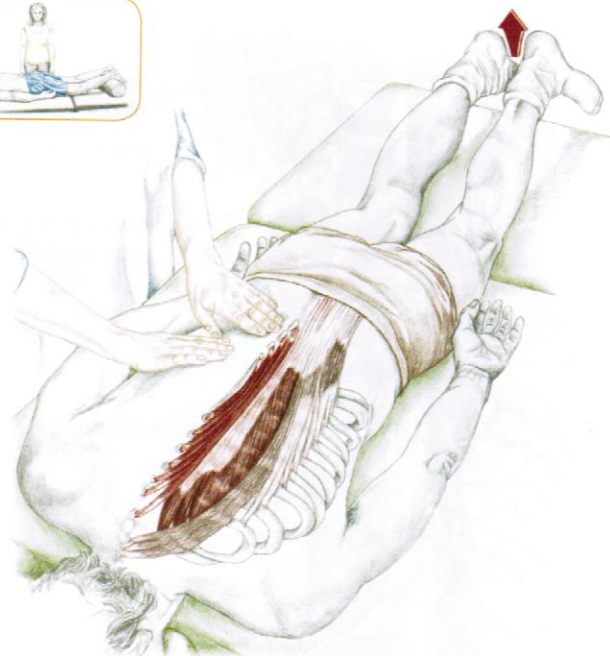


## Erector spinae group

- 1) Partner prone. Lay both hands along either side of the lumbar vertebrae. Locate the region of the lower erectors by asking your partner to alternately raise and lower his feet slightly. The erectors do not, of course, raise the feet, but they will contract in order to stabilize the pelvis. Notice how the strong, rounded erector fibers tighten and relax with this action (4.68).
- 2) As your partner maintains this contraction, palpate inferiorly onto the sacrum and then superiorly along the thoracic vertebrae. Ask your partner to extend his spine and neck slightly in order to contract the erectors in the thoracic region (4.69).
- 3) Follow the ropy fibers of the erectors between the scapulae and along the back of the neck. These fibers are smallest in the cervical region and are primarily situated lateral to the lamina groove.
- 4) With your partner relaxed, sink your fingers into the erector fibers, feeling their ropy texture and vertical direction (4.70).

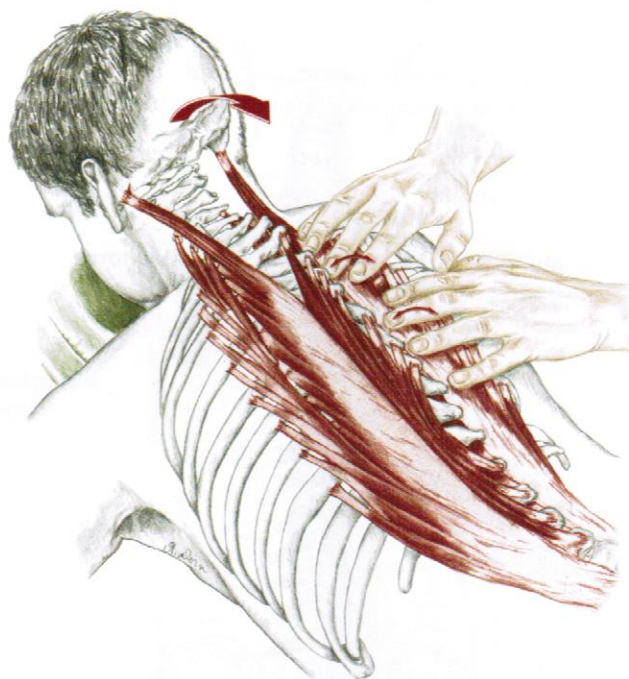
*Is the tissue you are palpating directly beside the spinous processes of the vertebrae? Do the fibers run parallel to the spine? When the muscles are contracted, can you locate the lateral edge of the erector group? Can you distinguish the fiber direction of the middle trapezius, rhomboids and erectors between the scapulae?*



**4.68** Partner prone, palpating the lower erectors while your partner raises his feet



**4.70** Partner prone, strumming your thumbs across the fibers of the spinalis



**4.69** Partner prone, palpating the upper erectors while your partner extends his spine

multifidi  
rotatores

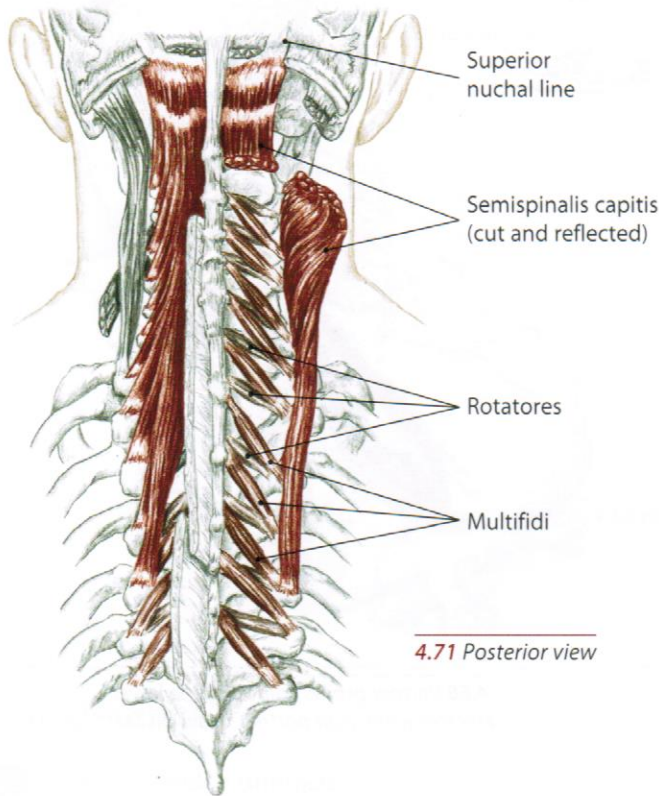
mul-**tif**-i-di  
ro-ta-**tor**-ays

L. *fid*i, to split  
L. plural for rotator



## Transversospinalis Group

*Multifidi*  
*Rotatores*  
*Semispinalis Capitis*

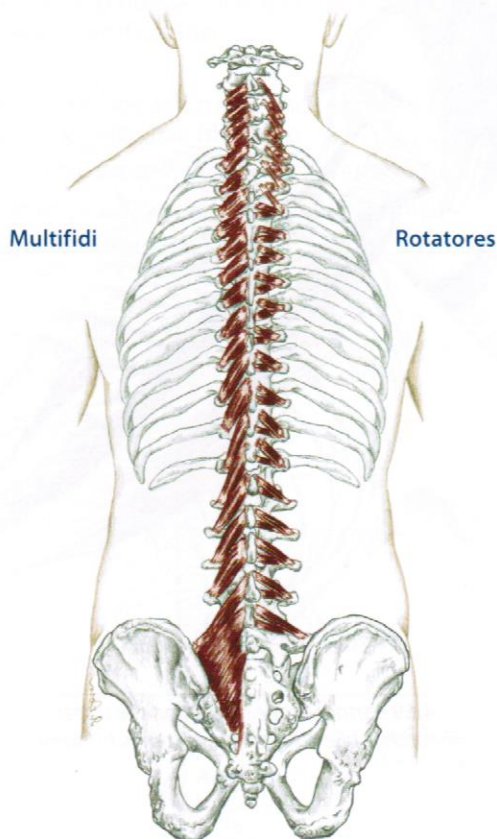


4.71 Posterior view

Deep to the erector spinae muscle group is the transversospinalis muscle group. The transversospinalis is composed of three branches—multifidi, rotatores and semispinalis—and extends the length of the vertebral column. Unlike the long, vertical erector fibers, the branches of the transversospinalis consist of many short, diagonal fibers. These fibers form an intricate stitchlike design that links the vertebrae together. The name “transversospinalis” refers to the fact that the fibers of this muscle group extend at varying lengths from the transverse and spinous processes of the vertebrae.

The surprisingly thick **multifidi** are directly accessible in the lumbar spine. They are the only muscles with fibers that lie across the posterior surface of the sacrum. The shorter, smaller **rotatores** lie deep to the multifidi (4.72). The **semispinalis capitis** is located along the thoracic and cervical vertebrae and ultimately reaches the cranium (4.71). Both semispinalis muscles form the twin “speed bumps” easily seen on the posterior neck when the neck is extended against resistance.

It can be difficult to isolate the individual bellies of the transversospinalis muscles as they are closely interwoven; however, as a group, their mass or density can be easily felt along the lamina groove of the thoracic and lumbar vertebrae.



4.72 Posterior view with the multifidi on the left and the rotatores on the right

### Multifidi and Rotatores

**A** *Unilaterally:*

**Rotate** the vertebral column to the opposite side

*Bilaterally:*

**Extend** the vertebral column

**O** *Multifidi:*

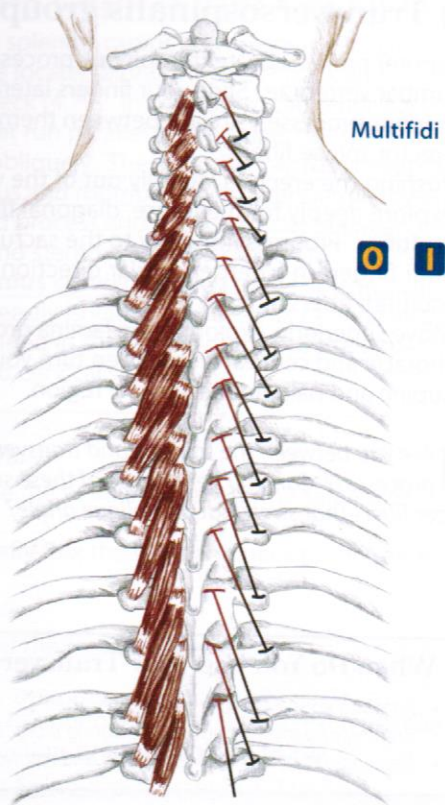
Sacrum and transverse processes of lumbar through cervical vertebrae

*Rotatores:*

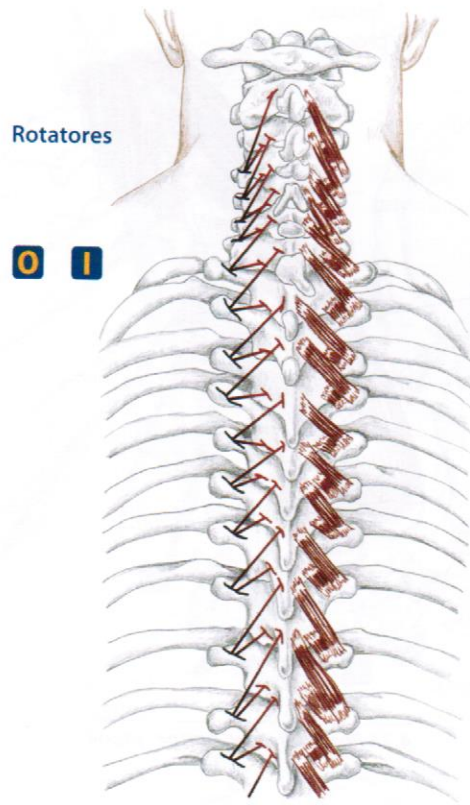
Transverse processes of lumbar through cervical vertebrae

**I** Spinous processes of lumbar vertebrae through second cervical vertebra  
(*Multifidi span two to four vertebrae*)  
(*Rotatores span one to two vertebrae*)

**N** Spinal



4.73 Posterior view, showing origins and insertions of the upper multifidus

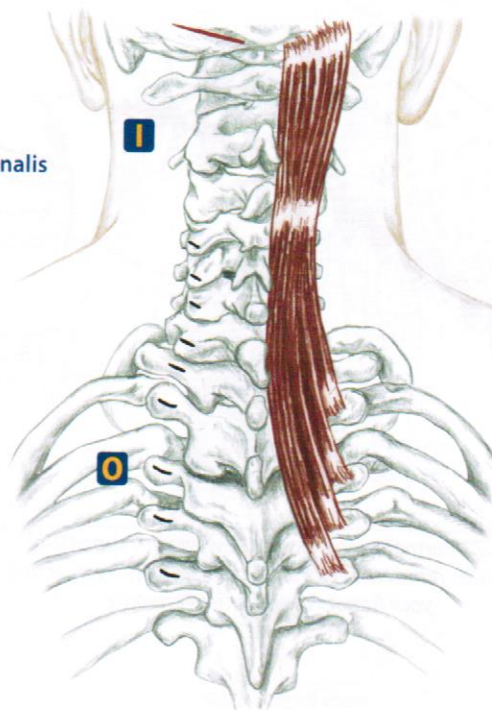


4.74 Posterior view, showing origins and insertions of the upper rotatores

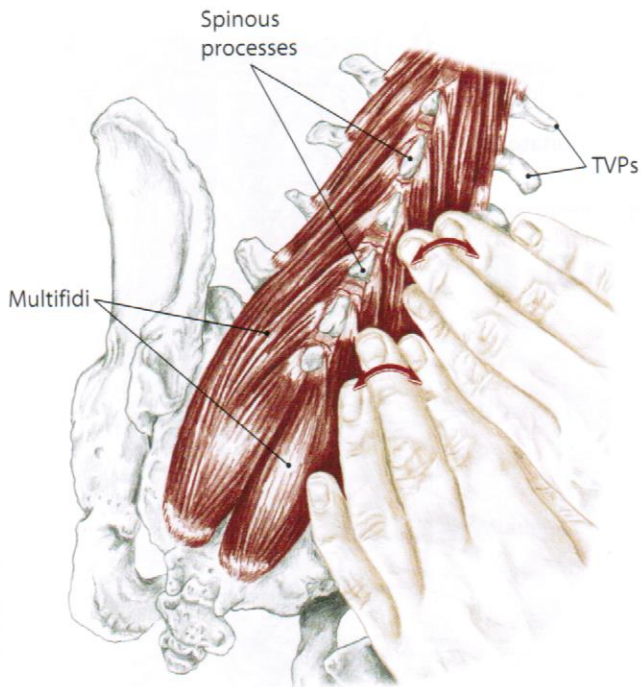
## Semispinalis Capitis

- A** Extend the vertebral column and head
- O** Transverse processes of C-4 to T-5
- I** Between the superior and inferior nuchal lines of the occiput
- N** Cervical

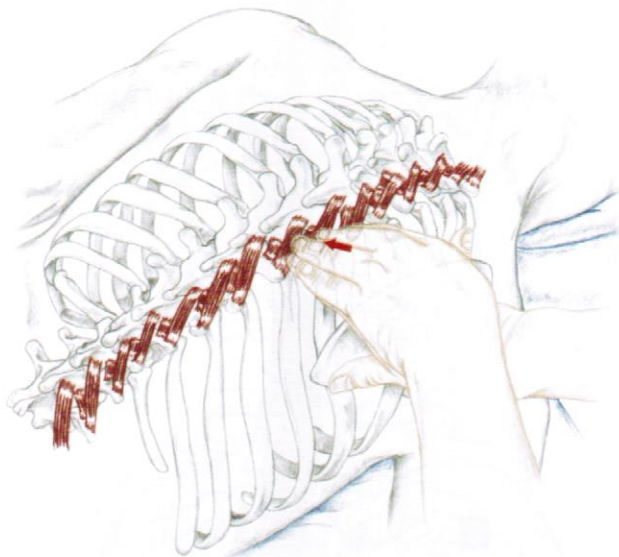
Semispinalis capitis



4.75 Posterior view, showing origin and insertion of the semispinalis capitis



4.76 Posterior view, partner prone



4.77 Partner prone, posterior view with superficial muscles removed. Accessing the rotatores by directing your fingers **toward** the vertebrae.

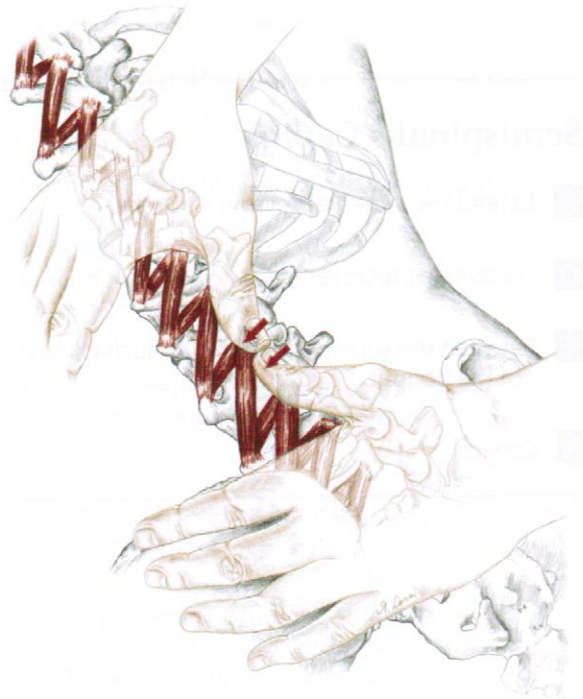
## Transversospinalis group

- 1) Partner prone. Locate the spinous processes of the lumbar vertebrae. Slide your fingers laterally off the spinous processes, sinking between them and the erector spinae fibers.
- 2) Pushing the erectors laterally out of the way, explore deeply for the dense, diagonal fibers of the multifidi. Progress inferiorly to the sacrum, rolling your fingers in a perpendicular direction to the multifidi fibers (4.76).
- 3) Move superiorly, exploring the lamina groove of the thoracic and cervical areas. Then turn your partner supine and palpate the cervical region.

Are you between the spinous and transverse processes? Can you get a sense of these smaller, deeper fibers that stretch at an oblique angle?

### When Do You Use Your Transverso?

- Rotating your torso to strap on a seat belt
- Arching and rotating your spine during a big "power yawn"
- Heaving dirt off a shovel (extension and rotation of spine)

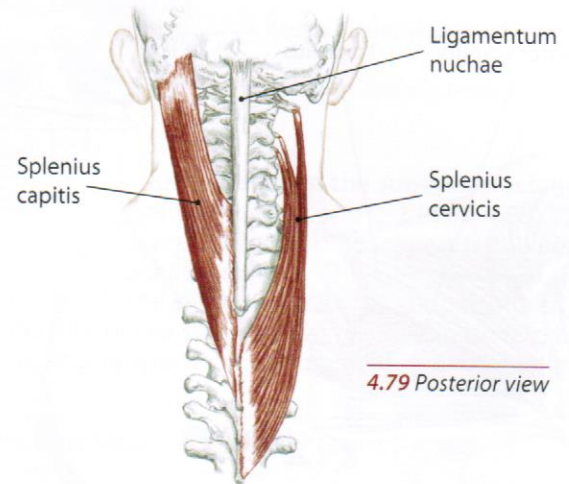


4.78 Partner prone, posterior/lateral view with superficial muscles removed. Palpating into the lamina groove on opposite side of the body with the thumbs sliding **away** from the vertebrae.

## Splenius Capitis and Cervicis

The long splenius capitis and splenius cervicis muscles are located along the upper back and posterior neck (4.79). In contrast to the other back muscles that run parallel to the spine, the splenii fibers run obliquely. The splenius capitis is deep to the trapezius and rhomboids. Its fibers angle toward the mastoid process and are superficial between the trapezius and sternocleidomastoid (4.81).

The splenius cervicis is deep to the splenius capitis and not as easily isolated; however, its general location can be outlined in the lamina groove of the upper thoracic and cervical spine.



4.79 Posterior view

### A Unilaterally:

**Rotate** the head and neck to the same side

**Laterally flex** the head and neck to the same side

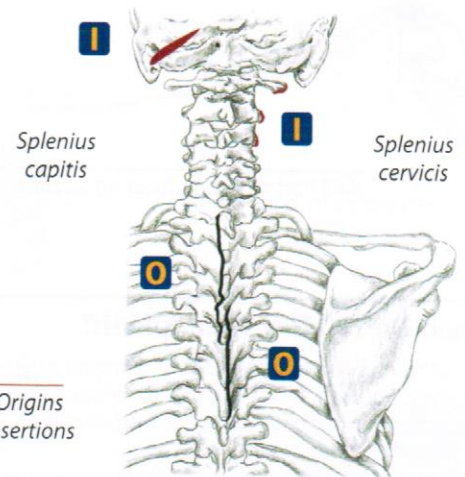
### Bilaterally:

**Extend** the head and neck

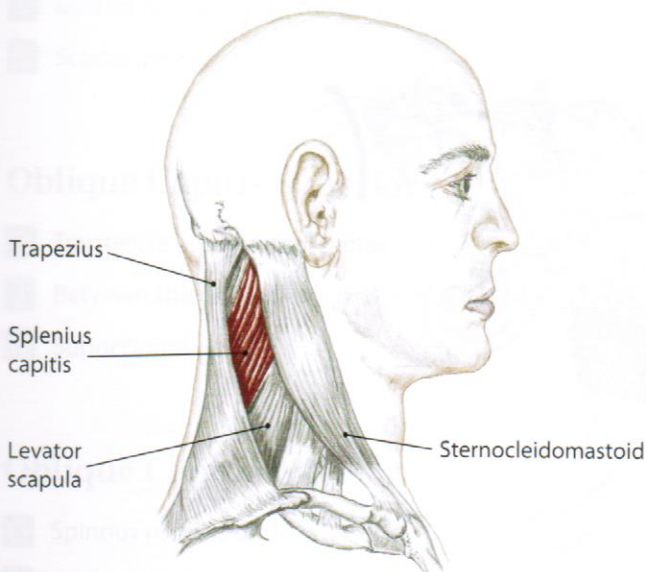
- O** *Capitis:* Inferior one-half of ligamentum nuchae and spinous processes of C-7 to T-4  
*Cervicis:* Spinous processes of T-3 to T-6

- I** *Capitis:* Mastoid process and lateral portion of superior nuchal line  
*Cervicis:* Transverse processes of C-1 to C-3

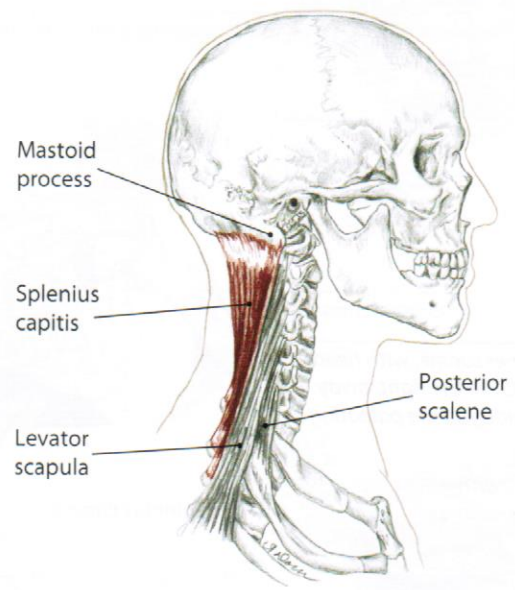
- N** Cervical



4.80 Origins and insertions



4.81 Lateral view

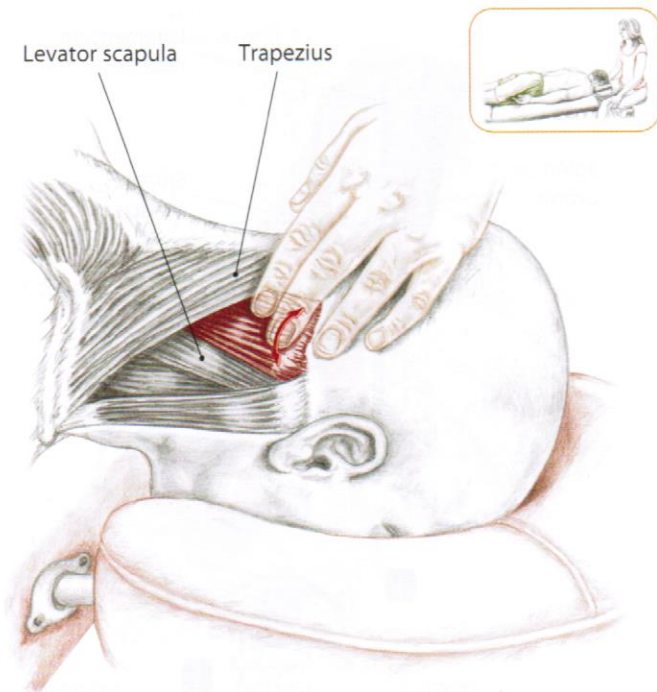


4.82 Lateral view

splenius capitis  
splenius cervicis

sple-nee-us kap-i-tis  
sple-nee-us ser-vi-sis

L. bandage-like (muscle) of the head



4.83 Partner prone, locating splenius capitis

### When Do You Use Your Splenii?

- Rotating your head and neck before changing lanes in traffic
- Applying ear drops (holding your head in lateral flexion)
- Crouched over in a huddle during a football game (extension of neck)

## Splenius capitis

- 1) Prone. Locate the upper fibers of the trapezius.
- 2) Isolate the lateral edge of the trapezius by having your partner extend his head slightly.
- 3) Ask your partner to relax. Palpate just lateral to the trapezius for the splenius capitis' oblique fibers, following them up to the mastoid process and inferiorly through the trapezius (4.83).

✓ Do the fibers you feel lead toward the mastoid process? Distinguish the trapezius fibers from the splenius capitis fibers by asking your partner to rotate his head slightly toward the side you are palpating. Do you feel these oblique fibers contract while the trapezius remains passive?

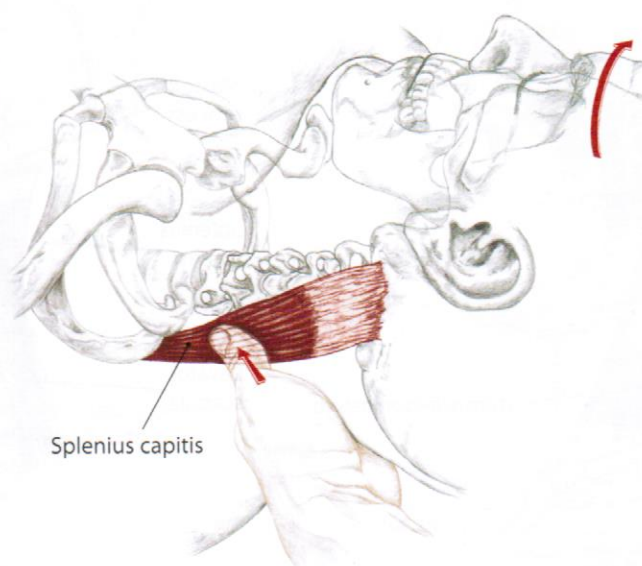
◆ Locate the mastoid process and slide medially and inferiorly onto the superficial capitis fibers.

## Both splenii muscles

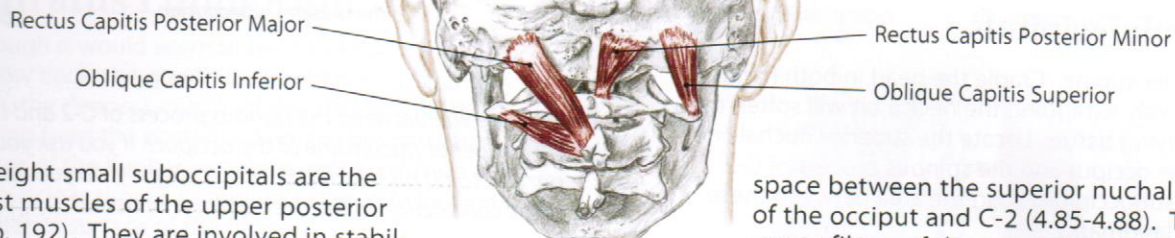
- 1) Partner supine with the head rotated 45° away from the side you are palpating. Cradle the head with one hand while the other hand locates the lamina groove of the upper cervical and thoracic vertebrae (4.84).
- 2) Passively extend the neck slightly to shorten the tissue and palpate through the overlying trapezius fibers. These bellies will not be particularly distinct; however, the density of both splenii can be felt in the lamina groove.



4.84 Partner supine, with head rotated 45° to the right, away from the side you are palpating



# Suboccipitals



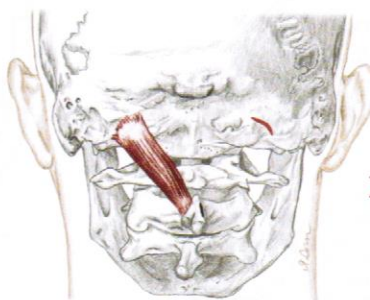
The eight small suboccipitals are the deepest muscles of the upper posterior neck (p. 192). They are involved in stabilizing the axis and atlas and in creating intrinsic movements such as rocking and tilting of the head. To outline the suboccipitals' location, find the spinous process of C-2, the transverse processes of C-1 and the

space between the superior nuchal line of the occiput and C-2 (4.85-4.88). The upper fibers of the trapezius can also be used as a marker. The lateral edge of the muscle is the same width as the suboccipitals. The density of the suboccipital bellies can be felt, but accessing specific muscle bellies may be challenging.

<p><i>Rectus Capitis Posterior Major</i> <i>Rectus Capitis Posterior Minor</i> <i>Oblique Capitis Superior</i></p> <p><b>Rock</b> and <b>tilt</b> the head back into extension</p>	<p><b>A</b> <i>Rectus Capitis Posterior Major</i> <i>Oblique Capitis Inferior</i></p> <p><b>Rotate</b> the head to the same side</p>	<p><b>A</b> <i>Oblique Capitis Superior</i></p> <p><b>Laterally flex</b> the head to the same side</p>
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## Rectus Capitis Posterior Major

- O** Spinous process of the axis (C-2)
- I** Inferior nuchal line of the occiput
- N** Suboccipital



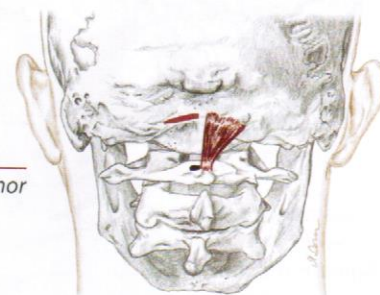
Posterior views with origins (black) and insertions (red)

4.85 Rectus capitis posterior major

## Rectus Capitis Posterior Minor

- O** Tubercle of the posterior arch of the atlas (C-1)
- I** Inferior nuchal line of the occiput
- N** Suboccipital

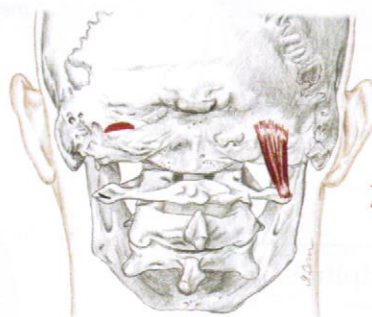
4.86 Rectus capitis posterior minor



## Oblique Capitis Superior

- O** Transverse process of the atlas (C-1)
- I** Between the nuchal lines of the occiput
- N** Suboccipital

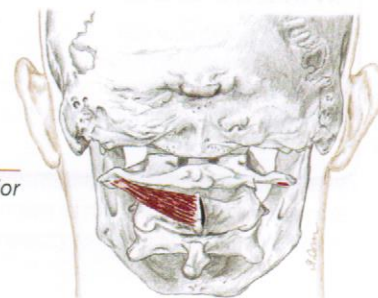
4.87 Oblique capitis superior



## Oblique Capitis Inferior

- O** Spinous process of the axis (C-2)
- I** Transverse process of the atlas (C-1)
- N** Suboccipital

4.88 Oblique capitis inferior



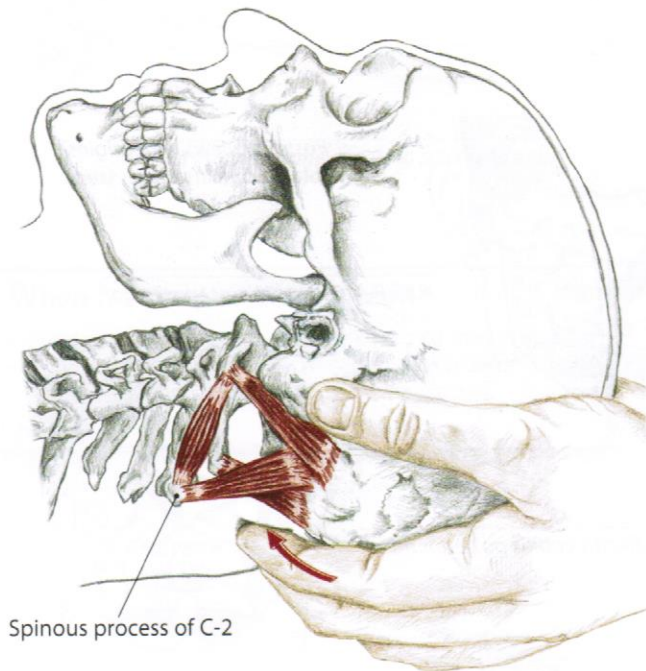
occiput      **ok**-si-put      L. the back of the skull

## Suboccipitals

Located deep to the suboccipital bellies are portions of the vertebral artery and suboccipital nerve. So when exploring the muscles, use caution.



- 1) Partner supine. Cradle the head in both hands. Passively extending the neck a bit will soften the overlying tissue. Locate the superior nuchal line of the occiput and the spinous process of C-2. The suboccipitals span the area between these two landmarks.
- 2) Cradle the head with one hand while two fingertips of the other hand palpate slowly through the trapezius, splenius capitis and semispinalis capitis fibers (4.89).
- 3) Roll your fingers across the suboccipitals' small, short bellies. Again, you may initially feel only the density of these muscles rather than the individual bellies.



