Lower Limb Anatomy

The basis of any surgical discipline and radiological imaging is structural anatomy. This article envisages clarifying the basics of lower limb anatomy with a focus on the gluteal region, posterior thigh, and the popliteal fossa. The muscles of the gluteal region are specialized to bear weight and maintain the horizontal balance of the pelvis. The posterior thigh muscles are the lateral rotators of the hip and the popliteal fossa is responsible mainly for extension/flexion and adduction.

Introduction to Lower Limb Anatomy

Lower limb anatomy includes the foot, leg, thigh, and gluteal region. The lower limb is comprised of four major parts, i.e., a girdle formed by the hip bones, thigh, leg, and foot. The human lower limb, particularly the gluteal muscles, knee extensors, and the posterior calf muscles are specially adapted to bear weight in an upright position and to walk.

Gluteal Region

The posterolateral surface of the buttocks constitutes the gluteal region. The gluteal muscles, namely, the glutei maximus, medius, and minimus, form the bulk of the buttock, arranged from superficial to deep. Posterior to the bony pelvis, the mass of muscles in
the gluteal region is limited by the inferior gluteal cleft inferiorly and the intergluteal cleft medially.

**There are 2 layers of muscles in the gluteal region:**

- **Superficial** — Gluteal muscles and tensor fasciae latae
- **Deep** — Lateral rotators and hip stabilizers

**They are supplied by gluteal nerves and arteries approaching through the greater sciatica foramen.**

The gluteus medius and minimus are fan-shaped and positioned deep to the gluteus maximus, a large muscle with numerous attachments. Laterally, the tensor fasciae latae help stabilize the lateral aspect of the knee joint.

The **anatomical and functional details of these muscles** can be tabulated as follows:

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve supply</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gluteus maximus</td>
<td>Ilium posterior to the posterior gluteal line, posterior sacrum, and coccyx and sacrotuberous ligament.</td>
<td>Iliotibial tract (75%) and gluteal tuberosity (25%).</td>
<td>Inferior gluteal nerve (S1, S2).</td>
<td>Extends hip and assists lateral rotation.</td>
</tr>
<tr>
<td>Gluteus medius</td>
<td>External ilium between anterior and inferior gluteal lines.</td>
<td>Greater trochanter of femur.</td>
<td>Superior gluteal nerve (L4, L5, S1).</td>
<td>It brings about the abduction and medial rotation of the pelvis. It keeps the pelvis level when the opposite limb is off the ground.</td>
</tr>
<tr>
<td>Gluteus minimus</td>
<td>External ilium between anterior and inferior gluteal lines.</td>
<td>Greater trochanter of femur.</td>
<td>Superior gluteal nerve (L4, L5, S1).</td>
<td>Same as gluteus medius; it abducts and medially rotates the pelvis. It keeps the pelvis level when the opposite limb is off the ground.</td>
</tr>
<tr>
<td>Tensor fasciae latae</td>
<td>Anterior superior iliac spine.</td>
<td>Iliotibial tract to the lateral condyle of the tibia.</td>
<td>Superior gluteal nerve (L4, L5, S1).</td>
<td>This muscle assists in flexing the hip and stabilizing the knee joint.</td>
</tr>
</tbody>
</table>

**Neurovasculature of Lower Limb Anatomy**

**The femoral artery**

Most of the lower limb is **supplied by the femoral artery**, which is the direct continuation of the external iliac artery as it passes deep to the inguinal ligament through the retro-inguinal space. The femoral artery enters the femoral triangle deep to the inguinal ligament.

It exits the canal, via the adductor hiatus, to enter the popliteal fossa, becoming the popliteal artery.
Within the femoral triangle, the femoral artery gives rise to a branch called the profunda brachii, which is a deep artery. It passes deep to the adductor longus and supplies the thigh musculature.

The femoral artery, which gives rise to lateral and medial circumflex arteries. It courses around the proximal femur. The medial circumflex artery passes deep to the iliopsoas and pectineus. The lateral circumflex artery goes across the joint capsule anterior to quadrates femoris.

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**Exception 1**

The gluteal region is supplied by gluteal arteries (internal iliac artery) – important anastomoses may occur between the two.

**Exception 2**

The medial thigh is supplied by the obturator artery (a branch of the internal iliac artery). As the femoral artery passes distally, it changes its name to reflect its new location.

As the femoral artery descends through the thigh, perforating arteries (branches of the femoral artery) course around the femur to supply the adductor magnus and posterior compartment of the femoral triangle.

