Lower Limb Anatomy

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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

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

Gluteal Region

The posterolateral surface of the buttocks constitutes the gluteal region. The muscles of the gluteal region, 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 are positioned deep to the gluteus maximus. Laterally, the tensor fasciae latae helps to stabilize the lateral aspect of the knee joint.

The gluteal Maximus is a large muscle with numerous attachments.

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 pelvic 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 pelvic 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 lateral condyle of 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**

The majority of the lower limb is **supplied by the femoral artery**. The femoral artery 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 canal via the adductor hiatus to enter the popliteal fossa and becomes the
popliteal artery.

Within the femoral triangle, the femoral artery gives rise to a branch called the profunda brachii artery which is a deep artery. It passes deep to the adductor longus and supplies the thigh musculature.

The femoral artery 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.

**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 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 femoral artery) course around the femur to supply adductor magnus and posterior compartment of femoral triangle.
Gluteal arteries

There are 2 gluteal arteries, namely, the superior and inferior gluteal artery, respectively.

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.

An important connection exists between the profunda brachii and inferior gluteal arteries; known as the "Cruciate anastomosis". The contributing branches within the same can be mentioned as follows:

- 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 neuro vasculature relations in the gluteal region.

The important **structures and their relative location to the piriformis muscle** can be summarized as follows:

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 nerve supply of the gluteal region is maintained by the following:

1. Superior gluteal nerve (L4,5,s1) - supplies the gluteus medius and minimus, tensor fasciae 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**

The **majority of muscles in the thigh act on the hip and knee joint**. 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**

Piriformis, gemelli, obturator internus and quadrates femoris are the lateral rotators of the hip. **Basic details about these posterior thigh small muscles** 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>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>
</tbody>
</table>
| Gemelli            | Superior: Ischial spine
                     Inferior: Ischial tuberosity | Greater trochanter (medial surface)            | Nerve to obturator internus (S1)
Nerve to quadrates femoris (L5, S1)
Nerve to Obturator internus (S1) | Lateral rotation of extended hip and abduction of flexed hip |
| Obturator internus | Pelvic surface of ilium and ischial, and obturator membrane            |                                               |                                                   |                                               |
| Quadratus femoris  | Ischial tuberosity                                                     | Intertrochanteric crest                        | Nerve to quadrates femoris (L5, S1)               | Lateral rotation, and holds head of femur in acetabulum. |
‘Hamstrings’ muscles are present posterior to the femur bone in the thigh. The semimembranous, semitendinosus and long head of biceps femoris constitute the hamstrings. They originate from ischial tuberosity and insert onto the tibia and fibula, thus, **cross two joints: the hip and the knee**. They participate in the extension of the thigh and in flexion of the leg.

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

They are supplied by perforating branches which originate from profunda femoris (branch of femoral artery). These pierce 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></td>
<td>Short head: Linea aspera and lateral supracondylar line.</td>
<td></td>
<td>Short head: Common fibular division of sciatic nerve (S1).</td>
<td></td>
</tr>
<tr>
<td>Semitendinosus</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>
<tr>
<td>Semimembranosus</td>
<td>Ischial tuberosity.</td>
<td>Posterior surface of medial condyle of tibia.</td>
<td>Tibial division of sciatic nerve (L5,S1).</td>
<td>Flex knee joint and medial rotation when flexed.</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 can be mentioned as follows:

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

The 3 compartments thus formed are the anterior, posterior and medial thigh compartment.

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

3 or 4 perforating arteries from profunda brachii pierce adductor magnus to enter the posterior compartment of the thigh. They typically send superior and inferior branches to join with adjacent perforating arteries. Superiorly, 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 can be tabulated as follows:

<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>
</tbody>
</table>
Popliteal fossa: Contents

All neurovascular structures that pass from the thigh to the leg are basically the contents of the popliteal fossa.

<table>
<thead>
<tr>
<th>Inferomedially</th>
<th>Medial head of gastrocnemius</th>
</tr>
</thead>
<tbody>
<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>

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

- Small saphenous vein entering 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 the 5 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, while the gluteus medius and minimus are innervated by the superior gluteal nerve.

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 the internal iliac artery**. The piriformis muscle is an important landmark for neurovasculature in the gluteal region.
Posterior thigh muscles

Posterior thigh muscles are the lateral rotators of the hip, namely:

- The piriformis,
- Gemelli (superior and inferior),
- Obturator internus and quadrates femoris, and
- 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

Thigh cross-section reveals the 3 compartments of the thigh, namely, the anterior, posterior and the medial compartment. While the anterior compartment muscles bring about mainly extension of the knee and are supplied by the femoral nerve, the posterior compartment muscles are responsible for flexion and are innervated by the tibial nerve. The adductors rule the medial compartment and receive innervations 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 comprises 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.

Review Questions

The correct answers can be found below the references.

1. Which of the following is not the content of the popliteal fossa?
   
   A. Tibial nerve
   B. Fat
   C. Small saphenous artery
   D. Common fibular nerve

2. Which of the following is a part of the cruciate anastomosis in the gluteal region?
   
   A. First perforating artery: Ascending branch
   B. Fourth perforating artery: Ascending branch
   C. Third perforating artery: Ascending branch
   D. Second perforating artery: Ascending branch

3. Identify the insertion site of the piriformis muscle.
A. Lesser trochanter  
B. Greater trochanter  
C. Ischial spine  
D. Ischial tiberosity  

References  

Last’s book of anatomy  
Snell’s book of anatomy  

**Correct answers: 1C, 2A, 3B**  

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