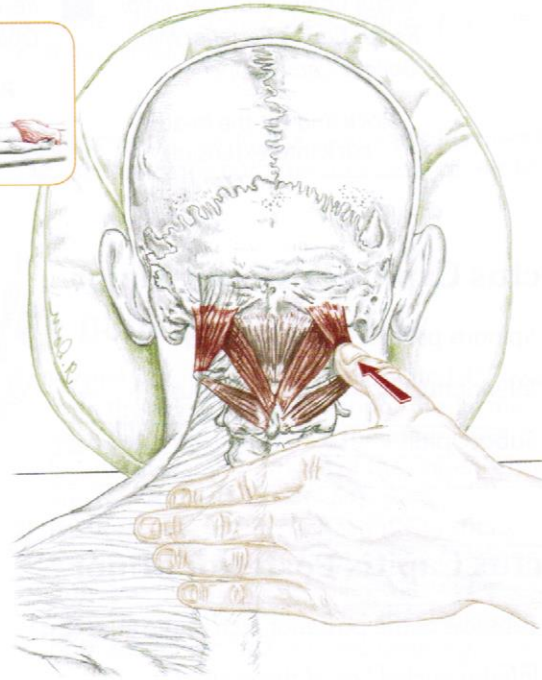
4.89 Partner supine, curling the fingers under the occiput

### When Do You Use Your Suboccipitals?

- Shampooing your hair
- Appreciating a large painting from a close proximity (small, fine movements of the head and neck)
- Nodding your head incessantly to a person you wish would just stop talking

✓ Are you between the spinous process of C-2 and the superior nuchal line of the occiput? If you ask your partner to tilt his head back ever so slightly, do you feel some contraction in the deepest layer of tissue?

◆ Partner prone. Locate the lateral edge of the trapezius' upper fibers (4.90). Palpating beside the level of C-1, place one finger at the lateral edge of the trapezius. Slowly sink medially into the suboccipitals.



4.90 Partner prone, sinking your thumb medially, just lateral to the edge of the trapezius

Researchers have discovered that the rectus capitis posterior minor not only attaches to the occiput, but also to the dura mater, the connective tissue that surrounds the spinal cord and brain. Because of this connection between the rectus capitis posterior minor and the dura mater, this muscle may cause headaches by disrupting normal cerebrospinal fluid fluctuations and hence the functioning of the vertebral artery and suboccipital nerve.

## Quadratus Lumborum

Although it would seem to be the deepest muscle of the low back, the quadratus lumborum is, strangely enough, the deepest muscle of the abdomen (4.92). Stretching from the posterior ilium to the transverse processes of the lumbar vertebrae and twelfth rib, this squat muscle is simply an abdominal muscle located on the posterior surface of the thorax.

While the medial portion of the quadratus lumborum is buried beneath the thoracolumbar aponeurosis and the thick erector spinae (4.91), its lateral edge is accessible from the side of the torso.

### **A** Unilaterally:

**Laterally tilt** (elevate) the pelvis

**Laterally flex** the vertebral column to the same side

Assist to **extend** the vertebral column

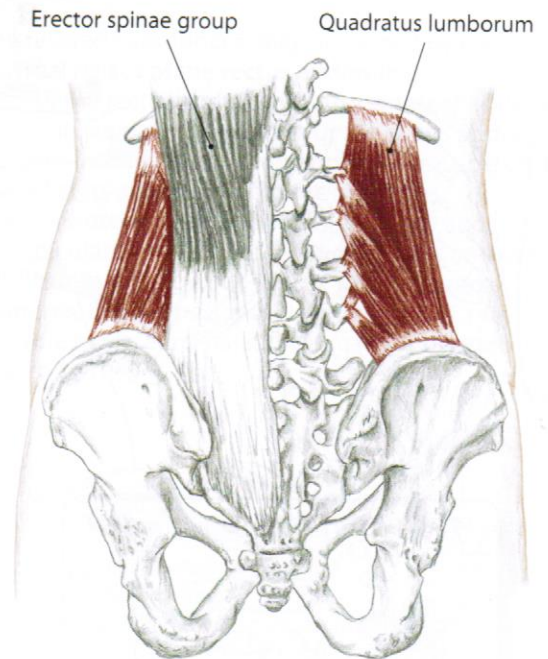
### Bilaterally:

**Fix** the last rib during forced inhalation and exhalation

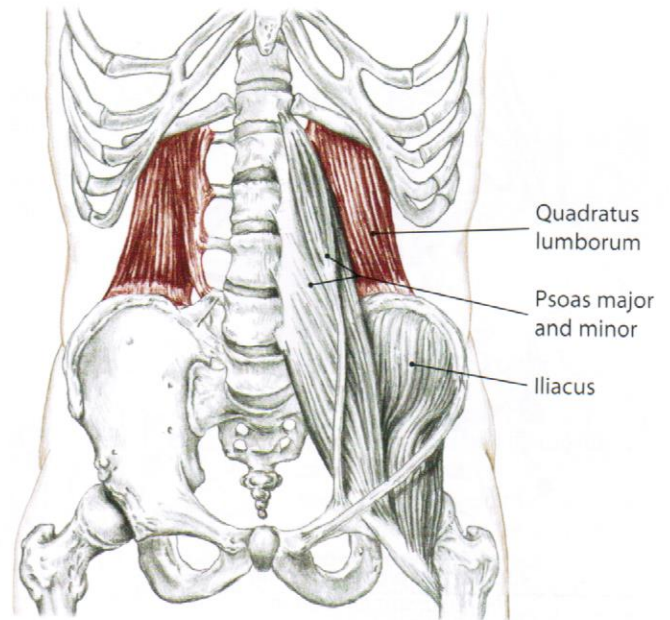
**O** Posterior iliac crest

**I** Last rib and transverse processes of first through fourth lumbar vertebrae

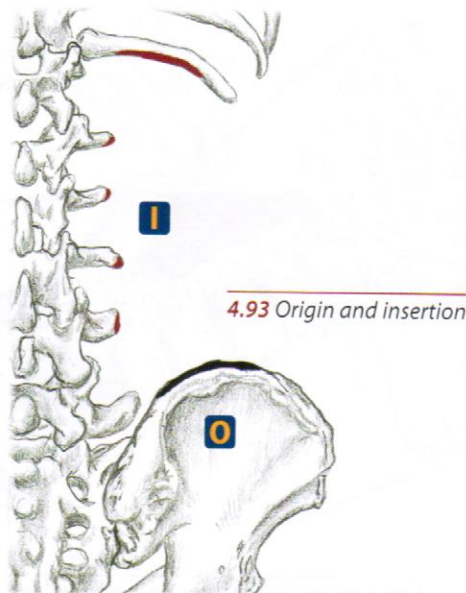
**N** Lumbar plexus T12, L1, 2, 3



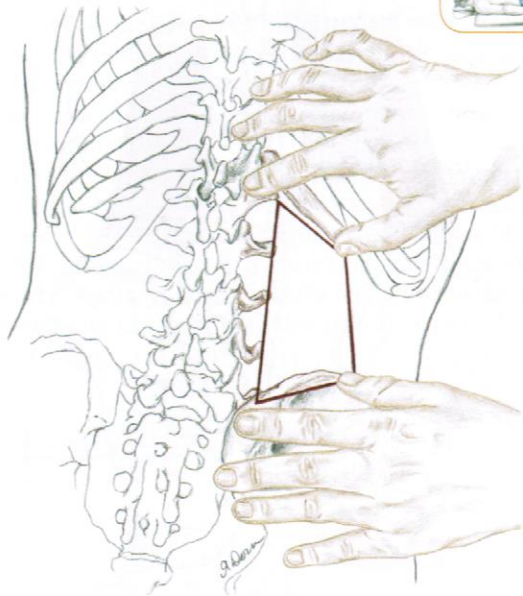
4.91 Posterior view, erector spinae group removed on right side



4.92 Anterior view



The quadratus lumborum is sometimes known as the "hip hiker" because of its capacity to laterally tilt (elevate) the hip.



4.94 Partner prone, laying your fingers along the corners of the quadratus lumborum

## 👇 Quadratus lumborum

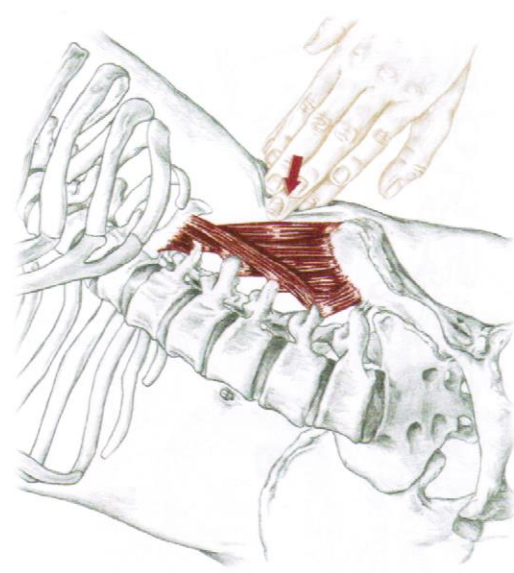
- 1) Prone. Isolate the borders of the quadratus by locating the twelfth rib, posterior iliac crest and transverse processes of the lumbar vertebrae.
- 2) Lay your fingers along these landmarks to outline the edges of the quadratus (4.94).
- 3) Lay your thumbpad along the lateral edge of this square. Using slow, firm pressure, sink your thumb medially toward the lumbar vertebrae and into the edge of the quadratus (4.95).
- 4) Ask your partner to laterally tilt (elevate) his hip toward his shoulder in order to feel its solid contraction. The hip should remain on the table.

✓ As you palpate, be sure you are accessing the deeper tissue in the low back and not just the superficial external oblique fibers. When your partner hikes his hip, can you feel the lateral edge of the quadratus contract? Can you distinguish between the edge of the erector spinae and the quadratus?

👇 Follow the above instructions, only this time with your partner side lying (4.96). Placing a bolster between his knees will balance the pelvis and soften the tissue around the quadratus. This position will also allow the abdominal contents to shift away from where you are accessing.



4.95 Partner prone, accessing the quadratus lumborum



4.96 Anterior/lateral view, partner side lying

### When Do You Use Your QL?

- Hiking up your hip when stepping over a big log
- Raising yourself up from a side lying position (lateral flexion)
- Salsa, tango and ballroom dancing

# Abdominals

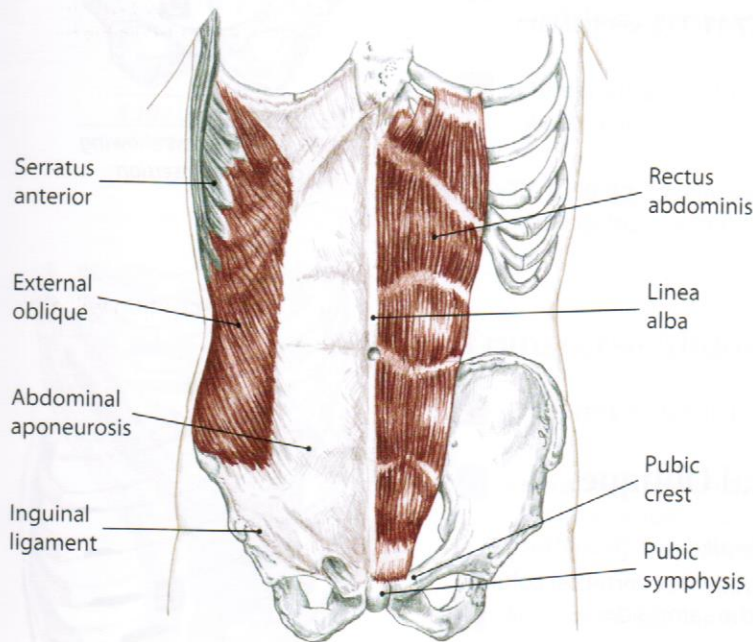


- Rectus Abdominis
- External Oblique
- Internal Oblique
- Transverse Abdominis

The four abdominal muscles expand far beyond the "stomach" region. In fact, they form a muscular girdle that reaches around the sides of the thorax to the thoracolumbar aponeurosis, superiorly to the middle ribs and inferiorly to the inguinal ligament. The immense span of these muscles, with its unique overlapping arrangement and varying fiber direction, helps to stabilize the entire abdominal region.

The revered "washboard belly" is formed by the multiple, superficial bellies of the **rectus abdominis** (4.97, 4.98). Lateral to the rectus abdominis is the **external oblique** (4.100). Unlike the round bellies of the rectus abdominis, the external oblique is a broad, superficial muscle best palpated at its attachments to the lower ribs.

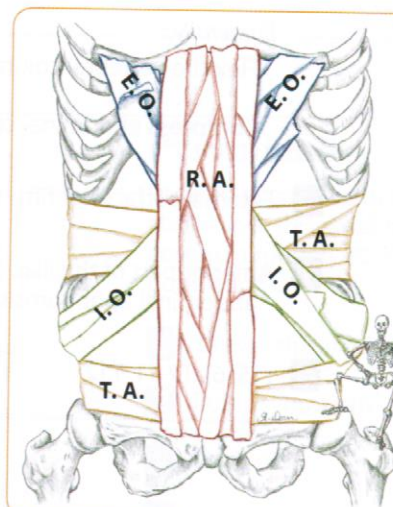
The thin **internal oblique** fibers are deep and perpendicular to the external oblique fibers and can be difficult to distinguish (4.102). The **transverse abdominis**, the deepest muscle of the group, plays a major role in forced exhalation. It cannot be specifically palpated (4.104).



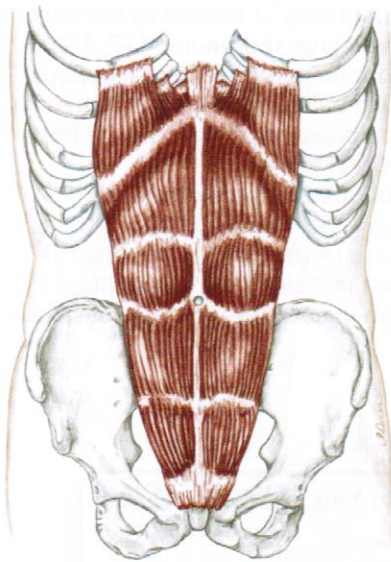
4.97 Anterior view

### When Do You Use Your Abs?

- A sit-up (flexion)
- Belly dancing
- A Navy Seal sit-up (flexion with rotation)
- Sitting up in bed and reaching over for the alarm clock (flexion, rotation)
- Coughing, vomiting, defecating (hopefully not at the same time)



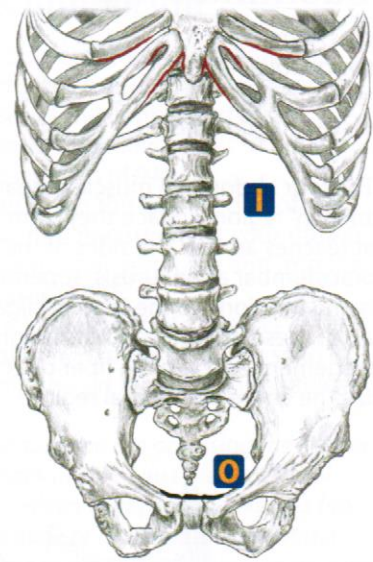
The organs of the upper thorax are protected by the rib cage while the viscera of the lower thorax rely on the four abdominal muscles for support and protection. The four abdominal muscles wrap the entire abdomen in vertical, horizontal and diagonal directions, in the same way packing tape is wrapped around a box going for a long journey.



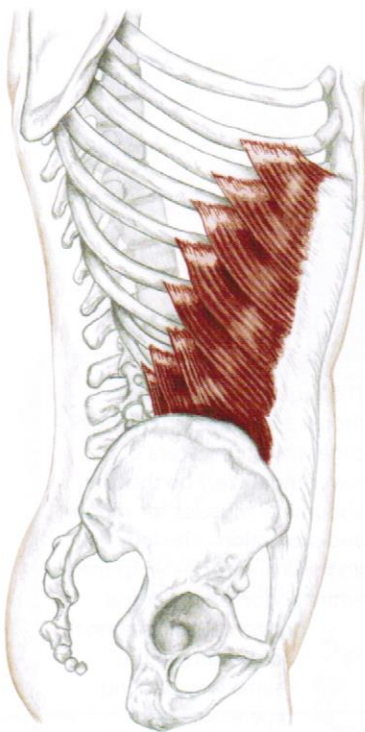
4.98 Anterior view of rectus abdominis

## Rectus Abdominis

- A** Flex the vertebral column  
Tilt pelvis posteriorly
- O** Pubic crest, pubic symphysis
- I** Cartilage of fifth, sixth and seventh ribs and xiphoid process
- N** T5, 6, T7-11, T12, ventral rami



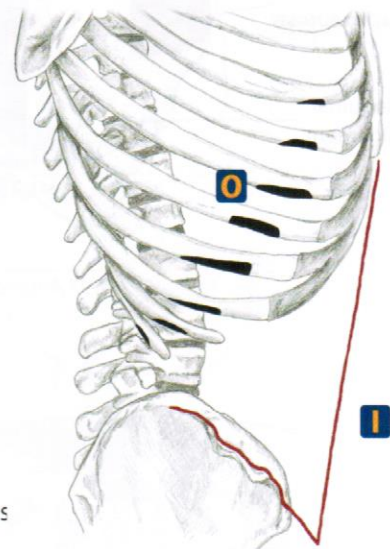
4.99 Anterior view showing origin and insertion



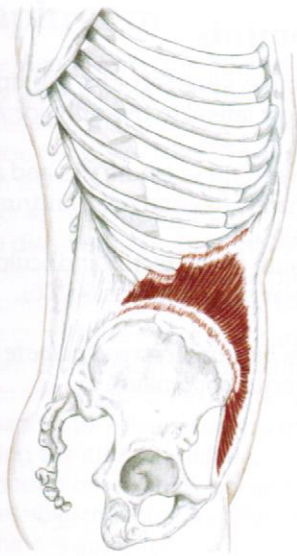
4.100 Lateral view of external oblique

## External Oblique

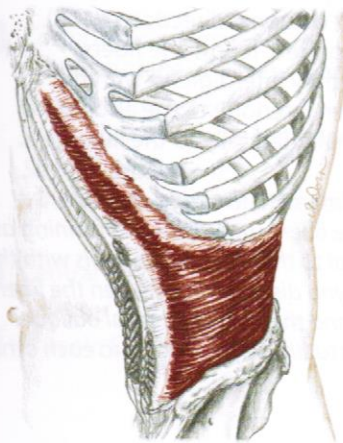
- A** Unilaterally:  
Laterally flex vertebral column to the same side  
Rotate vertebral column to the opposite side
- Bilaterally:  
Flex the vertebral column  
Compress abdominal contents
- O** External surfaces of fifth to twelfth ribs
- I** Anterior part of the iliac crest, abdominal aponeurosis to linea alba
- N** (T5, 6), T7-11, T12



4.101 Lateral view showing origin and insertion



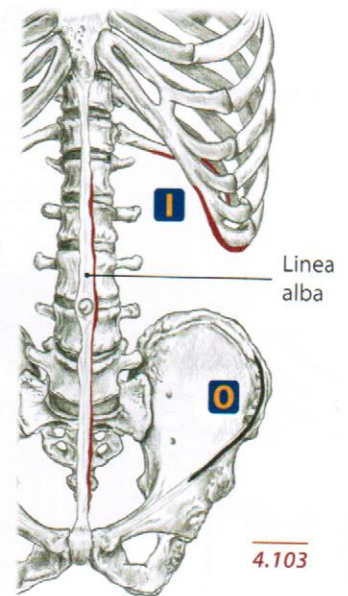
4.102 Lateral view of internal oblique



4.104 Anterior view of transverse abdominis (both obliques cut and reflected)

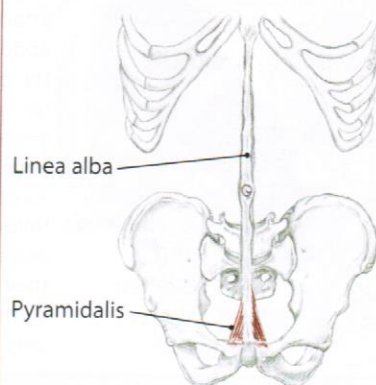
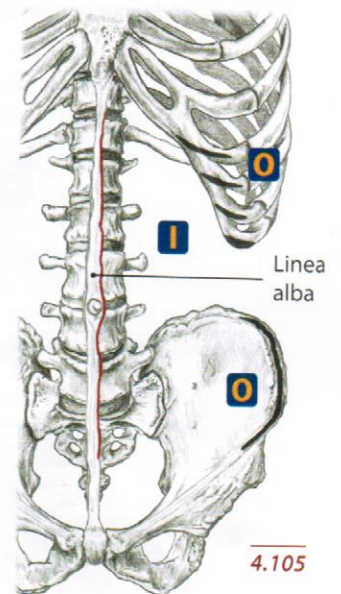
## Internal Oblique

- A** Unilaterally:  
**Laterally flex** vertebral column to the same side  
**Rotate** vertebral column to the same side
- Bilaterally:  
**Flex** the vertebral column  
**Compress** abdominal contents
- O** Lateral inguinal ligament, iliac crest and thoracolumbar fascia
- I** Internal surface of lower three ribs, abdominal aponeurosis to linea alba
- N** T7, 8, T9-12, L1, iliohypogastric and ilioinguinal, ventral rami



## Transverse Abdominis

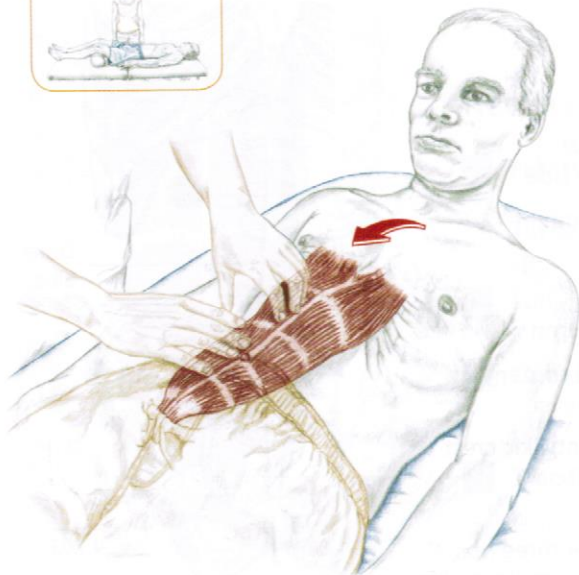
- A** **Compress** abdominal contents
- O** Lateral inguinal ligament, iliac crest, thoracolumbar fascia and internal surface of lower six ribs
- I** Abdominal aponeurosis to linea alba
- N** T7-12, L1, iliohypogastric and ilioinguinal, ventral divisions



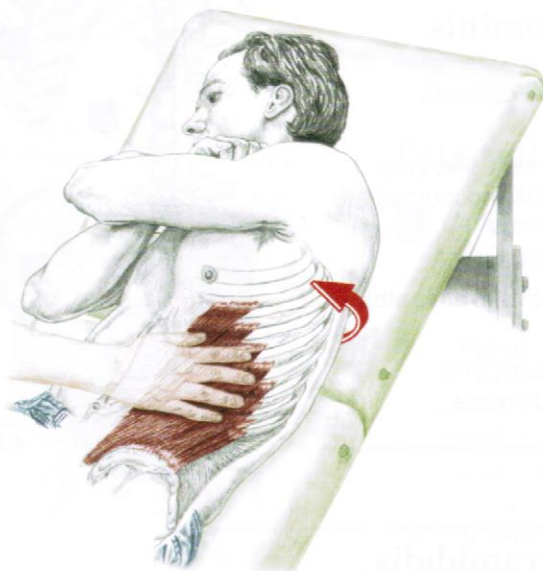
## Pyramidalis

Located superficial to the rectus abdominis, this small muscle is absent in roughly 20% of the population.

- A** **Tenses** the linea alba
- O** Pubic symphysis
- I** Linea alba
- N** Twelfth thoracic nerve




**4.106** Palpating rectus abdominis while your partner flexes his trunk



**4.107** Accessing the external oblique while your partner rotates his trunk toward the opposite side


## Rectus abdominis

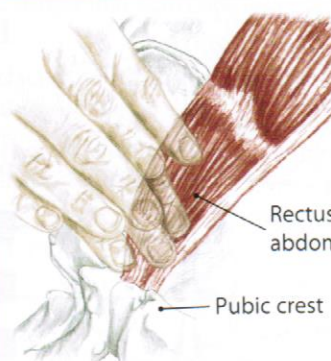
- 1) Partner supine with knees flexed. Locate the xiphoid process and the ribs just lateral to the xiphoid. Also locate the pubic crest (p. 293).
- 2) Place your hand between these landmarks and ask your partner to alternately flex and relax his trunk slightly. "Do a small sit-up."
- 3) Explore the entire length of the rectus and sculpt between its rectangular muscle bellies (4.106).

 As your partner flexes his trunk, can you palpate the lateral edges of the rectus abdominis?

## External oblique (left side)

- 1) Partner supine with his knees flexed. Lay your hand on the left side of the abdomen and lower ribs. Ask your partner to raise his left shoulder toward his right hip (rotating his trunk).
- 2) Palpate across the superficial fibers of the external oblique, noting their diagonal direction (4.107).
- 3) With the trunk still rotated, follow the fibers superiorly to where they interdigitate with the serratus anterior, then inferiorly to the abdominal aponeurosis and, finally, laterally to the iliac crest.

 Are you palpating lateral to the edge of rectus abdominis? Are the fibers superficial and running at an angle? Palpate lateral to the rectus abdominis with the abdomen relaxed. Can you distinguish between the fibers of the external oblique and the deeper internal oblique? Their fibers should be virtually perpendicular to each other.



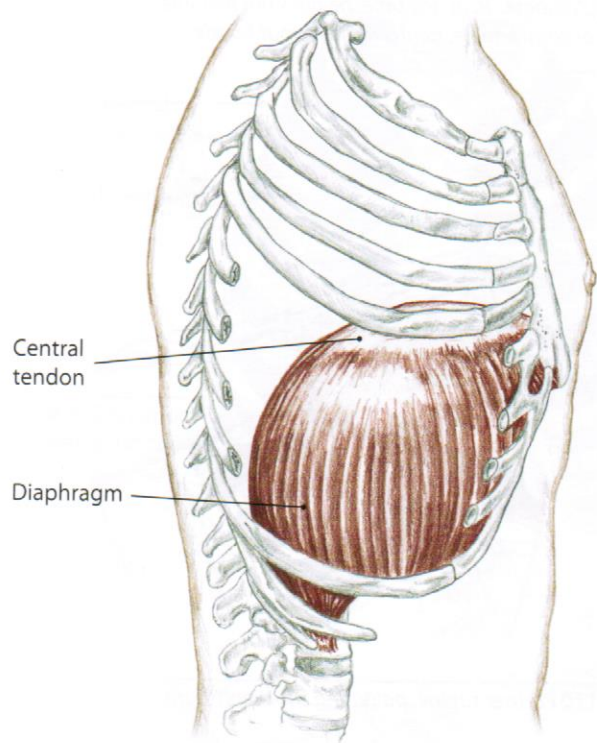
Palpating the inferior attachment of the rectus abdominis requires locating the pubic crest. (See p. 293 for instructions.) Explore the inferior rectus by first locating your partner's umbilicus. As he does a small sit-up, follow the narrowing muscle bellies to the pubic crest. At their insertion site, they are surprisingly slender, perhaps only three inches wide.

## Diaphragm

The diaphragm is the primary muscle of respiration and is unique in both its design and function. Its broad, umbrellalike shape separates the upper and lower thoracic cavities (4.108). The diaphragm's muscle fibers attach to the inner surface of the ribs and the lumbar vertebrae and converge at the central tendon (4.109).

The diaphragm creates inspiration (inhalation) when its muscle fibers contract and pull the central tendon inferiorly. Because the central tendon is attached to the connective tissue that surrounds the lungs, a vacuum is created in the upper thoracic cavity, pulling air into the lungs. On exhalation, the muscle fibers of the diaphragm relax, releasing the central tendon and allowing the lungs to deflate.

Although only a small portion of the diaphragm is accessible, the muscle's effect on the thorax and breathing is easily felt.



4.108 Lateral view of thorax showing diaphragm in position of exhalation

**A** Draw down the central tendon of the diaphragm

Increase the volume of the thoracic cavity during inhalation

**O** Costal attachment:  
Inner surface of lower six ribs

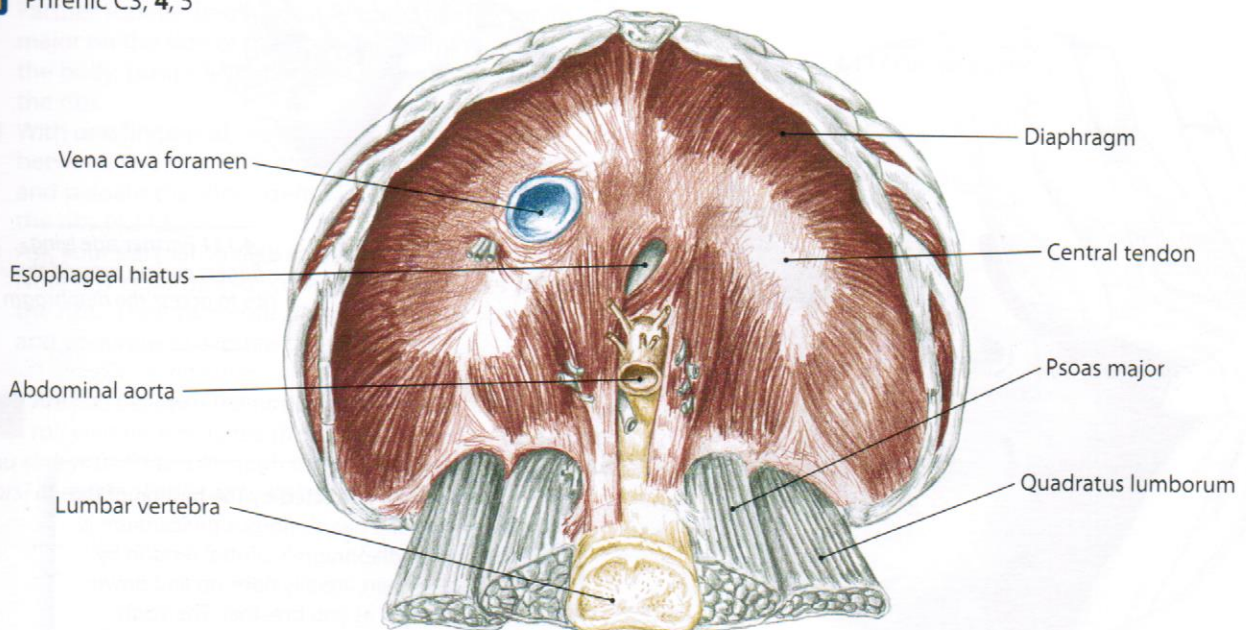
Lumbar attachment:  
Upper two or three lumbar vertebrae

Sternal attachment:  
Inner part of xiphoid process

**I** Central tendon

**N** Phrenic C3, 4, 5

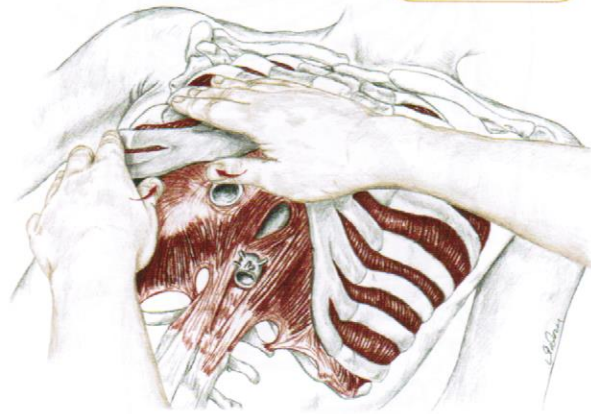
An involuntary contraction of the diaphragm will cause air to rush into the lungs and the vocal cords to snap shut. The audible result is a hiccup.



4.109 Inferior view of the diaphragm

diaphragm    **di-a-gram**    Grk. a partition, wall

Move slowly, communicating with your partner as you palpate. If, at any time, he does not feel safe or comfortable, gently remove your hands.



4.110 Partner supine, palpating the diaphragm

## Diaphragm

- 1) Partner supine, with knees bolstered. Locate the inferior edge of the rib cage, lateral to the xiphoid process.
- 2) Lay your thumbpads just inferior to the ribs on the abdomen and ask your partner to take slow, deep breaths.
- 3) Moving only as your partner exhales, slowly press and curl your thumbpads underneath the edge of the ribs (4.110). During inhalation, you may not feel the tissue of the diaphragm, but you will most likely feel its contraction as it pushes other tissues into your thumbpads.

✓ Are your thumbs curling under the ribs rather than sinking into the abdominal organs? Ask your partner to breathe into his belly and notice how the abdominal region expands as the diaphragm contracts.

✦ Try the above procedure with your partner side lying and his trunk flexed slightly. This position will allow the abdominal contents to shift away from where you are accessing (4.111).