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[Image: “Thigh arteries schema” by Jecowa. License: CC BY 3.0]
Gluteal arteries

There are two gluteal arteries: the superior and inferior gluteal artery.

![Image: "The arteries of the pelvis. Right side (distal from spectator)." by Mikael Häggström. License: Public Domain]

They arise from the internal iliac artery within the pelvis. While the superior gluteal artery enters the gluteal region by passing through the suprapiriform (above piriformis) foramen, the inferior gluteal artery passes through the infrapiriform foramen.

1. The superior gluteal artery supplies the gluteus medius, minimus, and tensor fascia latae muscles.
2. The inferior gluteal artery supplies the gluteus maximus, obturator internus, quadrates femoris, and proximal posterior thigh muscles.

The Cruciate anastomosis connects the profunda brachii and inferior gluteal arteries. The contributing branches are:

- Inferior gluteal: Descending branch.
- Medial circumflex: Transverse branch.
- Lateral circumflex: Transverse branch.
- First perforating artery: Ascending branch.

The piriformis muscle is an important landmark for neurovasculature relations in the gluteal region.

The important structures, and their relative locations to the piriformis muscle, are:

1. Superior — Superior gluteal artery, vein, and nerve.
2. Inferior — Inferior gluteal artery, vein, and nerve.
3. Inferior — Sciatic and posterior cutaneous nerve of the thigh.
4. Inferior — Pudendal neurovascular bundle (then enters the perineum via the lesser sciatic foramen).

Gluteal nerves

The gluteal region’s nerve supply is maintained by the following:

1. Superior gluteal nerve (L4,5,s1) - supplies the gluteus medius and minimus, tensor fascia latae.
2. Inferior gluteal nerve (L5,S1,2) – supplies the piriformis muscle and gluteal maximus.
3. Posterior femoral cutaneous nerve (S1,3) – supplies the calf muscle.
4. Pudendal nerve – supplies the piriform muscle.
5. Sacral plexus (L4,S3) – supplies the obturator externus and internus.

**Posterior Thigh**

**Most thigh muscles act on the hip and knee joints.** There are two types of movements possible, namely, **flexion/extension and adduction.** Abduction is performed by muscles in the gluteal region. The posterior thigh muscles bring about lateral rotation, an extension of the hip and flexion of the knee joint.

**Posterior Thigh Muscles**

The piriformis, gemelli, obturator internus, and quadrates femoris are the hip’s lateral rotators. **Basic details about these posterior thigh small muscles** are summarized as follows:

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve supply</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piriformis</td>
<td>Anterior surface of sacrum</td>
<td>Greater trochanter (superior surface)</td>
<td>Anterior rami of S1</td>
<td>Lateral rotation of extended hip and abduction of flexed hip</td>
</tr>
<tr>
<td>Gemelli</td>
<td>Superior: Ischial spine Inferior: Ischial tuberosity</td>
<td>Greater trochanter (medial surface)</td>
<td>Nerve to obturator internus (S1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nerve to quadrates femoris (L5, S1)</td>
<td></td>
</tr>
<tr>
<td>Obturator internus</td>
<td>Pelvic surface of ilium and ischium, and obturator membrane</td>
<td></td>
<td>Nerve to obturator internus (S1)</td>
<td></td>
</tr>
<tr>
<td>Quadratus femoris</td>
<td>Ischial tuberosity</td>
<td>Intertrochanteric crest</td>
<td>Nerve to quadrates femoris (L5, S1)</td>
<td>Lateral rotation, and holds head of femur in acetabulum.</td>
</tr>
</tbody>
</table>
‘Hamstring’ muscles are posterior to the femur bone in the thigh. The semimembranosus, semitendinosus, and long head of biceps femoris constitute the hamstrings. They originate from ischial tuberosity and insert onto the tibia and fibula, thus crossing two joints: the hip and the knee. They participate in the extension of the thigh and the flexion of the leg.

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

The hamstring muscles are supplied by perforating branches which originate from the profunda femoris (a branch of the femoral artery). These pierce the adductor magnus to enter the posterior compartment.

The anatomical nature and functional status of the muscles of the posterior thigh “hamstrings” can be summarized as follows:

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve supply</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semitendinosus</strong></td>
<td>Ischial tuberosity.</td>
<td>Medial surface of proximal tibia.</td>
<td>Tibial division of sciatic nerve (L5, S1).</td>
<td>Extends hip joint.</td>
</tr>
</tbody>
</table>
Cross-section of the thigh

The transverse section of the thigh reveals the fascia lata forming three muscular compartments. The septae in between these compartments are:

1. Lateral — Femoral intermuscular septum
2. Medial — Femoral intermuscular septum
3. Posterior — Femoral intermuscular septum

The three compartments form the anterior, posterior, and medial thigh compartments.

