Anatomy of the Lower Limb: Muscles of the Hip and Thigh

The hip is one of the strongest joints of the human body. This circumstance is due to the variety of muscles that surrounds, stabilizes and moves it. Medical students often have difficulties to properly understand a large number of individual muscles with their structures and functions. It is, therefore, advisable to divide the muscles into groups in order to obtain a better overview that will, in turn, facilitate the learning process. This article is intended to provide the desired overview.

The Flexors of the Hip

There are 4 large muscles that constitute the flexor muscle group of the hip joint: these include the iliopsoas, the rectus femoris, the tensor fasciae latae, and the sartorius muscles.
There are also some other muscles that assist in the flexion of the thigh at the hip joint, but they are not part of the flexor muscle group. These muscles include:

- **Pectineus**
- **Adductor longus**
- **Adductor brevis**
- **Gracilis**
- **Gluteus medius**
- **Gluteus minimus**

**Iliopsoas muscle**

The *iliopsoas muscle* is anatomically a combination of 2 muscles: the *psoas major* and the *iliacus muscles*. Both these muscles are separate and distinct at their proximal origin but they combine in the thigh and are distally inserted at the common point, the *lesser trochanter* of the femur.
The **psoas major** is subdivided into a superficial and deep layer. The superficial layer originates from the **12th thoracic vertebra**, the **1st to 4th lumbar vertebrae**, and the corresponding **intervertebral discs and bodies**. The deep layer originates from the **processus costalis of 1st to 5th lumbar vertebrae**. Their common insertion is the **lesser trochanter** of the femur. It is innervated by the **lumbar plexus** at the levels of **L1–L3**. It is the strongest flexor of the hip because of its large physiological cross-section.

The **iliacus** muscle originates from the **iliac fossa, ala of the sacrum**, and the articular capsule of the hip joint. It is inserted together with the psoas major on the **lesser trochanter** of the femur. It is mainly innervated by the **femoral nerve (L3–L4)** and is important for flexing the thigh at the hip joint.

**Functional notes:** In addition to their function as hip flexors, both psoas major and iliacus can also synergize other movements. The psoas major is able to perform external and internal rotations of the hip joint. It is also able to cause lateral flexion and inclination of the lumbar spine. Additionally, the iliacus performs adduction, internal and external rotations at the hip joint, and a forward bend of the torso with bilateral innervation.

**Rectus femoris**
The **rectus femoris** muscle originates from the anterior inferior iliac spine, and the upper edge of the **acetabulum**, while it inserts into the **tibial tuberosity**. It is innervated by the **femoral nerve (L2-L4)** and flexes the hip joint.

**Particularities:** The tendon already starts a hand’s width cranial from the patella and continues as **ligamentum patellae**.

**Functional notes:** In addition to its function as a hip flexor, the **rectus femoris** also works as an abductor of the hip joint and as an extensor of the knee joint.

**Clinical notes:** During endoprosthesis, some parts of the capsule-ligament apparatus of the hip joint are removed. This results in cutting off a part of the origin of the rectus femoris, which may lead to the patient having postoperative problems during the contraction of the quadriceps.

**Tensor fasciae latae**
The *tensor fasciae latae* is originated from the *anterior superior iliac spine*, it runs together with the gluteus maximus muscle, and is inserted into the *iliotibial tract*. It functions as a flexor at the hip joint and is innervated by the *superior gluteal nerve* (L4-L5).

**Particularities:** It is ventral to the gluteus medius muscle and is an evolutionary split of this muscle.

**Functional notes:** In addition to its primary function, this muscle can perform abduction and internal rotation of the thigh at the hip joint. It is involved in the lateral stabilization of the knee joint because of its connection with the knee joint via the *tractus iliotibialis*.

**Clinical notes:** If the lateral fascia is under extreme stress due to an irritation of the *tensor fasciae latae* muscle, it can lead to a so-called *coxa saltans* (‘snapping hip syndrome’). The result is a snapping sound when the iliotibial tract slips over the major trochanter during flexion and extension of the hip. If the problem is long-lasting, it may also lead to inflammation of the trochanteric bursa which can be very painful.

Sartorius
The *sartorius* muscle originates from the **anterior superior iliac spine** and is inserted at the **upper medial side of the tibia**. It is innervated by the **femoral nerve (L2-L3)** and it is a flexor of the hip joint.

**Particularities:** Together with gracilis and semitendinosus muscles, it forms the conjoined tendon ‘*Pes anserinus*’ (goose feet) at its insertion.