### When Do You Use Your Diaphragm and Intercostals?

- While singing at the Metropolitan Opera
- Blowing up a balloon
- Deep breathing during meditation
- During a triathlon—swimming, biking, running



4.111 Partner side lying, fingers curling around the ribs to access the diaphragm



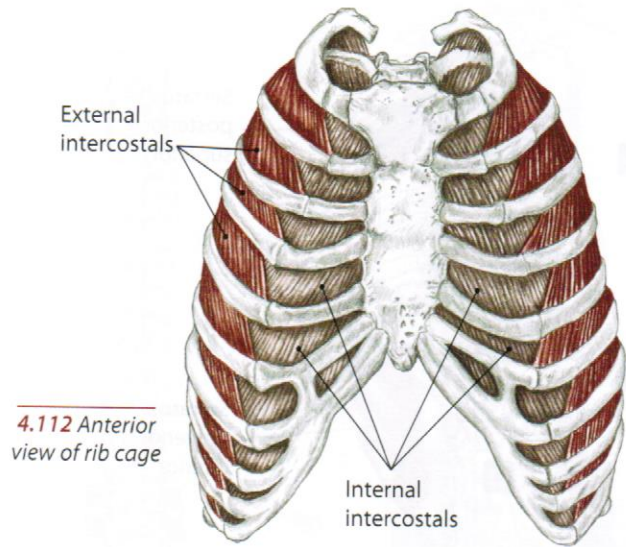
The heart is directly affected by the motion of the diaphragm. As the heart's fibrous pericardium is attached to the diaphragm's central tendon by ligaments, the heart literally rides up and down on the diaphragm as you breathe. The yogis were right—breathing can massage the heart!

## Intercostals

Better known to carnivores as the meat on spare ribs, the intercostals are the small, slender muscles between the ribs. They are divided into two groups: the external and the internal intercostals (4.112). The fibers of these two groups run perpendicular to each other and can be visualized as extensions of the external and internal oblique muscles (p. 210, 211).

The intercostals help to stabilize the rib cage and assist in respiration, but their specific role is debatable. Although the entire rib cage lies deep to one or more layers of muscle, portions of the intercostals remain easily accessible. It is not possible, however, to distinguish the external intercostals from the internal intercostals.

Since the ribs and the spaces between them can be sensitive areas to access, use slow, firm hand movements.



4.112 Anterior view of rib cage

### A External Intercostals:

Draw the ribs superiorly (increasing the space of the thoracic cavity) to assist with **inhalation**

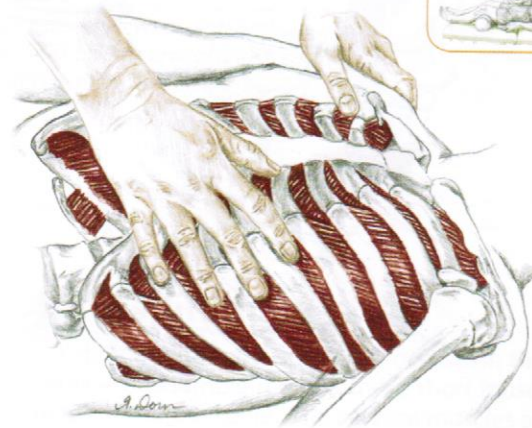
### I Internal Intercostals:

Draw the ribs inferiorly (decreasing the space of the thoracic cavity) to assist with **exhalation**

O Inferior border of the rib above

I Superior border of the rib below

N Thoracic

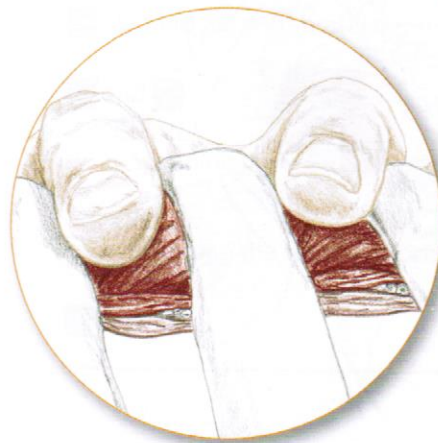


4.113 Partner supine

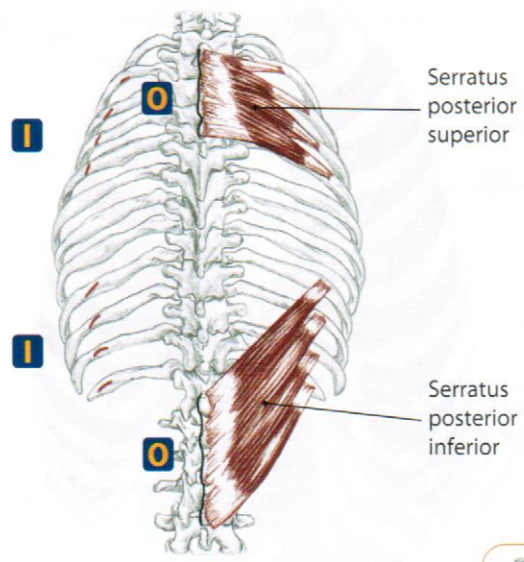


- 1) Partner supine. Begin just inferior to the pectoralis major on the side of the rib cage. Working across the body, position your fingers in the spaces between the ribs.
- 2) With one fingerpad, isolate and palpate the tissue between two ribs. Roll your finger along the rib space and palpate the short, dense intercostals that bridge the ribs (4.113).
- 3) Ask your partner to take several slow, deep breaths. Note any expansion or collapse in the spaces between the ribs. Then turn your partner prone or side lying and continue to explore the intercostals.

✓ Are you between the ribs or just on the surface? Can you roll your fingers across the small intercostal fibers? Can you sink your fingers through the pectoralis major, latissimus dorsi or external oblique to isolate the intercostals?



Cross section of palpating intercostals



4.114 Posterior view with origins and insertions shown on left side



4.115 Partner prone, palpating serratus posterior superior



4.116 Partner prone, palpating serratus posterior inferior

## Serratus Posterior Superior Serratus Posterior Inferior

Although they are sandwiched between the shoulder muscles and the erector spinae group, these two broad muscles only affect movement of the ribs (4.114). The belly of the **superior** is partially deep to the scapula and has fibers that parallel the superficial rhomboids. The **inferior** is deep to the thoracolumbar aponeurosis (p. 220) and, during exhalation, can stabilize the ribs against the pull of the diaphragm.

Both muscles are superficial enough to be accessed, but due to their thin, tendonous bellies, discerning them is a different story.

### Serratus Posterior Superior

- A** Elevate the ribs during inhalation
- O** Spinous processes of C-7 to T-3
- I** Posterior surface of second through fifth ribs
- N** T1, 2, 3, 4

### Serratus Posterior Inferior

- A** Depress the ribs during exhalation
- O** Spinous processes of T-12 to L-3
- I** Posterior surface of ninth through twelfth ribs
- N** T9, 10, 11, (12)



- 1) **Superior:** Partner prone. With the arm off the side of the table (pulling the scapula laterally), locate the upper portion of the medial border of the scapula.
- 2) Ask your partner to inhale as you sink your fingers deep to the rhomboid fibers (4.115). Although you may not feel the belly directly, explore this region for its fibers.
- 3) **Inferior:** Locate the bottom of the rib cage (11th or 12th rib). Ask your partner to slowly exhale as you begin to roll your fingers across the muscle fibers (4.116).

**✓** For sandwiched muscles such as these, it can be worthwhile to first identify the muscles that are not the serrati. Then, with a patient and delicate touch, explore the "space between."

## Intertransversarii

As their name suggests, these small, short muscles span between the transverse processes. They are the deepest muscles in the cervical and lumbar regions and, for this reason, are nearly impossible to detect, let alone access (4.117).

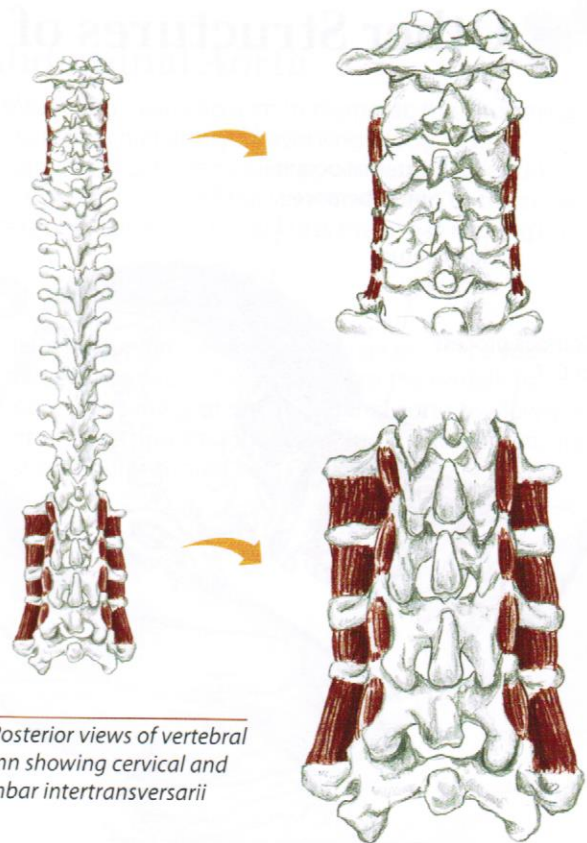
**A** *Unilaterally:*  
**Laterally flex** the vertebral column to the same side

*Bilaterally:*  
**Extend** the vertebral column

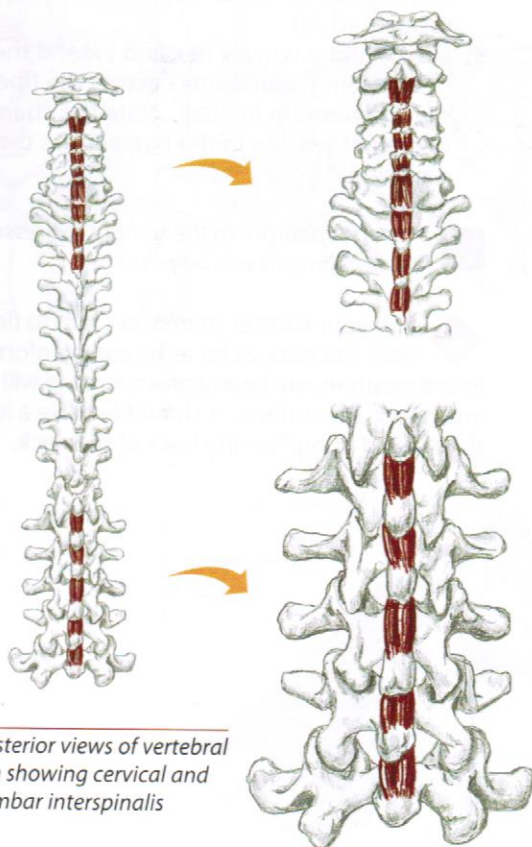
**O** and **I**  
*Cervical:*  
 Spanning the transverse processes of vertebrae C-2 to C-7

*Lumbar:*  
 Spanning the transverse processes of vertebrae L-1 to L-5

**N** Spinal



4.117 Posterior views of vertebral column showing cervical and lumbar intertransversarii



4.118 Posterior views of vertebral column showing cervical and lumbar interspinalis

## Interspinalis

Extending from the spinous processes in the cervical and lumbar regions, these short muscles help extend the spine. The cervical muscles are deep to the ligamentum nuchae while the lumbar muscles are deep to the interspinous ligament (4.118). Like the intertransversarii, these muscles are too deep to isolate.

**A** **Extend** the vertebral column

**O** and **I**  
*Cervical:*  
 Spanning the spinous processes of C-2 to T-3

*Lumbar:*  
 Spanning the spinous processes of T-12 to L-5

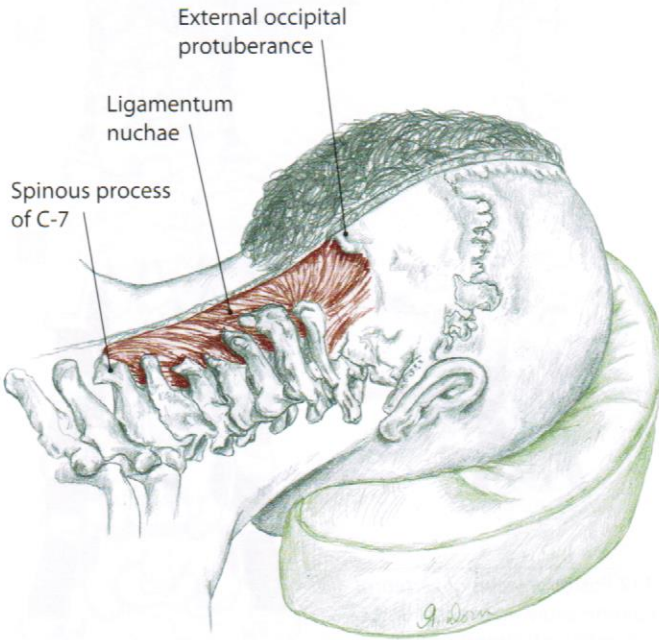
**N** Spinal

intertransversarii  
 interspinalis

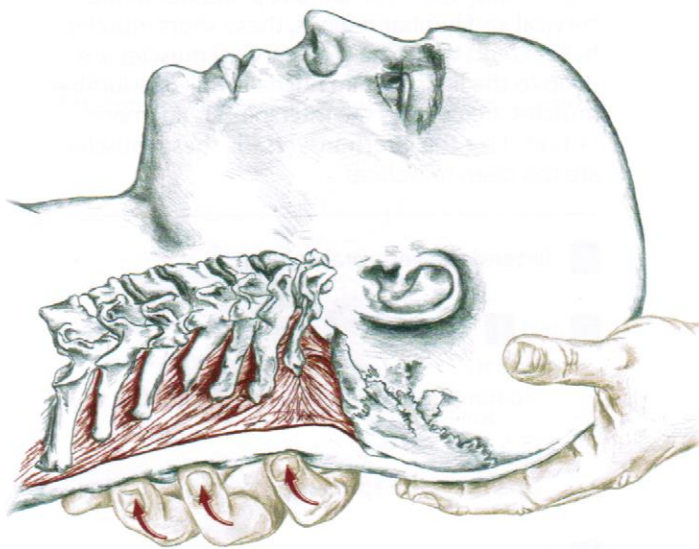
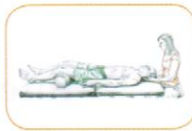
**in-ter-trans-verse-er-i**  
**in-ter-spi-na-lis**



# Other Structures of the Spine and Thorax



4.119 Posterior/lateral view with muscles and tissue removed from right side



4.120 Partner supine, palpating the ligamentum nuchae

## Ligamentum Nuchae

The ligamentum nuchae is the finlike sheet of connective tissue that runs along the sagittal plane from the external occipital protuberance to the spinous process of C-7 in the neck (4.119).

The chief function of the ligamentum nuchae is to help stabilize the head and neck. It is also an attachment site for the superficial muscles of the posterior neck such as the trapezius and splenius capitis. Since the cervical spinous processes do not extend far enough posteriorly for these superficial muscles to attach, they use the ligamentum nuchae instead.

For palpation purposes, the posterior edge of the ligamentum nuchae is superficial, but can be difficult to discern from the surrounding muscle tissue.



- 1) Supine. Locate the external occipital protuberance (p. 232) and the spinous process of C-7.
- 2) Palpate between these landmarks along the midline of the neck. Be sure you are superficial to the spinous processes. It might help to access the ligamentum nuchae if you roll your fingertips across its fiber direction and explore for what may feel like a flap of soft rubber (4.120).
- 3) Slowly and passively flex and extend the head, rolling your fingers across the fibers of the ligamentum nuchae. Note the changing degree of tension in the ligament as the head is moved.

✓ Are you superficial to the spinous processes of the vertebrae as you palpate?

◆ With your partner seated, ask him to flex his head and neck as far as he can comfortably. In this position, the ligamentum nuchae will stretch and rise to the surface. It should feel like a long, thin "speed bump" on the back of the neck.

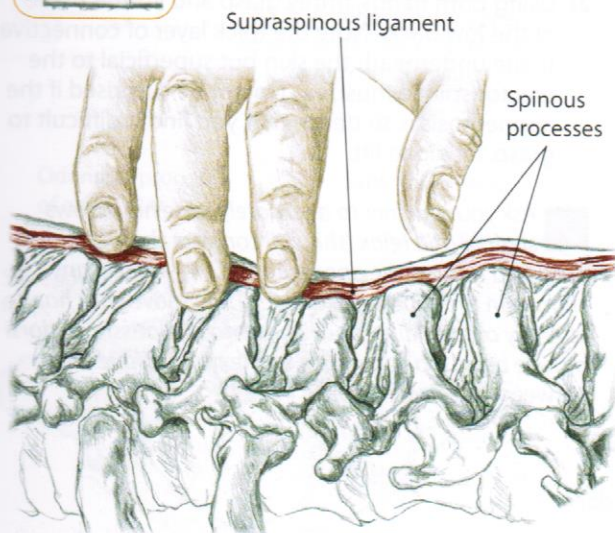
## Supraspinous Ligament

The long, thin supraspinous ligament extends inferiorly from the ligamentum nuchae. As it continues down the spine, it attaches to the spinous processes of the thoracic and lumbar vertebrae. It is superficial and easily accessed in the spaces between the spinous processes.



- 1) Partner prone. Locate several thoracic or lumbar spinous processes (4.121).
- 2) Palpate between the spinous processes. Feel the slender shape and vertical fiber direction of the ligament by rolling your fingertips across its surface.

**✓** With your partner seated, ask her to slowly flex and extend her spine. Can you feel any changes in the tension or prominence of the ligament as she moves it?



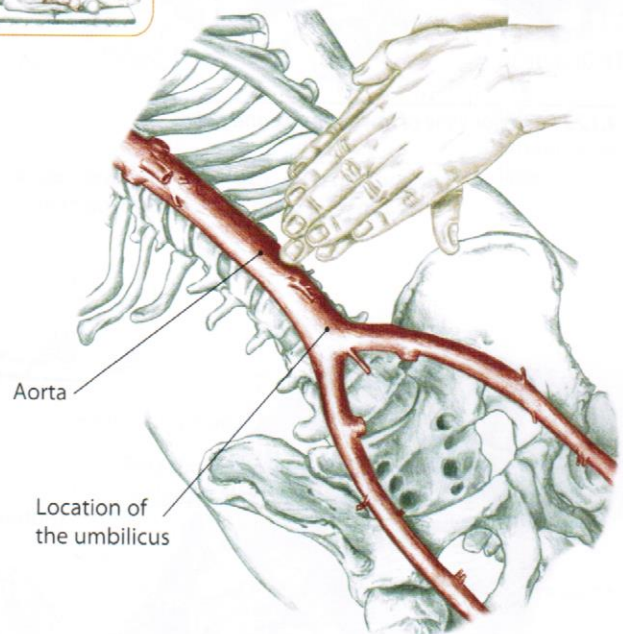
4.121 Partner prone, lateral view of the vertebrae

## Abdominal Aorta

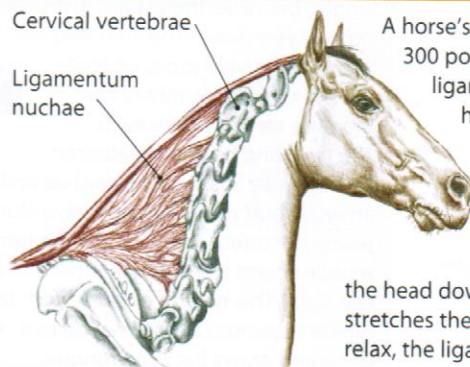
Measuring nearly an inch in diameter, the abdominal aorta is the chief artery for carrying blood to the abdominal organs and lower appendages. It lies on the anterior surface of the vertebrae, deep to the small intestines. Lateral to the aorta is the psoas major (p. 332).



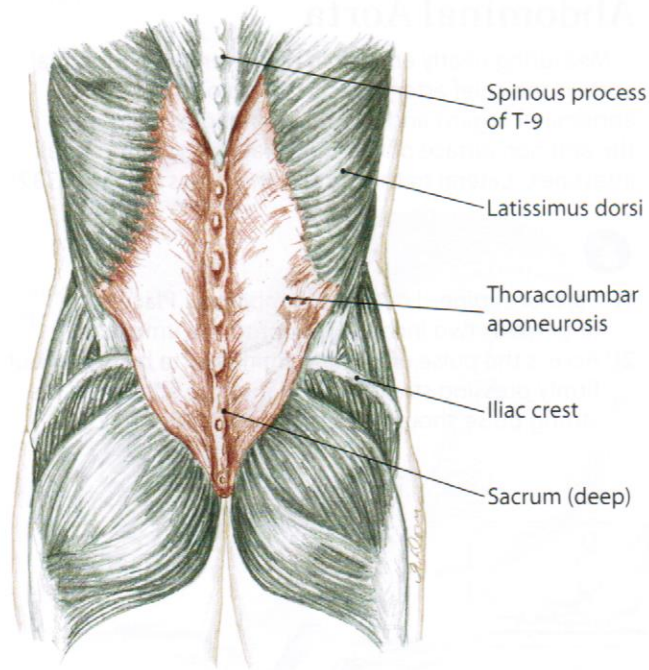
- 1) Partner supine. Locate the umbilicus. Place your fingerpads two inches superior to the umbilicus.
- 2) Access the pulse of the abdominal aorta by slowly but firmly pressing straight down into the abdomen. Its strong pulse should be easily detectable (4.122).



4.122 Partner supine, feeling the pulse of the abdominal aorta



A horse's head and neck can weigh up to 300 pounds and require an enormous ligamentum nuchae. Because the head and neck are normally held in a resting posture without any muscular effort, the ligamentum nuchae is primarily an antigravity device. A small muscle contraction brings the head down to the ground, which in turn stretches the ligament. When the muscles relax, the ligament recoils, raising the head.



4.123 Posterior view of lower thorax and pelvis

## Thoracolumbar Aponeurosis

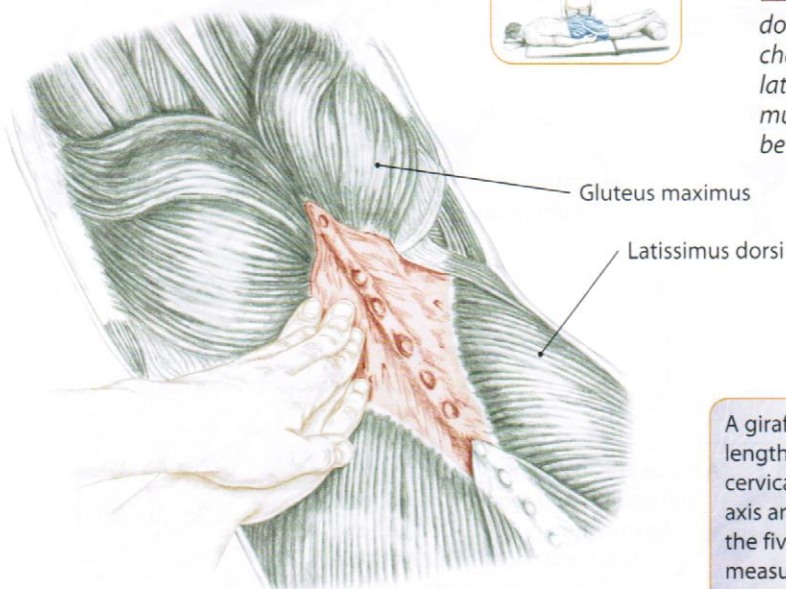
Despite its formidable name, the thoracolumbar aponeurosis is just what it says it is: a broad, flat tendon stretching across the thorax and lumbar regions. More accurately, the thoracolumbar aponeurosis is a thick, diamond-shaped tendon that lies superficially across the posterior thorax, stretches across the sacrum to the posterior iliac crest and runs upward to the lower thoracic vertebrae (4.123).

The aponeurosis is an anchor for several muscles in the thorax and hips, including the latissimus dorsi and the erector spinae group. It has a flat, dense texture that is difficult to distinguish from the deeper muscles.



- 1) Partner prone. Draw out the diamond shape of the aponeurosis by locating the posterior iliac crest, the surface of the sacrum and the lower thoracic vertebrae.
- 2) Using both hands, firmly grasp and lift the tissue of the low back. Note the thick layer of connective tissue underneath the skin but superficial to the erector spinae muscles. Do not be surprised if the aponeurosis is so dense that you find it difficult to grasp, let alone lift.

**✓** Ask your partner to alternately raise her elbows slightly and relax (this will contract the latissimus dorsi and tighten the aponeurosis). Do you feel any change in the superficial tissue? Then move your hands laterally off the “diamond” and onto the latissimus dorsi muscle belly. Do you notice any textural differences between these two tissues? (4.124)

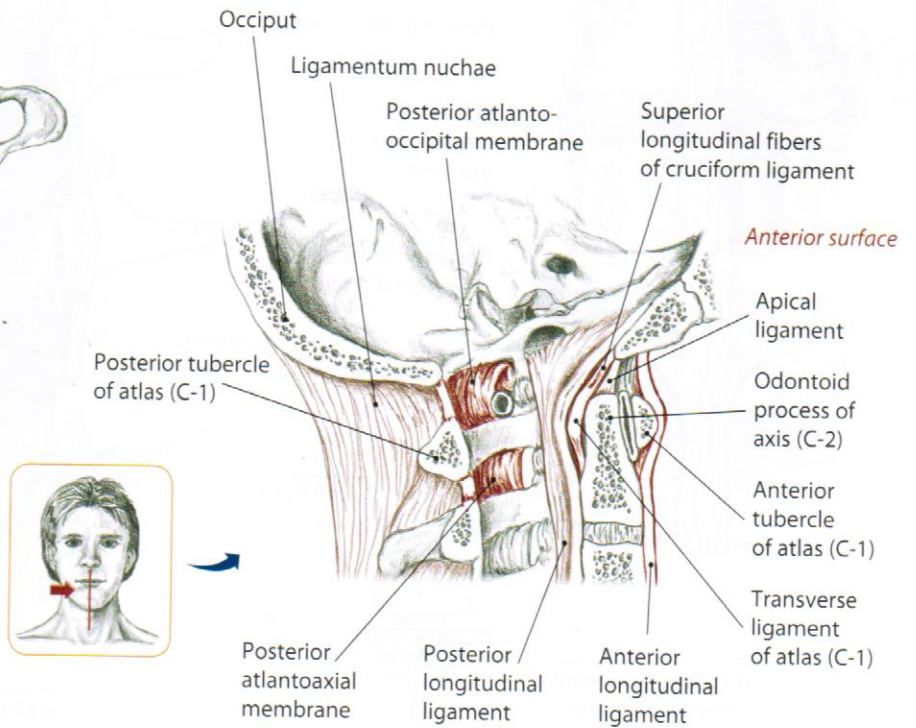
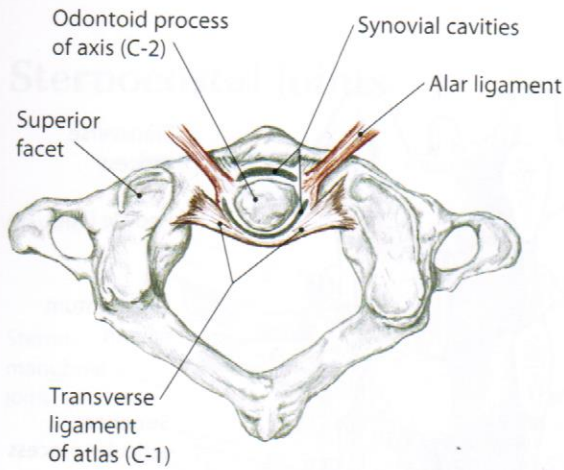
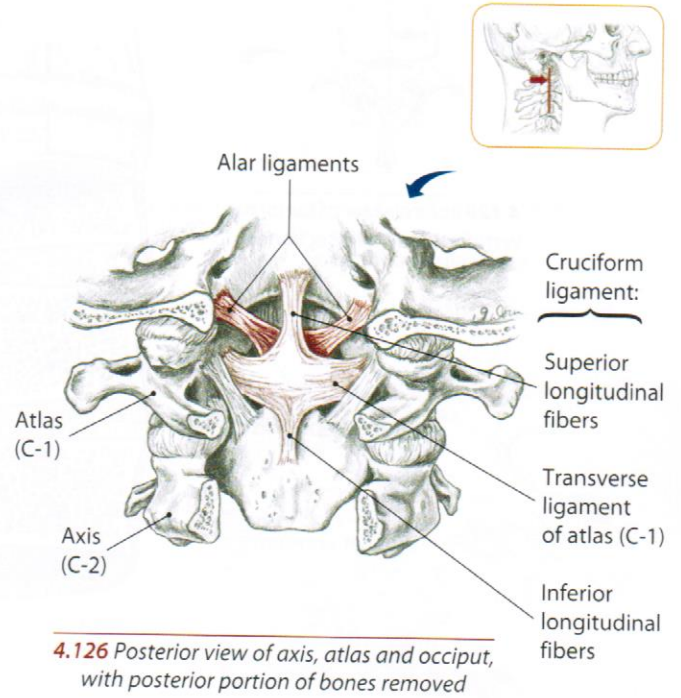
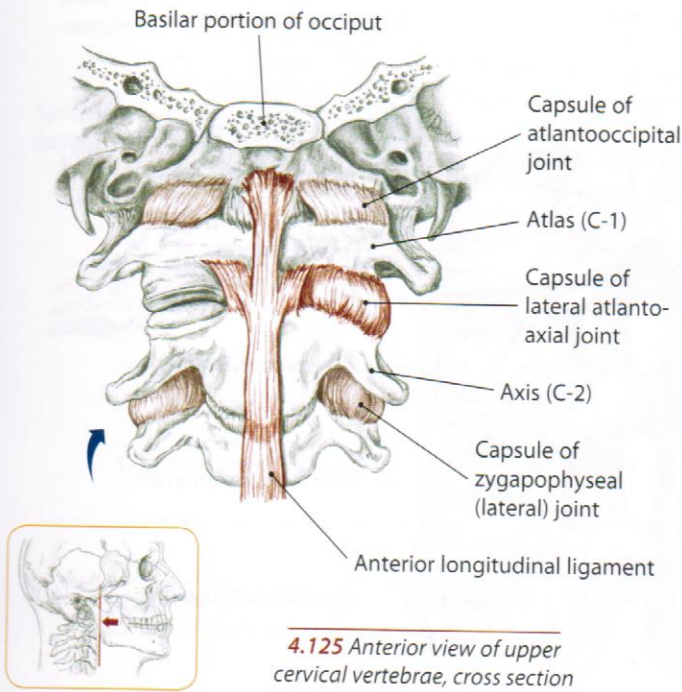


4.124 Partner prone, exploring the aponeurosis

A giraffe’s neck is more than five feet in length, but nevertheless has just seven cervical vertebrae. The atlas and axis are relatively short, whereas the five cervical vertebrae can measure eleven inches each. The neck and head are stabilized by a massive ligamentum nuchae and an array of short muscles that weave along the posterior surface of the neck. The retractor muscle covers the anterior surface of the cervicals. This muscle extends from the giraffe’s sternum all the way up to its hyoid bone and draws back the tongue.



