

## Stretching and Anatomy

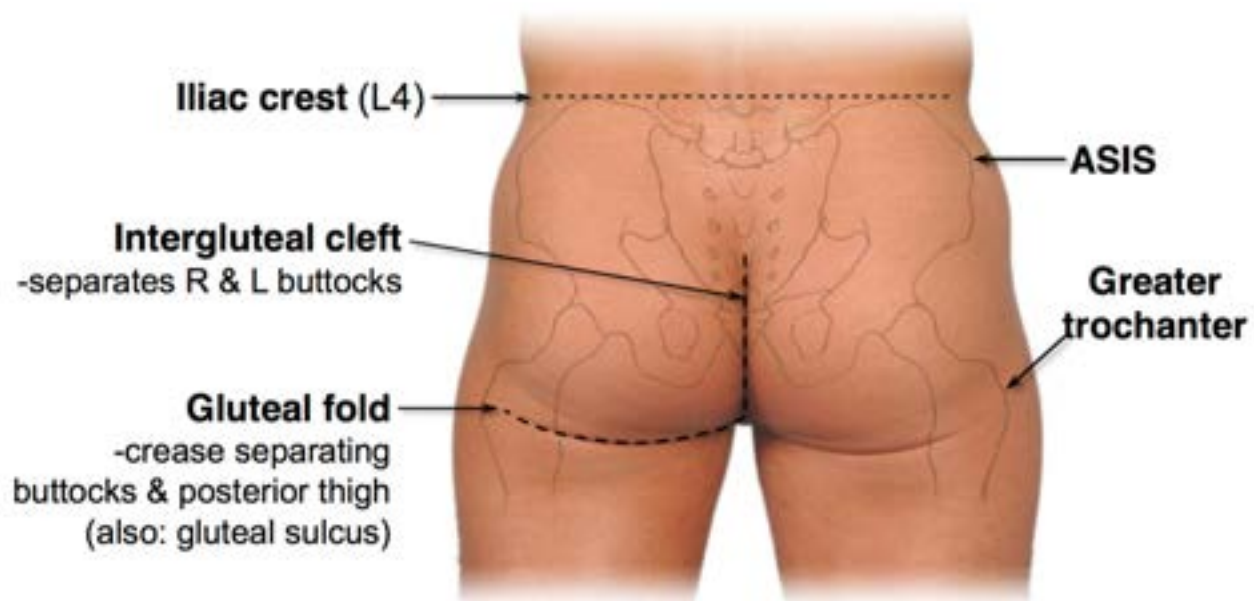
### The Gluteal Compartment

Although the demarcation of the trunk and lower limb is abrupt anteriorly at the inguinal ligament, posteriorly the gluteal region is a large transitional zone between the trunk and limb. Physically part of the trunk, functionally the gluteal region is definitely part of the lower limb.

#### Anatomy

- The Gluteal region is the prominent area posterior to the pelvis and inferior to the level of the iliac crests (the buttocks) and extending laterally to the posterior margin of the greater trochanter. (Image 1)
- The hip region overlies the greater trochanter laterally, extending anteriorly to the ASIS. Some definitions include both buttock and hip region as part of the gluteal region, but the two parts are commonly distinguished also.
- The gluteal muscles-gluteus maximus, medius and minimus and tensor fascia latae form the bulk of the region.
- The gluteal fold demarcates the inferior boundary of the buttock and the superior boundary of the thigh.

IMAGE 1



**Table 1. Muscles of gluteal region: Abductors and rotators of thigh**

Muscle	Proximal Attachment	Distal Attachment	Innervation	Main Action
<b>Gluteus maximus</b>	Ilium posterior to posterior gluteal line; dorsal surface of sacrum and coccyx; sacrotuberous ligament	Most fibers end in iliotibial tract, which inserts into lateral condyle of tibia; some fibers insert on gluteal tuberosity	Inferior gluteal nerve (L5, S1, S2)	Extends thigh (especially from flexed position) and assists in its lateral rotation; steadies thigh and assists in rising from sitting position
<b>Gluteus medius</b>	External surface off ilium between anterior and posterior gluteal lines	Anterior surface of greater trochanter of femur	Superior gluteal nerve (L5, S1)	Abduct and medially rotate thigh; keep pelvis level when ipsilateral limb is weight-bearing and advance opposite (unsupported) side during its swing phase
<b>Gluteus minimus</b>	External surface of ilium between anterior and inferior gluteal lines	Anterior surface of greater trochanter of femur		
<b>Tensor of fascia lata</b>	Anterior superior iliac spine; anterior part of iliac crest	Iliotibial tract, which attaches to lateral condyle of tibia		
<b>Piriformis</b>	Anterior surface of sacrum; sacrotuberous ligament	Superior border of greater trochanter of femur	Branches of anterior rami of S1, S2	Laterally rotate extended thigh and abduct flexed thigh; steady femoral head in acetabulum
<b>Obturator internus</b>	Pelvic surface of obturator membrane and surrounding bones	Medial surface of greater trochanters (trochanteric fossa) of femur <sup>1</sup>	Nerve of obturator internus (L5, S1)	
<b>Superior and inferior gemelli</b>	Superior: ischial spine Inferior: ischial tuberosity	Medial surface of greater trochanters (trochanteric fossa) of femur <sup>1</sup>	Superior gemellus: Same nerve supply as obturator internus Inferior gemellus: Same nerve supply as quadratus femoris	
<b>Quadratus femoris</b>	Lateral border of ischial tuberosity	Quadratus tubercle on intertrochanteric crest of femur and area inferior to it	Nerve to quadratus femoris (L5, S1)	Laterally rotates thigh <sup>2</sup> , steadies femoral head in acetabulum

1. The gemelli muscles blend with the tendon of the obturator internus as it attaches to the greater trochanter of the femur.