**Functional notes:** In addition to the flexion, it can also perform the abduction and external rotation in the hip joint and internal rotation in the knee joint.

### The Extensors of the Hip

The **extensor muscle group** of the hip joint consists of the *gluteus maximus* muscle, and the muscles of the **ischiocrural muscle group** which consists of the biceps femoris, the *semitendinosus*, and the *semimembranosus* muscles.

There are also some other muscles that assist in the extension of the hip, but these are not part of the extensor muscle group. These muscles are:

- *Gluteus medius*
- *Gluteus minimus*
- *Adductor magnus*
- Short external rotators (e.g. piriformis, obturators)

### Gluteus maximus
The *Gluteus maximus* is the largest and most superficial of all the gluteal muscles. It originates from the *ilium, sacrum, coccyx* and the *sacrotuberous ligament*. Together with the *tensor fasciae latae* muscle, some of its fibers are inserted into the *iliotibial tract*, while remaining fibers are inserted at the *gluteal tuberosity*. It is innervated by the *inferior gluteal nerve (L4–S1)* and functions as an extensor of the hip joint.

**Particularities:** The caudal part of this muscle also goes to the linea aspera.

**Functional notes:** In addition to its primary function, it is a strong external rotator of the hip. Because of its planar propagation, there are both cranial and caudal fibers present. This allows the performance of abduction and adduction in the hip joint (*auto-antagonism*). In addition, it centers the *caput femoris* in the socket.

**Clinical notes:** If the *musculus glutaeus maximus* is subjected to pathophysiological pressure for too long, the bursa near the insertion may become inflamed (bursitis).

**Biceps femoris**
The 1st muscle of the ischiocrural group has 2 heads of origin: **long head** and **short head**. Both muscle heads are the extensors of the hip joint.

The **long head** originates from the **ischial tuberosity**, while the **short head** originates from the **linea aspera** and the **lateral intermuscular femoral septum**. They insert together at the **dorsal surface of the head of the fibula**.

The long head of biceps femoris is innervated by the **tibial nerve (L5–S2)**, and the short head is innervated by the **common fibular nerve (L5–S2)**. Both these nerves are the divisions of the sciatic nerve.

**Functional notes:** In addition to its primary function in the hip, it is also a flexor and external rotator of the knee joint.

**Clinical notes:** Proximal damage to the tibial nerve does not impair the capability to flex the muscle at the knee. This is because of the fact that the small head is innervated by the common fibular nerve and can, therefore, continue its part of movement function.

**Semitendinosus**

The **semitendinosus muscle** originates from the **ischial tuberosity** and it is inserted at the **medial surface of the upper part of the tibia**. It extends the hip joint during active innervation by the **tibial nerve (L5–S2)**, which is a division of the sciatic nerve.

**Particularities:** At its insertion, it forms the conjoined tendon **pes anserinus** (goose feet) together with the **gracilis** and the **sartorius** muscles.

**Functional notes:** In addition to its primary function in the hip, it also performs flexion and internal rotation in the knee joint.
Semimembranosus

The *semimembranosus muscle* originates from the *ischial tuberosity* and it is inserted at the *medial condyle of the tibia*. It is innervated by the *tibial nerve* (*L5–S2*), which is a division of the sciatic nerve. It is an extensor at the hip joint.

**Functional notes:** In addition to its primary function in the hip, it can perform flexion and internal rotation in the knee joint.

The Abductors of the Hip

[Image: Gluteal Muscles that Move the Femur, By Phil Schatz, License: CC-BY 4.0]

The *abductor group of the hip* consists of the *gluteus medius, gluteus minimus*, and the *piriformis muscles*.

Other muscles also assist in the abduction of the thigh at the hip joint, but they do not belong to the abductor group. These include:

- *Tensor fasciae latae*
- *Gluteus maximus* (cranial fibers)

Gluteus medius

[Image: Posterior Hip Muscles 3. By Beth ohara~commonswikia, License: CC BY-SA 3.0]

The *gluteus medius* arises from the *ilium* bone between the medial and posterior gluteal lines and inserts at the *greater (major) trochanter* of the femur. It receives its innervation from the *superior gluteal nerve* (*L4–L5*) and abducts the hip joint.