# Craniovertebral Joints—Atlantooccipital and Atlantoaxial Joints



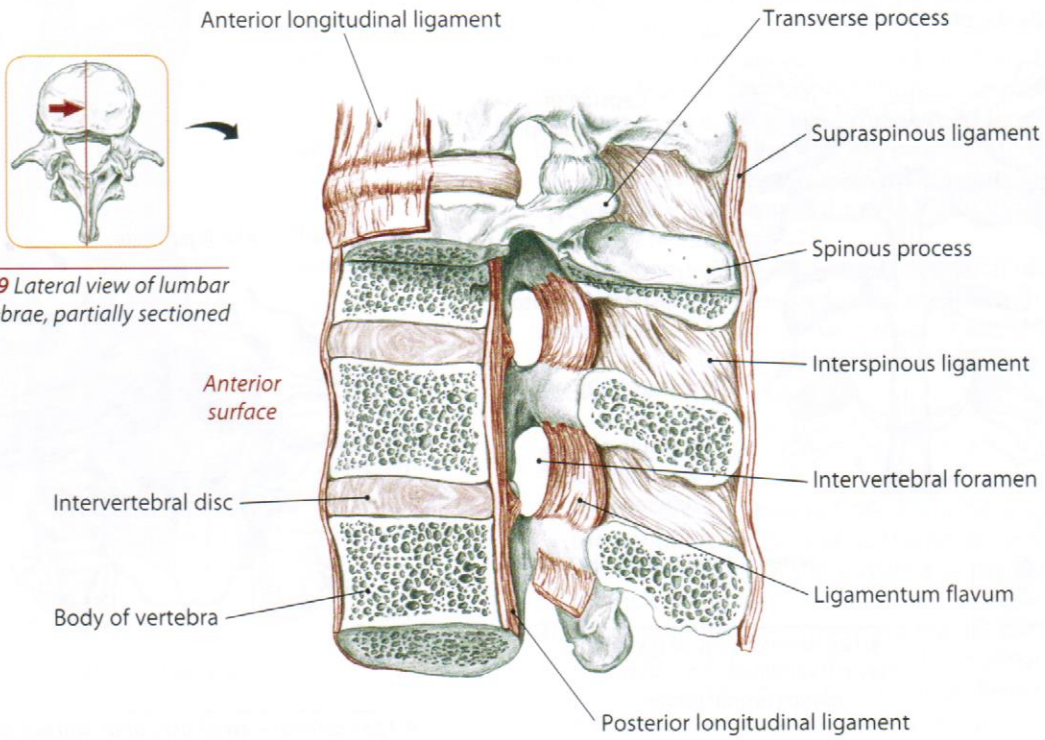
alar  
atlantooccipital

ay-lar  
at-lan-to-ok-si-pi-tal

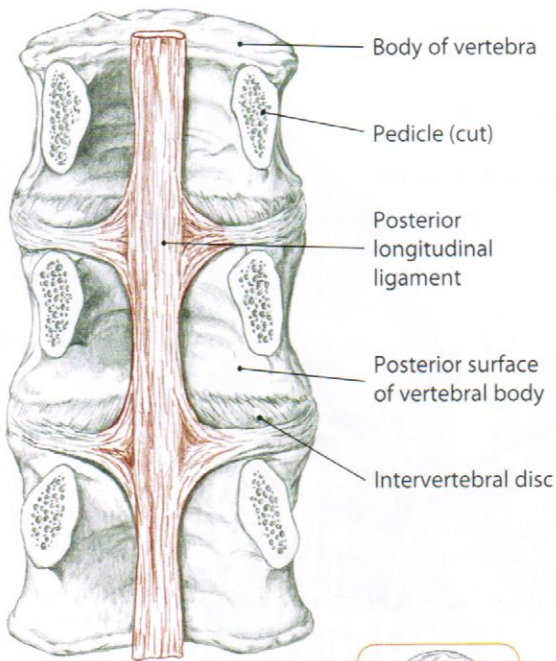
atlantoaxial  
zygapophyseal

at-lan-to-ak-se-al  
zy-gah-pof-i-se-al

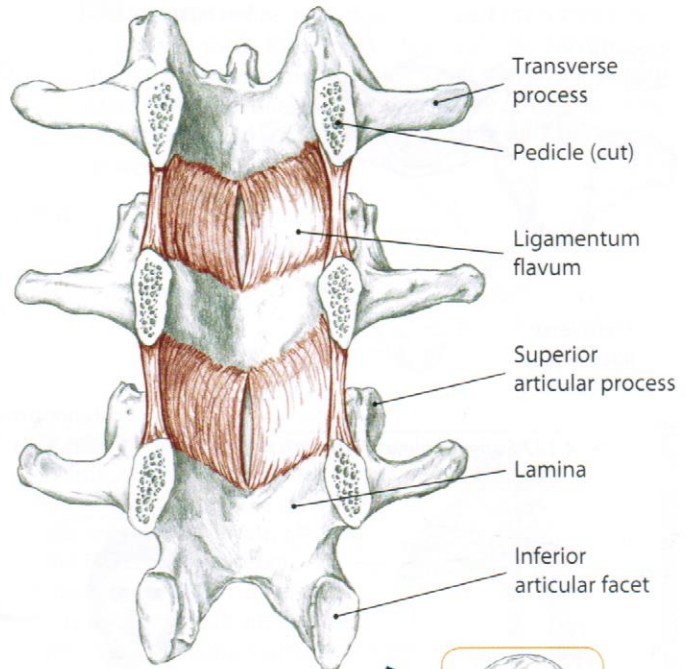
# Intervertebral Joints



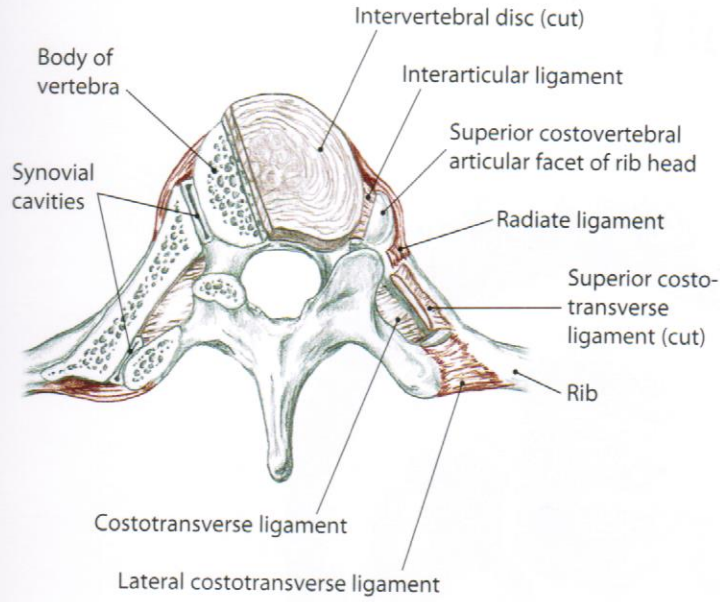
4.129 Lateral view of lumbar vertebrae, partially sectioned



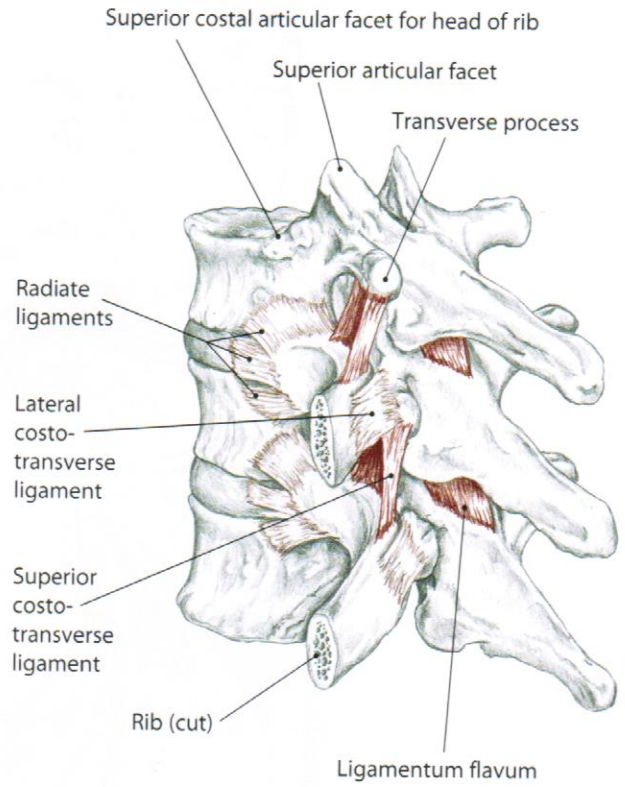
4.130 Posterior view of vertebral bodies



4.131 Anterior view of vertebrae's lamina and pedicle

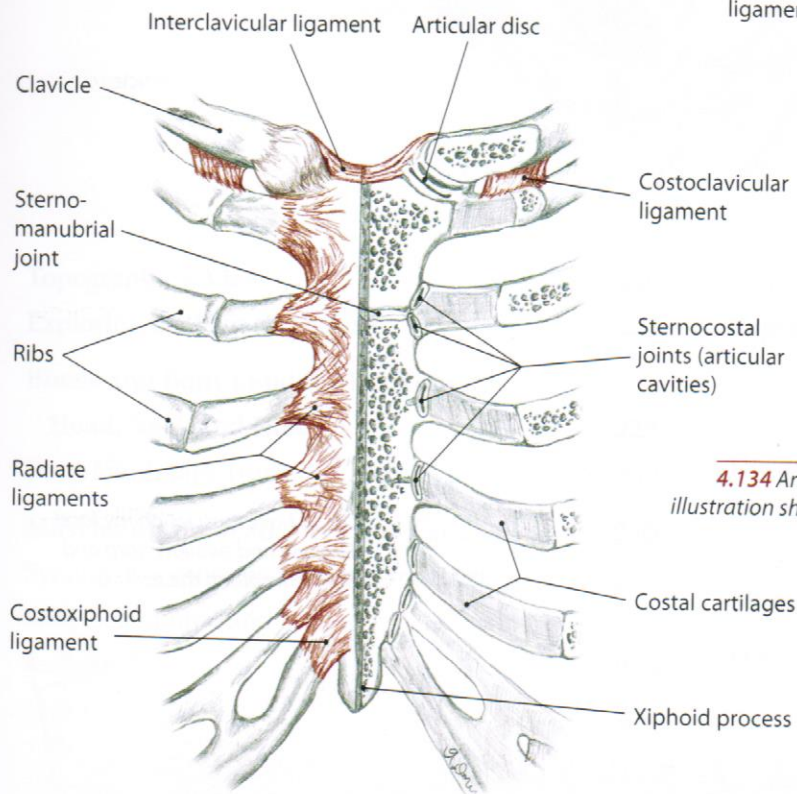


**4.132** Superior view of thoracic vertebra, left side of illustration cut in cross section



**4.133** Lateral/posterior view

## Sternocostal Joints



**4.134** Anterior view, right side of illustration shown in coronal cross section

# NOTES

*Oh, to have muscles on my face!  
To chew and swallow gorp and  
beef jerky along the trail...*

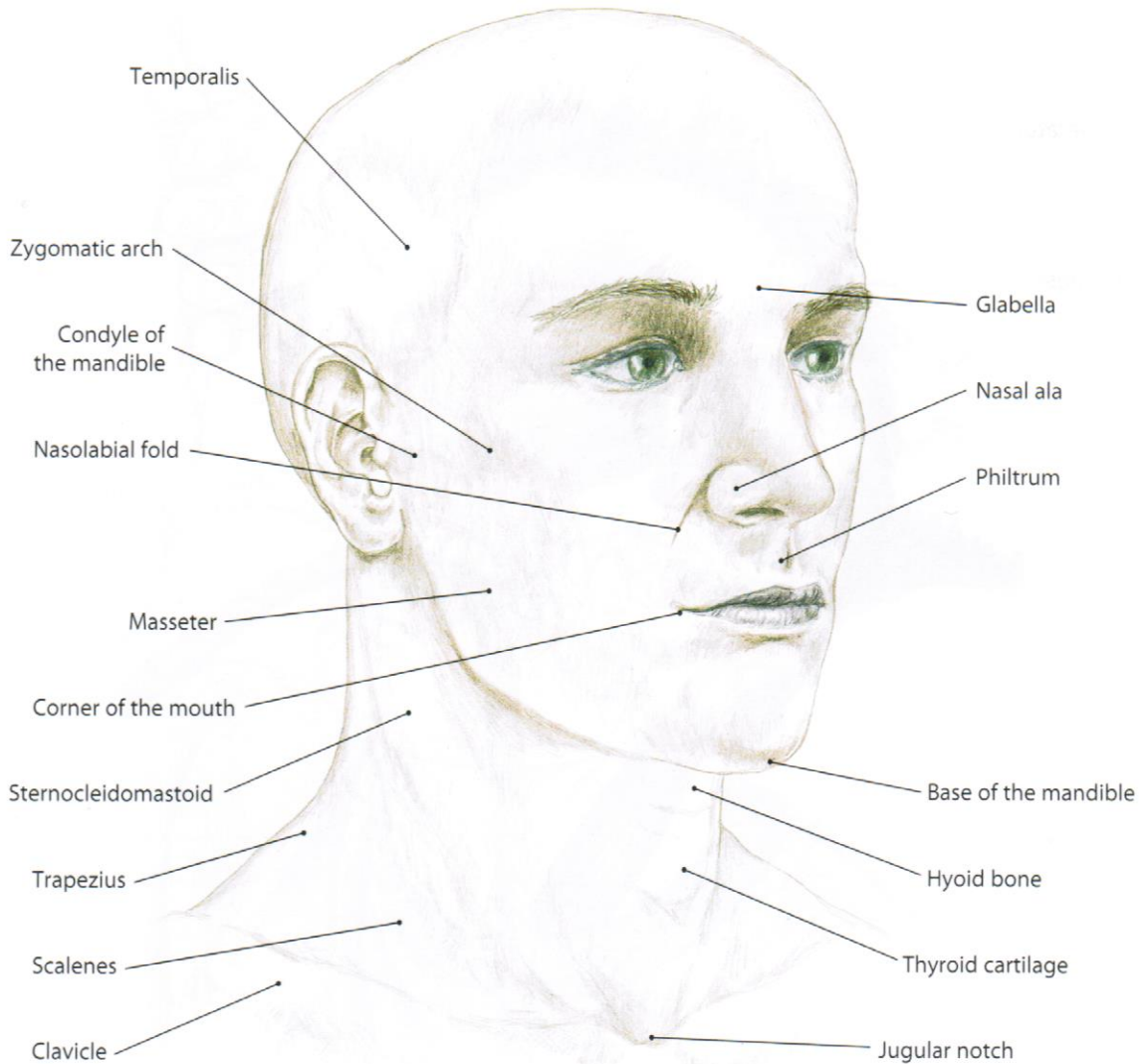




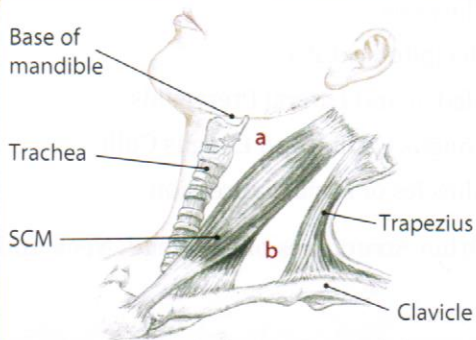
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# Topographical View



5.1 Anterior/lateral view

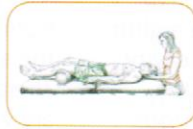


The anterior and lateral sides of the neck can be divided into two triangular regions. The **anterior triangle (a)** is bordered by the sternocleidomastoid (SCM), the base of the mandible and the trachea. The hyoid bone, thyroid gland, carotid artery, submandibular gland and styloid process of the temporal bone are some of the structures within the anterior triangle.

The **posterior triangle (b)** is formed by the sternocleidomastoid (SCM), clavicle and trapezius and contains, among other structures, the brachial plexus and the external jugular vein.



- 1) Partner supine. Sink your fingers into your partner's hair and onto her scalp. Note the temperature and moisture or oiliness.
- 2) Using your fingerpads for contact, gently tug the scalp in all directions (5.2). Rotate the head to the side to reach behind the ears and at the base of the skull. As you sense the tissue's thickness and mobility, do you notice any regions of the scalp that are more pliable than others?



5.2 Partner supine



5.3



- 1) Using your thumbpads, gently torque the skin and fascia of the forehead and face. Sense the tissue's elasticity and thickness (5.3).



5.4



- 1) Moving to the neck, gently grasp and lift the skin and fascia of the lateral neck (5.4). Oftentimes the tissue here will be quite thin, almost delicate. Turn your hand 90° and try lifting the tissue in a horizontal direction. Is it more challenging to lift? Next explore the anterior neck, including the tissue under the mandible. Do you notice any restrictions in the skin?
- 2) Resting the head on the heel of your hand, explore the skin and fascia of the posterior neck. Oftentimes this tissue is thicker and denser than the anterior tissue. Is this true?

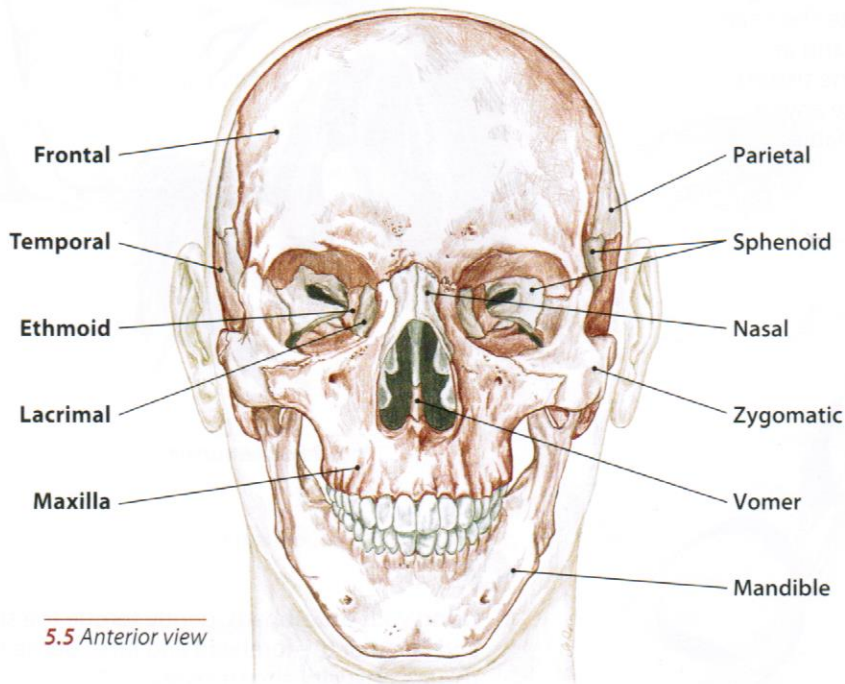


# Bones & Bony Landmarks of the Head, Neck and Face

The **skull** is composed of twenty-two bones: eight in the cranium and fourteen in the facial region. Seven of the eight **cranial** bones are directly accessible. The eighth, the ethmoid, is accessible only by way of the nasal cavity. Most of the cranial bones are superficial. Seven of the fourteen **facial** bones are palpable, as are the numerous

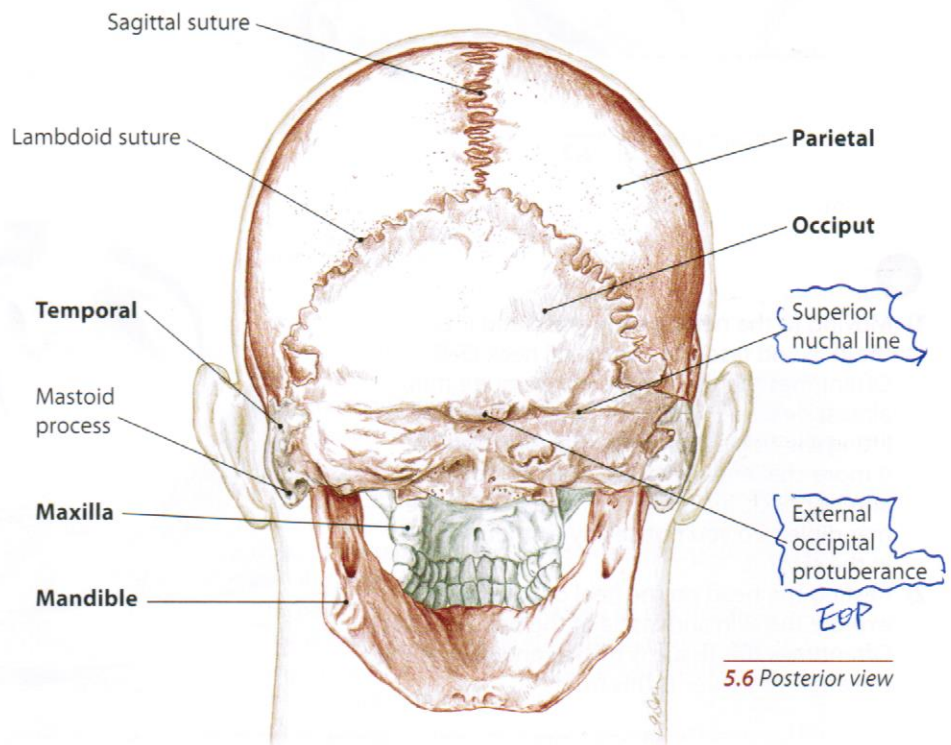
bony landmarks of the **mandible** (jaw) (5.5, 5.6).

The articulations of the cranial bones are different from the articulations of the appendages. The joints of the arms and legs have a synovial (mobile) joint structure. The cranial bones, in contrast, have fibrous joints that are woven together to form tight-fitting sutures.



- Facial bones (14)**
- Inferior nasal concha (2)
  - Lacrimal (2)
  - Mandible
  - Maxilla (2)
  - Nasal (2)
  - Palatine (2)
  - Vomer
  - Zygomatic (2)

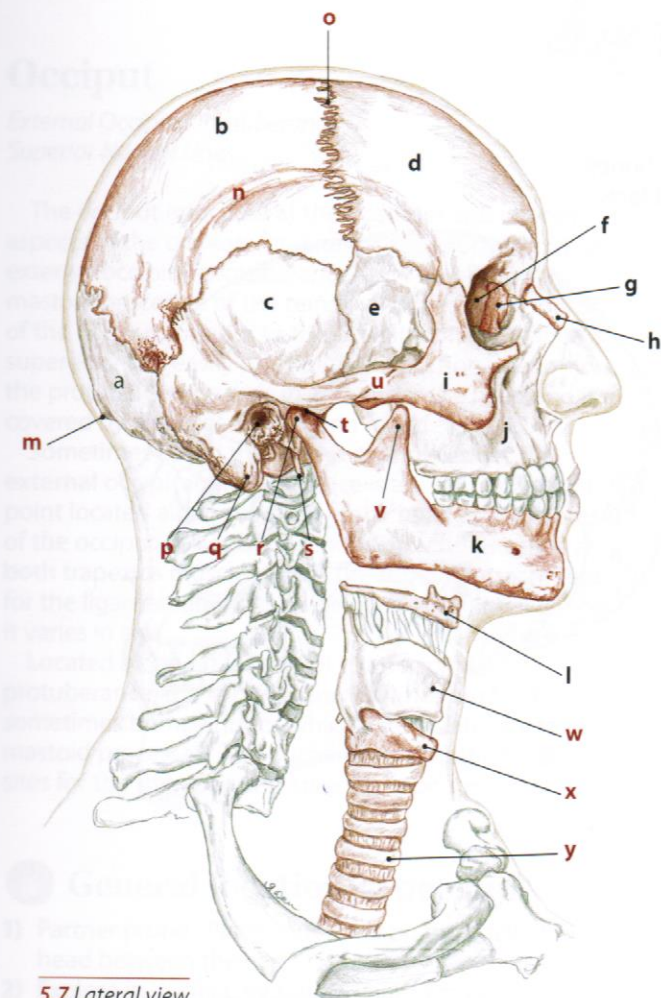
5.5 Anterior view



- Cranial bones (8)**
- Ethmoid
  - Frontal
  - Occiput
  - Parietal (2)
  - Sphenoid
  - Temporal (2)

5.6 Posterior view

Head, Neck & Face



5.7 Lateral view

- a) Occiput
- b) Parietal
- c) Temporal
- d) Frontal
- e) Sphenoid
- f) Ethmoid
- g) Lacrimal
- h) Nasal
- i) Zygomatic
- j) Maxilla
- k) Mandible
- l) Hyoid
- m) External occipital protuberance
- n) Temporal lines of parietal bones
- o) Coronal suture
- p) External auditory meatus
- q) Mastoid process
- r) Condyle of the mandible
- s) Styloid process of the temporal bone
- t) Temporomandibular joint
- u) Zygomatic arch
- v) Coronoid process
- w) Thyroid cartilage
- x) Cricoid cartilage
- y) Trachea

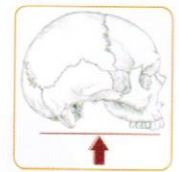
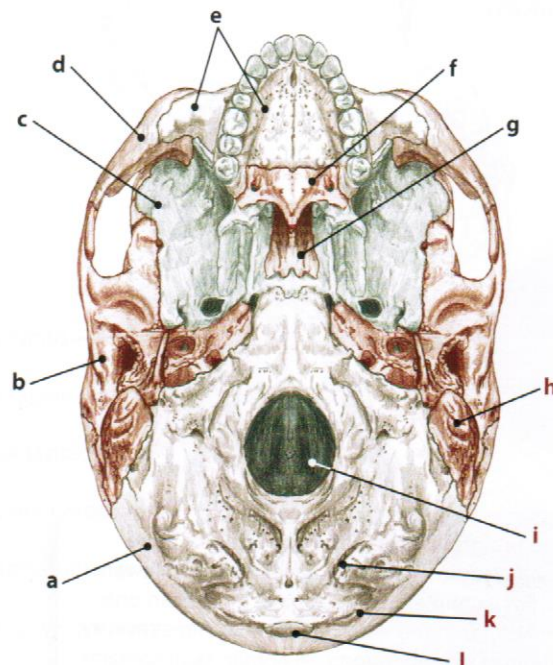
Black letters indicate bones, red letters indicate bony landmarks or other structures



Within the medical community, it was long believed that the cranial bones did not move. Since the cranial bones, with their tightly woven sutures, are designed to protect the brain, any cursory examination of the skull would seem to support the hypothesis that these bones are immobile.

In the 1920s, however, a young osteopath named William Sutherland was determined to prove that there was an infinitesimal, yet palpable, motion or rhythm of the cranial bones. Using himself as a guinea pig, Sutherland tested his hypothesis by applying a variety of homemade contraptions to his head, including a football helmet with screws drilled through it. While Sutherland monitored his cranial rhythm, his wife quietly detailed his dramatic personality and appearance changes.

Sutherland's research and perseverance lent support to the notion of cranial movement and helped cranial osteopathy to be accepted by the medical establishment.



5.8 Inferior view

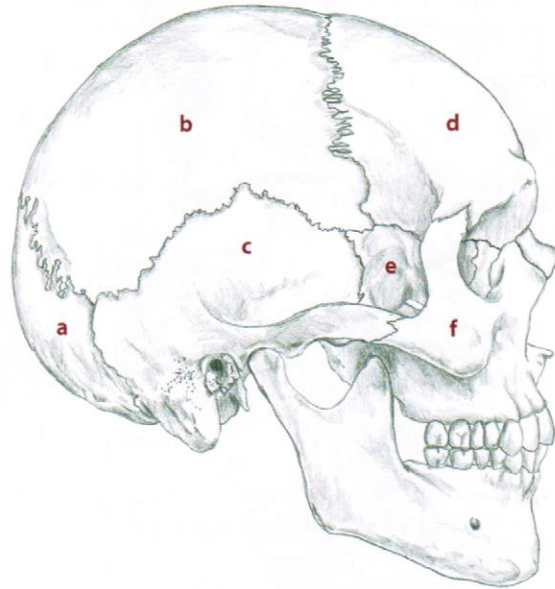
- a) Occiput
- b) Temporal
- c) Sphenoid
- d) Zygomatic
- e) Maxilla
- f) Palatine
- g) Vomer
- h) Mastoid process
- i) Foramen magnum
- j) Inferior nuchal line
- k) Superior nuchal line
- l) External occipital protuberance



# Bony Landmark Trails

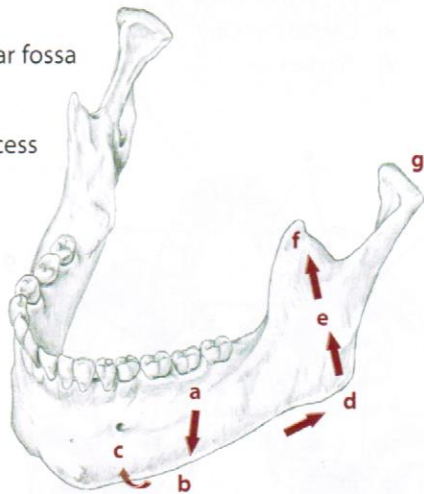
**Trail 1** "Around the Globe" palpates the bones and bony landmarks of the cranium and face.

- a** Occiput  
External occipital protuberance  
Superior nuchal lines
- b** Parietal
- c** Temporal  
Mastoid process  
Zygomatic arch  
Styloid process
- d** Frontal
- e** Sphenoid
- f** Nasal, zygomatic and maxilla



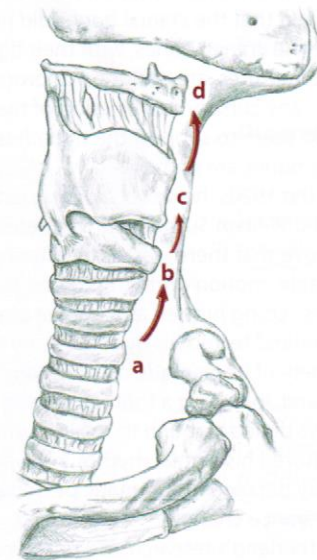
**Trail 2** "Jaw Jaunt" explores the mandible.

- a** Body
- b** Base
- c** Submandibular fossa
- d** Angle
- e** Ramus
- f** Coronoid process
- g** Condyle



**Trail 3** "Horseshoe Trek" locates the cartilaginous structures of the anterior neck and the horseshoe-shaped hyoid bone.

- a** Trachea
- b** Cricoid cartilage
- c** Thyroid cartilage
- d** Hyoid bone



Lateral view of neck

With the progress of evolution, the skulls of more advanced creatures began to have fewer and fewer bones. For example, some fish have more than one hundred bones in the skull, reptiles may have seventy, and primitive mammals forty. A human skull contains twenty-two bones, eight of which form the cranium. From a design perspective, this makes good sense: Fewer bones mean fewer sutures, and fewer seams mean greater protection.



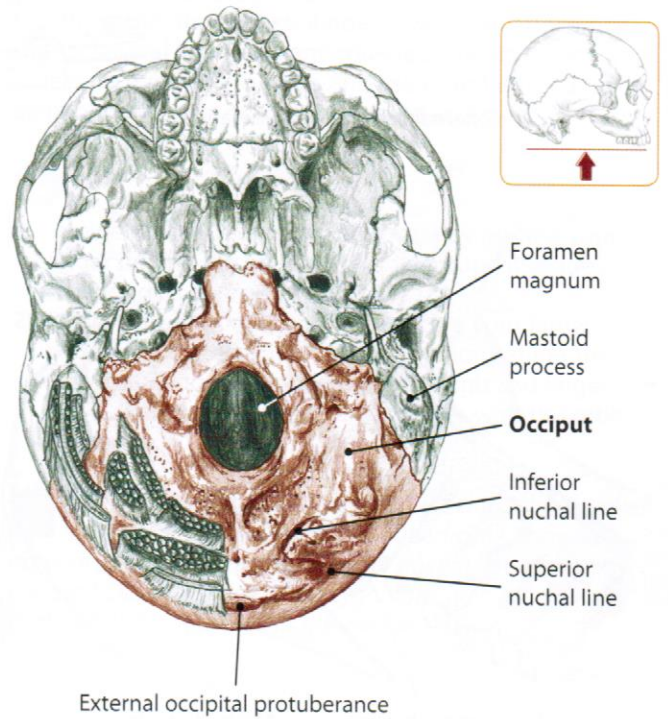
## Occiput

External Occipital Protuberance  
Superior Nuchal Lines

The occiput is located at the posterior and inferior aspects of the cranium. It extends superiorly from the external occipital protuberance and laterally to the mastoid processes of the temporal bones. The portion of the occiput superior to the occipital protuberance is superficial and easily palpable. The portion inferior to the protuberance curves in and under the head and is covered by layers of tendon and muscle (5.9, 5.10).

Sometimes called the "bump of knowledge," the **external occipital protuberance** is a small, superficial point located along the back of the head at the center of the occiput. It lies between the attachment sites of both trapezius muscles and is the superior attachment for the ligamentum nuchae. Regardless of intelligence, it varies in size.

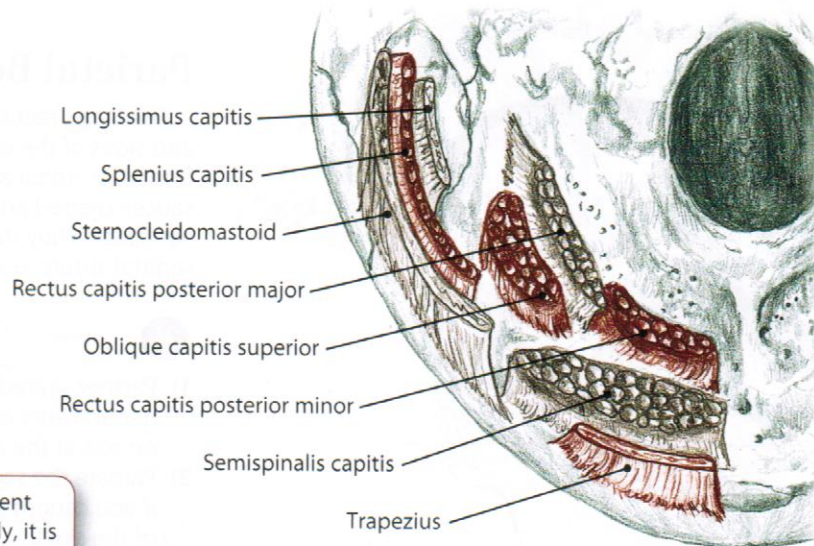
Located along either side of the occipital protuberance, the **superior nuchal lines** are faint, sometimes bumpy ridges which extend laterally to the mastoid processes. The nuchal lines are attachment sites for the trapezius and splenius capitis muscles.



5.9 Inferior view of cranium; muscle attachment sites on left side identified below

### General location of occiput

- 1) Partner prone. Place your hand on the back of the head between the ears.
- 2) Explore its surface by sliding your fingers
  - superiorly from the occipital protuberance two or three inches;
  - inferiorly where the occiput curves and sinks into the muscles of the neck;
  - laterally to the mastoid processes behind the ears.



5.10 Inferior view showing attachment sites

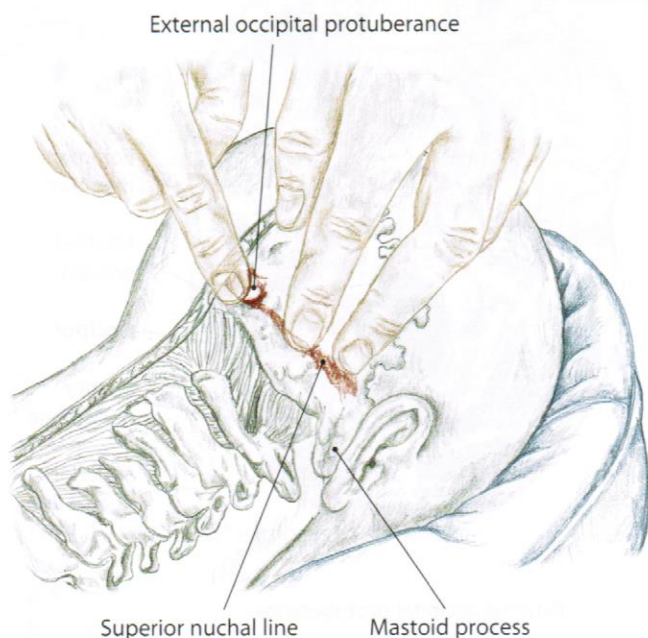
The superior nuchal line is an attachment site for several muscles. Metaphorically, it is the "shoreline" between the dry land of the cranium and the sea of neck muscles.