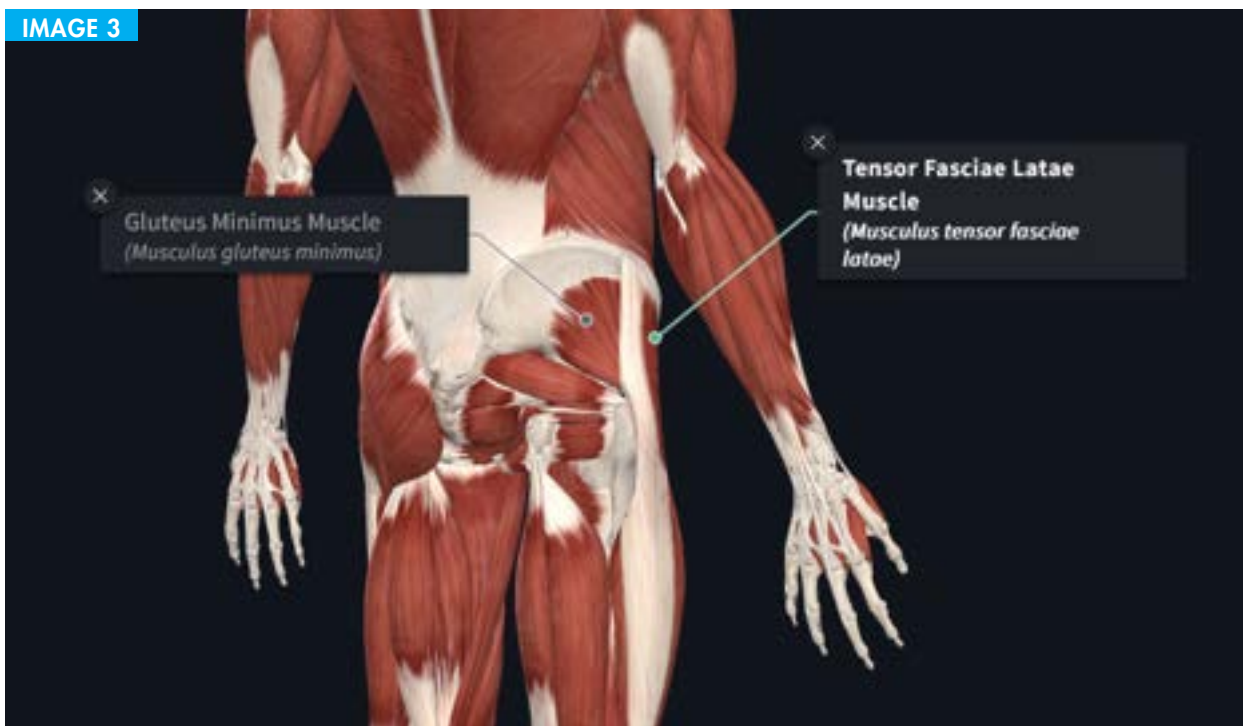
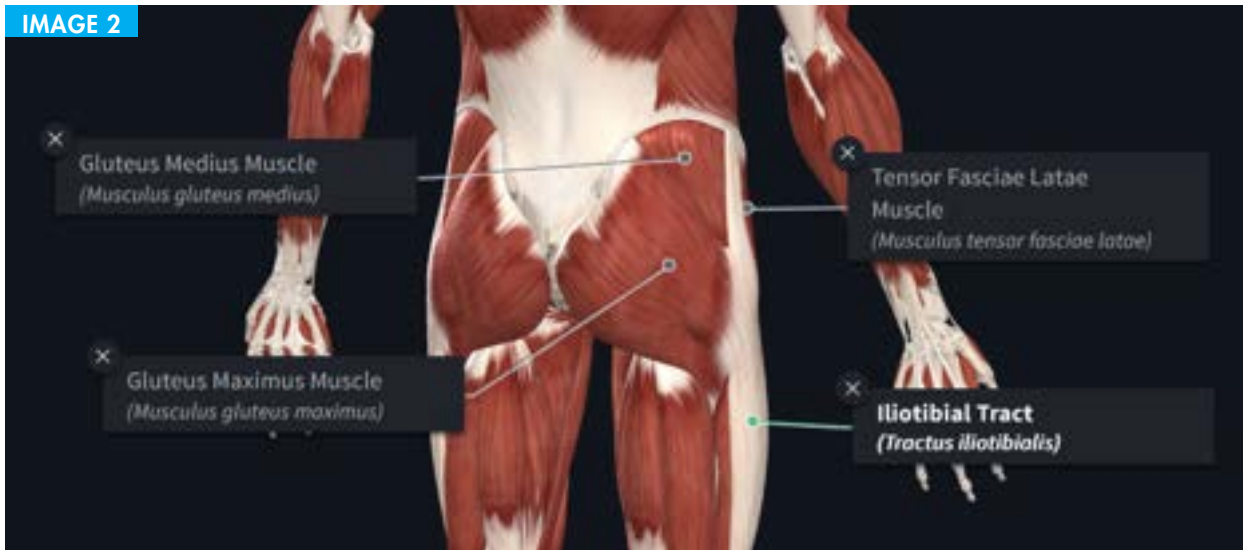
2. There are six lateral rotators of the thigh: piriformis, obturator internus, superior and inferior gemelli, quadratus femoris, and obturator externus. These muscles also stabilize the hip joint.

## Muscles of the gluteal region

The muscles of the gluteal region share a common compartment but are organized into **two layers, superficial and deep**:

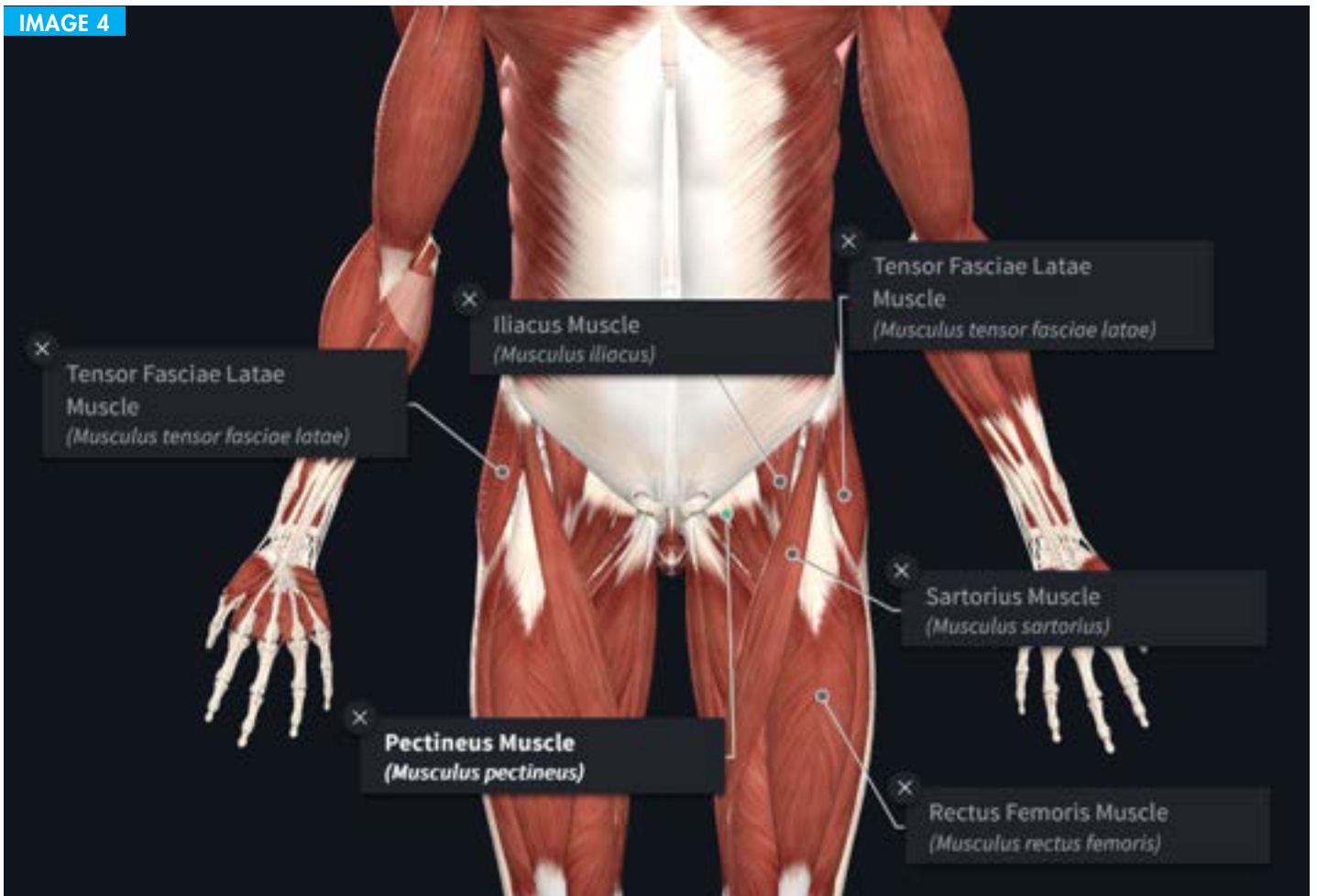
- The **superficial layer** consists of the three large overlapping glutei -maximus, medius and minimus and the tensor fascia lata.
- These muscles all have proximal insertions on the external (posterolateral) surface of the ilium and are mainly extensors, abductors and medial rotators of the thigh.

See Images 2, 3 & 4.