The nerve supply of each compartment can be mentioned as follows:

1. Anterior (extensor compartment) — Femoral nerve
2. Posterior (flexor compartment) — Tibial nerve
3. Medial (adductor compartment) — Obturator nerve

Arterial supply of the Lower Limbs

Three or four perforating arteries from the profunda brachii pierce the adductor magnus and enter the posterior compartment of the thigh. They typically have superior and inferior branches to join with adjacent perforating arteries. Superiorly, the inferior gluteal artery and inferiorly, the popliteal artery connect to them. They give branches to the sciatic nerve.

Popliteal Fossa

Popliteal fossa is 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.

The **boundaries of the popliteal fossa** are:
<table>
<thead>
<tr>
<th>Boundary</th>
<th>Structure at the boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superolaterally</td>
<td>Biceps femoris</td>
</tr>
<tr>
<td>Superomedially</td>
<td>Semimembranosus</td>
</tr>
<tr>
<td>Inferolaterally</td>
<td>Lateral head of gastrocnemius</td>
</tr>
<tr>
<td>Inferomedially</td>
<td>Medial head of gastrocnemius</td>
</tr>
<tr>
<td>Roof</td>
<td>Popliteal fascia and skin</td>
</tr>
<tr>
<td>Floor</td>
<td>Popliteal surface of femur and popliteus fascia and muscle</td>
</tr>
</tbody>
</table>

**Popliteal fossa: Contents**

The popliteal fossa is comprised of all neurovascular structures that pass from the thigh to the lower leg.

The contents of the popliteal fossa can be summarized by the following:

- Small saphenous vein entering the popliteal vein.
- Popliteal artery and associated branches.
- Tibial and common fibular nerves.
- The posterior cutaneous nerve of the thigh.
- Popliteal lymph nodes.
- Bursae.
- Fat.

**Popliteal artery**
The popliteal artery is the direct continuation of the femoral artery within the popliteal fossa. It terminates by dividing into anterior and posterior tibial arteries at the inferior border of popliteus.

The popliteal artery gives rise to five genicular arteries that supply the joint capsule and ligaments of the knee joint. They form the genicular anastomosis. They also receive descending branches from the femoral and lateral circumflex arteries. They can be summarized as follows:

- Superior lateral
- Superior medial
- Inferior lateral
- Inferior medial
- Middle

Summary of Lower Limb Anatomy

The gluteal region

The gluteal region consists of the glutei maximus, medius and minimus, and tensor fasciae latae muscles. They are specialized to bear weight and maintain the horizontal balance of the pelvis, while one leg goes in swing phase during walking. The inferior gluteal nerve supplies the gluteus maximus, and the superior gluteal nerve supplies the gluteus medius and minimus.

The arterial supply to the gluteal region is derived from the gluteal arteries, which make this area an important anastomosis site between the femoral and internal iliac artery. The piriformis muscle is an important landmark for neurovasculature in the gluteal region.
Posterior thigh muscles

The posterior thigh muscles are the **lateral rotators of the hip**, namely:

- The piriformis
- Gemelli (superior and inferior)
- Obturator internus and quadrates femoris
- The ‘hamstrings’

The hamstrings bring about flexion of the knee and extension of the hip joint. The semimembranosus, semitendinosus and long head of biceps femoris constitute the hamstrings. The tibial component of the sciatic nerve supplies the hamstrings.

Popliteal fossa

A thigh cross-section reveals the **three compartments of the thigh**, namely, the anterior, posterior, and medial compartments. The anterior compartment muscles extend the knee and are supplied by the femoral nerve. The posterior compartment muscles are responsible for flexion and are supplied by the tibial nerve. The adductors rule the medial compartment and are supplied by the obturator nerve.

The **diamond-shaped, fat-filled cavity behind the knee joint is bound by the gastrocnemius and the hamstrings**. While the popliteal fascia and skin constitute the roof of this fossa, the floor is comprised of the popliteal surface of the femur, popliteal fascia, and muscle.

The contents of the popliteal fossa are:

- The small saphenous vein
- Popliteal artery and associated branches
- Tibial and common fibular nerves
- The posterior cutaneous nerve of the thigh
- Popliteal lymph nodes
- Fat

References

Last’s book of anatomy

Snell’s book of anatomy


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