Head, Neck & Face

nuchal  
occiput

nu-kal  
ok-si-put

L. the back of the neck  
L. the back of the skull



5.11 Partner prone, superficial tissue removed on right side of cranium

## External occipital protuberance

- 1) Partner prone or supine. Place your fingers along the back of the neck at the body's midline (5.11).
- 2) Slide superiorly onto the bony surface of the cranium. The protuberance will be at the "shoreline" between the neck muscles and the cranium.

Are you level with the top of the ears? If your partner is prone, ask her to extend her head slightly. Is the bump you feel just superior to where the muscles tighten?

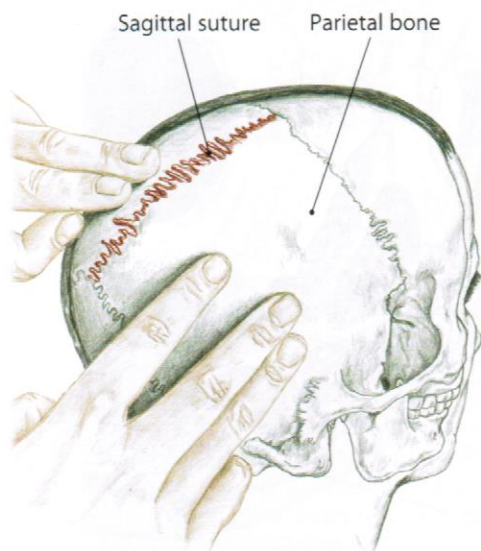
## Superior nuchal lines

- 1) Partner prone or supine. Stand at the head of the table and place both index fingers at the external occipital protuberance.
- 2) Allow the other fingers to fall in place beside them. Glide your fingerpads up and down and palpate the edge of the superior nuchal lines.
- 3) Follow these ridges laterally as they extend toward the ear and mastoid processes (5.11).

Are you just lateral to the occipital protuberance? Do the ridges lead toward the back of the ears? Can you find them from a prone position? Are you on the cranium as opposed to the muscles of the neck?

At birth, the cranial bones are neither fully developed nor joined. Usually there are six unossified gaps in the skull called fontanel. The name (old French, *little fountain*) perhaps came from the

pulse of the blood vessels felt under the skin that reminded physicians of the spurting of a fountain. The fontanel close over a period of between two and twenty-four months.



5.12 Partner seated, superficial tissue removed on right side of cranium



## Parietal Bones

The large, rectangular parietal bones form the top and sides of the cranium. Positioned between the frontal, occipital and temporal bones, the parietals are saucer-shaped and extend anteriorly to the level of the ear canal. They merge at the body's midline to form the sagittal suture, a slight crest that often can be felt.

- 1) Partner seated, prone or supine. To access the general area of the parietals, place both hands on top of the cranium.
- 2) Palpate the sagittal suture between the parietals. If you cannot feel its crest, visualize it along the top of the skull.
- 3) Follow it anteriorly to the level of the ear canal and posteriorly to the occiput (5.12).

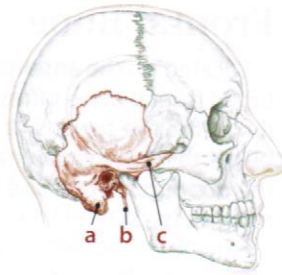
## Temporal Bone

- a) Mastoid Process
- b) Styloid Process
- c) Zygomatic Arch

The temporal bone is located on the side of the head, encompassing the area around the ear. It has three important bony landmarks: the mastoid process, the zygomatic arch and the styloid process. The temporal bone is superficial, except for its superior aspect which lies deep to the temporalis muscle.

The **mastoid process (a)** forms a large, superficial bump directly behind the earlobe. It is an attachment site for the sternocleidomastoid and other muscles. Also, it is larger on males than females and is undeveloped on infants.

The superficial **zygomatic arch (c)** (or cheekbone) is formed by the temporal and zygomatic bones. It is an attachment site for the masseter muscle. The space between the zygomatic arch and the cranium is filled by the thick temporalis muscle.

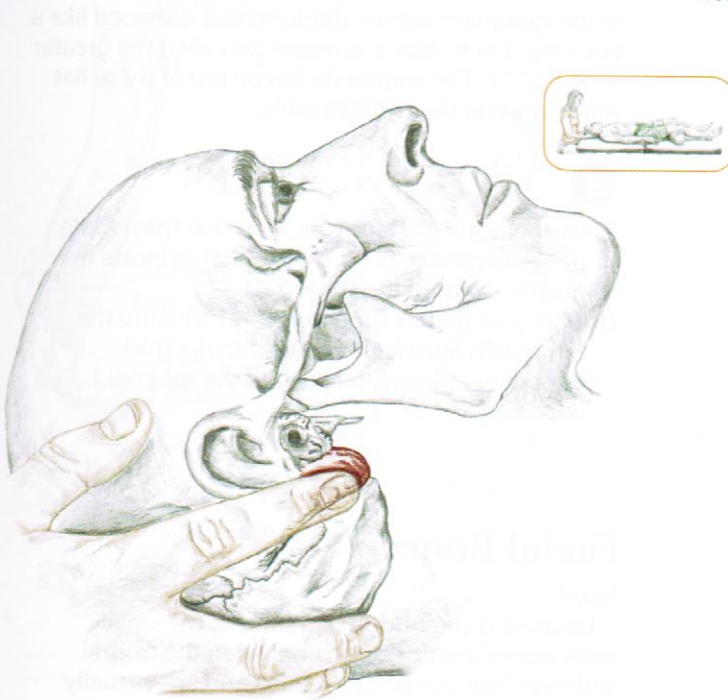


The **styloid process (b)** is located behind the earlobe between the mastoid process and the posterior edge of the mandible. Its fanglike shape serves as an attachment site for several ligaments and muscles. The styloid process is deep to overlying muscles and tissue and is not directly palpable; however, its location can be accessed.

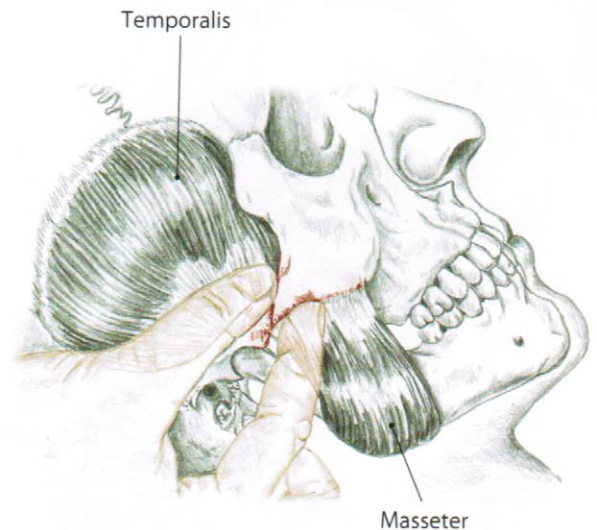


- 1) Supine. Locate the mastoid process by placing your finger behind the earlobe. Sculpt around its edges, exploring its entire surface (5.13).
- 2) Explore the zygomatic arch by placing your finger anterior to the ear canal. Move anteriorly along the arch, outlining its sides with your thumb and finger (5.14). Follow it anteriorly as it merges with the orbit of the eye.

*When locating the mastoid, are you behind the earlobe? Is the bone you feel round and superficial? Can you palpate posteriorly onto the superior nuchal line of the occiput? Does the ridge of the zygomatic arch run horizontally? Is it level with the ear canal?*



5.13 Partner supine, accessing the mastoid process, inferior portion of the ear removed



5.14 Partner supine, palpating the zygomatic arch

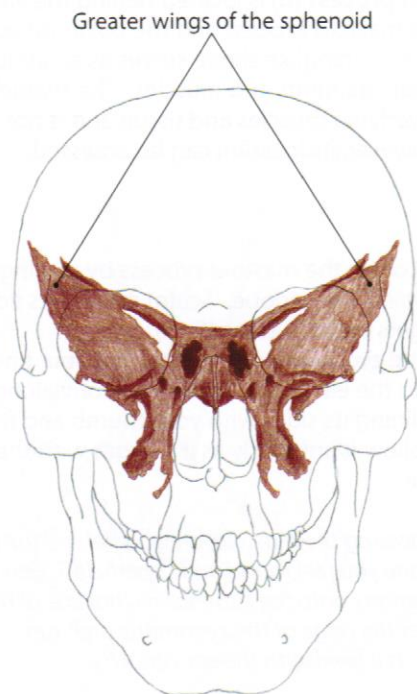
*The styloid process of the temporal bone is fragile and is deep to the facial nerve (p. 272), so exploration in this area should be very gentle.*



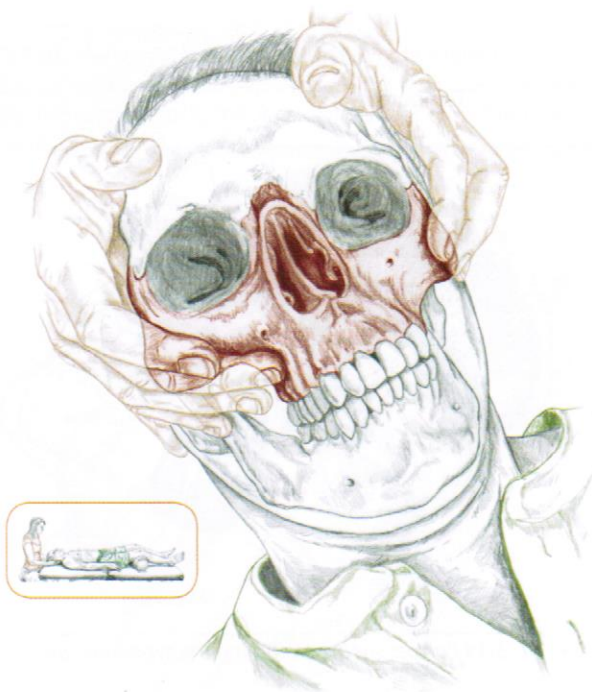
mastoid  
styloid  
zygomatic

**mas**-toyd  
**sti**-loyd  
**zy**-go-mat-ik

Grk. breast-shaped  
Grk. a pillar  
Grk. cheekbone



5.15 Anterior view showing location of the sphenoid bone



5.16 "Dawn of the Dead"? No, just exploring the facial bones with your partner supine.

## Frontal Bone

Located on the anterior aspect of the cranium, the broad frontal bone forms the forehead and upper rim of the eye sockets. It articulates with the parietal bones to form the coronal sutures which are deep to the occipitofrontalis and lateral edge of the temporalis muscles (p. 251).



- 1) Partner supine. Explore the region of the forehead, moving superiorly to the coronal sutures, inferiorly to the brow and laterally to the anterior edge of the temporalis muscle.

## Sphenoid Bone

The sphenoid bone is located inside the cranium and has major articulations with the fourteen bones of the skull. Located behind the eyeballs and superior to the zygomatic arches, the sphenoid is shaped like a butterfly, and its lateral portions are called the greater wings (5.15). The temporalis lies on top of these flat wings, making them inaccessible.



- 1) Partner supine. Place your fingers at the middle of the zygomatic arch (cheekbone) to locate the greater wings of the sphenoid.
- 2) Slide your fingers superiorly one inch onto the temporalis muscle belly. Deep to the thick temporalis, the greater wing of the sphenoid is located.

## Facial Bones

### Nasal

Located at the bridge of the nose, the small nasal bones are positioned between the frontal and maxillary bones (see p. 228) and are virtually indistinguishable from them.

### Zygomatic

Better known as the cheekbone, the zygomatic bone forms the anterior aspect of the zygomatic arch and the lateral portion of the orbit of the eye (5.16). It serves as an attachment site for the masseter muscle.

### Maxilla

The maxillary bones form the center of the face, the inferior portion of the orbit of the eye, the surface around the nose, and the upper jaw in which the upper row of teeth articulate.

maxilla  
nasal  
sphenoid

**max**-il-a  
**na**-zl  
**sfe**-noyd

L. jawbone  
L. nose  
Grk. wedge-shaped



# Trail 2 "Jaw Jaunt"

## Mandible

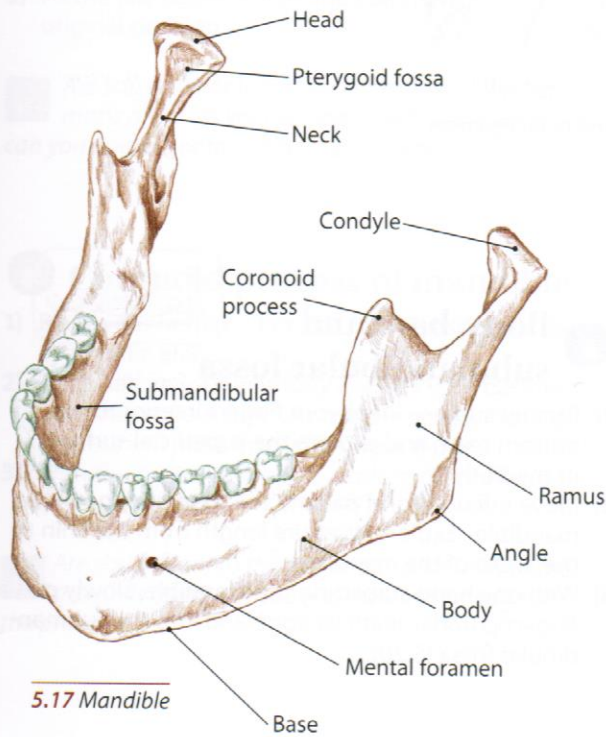
Body, Base, Submandibular Fossa, Angle, Ramus, Condyle and Coronoid Process

The mandible or "jaw" has numerous landmarks that are superficial and accessible (5.17). The **body** is the flat surface of the mandible inferior to the lower teeth. The **base** or "jaw line" is the edge of the body and an attachment site for the thin platysma muscle. The **submandibular fossa** is located on the underside of the mandible and is an attachment site for the suprahyoid muscles (p. 253).

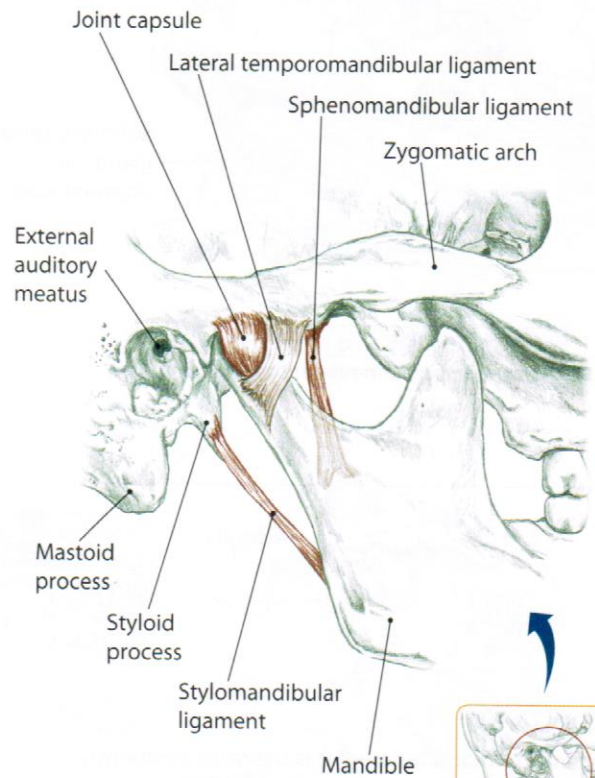
The superficial **angle** is located at the posterior end of the base. It forms part of the attachment for the masseter. The flat **ramus** is the posterior, vertical portion of the mandible and is deep to the masseter.

The mandible articulates with the cranium at two temporomandibular joints. The superficial **condyle** is located just anterior to the ear canal and inferior to the zygomatic arch. The deeper, inaccessible head of the condyle forms the articulating surface of the mandible at the temporomandibular (TM) joint (5.18).

The **coronoid process** is located an inch anterior to the condyle of the mandible and is the attachment site of the temporalis muscle. When the jaw is closed, the coronoid process lies underneath the zygomatic arch and is inaccessible. Opening the mouth fully, however, will bring the coronoid process out from under the arch and allow the process to be accessed.

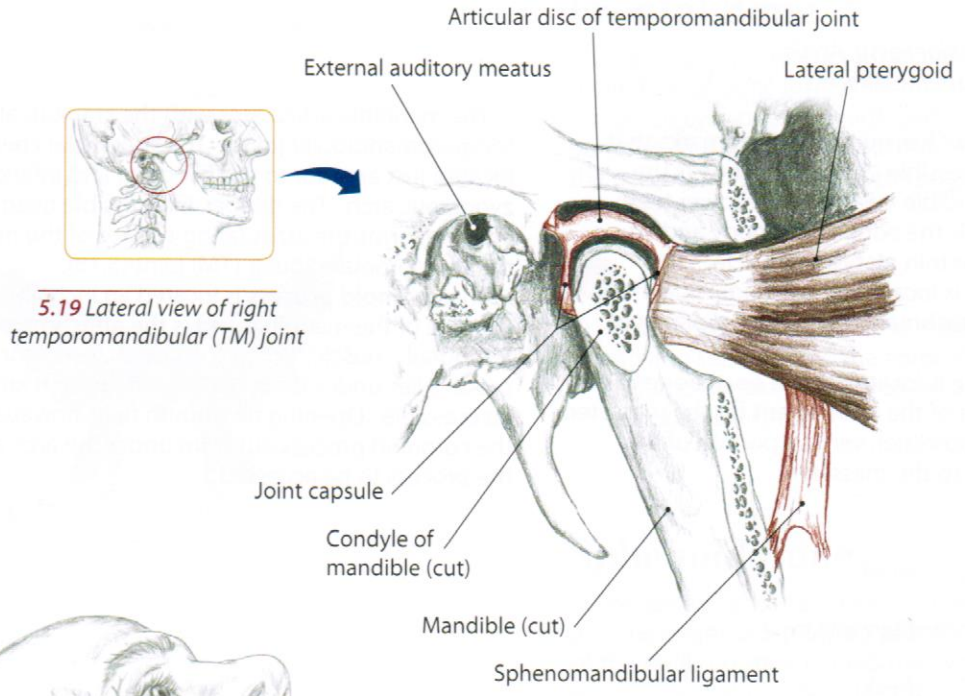


5.17 Mandible

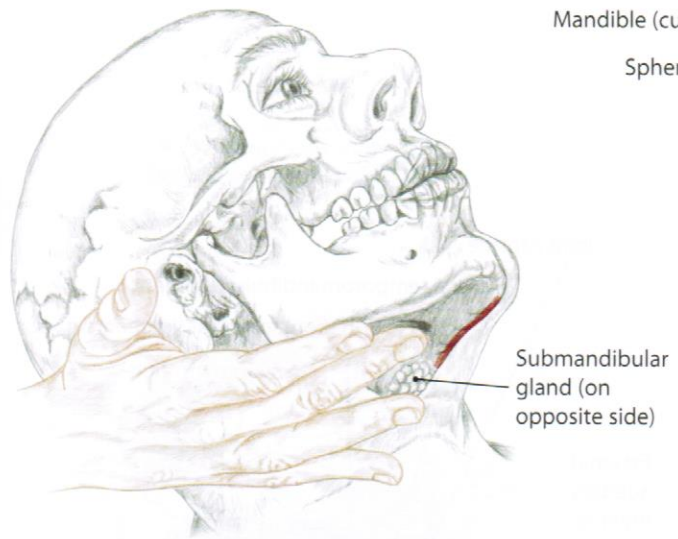


5.18 Lateral view of right temporomandibular (TM) joint

Exploring in the submandibular fossa can be uncomfortable for your partner because of neighboring glands and nerves. Move slowly, checking in as you proceed.



5.19 Lateral view of right temporomandibular (TM) joint



Submandibular gland (on opposite side)

5.20 Partner supine, palpating the submandibular fossa

**Body, base and submandibular fossa**



- 1) Partner supine. Place your fingers inferior to the bottom teeth and explore the superficial surface of the body.
- 2) Move inferiorly and palpate the base or edge of the mandible. Explore its entire length from the chin to the angle of the mandible.
- 3) With one hand stabilizing the mandible, slowly curl a fingertip underneath its edge and into the submandibular fossa (5.20).

The temporomandibular joint is the most frequently used joint in the body, moving 2,000-3,000 times a day. This wear and tear is compounded by the incongruity of its joint surfaces, namely the mandibular condyle and its fossa. Luckily, the TM joint is equipped with an articular disc (1). Shaped like a Lifesaver, this disc lies on top of the condyle and helps to create more congruity between the joint surfaces, reducing the potential for bone deterioration. When the mandible depresses, the condyle and disc move in tandem, pivoting anteriorly and inferiorly (2, 3). The reverse occurs when the mandible elevates.

## Angle and ramus of mandible

- 1) Partner supine. Slide posteriorly along the base of the mandible to the angle. Clarify your location by asking your partner to open her mouth and note the movement of the angle (5.21).
- 2) Slide superiorly from the angle onto the ramus, which is deep to the masseter muscle.

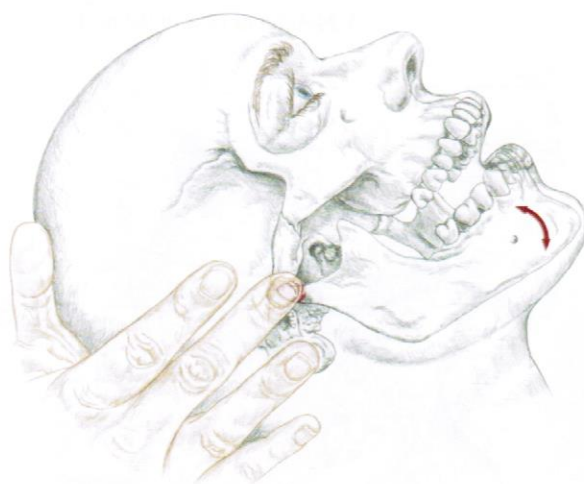


5.21 Partner supine, palpating the angle of the mandible

## Condyle of mandible

- 1) Place your fingerpad anterior to the ear canal and below the zygomatic arch.
- 2) Ask your partner to open her mouth fully. With this action, the condyle will become more palpable as it slides anteriorly and inferiorly (5.22).
- 3) As the jaw closes, follow the condyle to its original position.

Are you anterior to the ear canal, below the zygomatic arch? As your partner opens her mouth, can you palpate both condyles simultaneously?

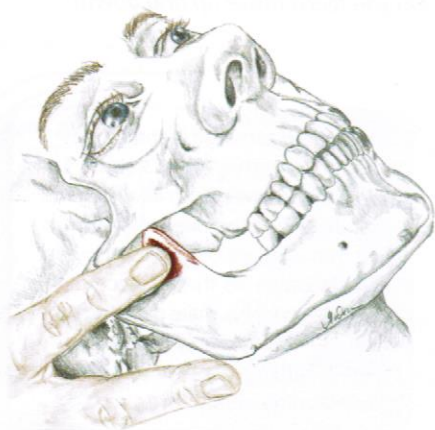


5.22 Partner supine, feeling the condyle shift as she opens and closes her mouth

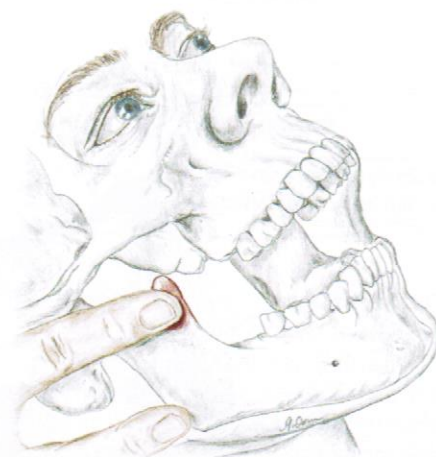
## Coronoid process of mandible

- 1) Place your fingerpad on the middle aspect of the zygomatic arch.
- 2) Drop half an inch inferiorly and ask your partner to open her mouth fully. As the jaw drops, the large process will press into your finger (5.23).
- 3) With the mouth still open, explore the surfaces of the process.

Are you inferior to the zygomatic arch? When the mouth is open, can you feel the anterior edge of the process?



5.23 Feeling the coronoid process come out from under the zygomatic arch as your partner opens her mouth



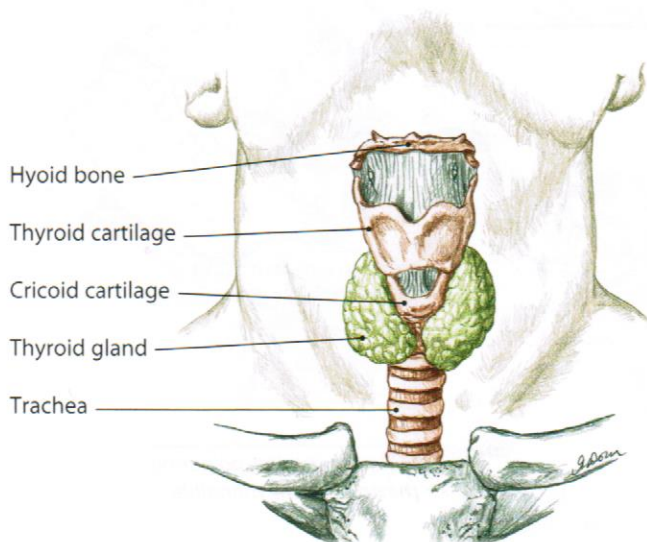
coronoid  
jugular  
ramus

**kor**-o-noyd  
**jug**-u-lar  
**ray**-mus

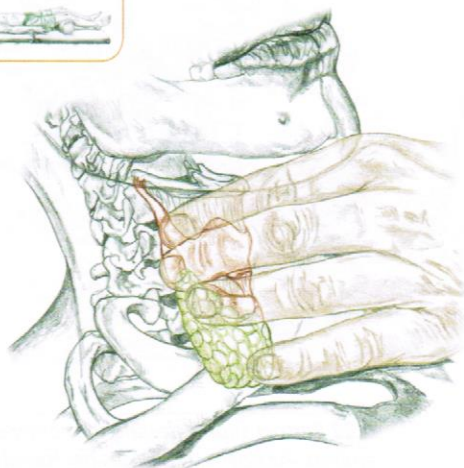
Grk. crown-shaped  
L. throat  
L. branch



## Trail 3 “Horseshoe Trek”

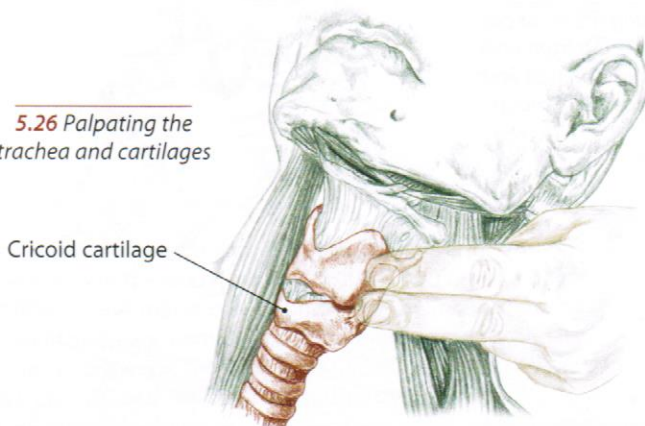


5.24 Anterior view of the neck



5.25 Partner supine, gently accessing the structures on the front of the neck

5.26 Palpating the trachea and cartilages



## Trachea

*Cricoid Cartilage, Thyroid Cartilage and Hyoid Bone*

The **trachea** (windpipe) is located at the center of the anterior neck (5.24). It is a ribbed, cartilaginous tube that is roughly an inch in diameter and deep to the thyroid gland. The **cricoid cartilage** is a slightly larger ring of the trachea superior to the thyroid gland. The **thyroid cartilage** (Adam’s apple) is superior to the cricoid cartilage below the level of the chin. Present in both sexes, the thyroid cartilage is larger and more visibly protruding on adult males. The three structures are partially deep to the slender infrahyoid muscles (p. 255), yet are easily palpable.

The horseshoe-shaped **hyoid bone** is located superior to the thyroid cartilage (5.27, 5.28). It is roughly an inch in diameter and lies parallel to the base of the mandible (jawline) and the third or fourth cervical vertebrae. The hyoid bone serves as an attachment site for the suprahyoid and infrahyoid muscles. It is accessible and elevates upon swallowing.

### Trachea and cartilages


- 1) Partner supine or seated. Using a fingerpad and thumb to palpate, gently explore the anterior surface of the neck for the tubular trachea.
- 2) Slide your finger up and down to feel the trachea’s ribbed surface, and slowly and gently shift it from side to side, noting its pliability (5.25).
- 3) The cricoid cartilage can be isolated by sliding your finger and thumb superiorly along the trachea to just below the thyroid cartilage. Explore for its large, ringed surface (5.26).
- 4) Slide superiorly from the cricoid cartilage onto the thyroid cartilage. Palpate its sides and central tip.

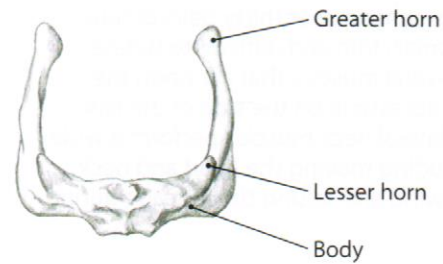
**Are you at the midline of the neck? Can you distinguish any rings along the trachea’s surface? Is the trachea roughly an inch in diameter? With your fingerpad on the thyroid cartilage, ask your partner to swallow. Do you feel it move up and down?**

The thyroid cartilage is sometimes referred to as the “Adam’s apple.” The name derives from a folk legend that described the biblical Adam’s first bite of apple became stuck halfway down his throat. According to the legend, his male descendants, with their more visibly protruding thyroid cartilage, appear to have carried on his condition.

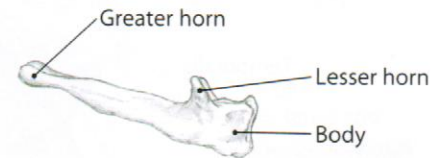
## Hyoid bone

- 1) Partner supine or seated. Place your index finger upon the thyroid cartilage. Roll your fingerpad superiorly over the thyroid cartilage, onto the hyoid.
- 2) Then gently palpate the sides of the hyoid with your first finger and thumb (5.29). The hyoid will be wider than the trachea.
- 3) Using gentle pressure, explore the surface of the hyoid as well as its small side-to-side movements. If you have difficulty accessing the hyoid, encourage your partner to relax her tongue and jaw.

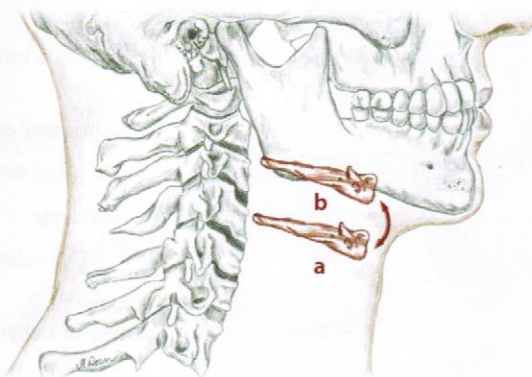
 Are you superior to the thyroid cartilage (Adam's apple)? Can you gently move the hyoid from side to side? With your first finger and thumb on either side of the hyoid, ask your partner to swallow. Do you feel the hyoid rise up and then return (5.30)?