**Particularities:** Its dorsal 3rd is covered by the *gluteus maximus* muscle and the *trochanteric bursa*.

**Functional notes:** In addition to its primary function, it causes flexion and internal rotation (ventral parts) as well as extension and external rotation (dorsal parts).
**Clinical notes:** In the case of a weakening of the *glutei medius* and *minimus* muscles, the stabilization of the pelvis while walking is no longer guaranteed, and it sinks to the free leg’s side. In medicine, this phenomenon is also called *Trendelenburg’s sign.*

**Gluteus minimus**

![Posterior Hip Muscles 1](https://upload.wikimedia.org/wikipedia/commons/thumb/7/71/Posterior_Hip_Muscles_1.png/220px-Posterior_Hip_Muscles_1.png)

The origin of the *gluteus minimus* muscle is from the *ilium* bone between middle and inferior lines, and it inserts at the *greater trochanter* of the femur. It performs abduction in the hip joint during active innervation by the *superior gluteal nerve.*

**Particularities:** It is covered by the *gluteus medius* muscle.

**Functional notes:** In addition to its primary function, it works synergistically with the *gluteus medius* muscle for flexion, extension, and internal and external rotations at the hip joint.

![Trendelenburg’s sign](https://upload.wikimedia.org/wikipedia/commons/thumb/7/70/Trendelenburg%27s_sign.png/220px-Trendelenburg%27s_sign.png)

**Clinical notes:** In the case of a weakening of the glutei medius and minimus muscles, the stabilization of the pelvis during walking is no longer guaranteed, and it sinks to the free leg’s side. In medicine, this phenomenon is also called *Trendelenburg’s sign.*

**Piriformis**
The **piriformis muscle** originates from the **pelvic surface of the sacrum, the sacrotuberous ligament** and the socket of the iliosacral joint and inserts at the **greater trochanter** of the femur. It is innervated by the **sacral plexus (S1-S2)** and acts as an abductor of the hip joint.

**Particularities:** There is a gap above the **piriformis**, the so-called **suprapiriform foramen.** The **superior gluteal nerves and vessels** pass through it.

**Functional notes:** Starting at a hip flexion of 60°, the muscle reverses its function. The course of the muscle changes in proportion to the rotation axis, which causes different biomechanical reactions. In an extended position, it goes dorsal, which results in an external rotational effect. In a flexed position, it goes ventral and, therefore, leads to internal rotation. Furthermore, in the flexion position of 60°, the **piriformis** muscle acts as the hip extensor.

**Clinical notes:** The irritation of the sciatic nerve at the level of the muscle is called **piriformis syndrome.** This may be caused by space-occupying morphological changes, like muscular hypertension or hematoma. Patients complain of pain and neural radiation in the buttocks and the lower 3rd of the dorsal lower leg. Erroneous diagnosis can quickly lead to mistaking this disease for a herniated disc, even though the area of radiation is not identical.

**Posterior Thigh: Cross-section**

Transverse section of the thigh reveals the **fascia lata** forming 3 muscular compartments:

- Lateral femoral intermuscular septum
- Medial femoral intermuscular septum
- Posterior femoral intermuscular septum

**Forms:**

- Anterior — extensor compartment (femoral nerve)
- Posterior — flexor compartment (tibial nerve)
- Medial — adductor compartment (obturator nerve)

**Movements:**

The majority of the muscles in the thigh act on the hip and knee joints.
Two types of movement:
- Flexion/extension
- Adduction (abduction is performed by muscles in the gluteal region)

**Posterior Thigh Muscles**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve supply</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps femoris</td>
<td>Long head: Ischial tuberosity Short head: Linea aspera and lateral supracondylar line</td>
<td>Lateral surface of the head of the fibula</td>
<td>Long head: tibial division of sciatic nerve (L5, S1) Short head: common fibular division of sciatic nerve (S1)</td>
<td>Flexes knee joint and lateral rotation when flexed Extends hip joint</td>
</tr>
<tr>
<td>Semitendinosus</td>
<td>Ischial tuberosity</td>
<td>Medial surface of the proximal tibia</td>
<td>Tibial division of sciatic nerve (L5, S1)</td>
<td>Extends hip joint Flexes knee joint and medial rotation when flexed</td>
</tr>
<tr>
<td>Semimembranosus</td>
<td>Posterior surface of medial condyle of tibia</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Posterior to the femur within the thigh — Hamstrings: *semitendinosus* | *semimembranosus* | *biceps femoris* (long head)

Originates from ischial tuberosity and insert onto tibia and fibula, so cross 2 joints: hip and knee.

The short head of the biceps is not a hamstring as it only crosses the knee joint and is innervated via the common fibular nerve.

Supplied by perforating branches that originate from the *profunda femoris* (branch of femoral artery). These pierce the adductor magnus to enter the posterior compartment.