**Image 3.** The gluteus medius and maximus have been removed to reveal the minimus lying deep

IMAGE 4

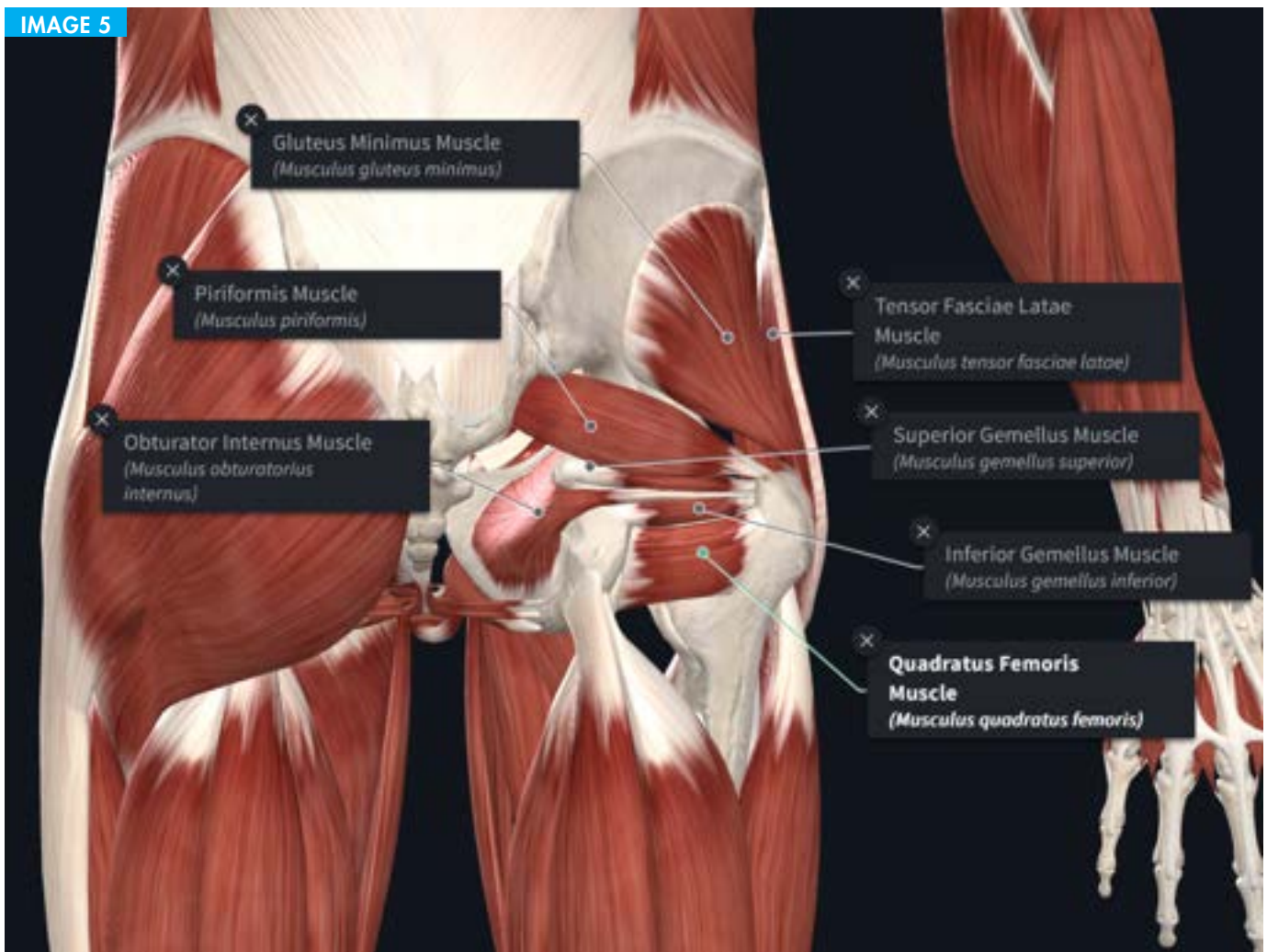


**Image 4.** The Tensor fascia latae shown in context with some surrounding muscles

- The **deep layer** consists of smaller muscles-piriformis, obturator internus, superior and inferior gemelli and quadratus femoris. [Image 5](#).
- They are covered by the inferior half of the gluteus maximus.
- They all have attachments on or adjacent to the intertrochanteric crest of the femur.
- These muscles are lateral rotators of the thigh, but they also stabilize the hip joint, working with the strong ligaments of the hip joint to steady the femoral head in the acetabulum.



IMAGE 5



## Gluteus Maximus

- The gluteus maximus is the most superficial gluteal muscle.
- It is the heaviest, largest and most coarsely fibered muscle of the body.
- The gluteus maximus covers all the other gluteal muscles except for the anterior superior third of the gluteus medius. (see image 6)
- The gluteus maximus slopes inferior laterally at a 45 degree angle from the pelvis to the buttock. The fibers of the superior and larger part insert into the iliotibial tract and indirectly, via the lateral intermuscular septum, into the linea aspera of the femur.
- Some deep fibers of the inferior part of the muscle insert to the gluteal tuberosity of the femur. [Image 6 & 7.](#)

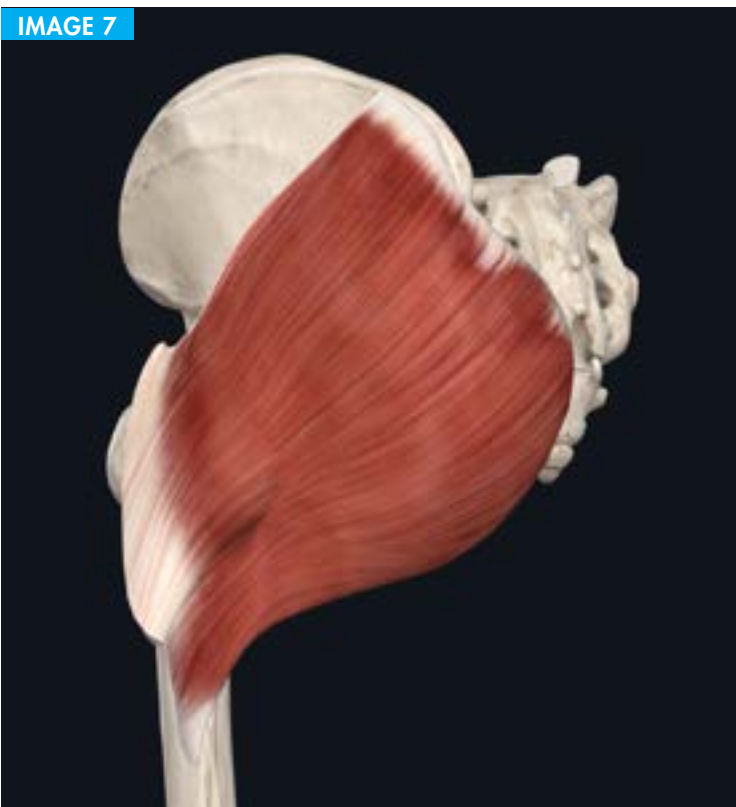
IMAGE 6



The **main actions** of the gluteus maximus are extension and lateral rotation of the thigh. When the distal attachments of the gluteus maximus is fixed, the muscle extends the trunk on the lower limb. Although it is the strongest extensor of the hip, it acts mostly when strong force is necessary for example, standing from sitting, fast running and walking up stairs.

Because the iliotibial tract crosses the knee and attaches to the anteriorlateral tubercle of the tibia, the gluteus maximus (and tensor fascia latae) are able to assist in making the extended knee stable.

IMAGE 7



◀ **Image 6 & 7.**

Note the attachments of the gluteus maximus into both the Iliotibial tract and the gluteal tuberosity on the posterior of the femur.

## Gluteus medius and gluteus minimus

- The smaller gluteal muscles, **gluteus medius** and **gluteus minimus**, are fan shaped, and their fibres converge in the same manner towards essentially the same target—the greater trochanter of the femur.
- They share the same actions and nerve supply and are supplied by the same blood vessel, the superior gluteal artery.
- The gluteus minimus and most of the gluteus medius lie deep to the gluteus maximus on the external surface of the ilium.
- The gluteus medius and minimus abduct or stabilize the thigh.
- The anterior fibres rotate the thigh medially and the posterior fibres rotate the thigh laterally.
- The gluteus medius can be palpated inferior to the iliac crest, posterior to the tensor fasciae latae, which is also contracting during abduction of the thigh.



**Image 8A.** Gluteus medius

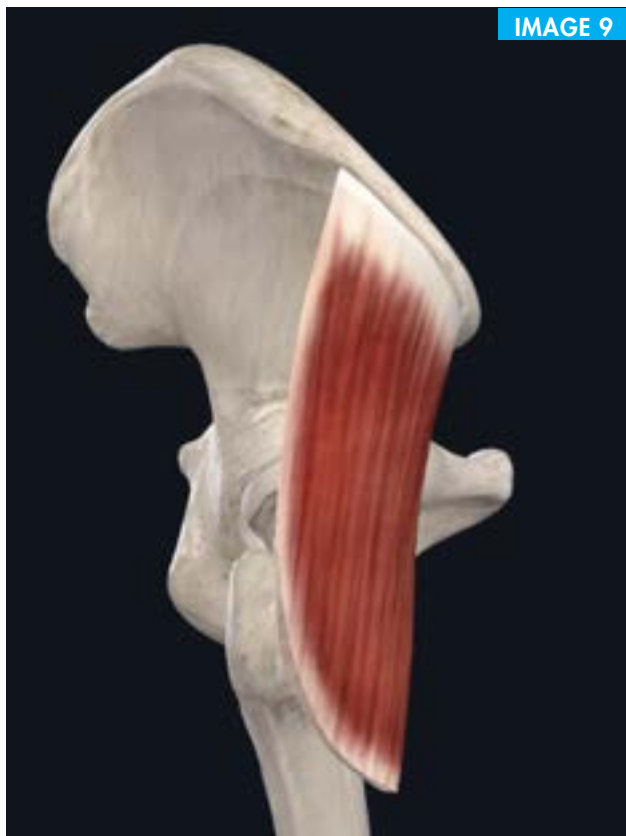


**Image 8B.** Gluteus Minimus lies deep to medius with a slightly more anterior insertion on the greater trochanter

## Tensor Fasciae Latae

The tensor fasciae latae is a fusiform muscle that is enclosed between two layers of fascia lata (Images 9, 10 & 11). 3 perspectives show the TFL with the ITB cut away.)