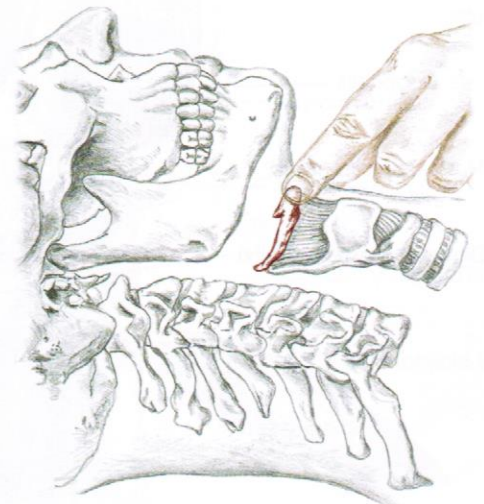
5.27 Superior view of hyoid



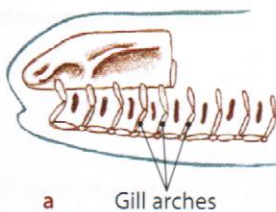
5.28 Lateral view of hyoid



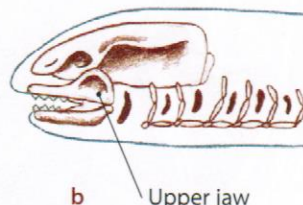
5.30 The hyoid bone at rest (a) and its placement during swallowing (b)



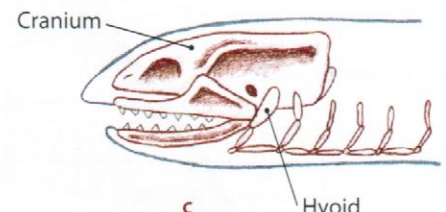
5.29 Partner supine, isolating the hyoid bone



a Gill arches



b Upper jaw



c Hyoid

The hyoid bone is an ancestral remnant of the tissue that once formed gills. In the evolution of the jaw, the gill arches (the bones around the gills) (a) gravitated toward the head to hold the upper

jaw next to the cranium (b). For fish, which do not have the long necks we do, the position of the hyoid provides an important link between the jaw and cranium (c). For humans, the hyoid lost

this function and shifted down the neck to become the only non-articulating bone in the body. It is supported instead by the muscles that attach to its surface, such as the suprahyoids and infrahyoids.

thyroid  
trachea

thi-royd  
tray-ke-a

Grk. shield  
Grk. rough

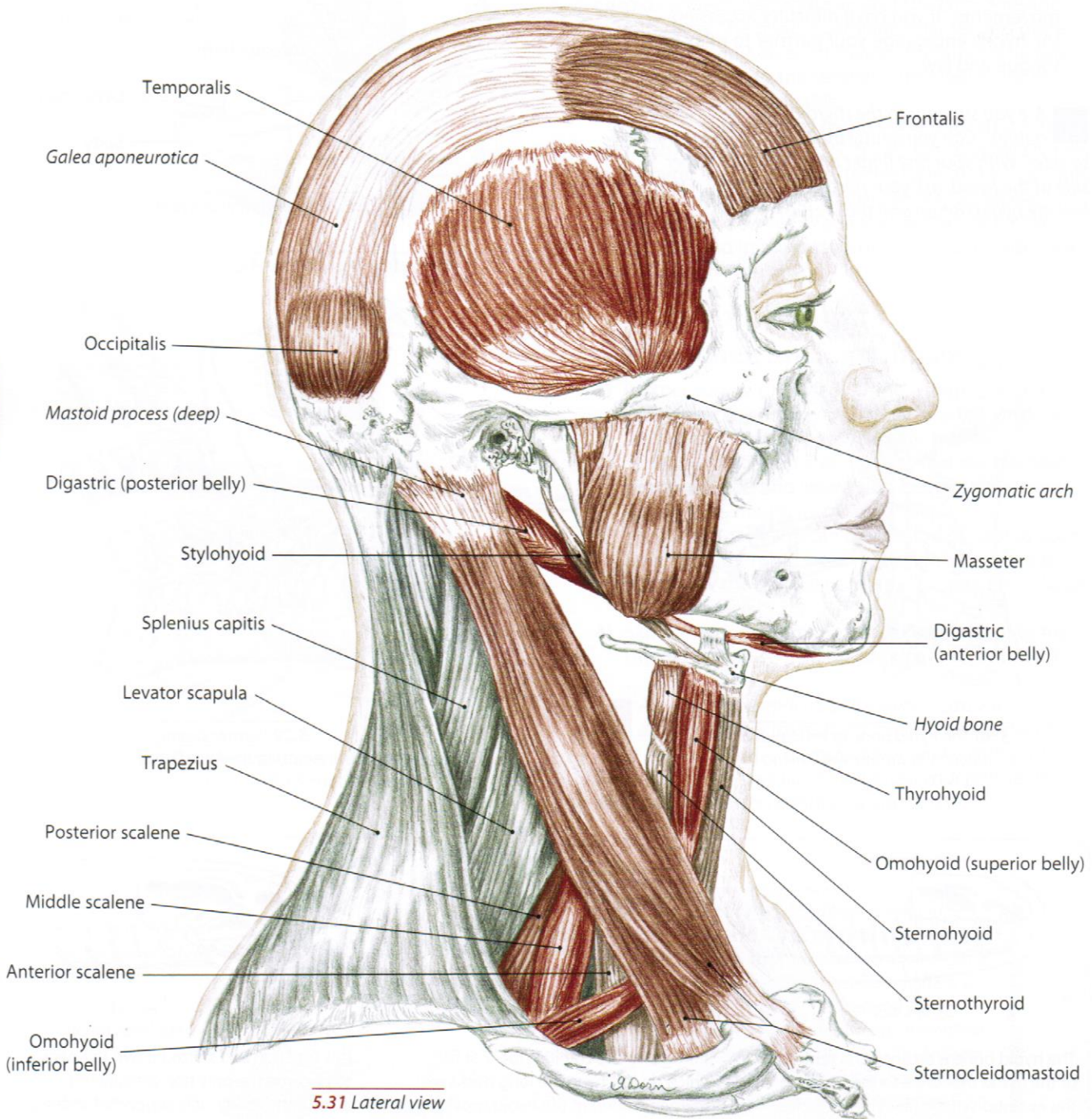
# Muscles of the Head, Neck and Face

The head and face contain over thirty pairs of muscles, many of which are small, thin and difficult to isolate. Nevertheless, the several muscles that act upon the mandible are easily accessible on the side of the jaw.

The anterior and lateral neck muscles perform a wide variety of tasks, including moving the head and neck, assistance in swallowing and raising the rib cage during

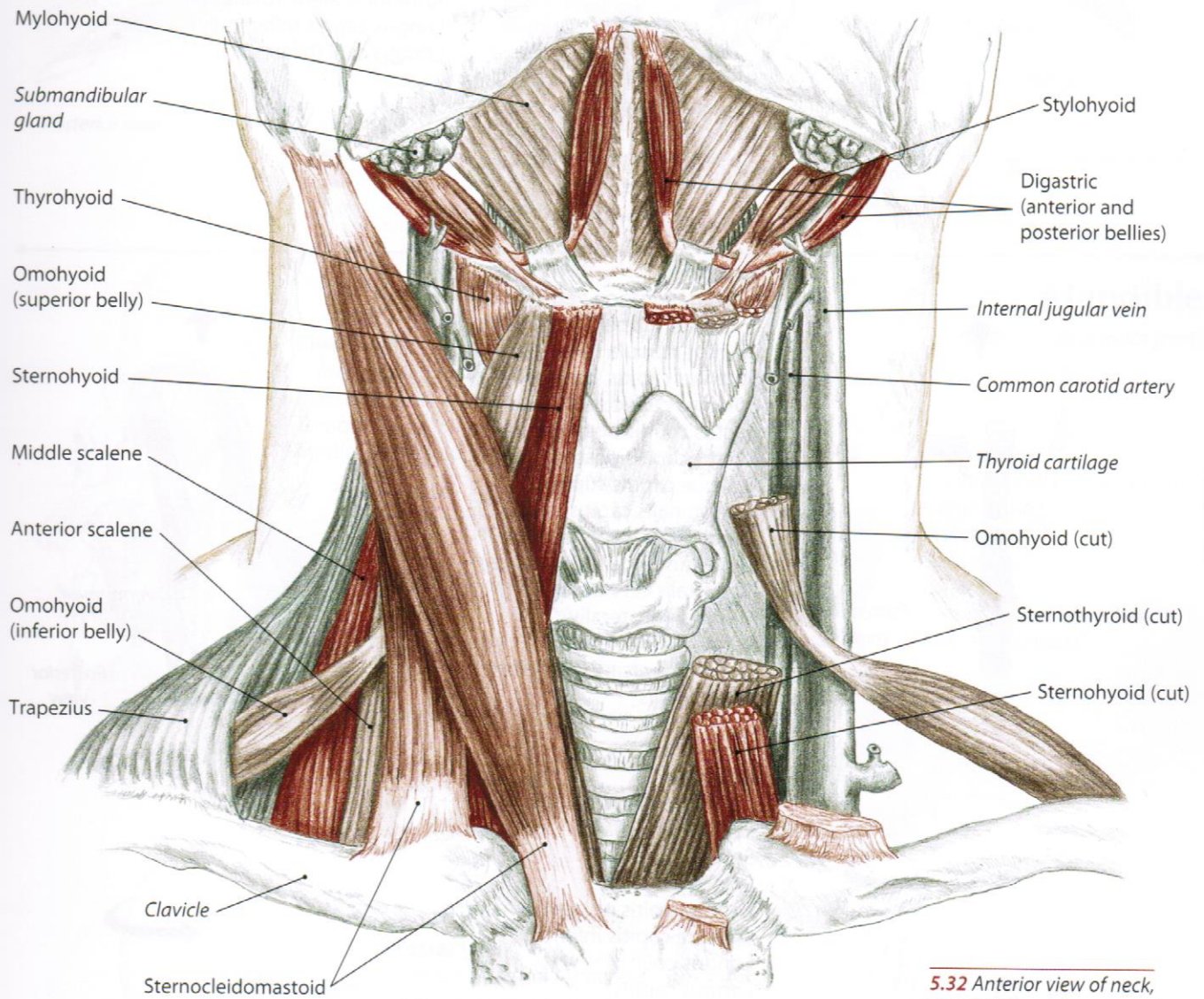
inhalation. The posterior neck muscles, which act primarily upon the cervical spine and head, are detailed in Chapter Four, *Spine and Thorax*.

Before you palpate the following muscles on your partner, you are advised to skip to the back of this chapter to familiarize yourself with the arteries, glands and nerves of the head, neck and face (p. 270).



5.31 Lateral view

# ✦ Muscles of the Head, Neck and Face



**5.32** Anterior view of neck, superficial muscles removed on his left side

The single smallest muscle in the human body is located in the middle ear. The stapedius muscle measures less than 1/20 of an inch, thinner than a U.S. dime. It activates the stirrup, one of the tiny bones of the ear, which sends vibrations from the eardrum into the inner ear.

The stapedius, however, may not be the absolute shortest muscle in the body. A minuscule involuntary muscle called the arrector pili (p. 10) attaches to every hair follicle on the human body. These microscopic muscles nevertheless have a big responsibility: When you are cold or

respond to a strong emotion such as fear, the arrector pili muscles raise the hair, producing goose bumps which help to retain body heat. They are also believed to have given our evolutionary ancestors the hair-raising ability of appearing larger to potential enemies.

arrector pili  
stapedius

a-**rek**-tor **pee**-li  
sta-**pe**-de-us

L. *arrector*, lifter; *pilus*, hair  
L. *stirrup*



# Synergists—Muscles Working Together

Muscles are listed in the order of their ability to create the movement. Asterisk indicates muscles not shown.

## Cervical Spine



Anterior/lateral view

### Flexion

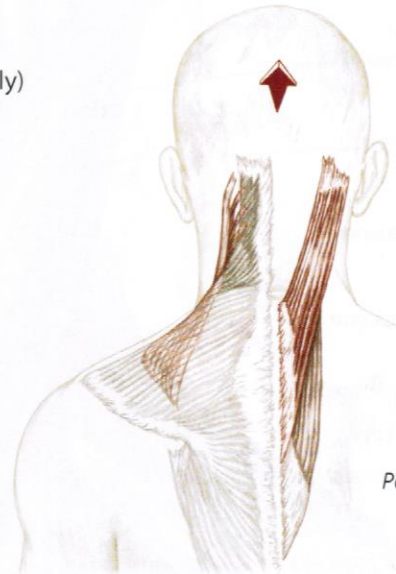
- (antagonists on extension)
- Sternocleidomastoid (bilaterally)
- Anterior scalene (bilaterally)
- Longus capitis (bilaterally)
- Longus colli (bilaterally)



Posterior view

### Extension

- (antagonists on flexion)
- Trapezius (upper fibers, bilaterally)
- Levator scapula (bilaterally)
- Splenius capitis (bilaterally)
- Splenius cervicis (bilaterally)
- Rectus capitis posterior major
- Rectus capitis posterior minor
- Oblique capitis superior
- Semispinalis capitis
- Longissimus capitis (assists)\*
- Longissimus cervicis (assists)\*
- Iliocostalis cervicis (assists)\*
- Multifidi (bilaterally)\*
- Rotatores (bilaterally)\*
- Intertransversarii (bilaterally)\*
- Interspinalis\*



Posterior view

### Rotation

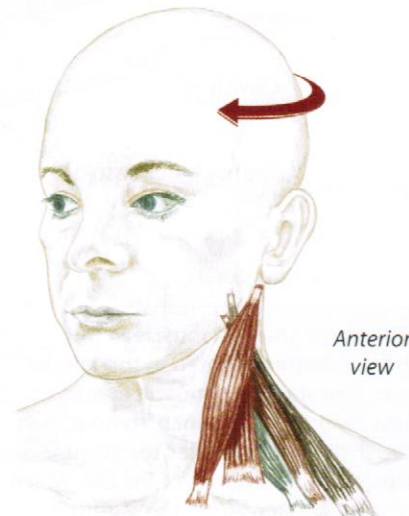
- (unilaterally to the **same** side)
- Levator scapula
- Splenius capitis
- Splenius cervicis
- Rectus capitis posterior major\*
- Oblique capitis inferior\*
- Longus colli\*
- Longus capitis\*
- Longissimus capitis (assists)\*
- Longissimus cervicis (assists)\*
- Iliocostalis cervicis (assists)\*



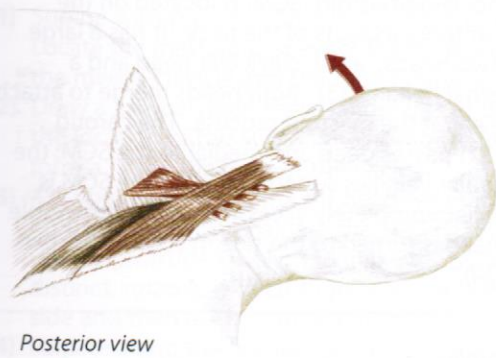
Posterior view

### Rotation

- (unilaterally to the **opposite** side)
- Trapezius (upper fibers)
- Sternocleidomastoid
- Anterior scalene
- Middle scalene
- Posterior scalene
- Multifidi\*
- Rotatores\*



Anterior view

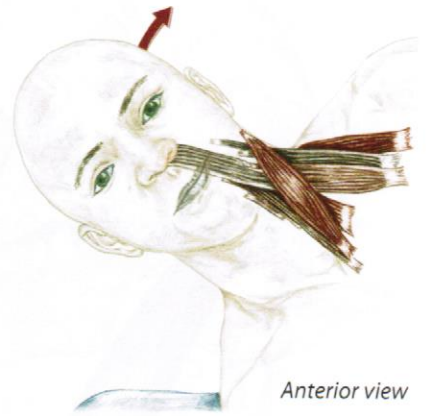


Posterior view

## Lateral Flexion

(unilaterally to the same side)

- Trapezius (upper fibers)
- Levator scapula
- Sternocleidomastoid
- Anterior scalene (with ribs fixed)
- Middle scalene (with ribs fixed)
- Posterior scalene (with ribs fixed)
- Splenius capitis
- Splenius cervicis
- Longus capitis
- Longus colli
- Longissimus capitis (assists)\*
- Longissimus cervicis (assists)\*
- Iliocostalis cervicis (assists)\*
- Oblique capitis superior\*
- Intertransversarii\*



Anterior view

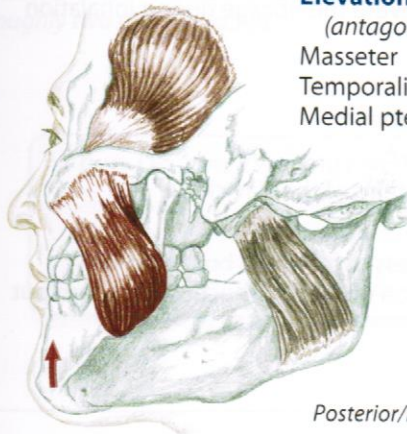
## Mandible

(temporomandibular joint)

### Elevation

(antagonists on depression)

- Masseter
- Temporalis
- Medial pterygoid

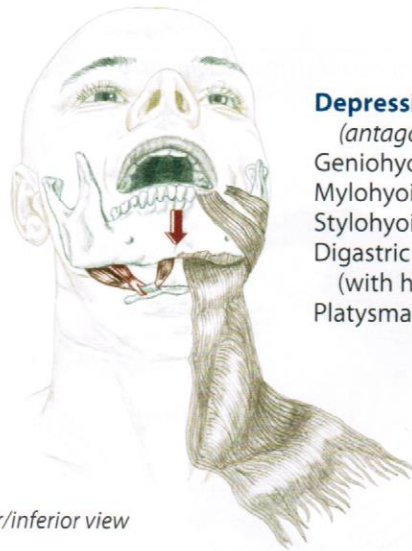


Posterior/lateral view

### Depression

(antagonists on elevation)

- Geniohyoid\*
- Mylohyoid\*
- Stylohyoid
- Digastric
- (with hyoid bone fixed)
- Platysma (assists)

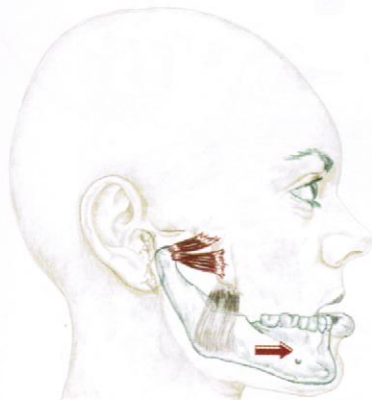


Anterior/inferior view

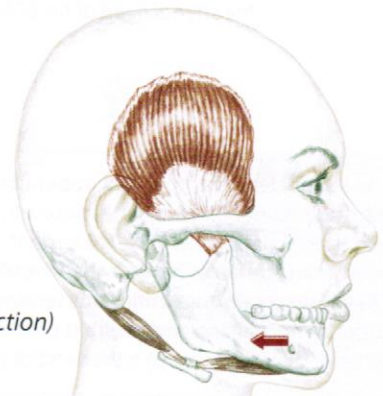
### Protraction

(antagonists on retraction)

- Lateral pterygoid (bilaterally)
- Medial pterygoid (bilaterally)
- Masseter (assists)\*



Lateral views



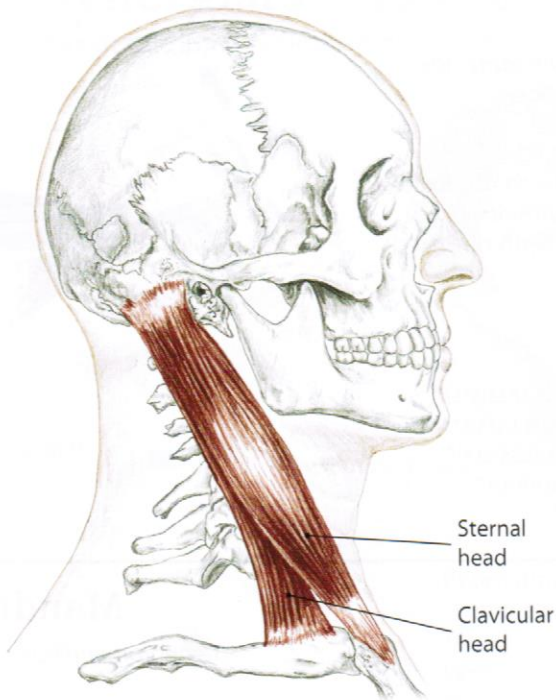
### Retraction

(antagonists on protraction)

- Temporalis
- Digastric

See p. 410 for synergists of lateral deviation of the mandible





5.33 Lateral view of sternocleidomastoid



*The power of thought,  
the magic of the mind...*

5.34 Lord Byron showing off the sternal head of his SCM

The sternocleidomastoid and upper fibers of the trapezius (p. 68) begin as one muscle in the embryo and then split later on in development. The location of their attachments hints at their initial relationship: They form an almost continuous tendon along the superior nuchal line and mastoid process. Their other attachments are at either end of the clavicle.

## Sternocleidomastoid

The sternocleidomastoid (SCM) is located on the lateral and anterior aspects of the neck. It has a large belly with two heads: a flat, clavicular head and a slender, sternal head (5.33). Both heads merge to attach behind the ear at the mastoid process. The carotid artery (p. 271) passes deep and medial to the SCM; the external jugular vein lies superficial to it. The SCM is also superficial, completely accessible and often visible when the head is turned to the side in Lord Byron-like fashion (5.34).

**A** *Unilaterally:*  
**Laterally flex** the head and neck to the same side

**Rotate** the head and neck to the opposite side

*Bilaterally:*  
**Flex** the neck

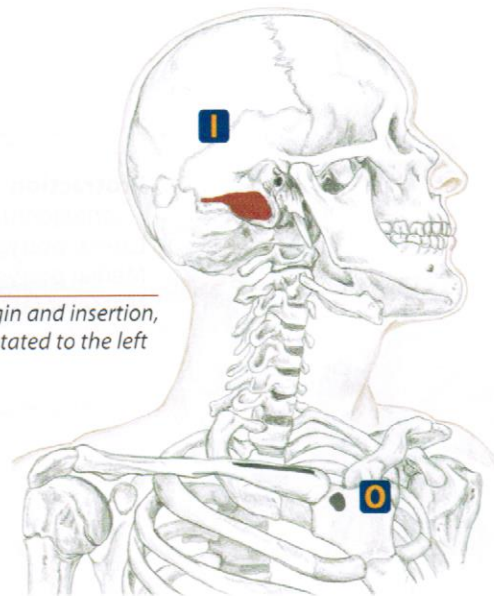
Assist to **elevate** the ribcage during inhalation

**O** *Sternal head:*  
Top of manubrium  
*Clavicular head:*  
Medial one-third of the clavicle

**I** Mastoid process of temporal bone and the lateral portion of superior nuchal line of occiput

**N** C(1), 2, 3

5.35 Origin and insertion, head rotated to the left



## Sternocleidomastoid

- 1) Supine with practitioner at head of the table. Locate the mastoid process of the temporal bone, the medial clavicle and the top of the sternum.
- 2) Draw a line between these landmarks to delineate the location of the SCM. Note how both SCMs form a "V" on the front of the neck.
- 3) Ask your partner to raise his head very slightly off the table as you palpate the SCM (5.36). It will usually protrude visibly. (To make the SCM more distinct, rotate the head slightly to the opposite side and then ask him to flex his neck.)
- 4) Palpate along the borders of the SCM, follow it behind the earlobe and then down to the clavicle and sternum (5.37). Sculpt around the skinny sternal tendon and the wider clavicular tendon.

*With your partner relaxed, can you grasp the SCM between your fingers and outline its thickness and shape? How much space is between the clavicular attachments of the SCM and trapezius? It should be roughly two to three inches.*

### When Do You Use Your SCM?

- Shaking your head "no" (opposite side rotation)
- Shaking your head "yes" (bilateral flexion)
- Stabilizing the head while riding a roller coaster
- Cocking your head to hear what someone is saying



5.38 Strumming across the sternal tendon of the SCM

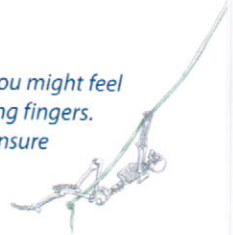


5.36 Partner supine, flexing his head slightly to engage the SCM



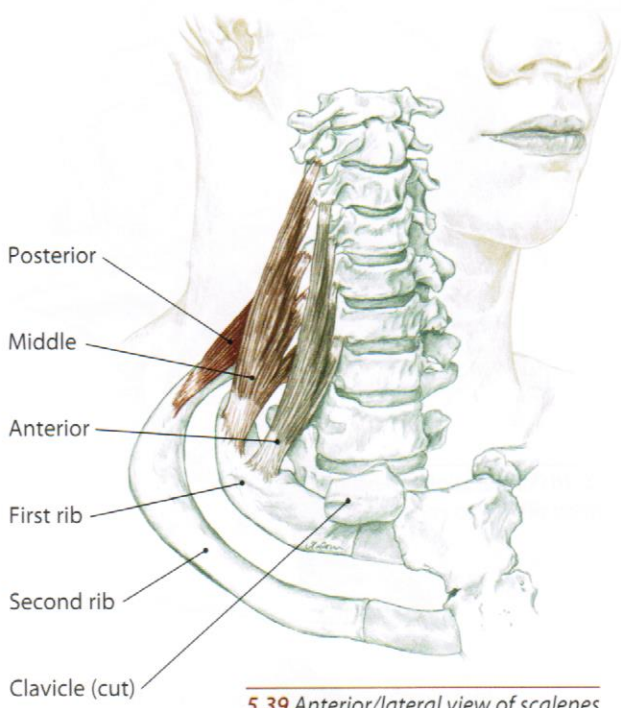
5.37 Grasping the bellies of the SCM

*Since the carotid artery passes deep to the SCM, you might feel its strong pulse beneath (or between) your grasping fingers. If so, simply release and reposition your hand to ensure that the vessel is not impinged.*



# Scalenes

- Anterior
- Middle
- Posterior

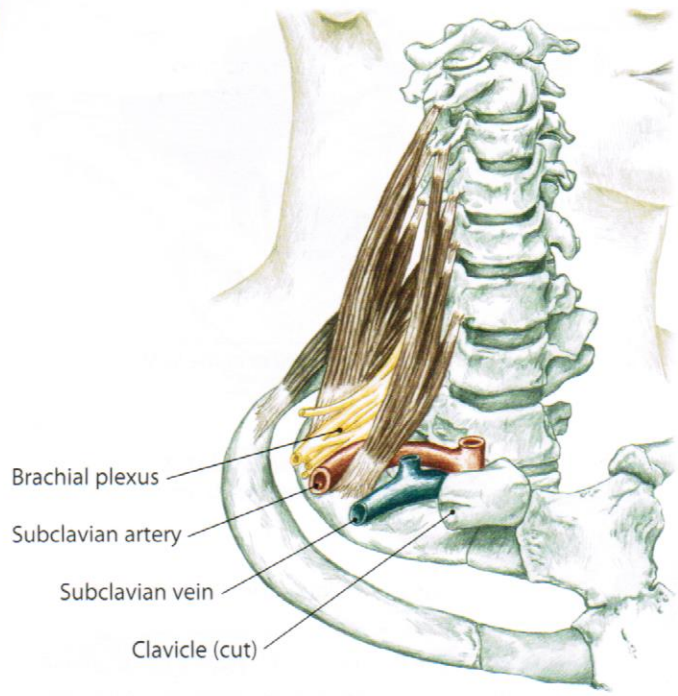


5.39 Anterior/lateral view of scalenes

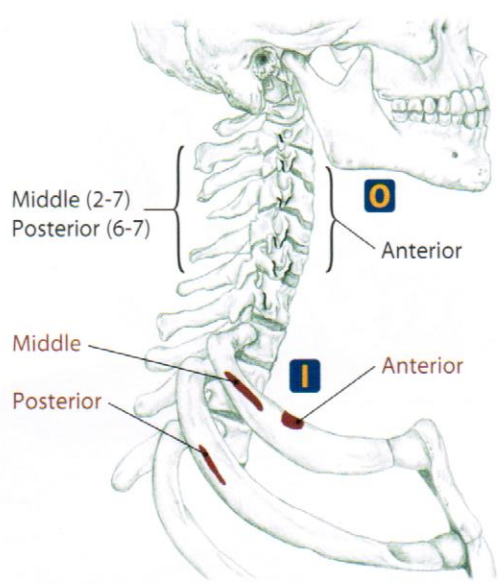
The three scalenes are sandwiched between the sternocleidomastoid and the anterior flap of the trapezius on the anterior, lateral neck. Their fibers begin at the side of the cervical vertebrae, dive underneath the clavicle and attach to the first and second ribs (5.39). During normal inhalation, the scalenes perform the vital task of elevating the upper ribs.

The **anterior scalene** (5.42) lies partially tucked beneath the sternocleidomastoid. The **middle scalene** (5.43) is slightly larger and lies lateral to the anterior scalene. Both muscle bellies are directly accessible. The smaller **posterior scalene** (5.44) is located between the middle scalene and levator scapula. The posterior scalene is positioned deeper than the other scalenes. Due to its small size and buried location, the posterior scalene can be difficult to distinguish from the surrounding bellies.

The large branches of the brachial plexus and subclavian artery pass through a small gap between the anterior and middle scalenes. Individual nerves of the brachial plexus may penetrate through or in front of the anterior scalene (5.40).



5.40 Anterior/lateral view



5.41 Lateral view of origins and insertions

## A All Scalenes

Unilaterally:

With the ribs fixed, **laterally flex** the head and neck to the same side (All)

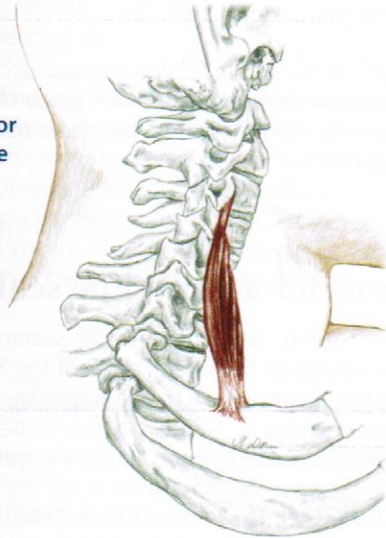
**Rotate** head and neck to the opposite side (All)

Bilaterally:

**Elevate** the ribs during inhalation (All)

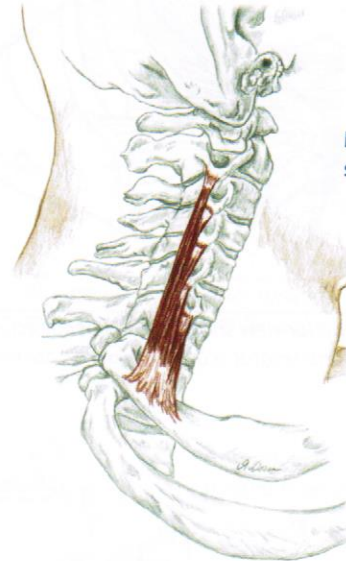
**Flex** the head and neck (Anterior)

Anterior scalene



5.42, 5.43, 5.44  
Lateral views

Middle scalene



### Anterior Scalene

**O** Transverse processes of third through sixth cervical vertebrae (anterior tubercles) <sup>3-6.</sup>

**I** First rib

**N** C(3), 4-8

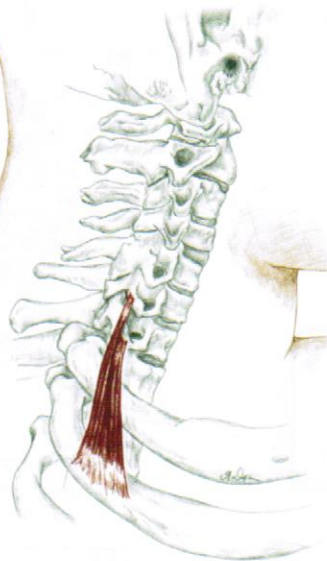
### Middle Scalene

**O** Transverse processes of second through seventh cervical vertebrae (posterior tubercles) <sup>2-7</sup>

**I** First rib

**N** C(3), 4-8

Posterior scalene



### Posterior Scalene

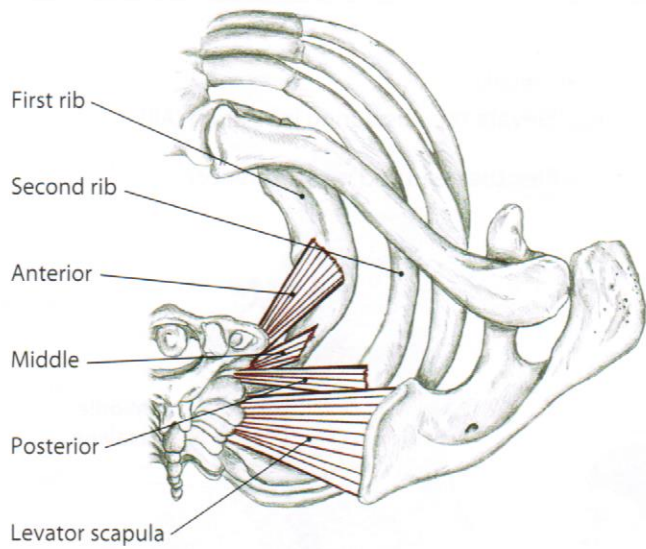
**O** Transverse processes of sixth and seventh cervical vertebrae (posterior tubercles) <sup>5-6.</sup>

**I** Second rib

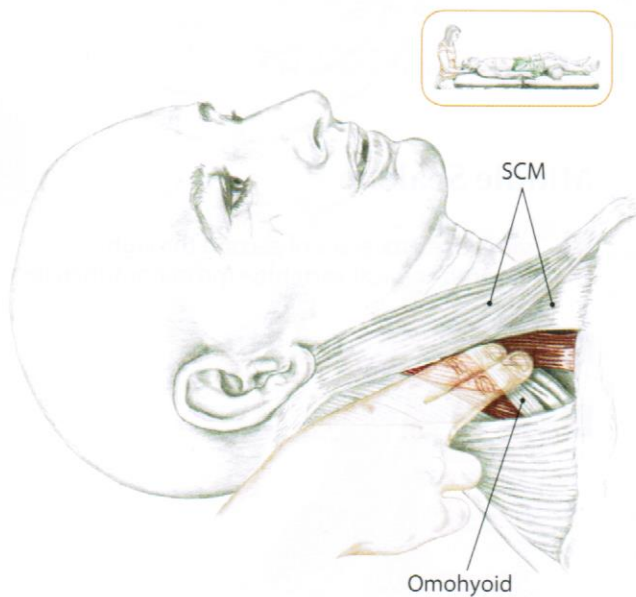
**N** C(3), 4-8

Compression or impingement of the brachial plexus or one of its nerves can send a sharp, shooting sensation or numbness down the arm. If this should occur, immediately release and adjust your position posteriorly. Be sure to ask your partner for feedback while palpating the scalene muscles.