**Popliteal Fossa: Boundaries**

A fat-filled diamond-shaped space located posterior to the knee joint. It contains all the neurovascular structures that pass from the thigh to the leg.

**Boundaries:**
- Superolaterally — *Biceps femoris*
- Superomedially — *Semimembranosus*
- Inferolaterally — lateral head of the gastrocnemius
- Inferomedially — medial head of the gastrocnemius

**Roof:**
- Popliteal fascia and skin

**Floor:**
- The popliteal surface of the femur and popliteal fascia and muscle

**Popliteal fossa: contents**

Contains all the neurovascular structures that pass from the thigh to the leg.

**Contents:**
- Small saphenous vein entering the popliteal vein
- Popliteal artery and associated branches
- Tibial and common fibular nerves
- Posterior cutaneous nerve of the thigh
- Popliteal lymph nodes
The Adductors of the Hip

Most of the muscles functioning in the hip joint belong to the adductor group. These include adductor longus, adductor brevis, adductor magnus, pectineus, and the gracilis muscles.

There are other muscles that also assist in the adduction of the hip but are not part of the adductor group. These include:

- Ischiocural muscle group
- Gluteus maximus (caudal fibers)
- Quadratus femoris

Pectineus

The pectineus muscle originates from the pectineal line of the pubis and the pubic tubercle. It inserts at the pectineal line and the linea aspera of the femur and is innervated by the obturator and femoral nerves (L2–L4). It serves as the adductor for the hip joint.

Particularities: Together with the iliopsoas muscle, it forms the iliopectineal fossa, which acts as a pass-through opening of various vessels.

Functional note: An additional function of the pectineus is flexing and external rotation at the hip joint.

Adductor longus

The adductor longus muscle arises from the pubic bone between the pubic crest and symphysis pubis, and inserts at the linea aspera of the femur. It is innervated by the obturator nerve (L2–L4) and performs adduction at the hip joint.

Particularities: It borders the entrance of the adductor canal, through which the femoral nerve and vessels pass.

Functional notes: In addition to its primary function, the adductor longus acts as a flexor of the hip until 70 degrees and beyond that acts as an extensor. Furthermore, it assists in external rotation of the hip.

Gracilis

The gracilis muscle arises from the inferior ramus of the pubic bone and pubic symphysis and inserts at the medial side of the tibial tuberosity. It is innervated by the obturator nerve (L2–L4) and functions as an adductor at the hip joint.

Particularities: At its point of insertion, it forms the conjoined tendon ‘Pes anserinus’ together with the sartorius and the semitendinosus muscles.
Functional notes: In addition to its primary function, the muscle also acts as a flexor of the hip until 70° and beyond that acts as an extensor. Furthermore, it can perform flexion and internal rotation of the knee.

Adductor brevis

The ‘little short adductor’ has its origin in the **body and inferior ramus of the pubic bone** and its insertion at the **linea aspera**. During active innervation by the **obturator nerve (L2-L4)**, it acts as an adductor of the hip.

**Particularities:** Together with the adductor magnus muscle, it forms the deep layer of the hip’s adductors.

Functional notes: In addition to its primary function, it is also a flexor of the hip until 80°. Beyond that, it functions as an extensor.

Adductor magnus

The **adductor magnus** muscle arises at the **inferior ramus of the pubis** and the **ischial tuberosity** and inserts at the **linea aspera (proximal part)** and at the **adductor tubercle (distal part)**. It gets its innervation from the **obturator nerve (L3-L4)** and the **tibial part of the sciatic nerve (L4-L5)**. It is a big adductor of the hip joint.

Functional notes: In addition to its primary function, it is a strong extensor of the hip and is also able to perform external rotation (proximal part) and internal rotation (distal part).

The External Rotators of the Hip

The **obturator internus, gemelli, obturator externus, and quadratus femoris** muscles form the external rotator group of the hip joint. The **piriformis** muscle is considered to be part of the group of external rotators in some medical literature, too. Considering the extensive external rotatory effect, this is not to be assessed as an error.

There are certain other muscles that assist in external rotation in the hip but are not part of the external rotator group. These are:

- **Gluteus maximus**
- **Gluteus medius**
- **Gluteus minimus**
- **Sartorius**
- **Biceps femoris**
- **Iliopsoas**
- **Adductor magnus**
- **Adductor longus**
- **Pectineus**

Obturator internus

The **obturator internus** muscle arises from the **obturator membrane and the ischiopubic rami** and inserts at the **greater trochanter**. It is innervated by the **nerve to the obturator internus (L5-S2)**. It performs an external rotation at the hip joint.
Particularities: In some patients, the innervation may additionally vary between the sacral plexus, gluteal nerves, and pudendal nerve.