- The tensor fasciae latae and the superficial and anterior part of the gluteus maximus share a common distal attachment to the *anterolateral tubercle of the tibia* via the *iliotibial tract*, which acts as a long aponeurosis for the muscles.
- Despite its gluteal innervation and shared attachment, this tensor is primarily a flexor of the thigh because of its anterior location; however, it generally does not act independently.
- To produce flexion, the tensor fasciae latae acts in concert with iliopsoas and rectus femoris.
- When the iliopsoas is paralyzed, the tensor fasciae latae undergoes hypertrophy in an attempt to compensate for the paralysis.
- It also works in conjunction with other abductor/medial rotator muscles (gluteus medius and minimus)
- It lies too far anteriorly to be a strong abductor and thus probably contributes primarily as a synergist or fixator.



**Image 9.** Lateral view of TFL



**Image 10.** Anterior view of TFL



IMAGE 11



Image 11. Posterior view of TFL

The tensor fasciae latae tenses the fascia lata and iliotibial tract. Because the iliotibial tract is attached to the femur via the lateral intermuscular septum, the tensor produces little if any movement of the leg. However, when the knee is fully extended, it contributes to increasing the extending force, adding stability, and plays a role in supporting the femur on the tibia when standing if lateral sway occurs. When the knee is flexed by other muscles, the tensor fasciae latae can synergistically augment flexion and lateral rotation of the leg.

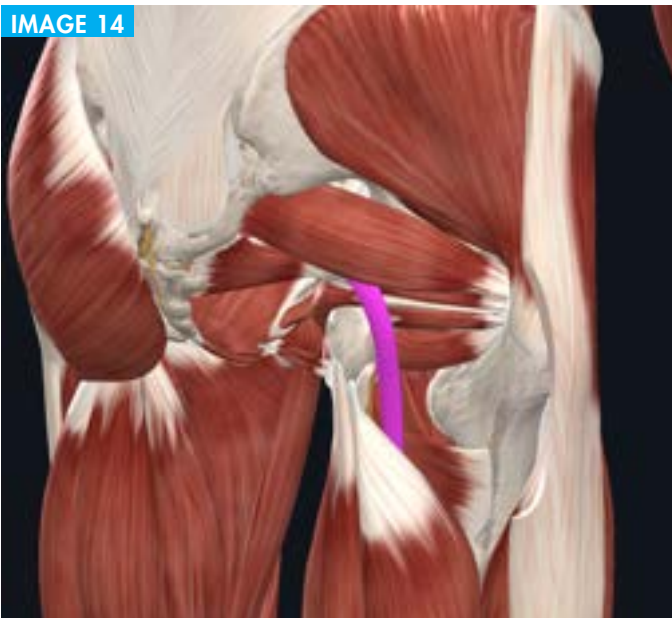
The abductors/medial rotators of the hip joint play an essential role during locomotion, advancing and preventing the sagging of the unsupported side of the pelvis during walking. Dropping of the hip is described as the "Trendelenburg sign."

## Piriformis

- The pear-shaper **piriformis** (L. *pirum*, a pear) is located partly on the posterior wall of the lesser pelvis and partly posterior to the hip joint ([Images 12 & 13](#)).
- The piriformis leaves the pelvis through the *greater sciatic foramen*, almost filling it, to reach its attachment to the superior boarder of the *greater trochanter*.
- Because of its key position in the buttock, the piriformis is the *landmark of the gluteal region*.

**IMAGE 12****IMAGE 13**

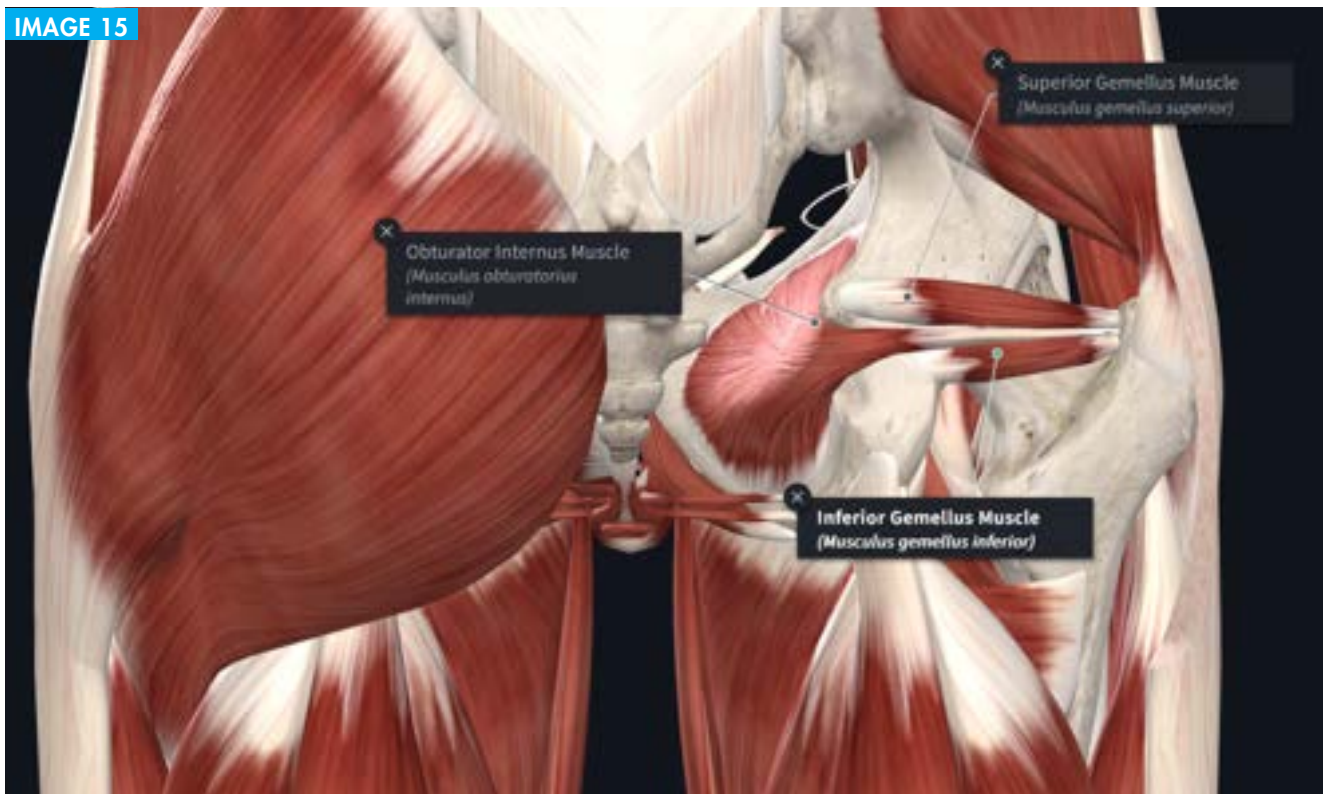
- In addition to the action of external rotation, the piriformis is a secondary hip abductor. Both actions are apparent in the muscle's line of force relative to the axis of rotation at the hip
- The sciatic nerve usually exits the pelvis inferior to the piriformis although it may pass through the belly of the piriformis. [Image 14](#).
- A shortened or "tight" piriformis may compress and irritate the nerve, a condition known as "piriformis syndrome."

