (Prone position) and perform extension of the hip and flexion of the knee.

The **hamstring muscles** perform extension of the hip and flexion of the knee. Therefore to stretch them, you must perform flexion of the hip and extension of the knee. (SLR: straight leg raising).