Functional notes: In addition to its primary function, this muscle is also capable of synergizing adduction and extension, as well as abduction above 90°.

Gemelli muscles

The gemelli muscles consist of superior gemellus muscle and inferior gemellus muscle.

The superior gemellus muscle arises from the ischial spine, and it inserts at the greater trochanter and obturator internus tendon. It is innervated by the nerve to the obturator internus (L5–S2) and is an external rotator of the hip joint.

The inferior gemellus muscle arises from the ischial tuberosity and has its insertion at the obturator internus tendon. It is innervated by the nerve to the quadratus femoris (L4–S1) and is an external rotator of the hip.

Particularities: In some patients, the innervation may also vary between the sacral plexus, inferior gluteal nerve, and pudendal nerve.

Functional notes: In addition to their primary function, these muscles act as adductors and extensors of the hip from the neutral zero position and can synergize the abduction at a hip flexion of 90°.

Obturator externus

The obturator externus muscle arises from the lateral area of the obturator foramen, the outer surface of the obturator membrane and the ischiopubic ramus. It is inserted at the intertrochanteric fossa of the femur. During active innervation by the nerve to the obturator externus (L3–L4), it performs an external rotation at the hip joint.

Functional notes: In addition to its primary function, the obturator externus muscle also acts as a weak adductor of the hip. It centers the head of the femur in the socket.
**Quadratus femoris**

The *quadratus femoris* muscle arises from the *ischial tuberosity* and inserts at the *intertrochanteric crest of the femur*. The innervation is done by the *nerve to the quadratus femoris* (L4–S1), and it is an external rotator of the hip.

**Particularities:** It may grow together with the inferior *gemellus* muscle or the adductor *magnus* muscle. In some patients, this muscle is even entirely missing, without any functional impairment at the hip joint. It can also be innervated by the inferior gluteal nerve and the tibial parts of the sciatic nerve.

**Functional notes:** The muscle synergizes the extension of the hip joint from flexion and adduction.

**The Internal Rotators of the Hip**

The actual *internal rotator group* is not exactly mentioned in the current anatomy literature because there are only a few muscles that perform a purely internal rotation, and their power delivery corresponds to only a 3rd of the external rotators. Muscles that perform an internal rotation at the hip joint are *gluteus medius, gluteus minimus, tensor fascia latae*, and *adductor magnus* muscles.

### A Tabular Overview of the Hip Muscles According to Their Function

<table>
<thead>
<tr>
<th>Muscle group</th>
<th>Muscles with primary function</th>
<th>Synergistic muscles</th>
</tr>
</thead>
</table>
| **Flexors of the hip joint** | *Iliopsoas*  
*Rectus femoris*  
*Tensor fasciae latae*                                                                 | *Pectineus*  
*Adductor longus*  
*Adductor brevis*  
*Gracilis*  
*Gluteus medius*  
*Gluteus minimus* |
| **Extensors of the hip joint** | *Gluteus maximus*  
*Biceps femoris*  
*Semitendinosus*  
*Semimembranosus*                                                                 | *Gluteus medius*  
*Gluteus minimus*  
*Adductor magnus*  
*Short external rotators* |
| **Abductors of the hip joint** | *Gluteus medius*  
*Gluteus minimus*  
*Piriformis*                                                                 | *Tensor fasciae latae*  
*Gluteus maximus* (cranial fibres) |
| **Adductors of the hip joint** | *Pectineus*  
*Adductor longus*  
*Gracilis*  
*Adductor brevis*  
*Adductor magnus*                                                                 | *Ischiocrural muscle group*  
*Gluteus maximus* (caudal fibres)  
*Quadratus femoris* |
| **External rotators of the hip joint** | *Obturatorius internus*  
*Gemelli muscles*  
*Obturator externus*  
*Quadratus femoris*  
*Piriformis*                                                                 | *Gluteus maximus*  
*Gluteus medius*  
*Gluteus minimus*  
*Sartorius*  
*Biceps femoris*  
*Iliopsoas*  
*Adductor magnus*  
*Adductor longus*  
*Pectineus* |
| Internal rotators of the hip joint | (not described separately) | • Gluteus medius  
• Gluteus minimus  
• Tensor fasciae latae  
• Adductor magnus (distal fibres) |

**References**


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