**IMAGE 14****Image 14.**

The sciatic nerve exiting inferior to the pelvis. In 20% of people it can exit through the piriformis muscle.

## Obturator internus and gemelli

- The **obturator internus** and the **superior and inferior gemelli** (L. *geminus*, small twin) form a tricipital (three-headed) muscle, the **triceps coxae** (triceps of the hip), which occupies the gap between the piriformis and the quadratus femoris (**Image 15**).
- The common tendon of these muscles lies horizontally in the buttock as it passes to the greater trochanter of the femur.
- The **bursa of the obturator internus** allows free movement of the muscle over the posterior border of the ischium, where the border forms the lesser sciatic notch and the trochlea over which the tendon glides.



**Image 15.** The “triceps of the hip”

- The *obturator internus* is located partly in the pelvis, where it covers most of the lateral wall of the lesser pelvis (**image 16 & 17**).
- It leaves the pelvis through the *lesser sciatic foramen*, makes a right-angle turn becomes tendinous, and receives the distal attachments of the gemelli before attaching to the medial surface of the greater trochanter (trochanteric fossa).

IMAGE 16



IMAGE 17



IMAGE 18

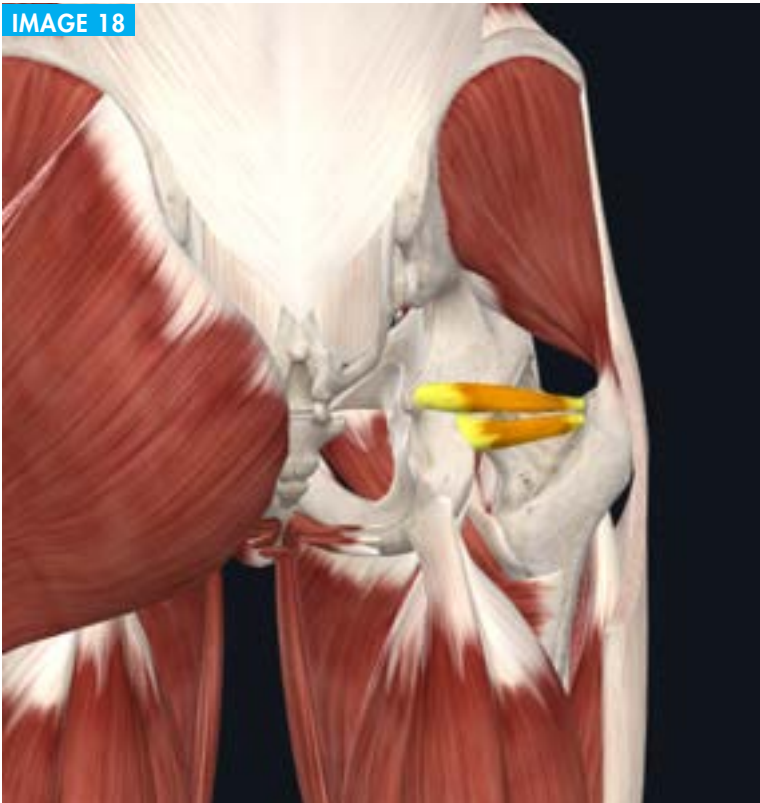


Image 18.

The smaller gemelli are narrow, triangular extra pelvic reinforcements of the obturator internus. Although the inferior gemellus received separate innervation from the nerve to the quadratus femoris, it is more realistic to consider these three muscles as a unit (i.e., as the triceps coxae) because they are incapable of independent action.

Image 18. The superior and inferior gemelli

IMAGE 19



## Quadratus femoris

The quadratus femoris is a short, flat quadrangular muscle located inferior to the obturator internus and gemelli ([Image 19](#)).

True to its name, the quadratus femoris is a rectangular muscle; it is a strong lateral rotator of the thigh.

## Obturator Externus

The obturator externus, with other short muscles around the hip joint, stabilizes the head of the femur in the acetabulum. It is most effective as a lateral rotator of the thigh when the hip joint is flexed. [Images 20-22](#).