**5.45** Superior view showing the fiber direction of the scalenes and levator scapula. Muscles are not to scale.



**5.46** Partner supine, feeling the scalenes contract as your partner inhales

**When Do You Use Your Scalenes?**

- Taking a deep breath into the upper chest
- Holding a phone between your ear and shoulder
- Stabilizing your head when reading in a reclined position

**Scalenes as a group**

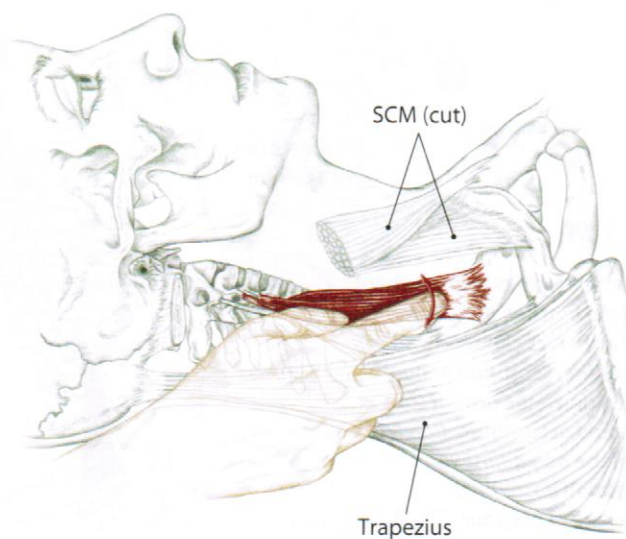
- 1) Partner supine, with practitioner at head of the table. Cradle the head (passively flexing it) to allow for easier palpation. Place your fingerpads along the anterior and lateral sides of the neck between the SCM and trapezius.
- 2) With the pads of your fingers, use gentle pressure to palpate the stringy, superficial muscle bellies in this triangle.

*Are you between the SCM and trapezius? Ask your partner to inhale deeply into her upper chest. As she fully inhales, do you feel the muscles in this triangle contract (5.46)?*

**Anterior and middle scalenes**

- 1) Partner supine. Since the anterior scalene lies partially deep to the lateral edge of the SCM, rotate the head slightly to the opposite side to better expose it. Gently palpate under the SCM's lateral edge and roll across the belly of the anterior scalene (5.47).
- 2) Follow it inferiorly as it tucks under the clavicle.
- 3) Move laterally to explore the middle scalene, noting its similarly shaped belly (5.48).

*Do the muscles you feel have a slender, stringy texture? If you follow them inferiorly, do they sink beneath the clavicle (in the direction of the ribs)? Can you follow them superiorly to the transverse processes of the cervical vertebrae? Ask your partner to flex her head slightly. Can you feel the scalenes contract?*



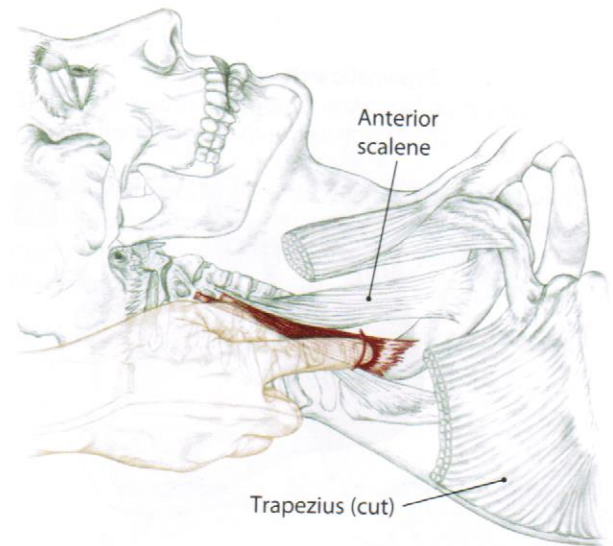
**5.47** Partner supine, rolling across the anterior scalene

## Posterior scalene



- 1) Partner supine. The posterior scalene extends laterally off the neck and is squeezed between the middle scalene and levator scapula (p. 83).
- 2) Locate the middle scalene and the levator scapula. Place a finger between these bellies and sink inferiorly (5.49).
- 3) Slowly strum across the thin band of tissue running laterally from the transverse processes to the second rib.

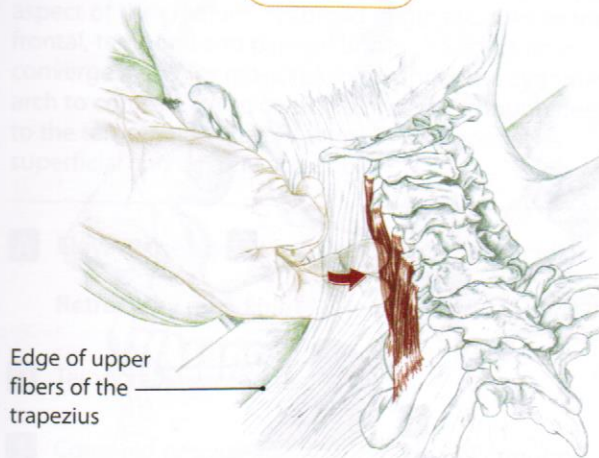
✓ *To distinguish between the posterior scalene and levator scapula, locate the posterior scalene and ask your partner to slowly elevate her scapula. Since the posterior scalene does not create this action, there should be no contraction of its fibers. However, if you ask your partner to slowly inhale into her upper chest, you should feel the posterior scalene contract.*



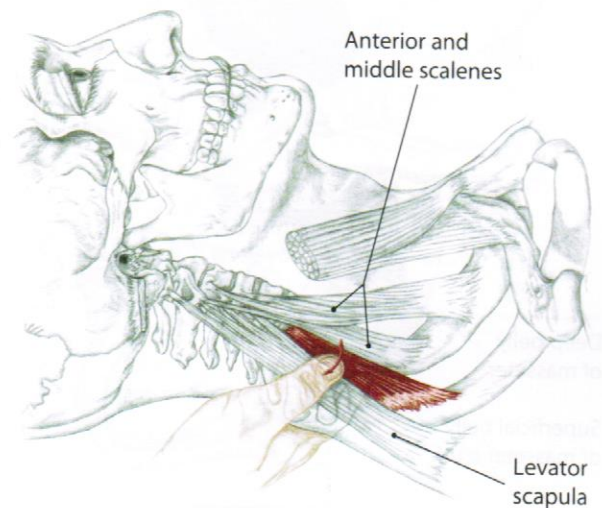
5.48 Lateral view, partner supine, strumming across the middle scalene

## All scalenes

Partner prone. Begin by isolating the edge of the upper fibers of the trapezius (p. 68). Then curl your fingers around the anterior edge of the trapezius into the tissue of the lateral neck (5.50). The levator scapula will be just anterior to the trapezius followed by the posterior and middle scalenes.

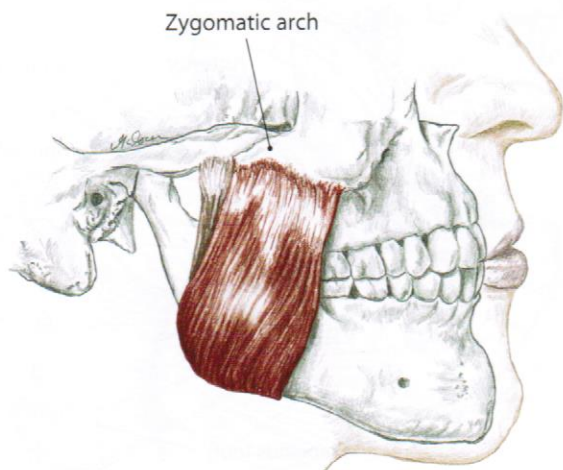


5.50 Posterior/lateral view, partner prone, palpating the middle and posterior scalenes

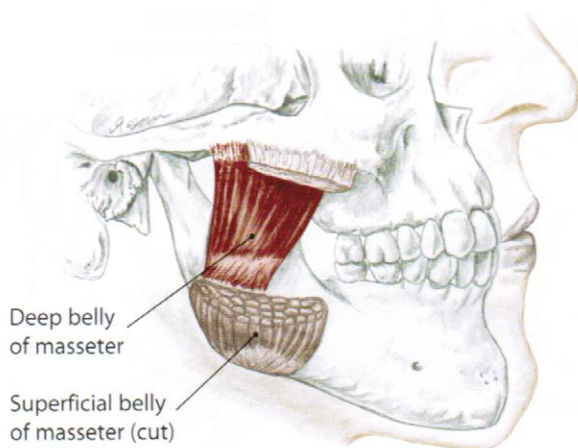


5.49 Lateral view, partner supine, palpating the posterior scalene

The existence of a fourth muscle, the scalene minimus, is one of several variations on the scalene muscle group. Present in roughly 40% of the population, the minimus often attaches from the sixth and seventh cervical vertebrae to the first rib or pleural dome of the lung. Lying inferior and deep to the anterior scalene, this muscle may nevertheless be quite strong.



5.51 Lateral view showing superficial head of masseter



5.52 Lateral view

**When Do You Use Your Masseter?**

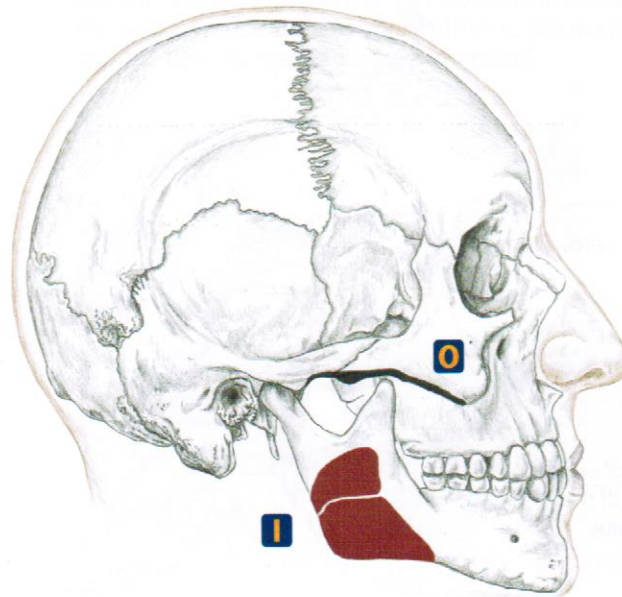
- Talking, gabbing, chin wagging, “chewing the fat”
- Chomping down on a wad of gum
- Gnashing your teeth together during an argument

**Masseter**  咬肌

The masseter is the strongest muscle in the body relative to its size. The two masseters together exert a biting force of nearly one hundred-fifty pounds of pressure—enough to bite off a finger! The masseter is the primary chewing muscle and is used in speaking and swallowing.

Located on the side of the mandible, the square-shaped masseter is composed of two overlapping bellies. The superficial belly can be accessed from the face (5.51); the deep belly is palpable from inside the mouth (5.52). The masseter is situated deep to the parotid gland (p. 272), yet is easily palpable.

- A** Elevate the mandible (temporomandibular joint)  
May assist to **protract** the mandible (TM joint)
- O** Zygomatic arch
- I** Angle and ramus of mandible
- N** Trigeminal (V) nerve (mandibular division)

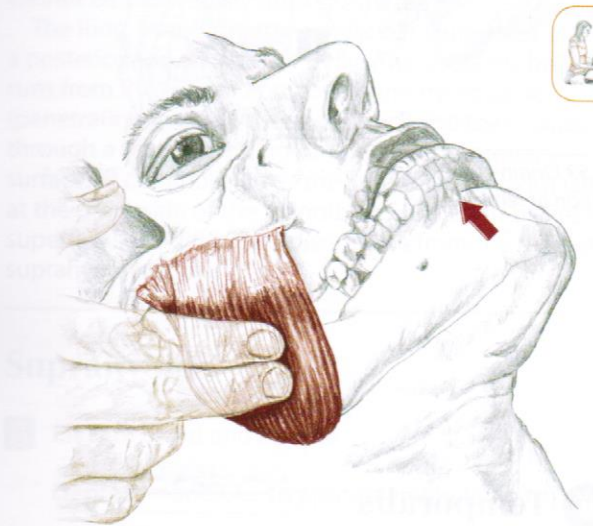


5.53 Origin and insertion

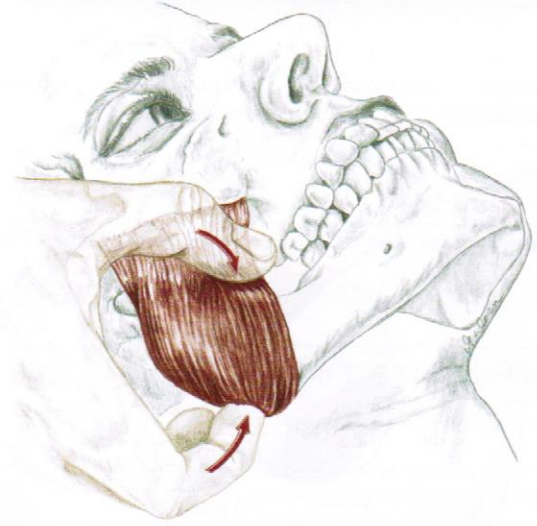
## **Masseter**

- 1) Partner supine. Locate the zygomatic arch and angle of the mandible. Place your fingers between these bony landmarks and palpate the surface of the masseter.
- 2) Ask your partner to alternately clench and relax her jaw as you sculpt out the square shape of the belly (5.54). Clarify the masseter's fiber direction by strumming your fingers horizontally across its muscle fibers.
- 3) Now ask your partner to relax and try grasping the chunky bellies of the masseter (5.55).

As your partner clenches her jaw, can you outline the anterior edge of the masseter? If your partner opens her jaw as wide as possible, can you feel the tissue lengthen?



5.54 Partner supine, clenching her jaw



5.55 Partner relaxes her jaw while you grasp the masseter

## **Temporalis** 颞肌

The temporalis muscle is located on the temporal aspect of the cranium. Its broad origin attaches to the frontal, temporal and parietal bones (5.56). Its fibers converge in a thick mass, reaching under the zygomatic arch to connect at the coronoid process. Though deep to the temporal fascia and artery, the temporalis is superficial and directly accessible.

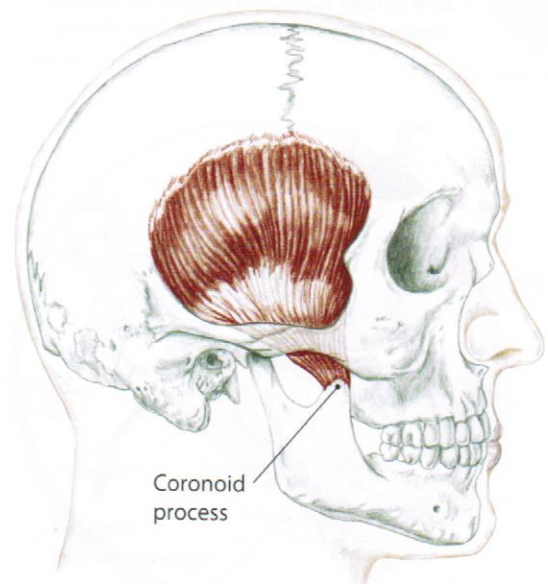
**A** Elevate the mandible (temporomandibular joint)

Retract the mandible (TM joint)

**O** Temporal fossa and fascia

**I** Coronoid process and anterior edge of ramus of the mandible

**N** Trigeminal (V) nerve (mandibular division)



5.56 Lateral view of temporalis

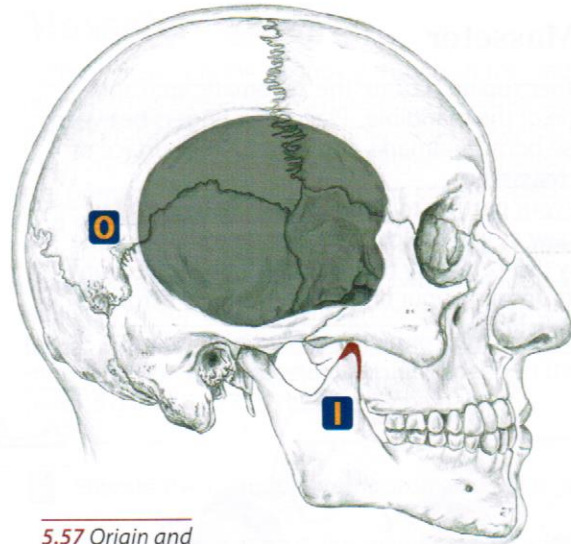
temporalis

tem-po-ra-lis

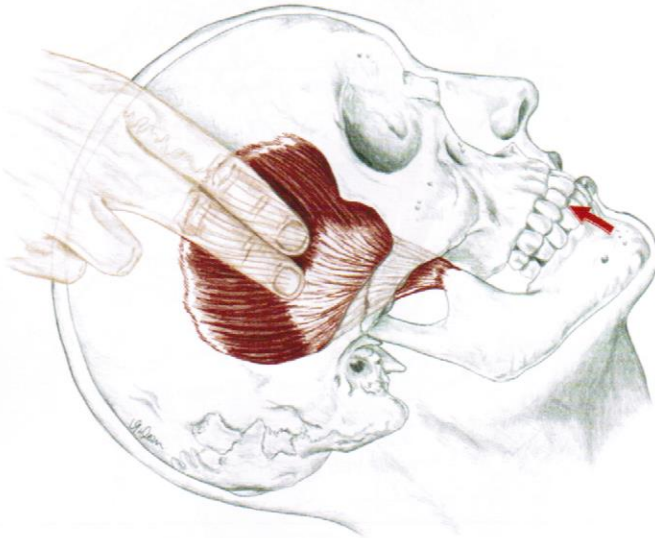
L. time, seen by the graying of hairs in this region

### When Do You Use Your Temporalis?

- Ripping off a piece of beef jerky
- Chewing that beef jerky
- Grinding your teeth while you sleep dreaming about beef jerky



5.57 Origin and insertion of temporalis



5.58 Partner supine, feeling the temporalis contract as your partner clenches her jaw



5.59 Isolating the temporalis tendon at the coronoid process of the mandible, with your partner's jaw open

### Temporalis



- 1) Partner supine with practitioner at head of the table. Locate the zygomatic arch.
- 2) Place your fingerpads one inch superior to the arch and ask your partner to alternately clench and relax her jaw. Do you feel the strong temporalis contracting beneath your fingers (5.58)?
- 3) To locate the insertion site of the temporalis tendon, ask your partner to open her mouth wide.
- 4) Locate and explore the coronoid process (5.59). Although the coronoid process is easily accessed, you may not be able to isolate the tendon of the temporalis.

✓ When exploring the muscle belly, are you superior to the zygomatic arch on the side of the head? Can you discern the direction of the muscle fibers and feel them converge?

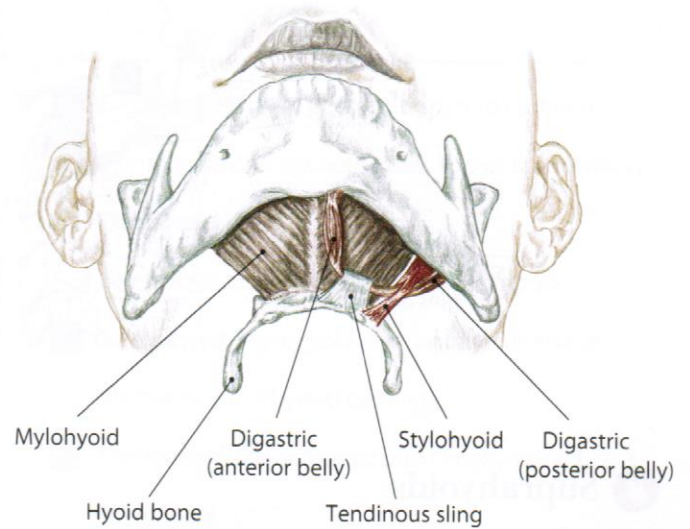
◆ To outline the wide origin of the temporalis, place your fingers in various positions on the side of the head and ask your partner to alternately clench and relax her jaw. If your fingers are on the muscle, you will feel the temporalis fibers tighten and soften. If you are off the muscle, you will feel nothing.

## Suprahyoids and Digastric

The suprahyoids (**geniohyoid**, **mylohyoid** and **stylohyoid**) form a wall of muscle along the underside of the jaw (5.60, 5.61). Stretching from the edge of the mandible to the hyoid bone, they lie inferior to the glossus muscles (the muscles of the tongue).

Even though each of the three suprahyoids is quite small, collectively they affect the tongue and hyoid bone and are important in chewing, swallowing and speaking. They are partially deep to the digastric muscle, yet are accessible. The suprahyoid bellies cannot be individually distinguished.

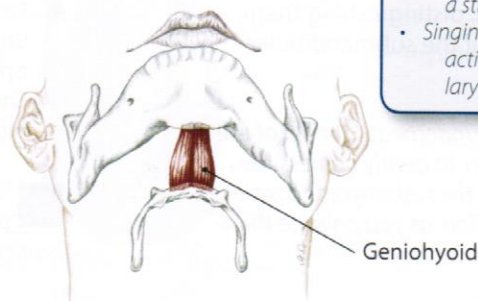
The long, round **digastric** muscle is composed of a posterior and an anterior belly. The posterior belly runs from the mastoid process to the hyoid bone (penetrating through the stylohyoid) and then loops through a tendinous sling on the hyoid's anterior surface. It continues on as the anterior belly to attach at the underside of the mandible (5.62). Both bellies are superficial, yet difficult to distinguish from the deeper suprahyoid muscles.



5.60 Anterior/inferior view; geniohyoid is deep to mylohyoid

## Suprahyoids

- A** **Elevate** hyoid and tongue
- Depress** mandible (temporomandibular joint)
- O** *Geniohyoid, Mylohyoid:*  
Underside of mandible  
*Stylohyoid:*  
Styloid process
- I** Hyoid bone
- N** *Geniohyoid:* C1, 2  
*Mylohyoid:* Trigeminal (V)  
*Stylohyoid:* Facial (VII)



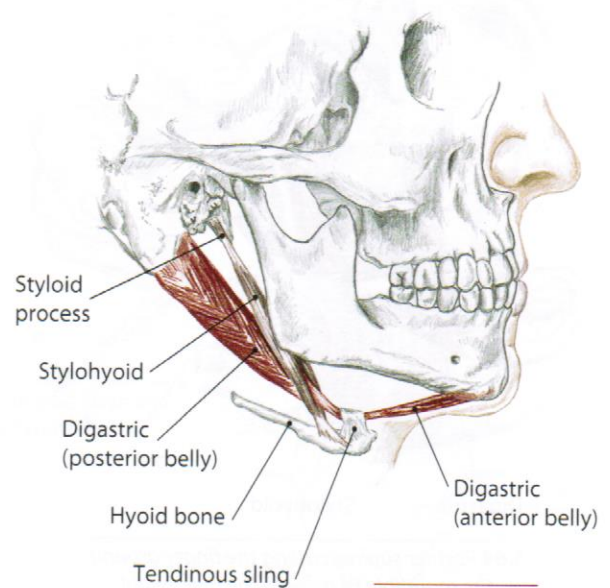
5.61 Anterior/inferior view

### When Do You Use Them?

- Chewing, swallowing, sucking on a straw
- Singing and speaking, since their actions affect the position of the larynx (voice box)

## Digastric

- A** With hyoid bone fixed, **depress** the mandible (temporomandibular joint)
- With mandible fixed, **elevate** the hyoid bone
- Retract** the mandible (TM joint)
- O** Mastoid process (deep to sternocleidomastoid and splenius capitis)
- I** Inferior border of the mandible
- N** *Anterior belly:* Trigeminal (V) (mandibular division)  
*Posterior belly:* Facial (VII)

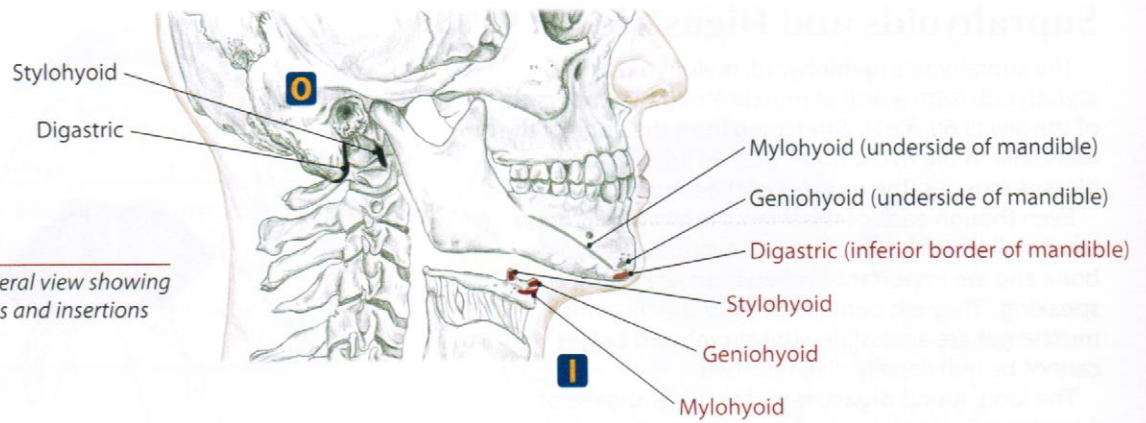


5.62 Lateral view

geniohyoid  
glossus

je-ne-o-hi-oyd  
glah-sis

Grk. *genion*, chin  
Grk. *tongue*

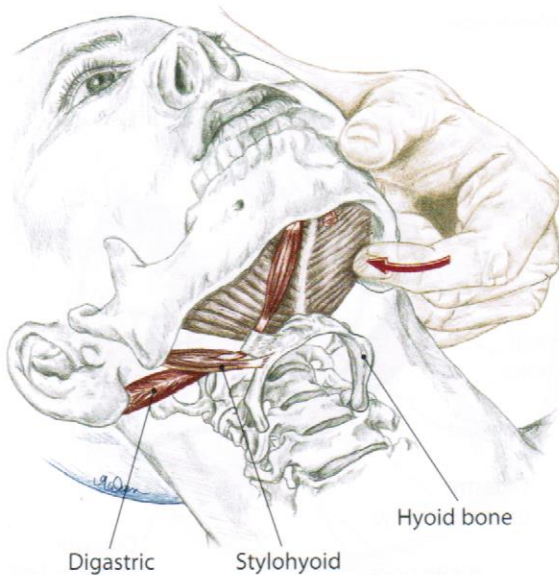


5.63 Lateral view showing origins and insertions

## Suprahyoids

- 1) Supine. With your partner's jaw closed, place your finger along the underside of the mandible.
- 2) Contract the suprahyoids by asking your partner to press the tip of her tongue firmly against the roof of her mouth. Note how this action forms a wall of taut muscle along the base of the mandible (jawline). Follow it as it extends down to the hyoid bone (5.64).
- 3) With the tongue relaxed, palpate the flat surface of the suprahyoid tissues, distinguishing them from the lumpy texture of the submandibular gland (p. 272).

✓ If you place a fingerpad underneath the tip of the chin and ask your partner to gently depress her mandible into your finger, do the suprahyoids contract? Also, ask your partner to swallow as you palpate the suprahyoids. Do these tissues contract?

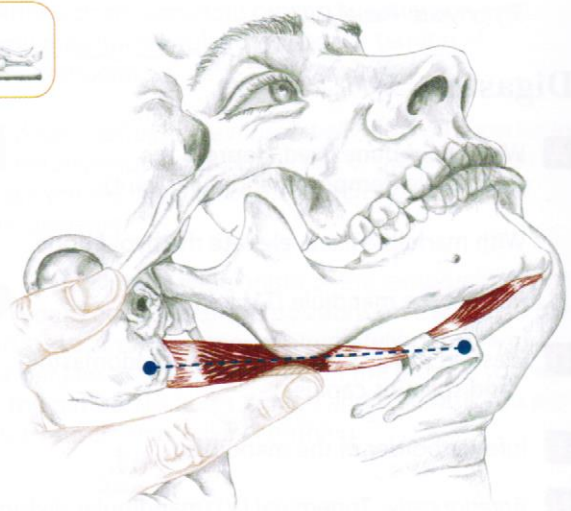


5.64 Partner supine, curling the finger around the mandible to palpate the mylohyoid

## Digastric

- 1) Partner supine with practitioner at head of table. Locate the mastoid process of the temporal bone and the hyoid bone.
- 2) Draw an imaginary line between these points. Using your index finger, palpate along this line for the skinny, posterior digastric (5.65).
- 3) Draw an imaginary line between the hyoid bone to the underside of the chin and palpate for its anterior belly.
- 4) To feel the digastric contract, place your finger under the chin and ask your partner to try to open her mouth against your gentle resistance. This contraction will sometimes allow both of the digastric bellies to be located more easily.

✓ Is the muscle you are palpating superficial and pencil-width? Does it extend from the mastoid process to the hyoid bone to the chin?



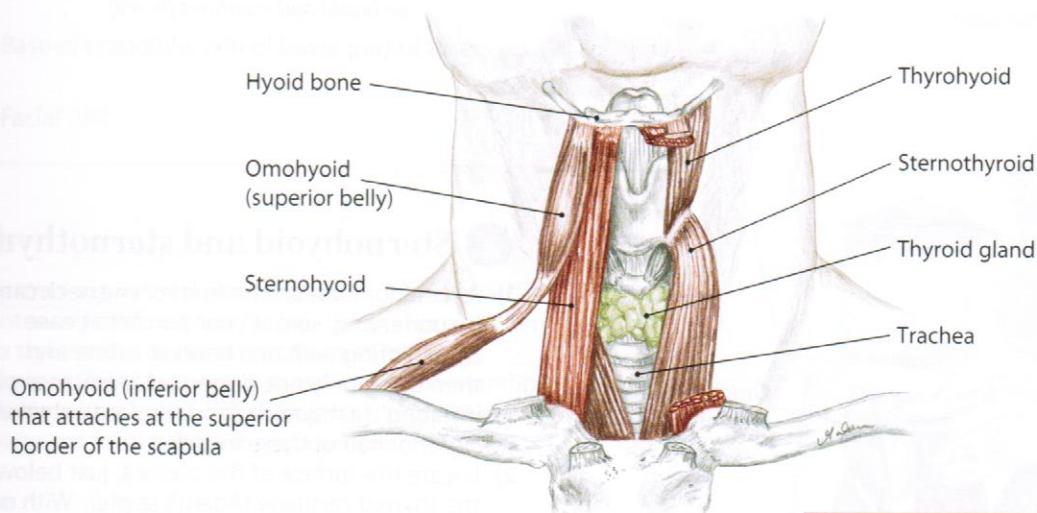
5.65 Isolating the digastric between the mastoid process and the hyoid bone

## Infrahyoids

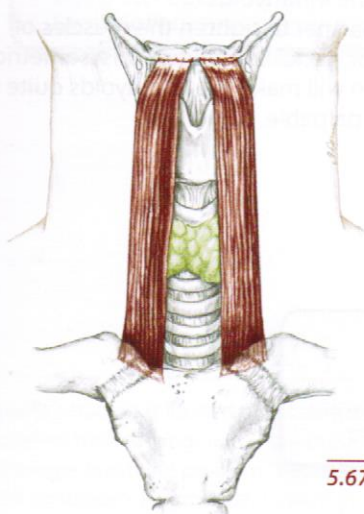
The infrahyoids are located on the anterior neck, superficial to the trachea (5.66). All four muscles are thin and delicate and function as antagonists to the suprahyoids. The superficial **sternohyoid** and **sternothyroid** are layered just to the side of the trachea and, although difficult to distinguish individually, are directly accessible. Deep to these two muscles is the **thyrohyoid**. As its name suggests, it spans from the thyroid cartilage to the hyoid bone.

The **omohyoid** (5.69) is perhaps the most bizarre muscle in the body. It has a skinny, ribbonlike belly running from the hyoid bone, passing underneath the SCM and scalenes, to the scapula. Aside from depressing the hyoid, the omohyoid tightens the fascia of the neck and dilates the internal jugular vein. Because of its depth and slender belly, the omohyoid is mostly inaccessible.