IMAGE 20



[Image 20](#). Lateral

IMAGE 21



[Image 21](#). Posterior

IMAGE 22



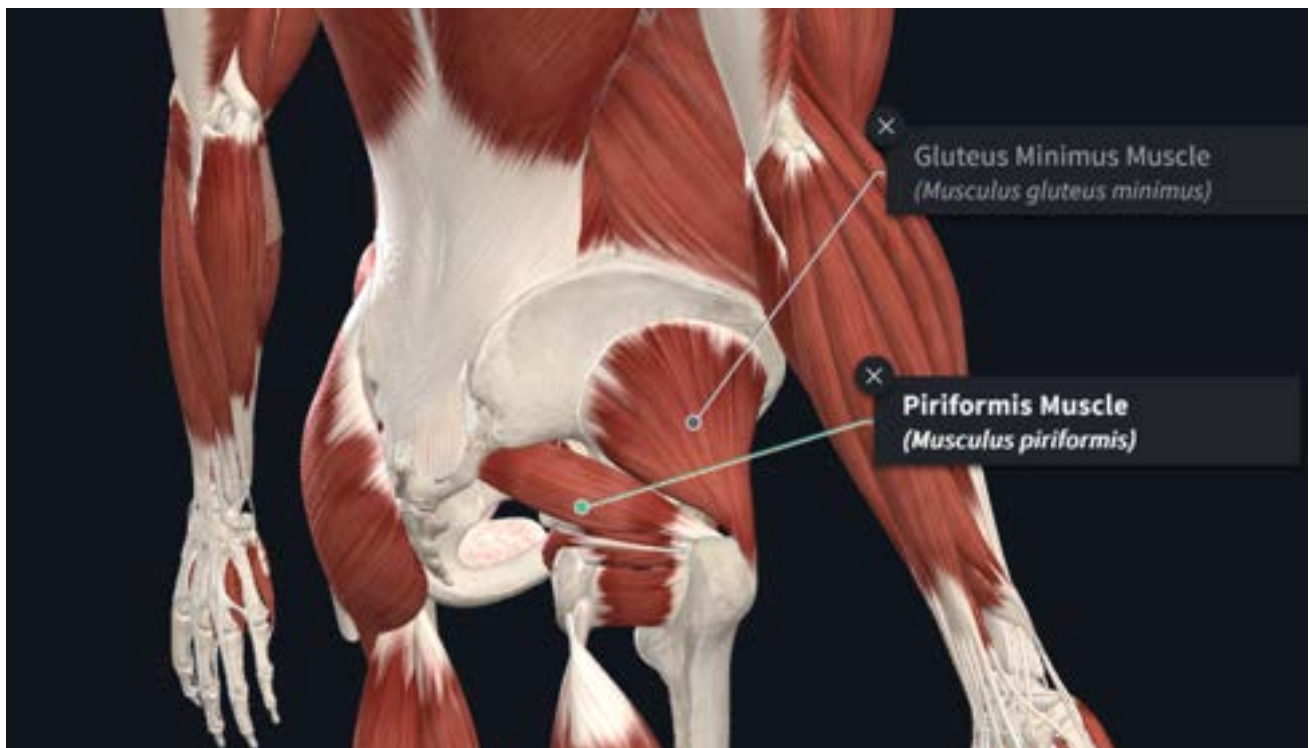
[Image 22](#). Anterior



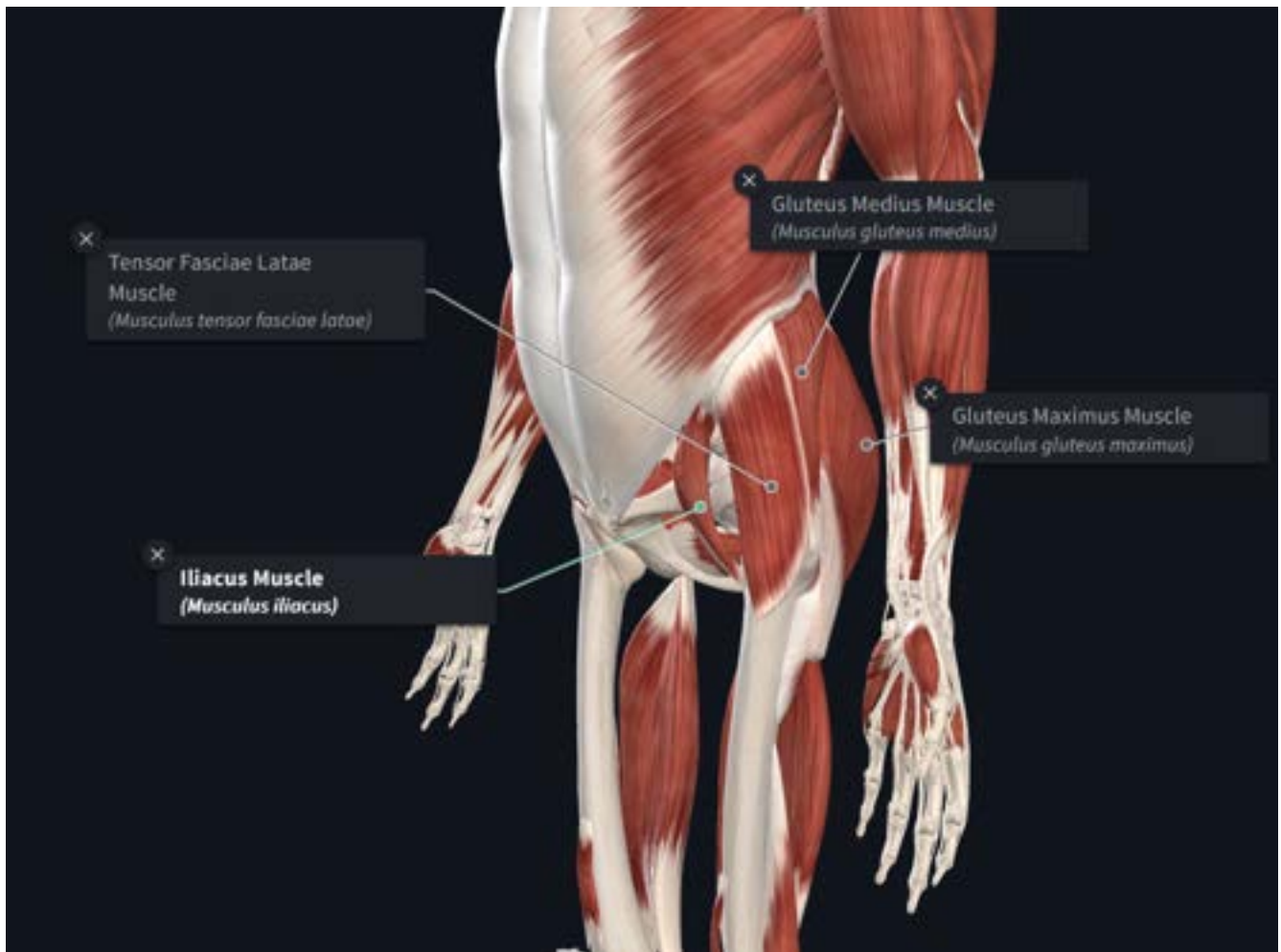
## Additional Images



The gluteus maximus is the most superficial of the compartment, obscuring much of the medius and the entire deep layer.



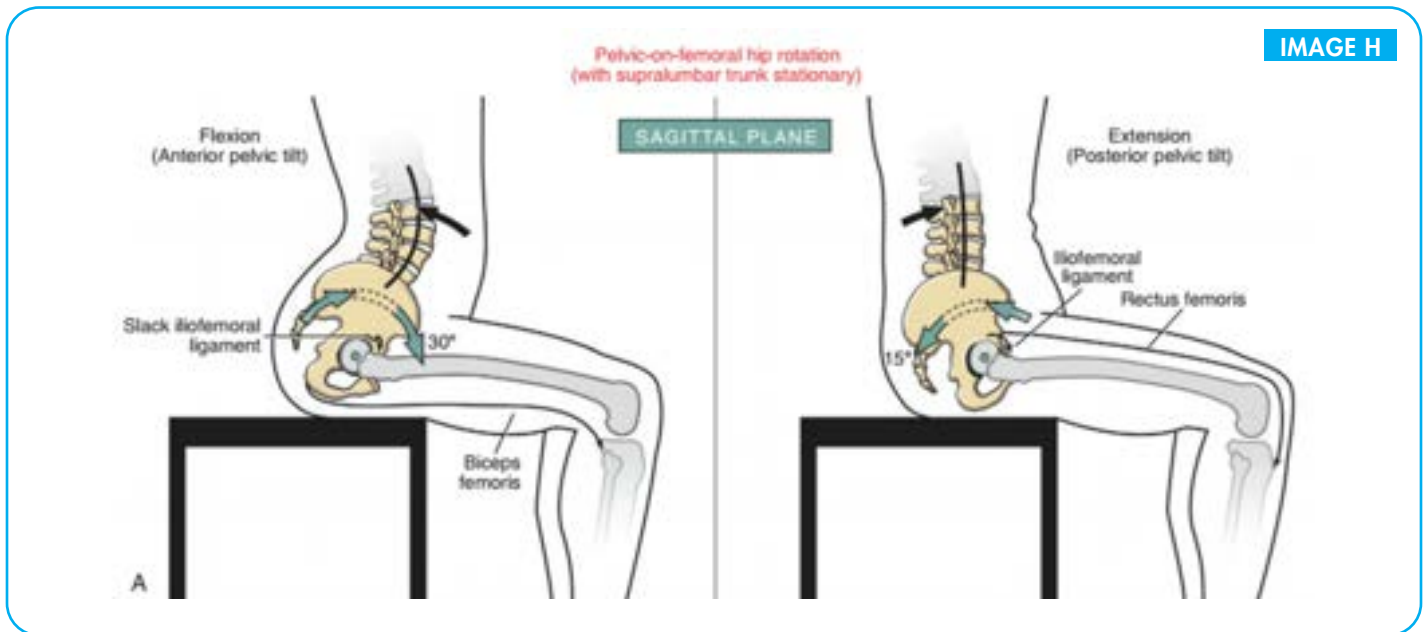
The gluteus medius has been cut away to reveal the minimus which lies deep to it.



The Tensor fascia latae is a fusiform muscle that is enclosed between two layers of fascia.

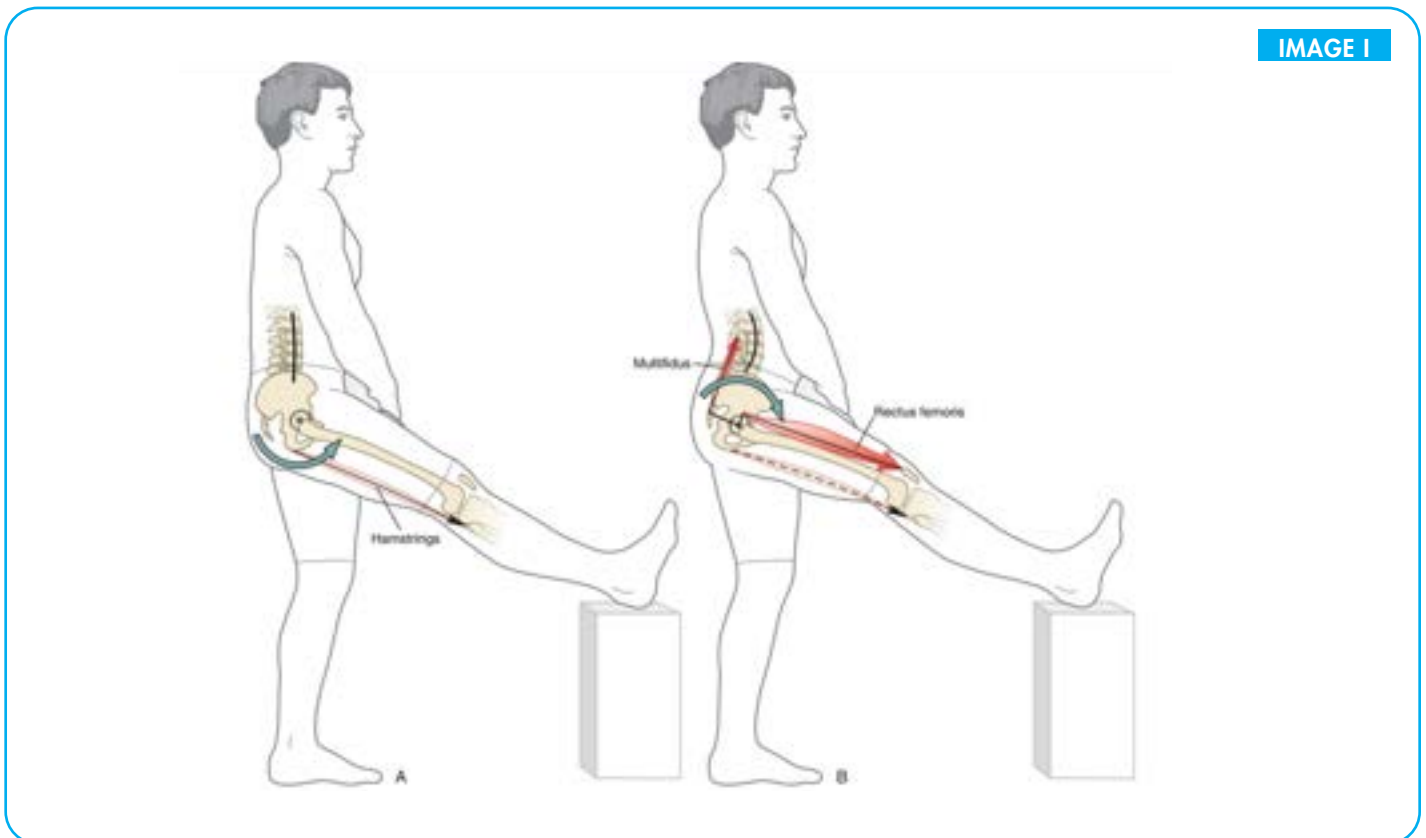
An important concept to understand when stretching the gluteals and their opposing muscle group, the hip flexors, is that of “Pelvic on femoral” rotation.

During pelvic on femoral rotation, the pelvis moves while the femur (thigh bone) remains relatively stable. The image below shows examples of an anterior rotation, or tilt, on the left and a posterior rotation, or tilt, on the right.



*An example of an anterior rotation, or tilt.*

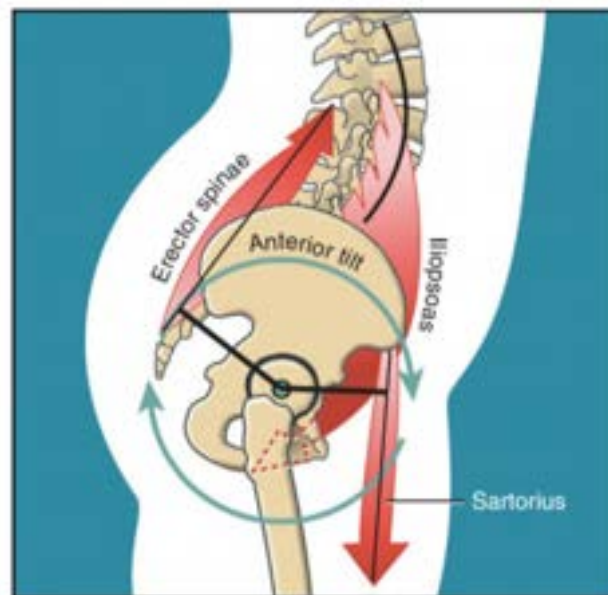
*A posterior rotation, or tilt.*



When stretching the posterior gluteal muscles, in particular gluteus maximus, because of its attachment on the femur, an anterior tilt is important. Any increase in anterior pelvic rotation causes an increase in the stretch tension in the gluteals and hamstrings. An anterior tilt is created by active contraction of the multifidus and erector spinae on the posterior side and hip flexors such as rectus femoris and iliopsoas on the anterior of the body. This co-contraction of muscles on the opposite side of a joint is called a “force couple.”

**Definition:** Force couples are commonly encountered in human movement and biomechanics. For example, in the human body, when muscles on opposite sides of a joint contract simultaneously with equal force but in opposite directions, they create a force couple that can produce rotational motion around that joint.

IMAGE J



**FIGURE 12-27.** The force couple is shown between two representative hip flexor muscles and the erector spinae to anteriorly tilt the pelvis. The moment arms for the erector spinae and sartorius are indicated by the dark black lines. Note the increased lordosis at the lumbar spine.

## Teaching Tip

When trying to achieve an anterior tilt the instruction to arch the low back or roll the pelvis forward will assist in activating the correct muscles. (Stress movement, not muscles!) The image below makes the analogy of the pelvis as a bowl of water. When tipping the water out the front of the bowl below, an anterior pelvic tilt is achieved.



# PELVIS AS A BOWL OF WATER



Your Hips  
Point Down

Your Hips  
Point Up

ANTERIOR  
PELVIC TILT

NEUTRAL

POSTERIOR  
PELVIC TILT

X

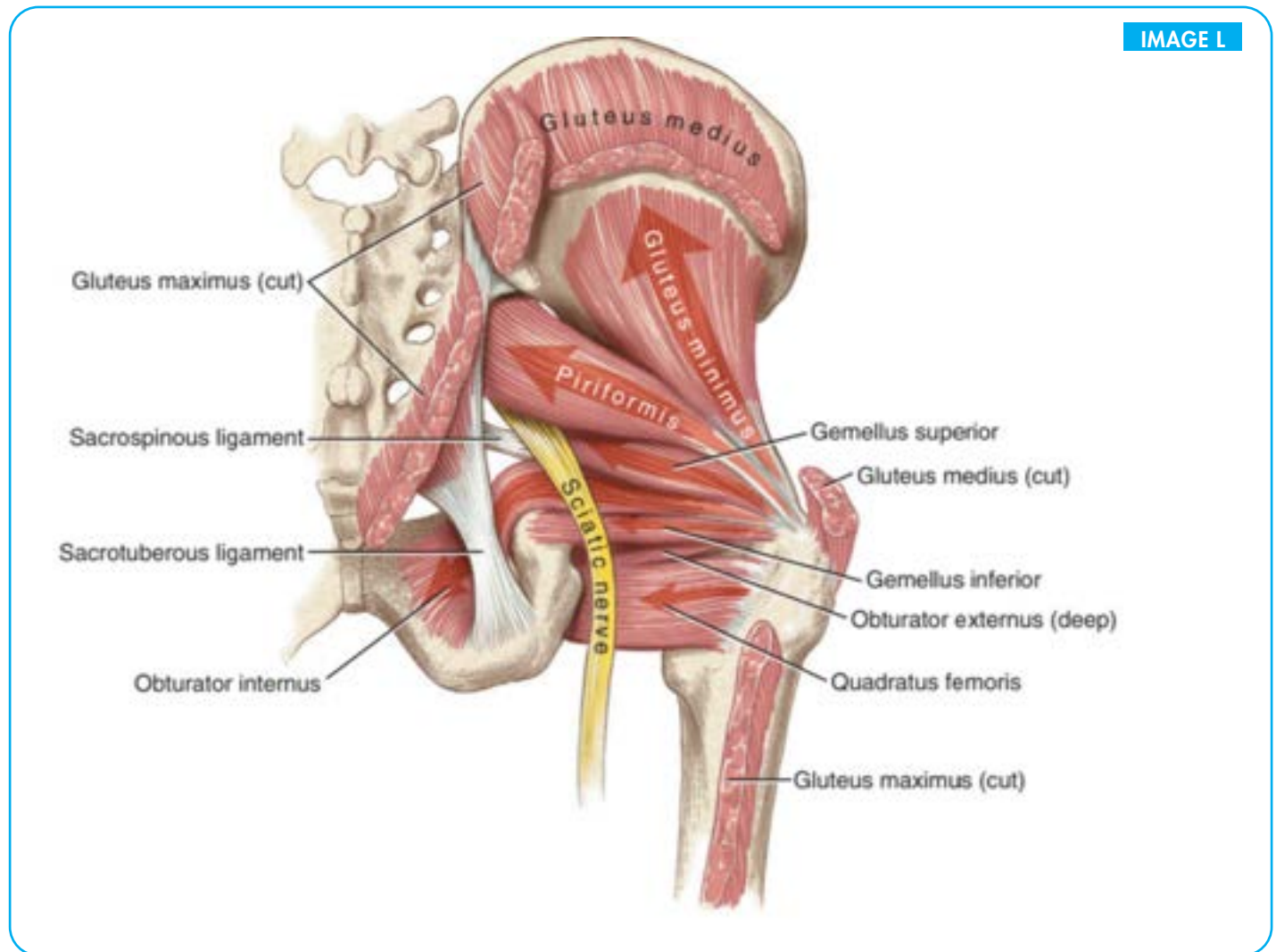
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X



# The Sciatic Nerve

The sciatic nerve is also important to the gluteal region, because it passes under and sometimes, through, the piriformis muscle. Please read the bonus article “what is piriformis syndrome at the conclusion of this short course for more information. You can also take the short course titled “piriformis syndrome and stretching,” with us.



# Stretching with equipment

## The seated glutes

A standard stretch for the glutes. Be sure to listen to the instructions to explore moving the sensations through the entire region.



[Click to play video](#)

## Kneeling abductors

This stretch will shift the focus to the lateral part of the glutes, in particular medius and minimus. The sensations are quite different to the stretch above and a comprehensive stretching program for this region should include both.



[Click to play video](#)

## TFL stretch

The TFL, although located on the ASIS and external lip of the iliac crest, is part of the gluteal region. While sometimes tricky to perform, this stretch will focus the sensations on that region.



[Click to play video](#)

# Stretches without equipment

## Seated Hip

**HOW TO STRETCH:** Photo A and B

- Hook elbow around opposite knee
- Lift chest
- Keep sit bones on box



**HOW TO CONTRACT:** Photo B

- Press knee away from armpit

**HOW TO RESTRETCH:** Photo B

- Pull the knee further to the armpit
- Arch spine
- Twist spine towards the stretching hip



Major muscles stretched

Gluteals

Deep rotators

# Box Pigeon

## HOW TO STRETCH: Photo A

- Sit on the box, thigh at 90° to pelvis
- Knee flexed to 90°

A



## PARTNER ASSISTANCE: Photo C

- Partner to press on pelvis to square hips

D



## HOW TO CONTRACT: Photo B

- Try to level hips
- Press foot on box down towards box

B



## HOW TO RESTRETCH: Photo C

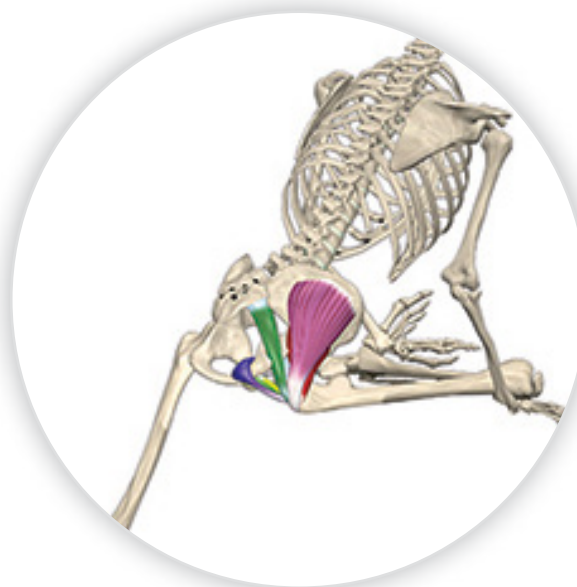
- Lean chest towards foot
- Keep spine straight

C



## Major muscles stretched

- Gluteals
- Deep hip rotators





# Box Twist

## HOW TO STRETCH: Photo A

- Sit on the box
- Align knee with navel
- Rotate opposite hip towards box

## HOW TO CONTRACT: Photo A

- Press front leg into the box to contract
- Square hips to line of leg

A



## HOW TO RESTRETCH: Photo B

- Lower opposite armpit to front knee

B



## PARTNER ASSISTANCE: Photo C

- Partner presses on pelvis to assist with pelvic rotation

C



## Major muscles stretched

- Gluteals
- Deep hip rotators



# Pigeon

## HOW TO STRETCH: Photo A

- Sit on the floor, hips square to line of leg
- Front knee at 90°
- Straighten rear leg
- Sit bone of front leg in contact with floor

A



## HOW TO CONTRACT: Photo B

- Press front foot down into floor

B



## HOW TO RESTRETCH: Photo C

- Lean centre of chest towards foot
- Partner to press on pelvis to keep hips square

C



## Major muscles stretched

- Gluteus medius
- Portions of gluteus maximus



# Piriformis Syndrome

## Background

Piriformis syndrome is a condition that involves the piriformis muscle, a small muscle located deep in the buttocks near the hip joint. The piriformis muscle plays a role in the external and internal rotation of the hip, the stabilization of the pelvic region and femoral head in the acetabulum.



Piriformis syndrome occurs when the piriformis muscle becomes tight, inflamed, or irritated, leading to compression or irritation of the sciatic nerve. The sciatic nerve is the largest nerve in the body and extends from the lower back down through the buttocks and into the legs. When the piriformis muscle puts pressure on the sciatic nerve, it can result in symptoms such as:

## Symptoms

**Pain:** Typically, there is pain in the buttocks and can radiate down the back of the leg. The pain may be sharp, burning, or tingling in nature.

**Numbness and tingling:** Along the path of the sciatic nerve, there may be sensations of numbness, tingling, or pins and needles in the buttocks and leg.

**Weakness:** Some individuals with piriformis syndrome may experience weakness in the affected leg.

## Causes

Piriformis syndrome can be caused by various factors, including overuse or repetitive activities that put strain on the muscle, injury, prolonged sitting, muscle imbalances, or anatomical variations (see below). It is more common in athletes, runners, and individuals who engage in activities that involve repetitive hip movements.

## Diagnosis

Diagnosis of piriformis syndrome can be challenging as its symptoms may overlap with other conditions such as herniated discs, spinal stenosis, nerve tethering (see below) or sciatica. Physicians may use physical examinations, medical history, and imaging tests to rule out other causes and arrive at a diagnosis. There is no definitive test for piriformis syndrome.

Diagnosis of piriformis syndrome is made by the patient's report of symptoms and by physical exam using a variety of movements to elicit pain to the piriformis muscle.

## Treatment

Treatment for piriformis syndrome typically includes a combination of conservative measures such as rest, ice or heat application, physical therapy, stretching exercises, and anti-inflammatory medications. In some cases, corticosteroid injections may be used to reduce inflammation and relieve pain. In severe or persistent cases, surgery may be considered, but it is relatively rare.

# The Anatomy



The piriformis muscle originates on the anterior surface of the sacrum around the 2,3 and 4th sacral foramina. The fibres travel anteriolaterally and insert via a rounded tendon onto the superior border of the greater trochanter of the femur.

The **sciatic and peroneal nerve**, pictured below is the thickest and longest nerve in the body. Sometimes both nerves pass the underside of the piriformis muscle before dividing (first image on left), and sometimes they divide and only the sciatic nerve passes through the piriformis muscle (second image). Other times they both pass through the piriformis muscle before travelling down the back of the leg, and eventually branching off and ending in the top and the sole of the feet. (See third image). Compression of these nerves, particularly in the instances of pictures 2 and 3, can be caused by spasm of the piriformis muscle.





IMAGE E



## How does the muscle compress the nerve?

The compression of the sciatic nerve by the piriformis muscle is a mechanical action. The exact mechanism by which the piriformis muscle compresses the nerve is not fully understood, and there may be multiple contributing factors. However, there are a few proposed mechanisms that could explain how the compression occurs:

**Muscle Tightness:** When the muscle tightens, it can put pressure on the sciatic nerve, which runs very close to or in some cases, through the muscle.

**Muscle Spasm:** In some cases, the piriformis muscle may go into spasm, causing it to contract forcefully and compress the nearby sciatic nerve.

**Anatomical Variation:** The sciatic nerve and the piriformis muscle have a close anatomical relationship in some individuals. As described above, in some people, the sciatic nerve may pass through or underneath the piriformis muscle rather than beside it. If the piriformis muscle is tight or spasms, it can put direct pressure on the nerve.

**Inflammation:** Inflammation of the piriformis muscle can occur due to injury or overuse. Inflammation can cause the muscle to swell, leading to pressure on the sciatic nerve.

The combination of tightness, spasms, anatomical variation, and inflammation can lead to irritation and compression of the sciatic nerve, resulting in the symptoms associated with piriformis syndrome, such as pain, numbness, tingling, and weakness in the buttocks and leg.