- A** Depress the hyoid bone and thyroid cartilage
- O** *Sternohyoid and Sternothyroid*: Top of manubrium  
*Thyrohyoid*: Thyroid cartilage  
*Omohyoid*: Superior border of the scapula
- I** *Sternohyoid, Thyrohyoid and Omohyoid*: Hyoid bone  
*Sternothyroid*: Thyroid cartilage
- N** *Sternohyoid, Sternothyroid and Omohyoid*: C1, 2, 3  
*Thyrohyoid*: C1, 2



5.66 Anterior view of neck, SCM removed



5.67 Sternohyoid

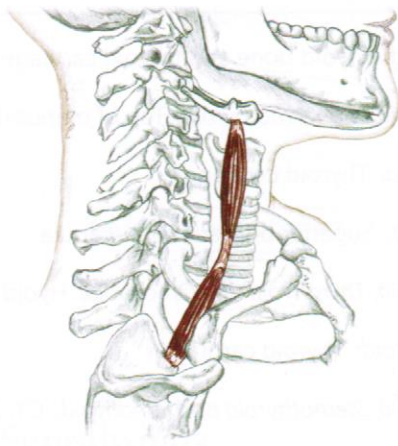


5.68 Thyrohyoid (top) and sternothyroid (below)

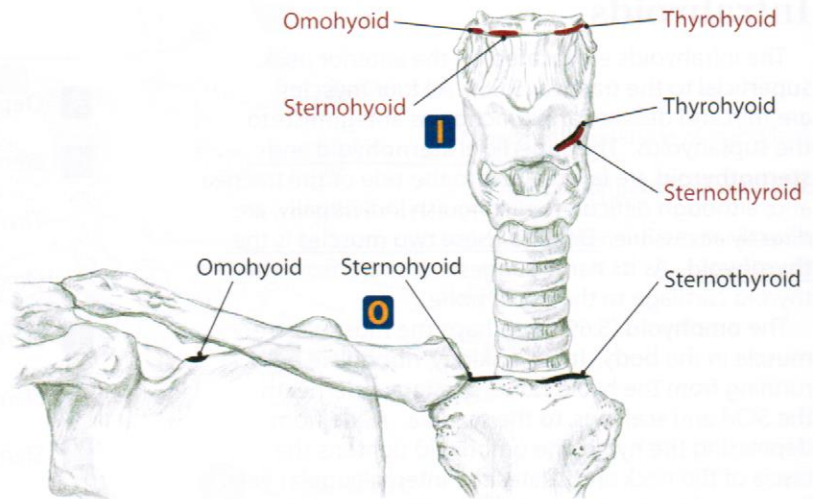
omohyoid  
sternohyoid  
sternothyroid

o-mo-hi-oyd  
ster-no-hi-oyd  
ster-no-thi-royd

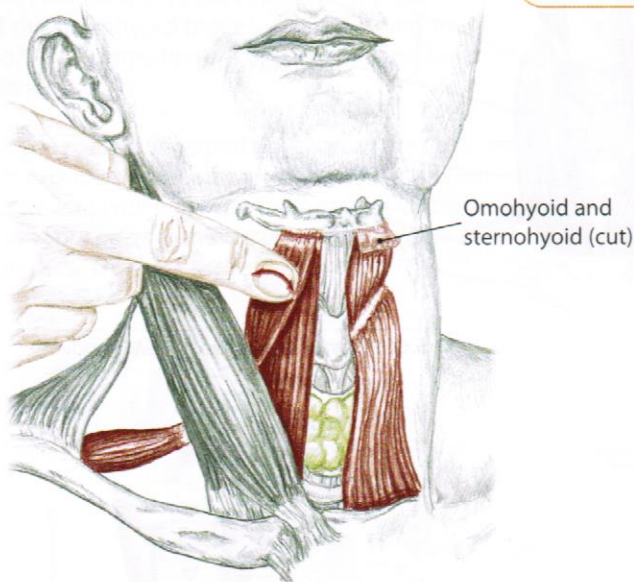
Grk. *omos*, shoulder



5.69 Lateral view of omohyoid



5.70 Anterior view showing origins (in black) and insertions (in red)



5.71 Partner supine, palpating the infrahyoids

### Sternohyoid and sternothyroid

- 1) A hand (or two) on the front of the neck can be unnerving, so put your partner at ease by exploring with one hand at a time and then using only one fingerpad. Also, to avoid irritating the thyroid gland, explore only the superior half of these muscles.
- 2) Locate the surface of the trachea, just below the thyroid cartilage (Adam's apple). With one fingerpad, slide lateral to the trachea and gently explore the thin tissue lying superficial to the windpipe. Try to roll your finger across the thin bellies of the infrahyoids (5.71).
- 3) Ask your partner to tighten the muscles of the anterior neck. Sometimes this isometric contraction will make the infrahyoids quite solid and easily palpable.

#### When Do You Use Your Infrahyoids?

- Drinking and swallowing
- Speaking (through their opposing action with the suprahyoids)
- Tightening the tissue of the anterior neck when threatened

## Platysma

The platysma is a thin, superficial sheath spanning the anterior neck from the mandible to the chest (5.72). The platysma and other facial muscles are integumentary muscles. Instead of connecting to bones, these muscles are embedded in the superficial fascia and attach to the skin and overlying muscle. The platysma's claim to fame is its ability to create the infamous "Creature from the Black Lagoon" expression.

**A** Assist to **depress** the mandible (temporomandibular joint)

**Tighten** the fascia of the neck

**Draw down** corner of the mouth

**O** Fascia covering superior part of pectoralis major

**I** Base of mandible, skin of lower part of face

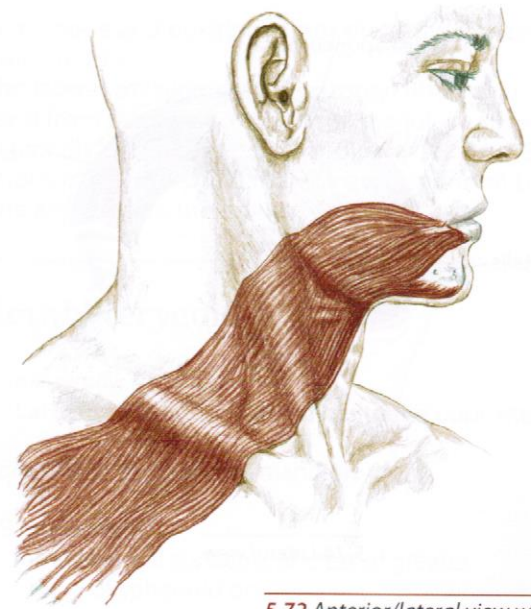
**N** Facial (VII)



- 1) **Partner supine.** Ask your partner to jut his head anteriorly and protract his jaw (5.73). Then ask him to tighten the tissue on the front of his neck.
- 2) Explore this thin sheet of muscle from the mandible down to the upper chest. Note any "flaps" the platysma forms along the lateral side of the neck.

### When Do You Use Your Platysma?

- Frowning or pouting
- Saying "ahh" at the dentist's office
- Forming an unequivocal expression of terror



5.72 Anterior/lateral view with head turned showing platysma



*Slaba...slaaaba*



5.73 Partner supine, contracting the tissue of the anterior neck

A giraffe's trachea is formed by more than a hundred tracheal rings and is the cause of a unique breathing problem. Because of the windpipe's length, each inhalation includes nearly two gallons of air that

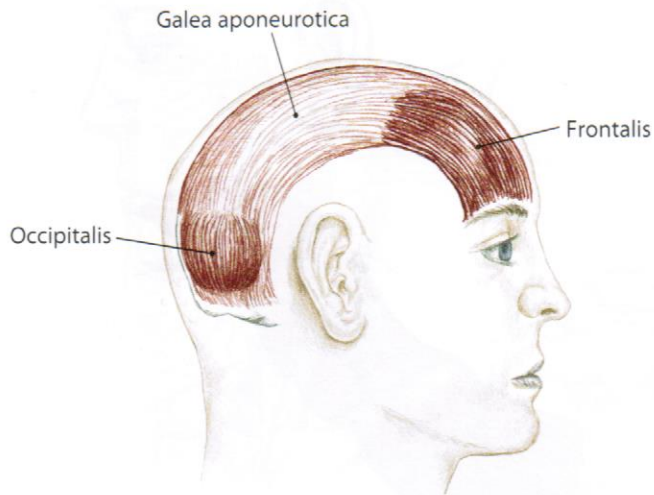
never reach the lungs. (Comparatively, a resting human takes in two gallons of air every minute.) To counteract this anatomical dead space, a giraffe is equipped with a massive lung capacity

of nearly twelve gallons. It has also been suggested that a giraffe's trachea might serve as a cooling device. As the trachea is filled with moist air, it cools the nearby blood vessels that travel up to the brain.

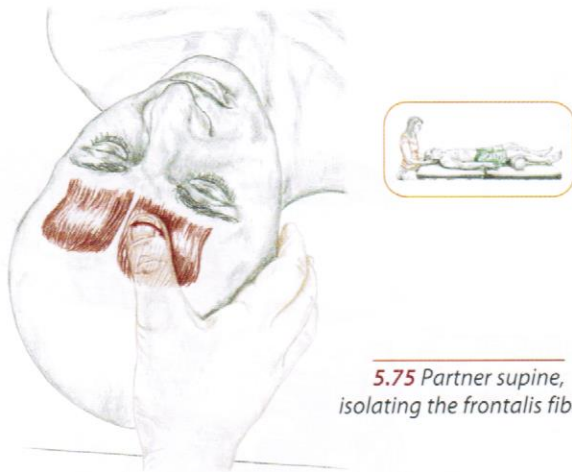
panniculus carnosus  
platysma

pan-ik-u-lus car-no-sis  
pla-tiz-ma

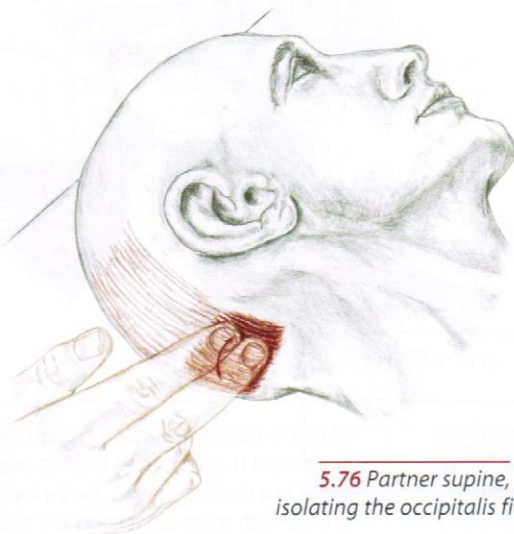
L. small, fleshy garment  
Grk. plate



5.74 Lateral view



5.75 Partner supine, isolating the frontalis fibers



5.76 Partner supine, isolating the occipitalis fibers

## Occipitofrontalis (Frontalis & Occipitalis)

The occipitofrontalis is the muscle primarily responsible for raising the forehead into an expression of surprise. It is a unique muscle with four thin bellies—two **frontalis** bellies on the forehead and two **occipitalis** bellies located on the back of the head. The four bellies are joined by the galea aponeurotica, a broad sheath of connective tissue stretching across the top of the cranium (5.74). Although the occipitofrontalis is superficial, its thin fibers cannot be isolated.

**A** *Frontalis:*  
**Raise** the eyebrows and wrinkle the forehead

*Occipitalis:*  
**Anchor** and **retract** the galea posteriorly

**O** *Both:* Galea aponeurotica

**I** *Frontalis:* Skin superior to eyebrows  
*Occipitalis:* Superior nuchal line of the occiput

**N** Facial (VII)

### Frontalis fibers

Partner supine. Place your fingers on the forehead and ask your partner to **raise his eyebrows** (5.75). Do you feel the tissue of the forehead contract?

### Occipitalis fibers

Supine or prone. Locate the superior nuchal line of the occiput (p. 232) and **slide your fingers one inch superiorly to isolate** the region of the oval occipitalis bellies (5.76).

#### When Do You Use Your OF?

- Raising your eyebrows in shock or surprise (frontalis)
- Smiling and yawning—according to a study of thirty volunteers who allowed electrodes to measure their muscle activity

## Medial and Lateral Pterygoids

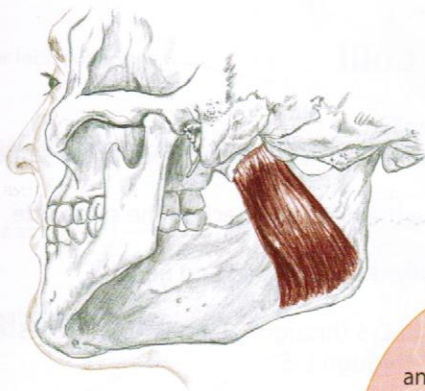
The medial and lateral pterygoids assist the masseter and temporalis with movement of the mandible. The **medial pterygoid** helps to elevate the mandible, while the lateral pterygoid protracts it. The medial pterygoid is located on the *interior* side of the mandible (5.77)

and its shape and position mirror the *exterior* masseter muscle (p. 250).

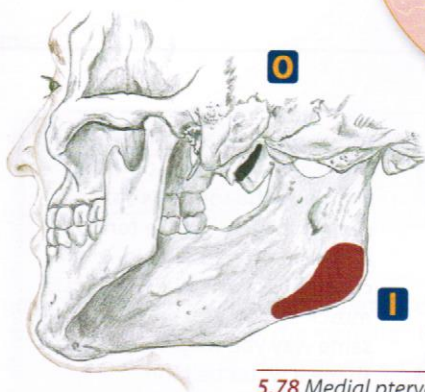
The **lateral pterygoid** has horizontal fibers that extend from the sphenoid bone to the joint capsule and articular disc of the temporomandibular joint (5.79). Portions of the pterygoids can be accessed from both inside and outside the mouth.

### Medial Pterygoid

- A** Unilaterally:  
**Laterally deviate** the mandible to the opposite side
- Bilaterally:  
**Elevate** the mandible
- Protract** the mandible
- O** Medial surface of lateral pterygoid plate of sphenoid bone and tuberosity of maxilla
- I** Medial surface of ramus of the mandible
- N** Trigeminal (V)



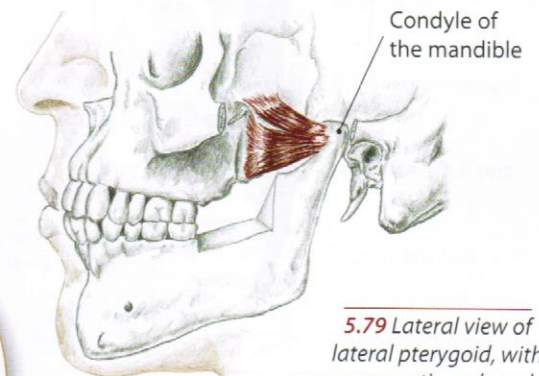
5.77 Posterior/lateral view of medial pterygoid



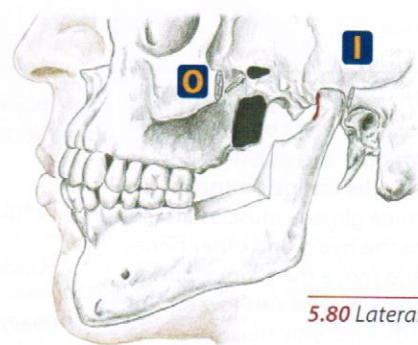
5.78 Medial pterygoid

### Lateral Pterygoid

- A** Unilaterally:  
**Laterally deviate** the mandible to the opposite side
- Bilaterally: **Protract** the mandible
- O** Superior head:  
Infratemporal surface and crest of greater wing of sphenoid bone
- Inferior head:  
Lateral surface of lateral pterygoid plate of sphenoid bone
- I** Articular disc and capsule of temporomandibular joint, neck of mandible
- N** Trigeminal (V)

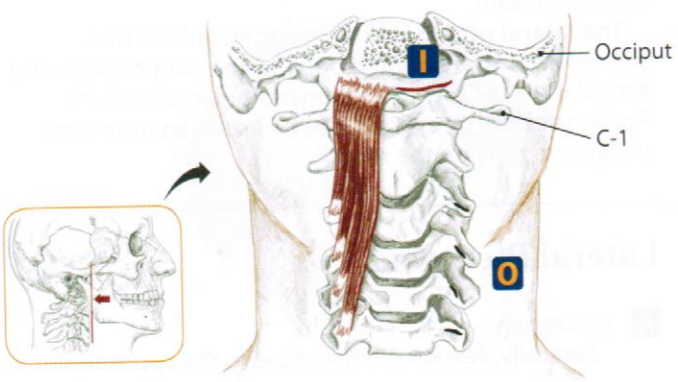


5.79 Lateral view of lateral pterygoid, with zygomatic arch and mandible cut

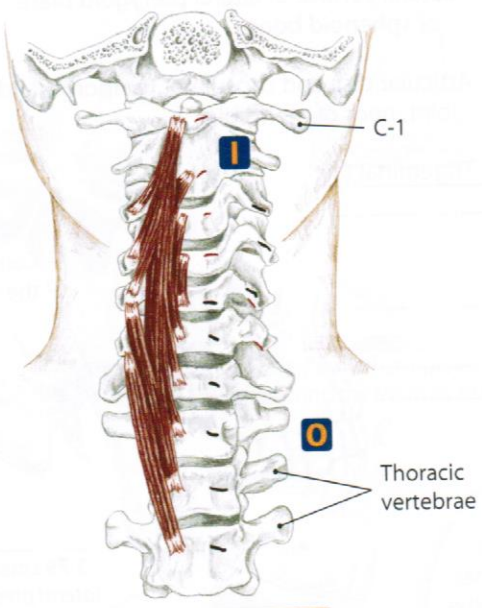


5.80 Lateral pterygoid

While the pterygoids can be accessed safely and effectively through the mouth (and the longus muscles on p. 260 can be located on the anterior neck), these palpation techniques are best learned at a specific hands-on workshop in the presence of an experienced, patient instructor.



5.81 Anterior view of cervical vertebrae showing longus capitis



5.82 Anterior view of cervical vertebrae showing longus colli

## Longus Capitis and Longus Colli

Tucked between the trachea and the cervical vertebrae are two small muscles—**longus capitis** and **longus colli** (5.81, 5.82). Attaching from the anterior surface of the cervical vertebrae to the occiput and atlas, they laterally flex, rotate and flex the head and neck. They also help to reduce the lordotic curve of the cervical vertebrae. Each muscle has a multi-branched design similar to that of the erector spinae muscles of the back.

### Longus Capitis

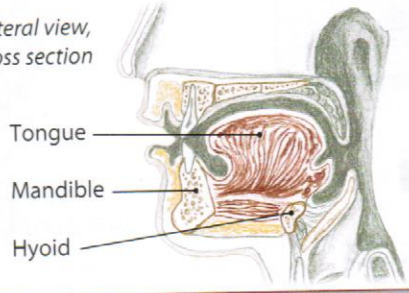
- A** Unilaterally:
  - Laterally flex** the head and neck to the same side
  - Rotate** the head and neck to the same side
- Bilaterally: **Flex** the head and neck
- O** Transverse processes of C-3 through C-6
- I** Inferior surface of occiput
- N** C1, 2, 3, (4)

### Longus Colli

- A** Unilaterally:
  - Laterally flex** the head and neck to the same side
  - Rotate** the head and neck to the same side
- Bilaterally: **Flex** the head and neck
- O** Bodies of C-5 through T-3, transverse processes of C-3 through C-5
- I** Tubercle on anterior arch of the atlas; bodies of the axis, C-3 and C-4; transverse processes of C-5 and C-6
- N** C2-6, (7)

There are two groups of muscles that coordinate the tongue: the glossus muscles and the intrinsic muscles. The three glossus muscles attach to the hyoid and other bones and move the tongue during chewing and swallowing. Three other intrinsic muscles of the

Lateral view, cross section



tongue interweave with each other and are responsible for changing the tongue's shape during speech. As the tongue is basically a bag of fluid with a constant volume, these intrinsic muscles mold and twist it in the same way you might bend and shape a water balloon.



# Muscles of Facial Expression

The vast range of expressions the human face displays is created by <sup>30</sup>thirty facial muscles—more than on any other animal. They can be divided into four groups: muscles of the mouth, nose, eyes and scalp.

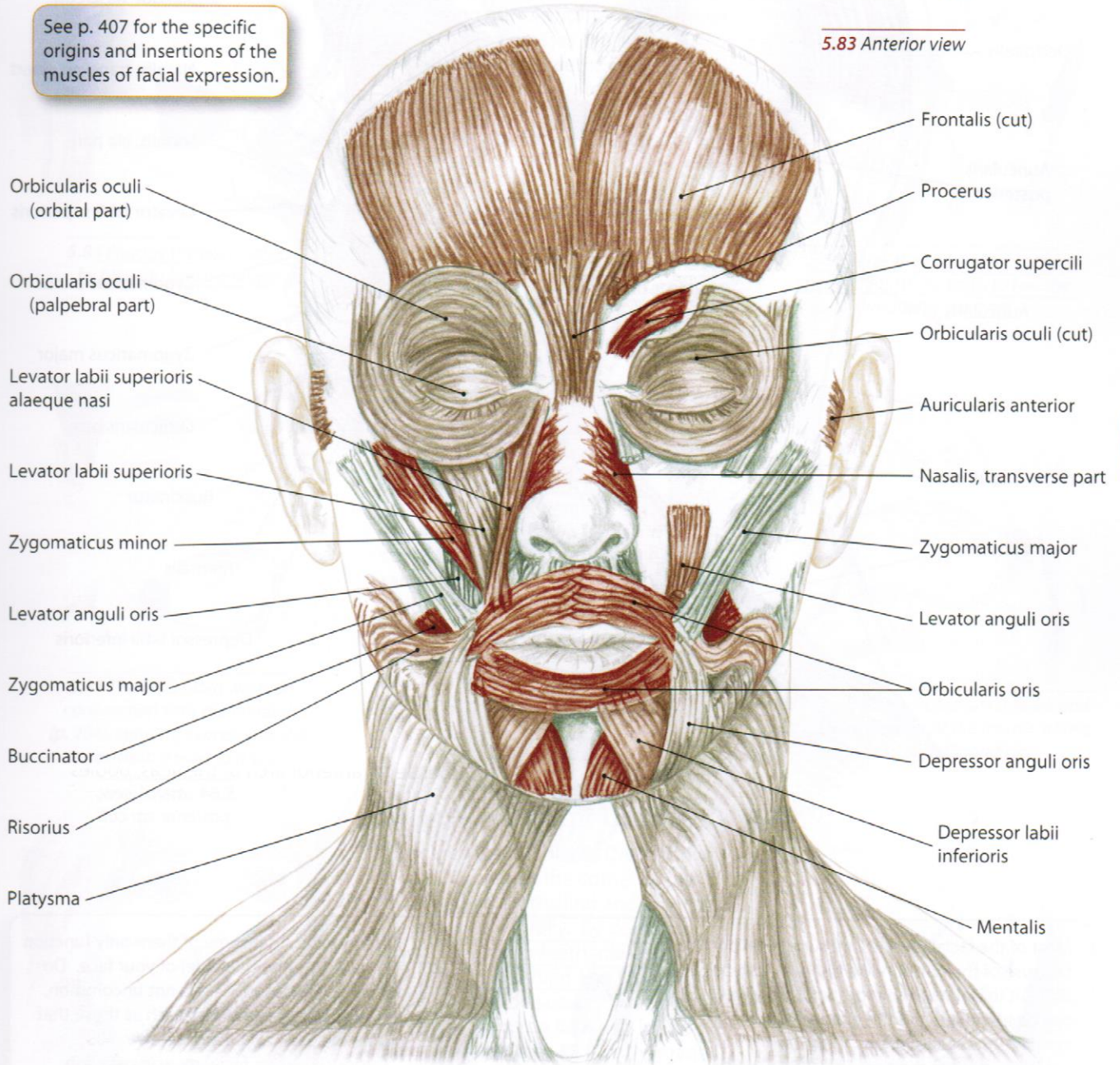
Unlike skeletal muscles that connect to bones, many of the muscles of facial expression are *integumentary* muscles, meaning they are embedded in the superficial fascia and attach to the skin and overlying muscle.

They are also *mimetic* muscles, since they express emotion. Many of the facial muscles are structurally integumentary and functionally mimetic.

Collectively these muscles form expressions or actions such as crinkling the eyebrows in confusion, flaring the nostrils in anger, puckering the lips for a kiss or raising the chin to pout. Smiling is generated by eight muscles while frowning can require up to twenty.

See p. 407 for the specific origins and insertions of the muscles of facial expression.

5.83 Anterior view



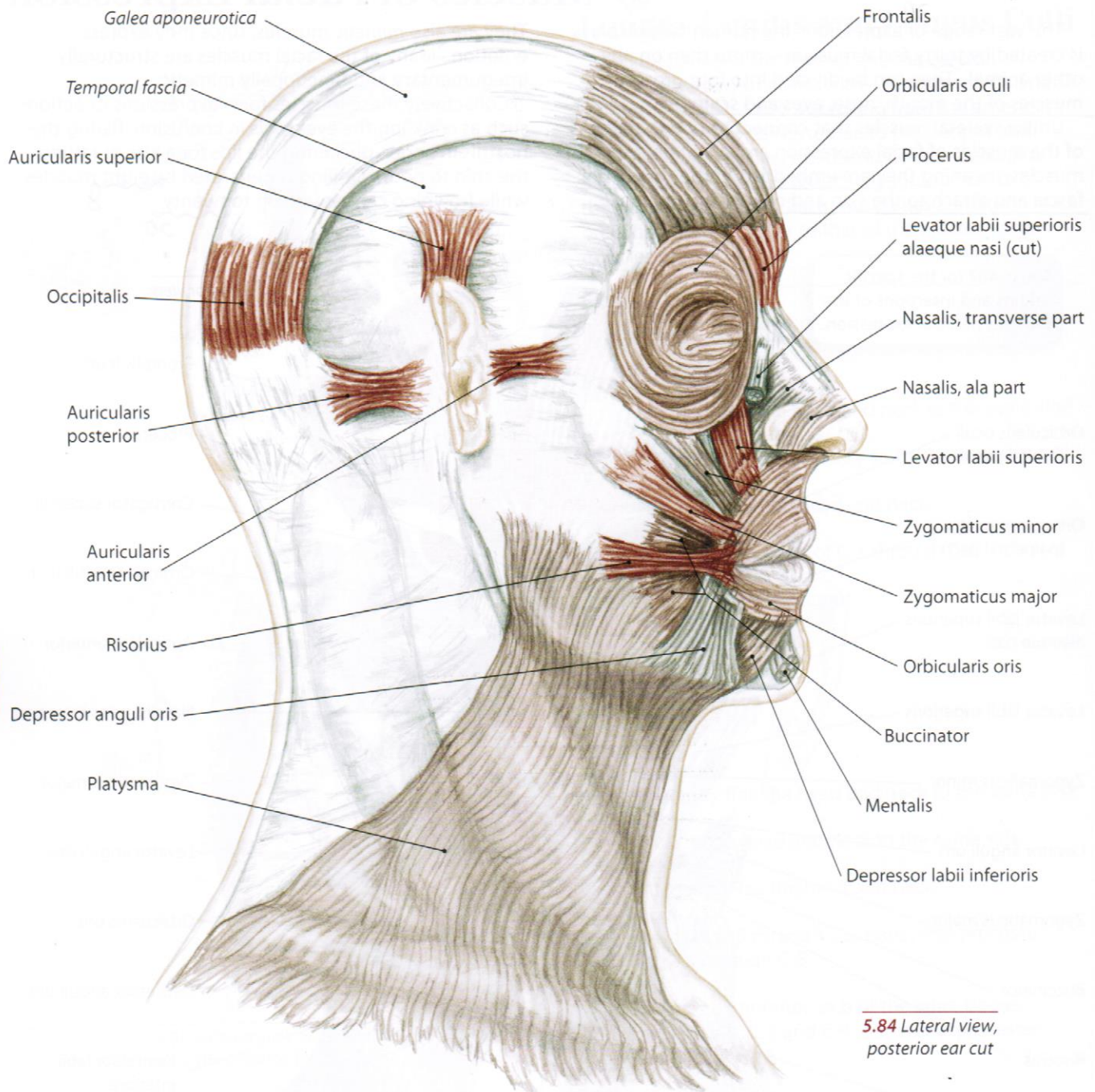
Some muscles are identified with a certain expression. For example, a pout requires the mentalis. But, in reality, a clear facial message—doubt, fear, joy—is the result of several muscles. For that pout, the mentalis will push out

the lower lip; but for a more convincing sulcus, one would also need both depressor anguli oris muscles to pull down the corners of the mouth and the corrugator supercili to furrow the brow. Now *that's* an expression.

philtrum  
integumentary  
mimetic

fil-trum  
in-teg-u-ment-ary  
mi-me-tik

Grk. to love, to kiss  
something that covers or encloses  
relating to, characterized by, or exhibiting mimicry



5.84 Lateral view, posterior ear cut

Most of the facial muscles are superficial but, because of their ribbon-like thinness, can be difficult to isolate. Their locations, however, can be identified and the effects of their contractions can be seen.

Unlike other sections of *Trail Guide*, which are designed for you to palpate on a partner, this section is designed for you to palpate on your own face (optimally in front of a mirror). You may discover, while attempting to engage



these muscles, that some of them only function on one side (or neither side) of your face. Do not be disheartened. This is not uncommon, and, with practice, muscles such as those that wiggle the ears can become active.

Curiously, when facial muscles are contracted involuntarily by emotion, they are more symmetrical, while deliberate or voluntary expressions often produce a more asymmetrical contraction.

## Muscles of the Mouth

There are eleven mimetic muscles that form expressions of and around the mouth (twelve including the LLSAN, a muscle of the nose, p. 267). Except for the single orbicularis oris that encircles the mouth, all of these

muscles are present bilaterally on the face. This brings the total number of muscles that create expressions of the mouth to twenty-three.

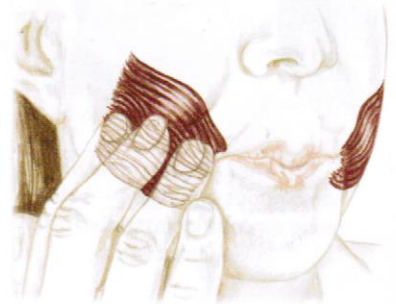


5.85 Engage the buccinators by blowing into a trumpet

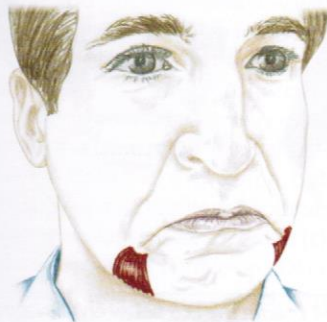
### Buccinator 颊肌

Located at the center of the cheek, this strong muscle tightens the corner of the lip and presses the cheek firmly against the teeth. Bilateral involvement will help to blow a trumpet, suck on a straw or assist in mastication by keeping food between the molars.

Visually, it can produce a small dimple at the cheek's center and, with a unilateral contraction, generate a look of contempt. Blowing out the cheeks will stretch the buccinators.



5.86 Purse the lips and press the cheeks against the teeth to feel the buccinator contract



5.87 The DAO often works in conjunction with the mentalis (p. 264), creating expressions that range from a pout to a scowl

### Depressor Anguli Oris 角降肌

The DAO pulls the corner of the mouth inferiorly and laterally. With a bilateral contraction it forms an inverted "clown smile." Mild engagement of the DAOs is a common, involuntary signal of sadness, while a solid contraction is often associated with frowning. Look for it during both reprimands (upset parent to mischievous child) and apologies (contrite politician to skeptical public).



5.88 The DAO is located just inferior and lateral to the corner of the mouth, above the base of the mandible

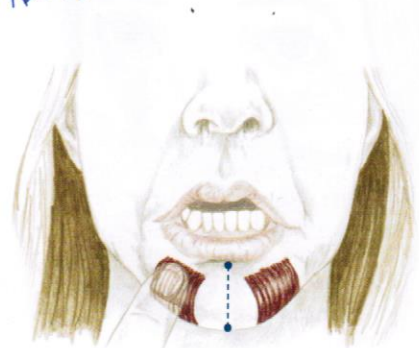


5.89 The DLI, along with orbicularis oris (p. 265), helps to shape the mouth during speech

### Depressor Labii Inferioris 唇降肌

Located just medial to DAO (above), the DLI depresses the corner of the mouth while protruding and drawing the lower lip laterally. By doing so, it bares the lower teeth, making it essential for brushing and flossing.

The DLI can be seen at sporting events both on the field and in the stands. An athlete's DLIs will engage to display determination (for example, a soccer player sprinting for the goal) while opposing fans will use their DLIs to express mock anger (especially if the player scores).



5.90 The DLI is located lateral to the center of the chin

buccinator  
labii

buk-sin-aye-tor  
lay-bee-eye

L. trumpeter, proclaimer  
L. pert to the lips

## Muscles of the Mouth



5.91 The LAO can create an ambiguous expression—is she being sardonic or just ticked off?

### Levator Anguli Oris 嘴角肌

This short muscle arises off the corner of the mouth and is located lateral to the levator labii superioris (below). *Bilateral* contraction of the LAOs will assist in smiling. A mild, *unilateral* contraction of this muscle will elevate the corner of the mouth, giving the impression of self-confidence. A strong clench, however, will replace assuredness with a smirk (left).



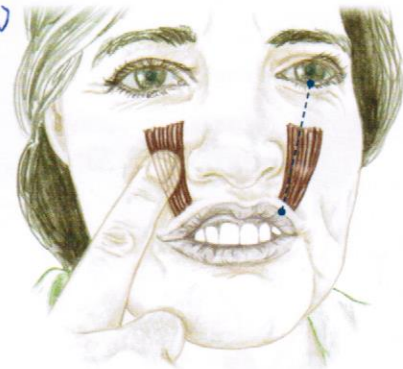
5.92 The LAO is located between the corner of the mouth and the center of the eye



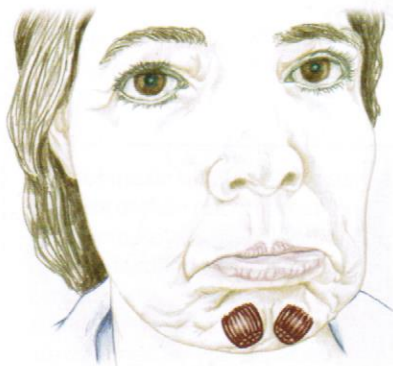
5.93 Grrr!

### Levator Labii Superioris 唇提肌

The LLS is located medial to the levator anguli oris (above). *Bilateral* contraction will elevate and protrude the upper lip, such as when searching for food stuck between the teeth. A mild *unilateral* flex will produce an Elvis-like lip curl, while a *strong* contraction (left) manifests a contemptuous snarl that displays the canine tooth.



5.94 Locate the LLS between the upper lip and the center of the eye, passing next to the ala of the nose

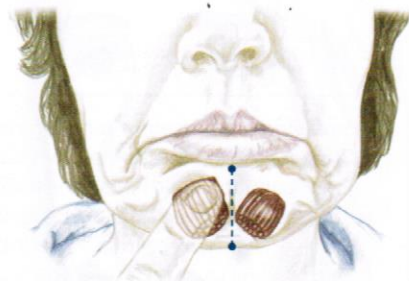


5.95 "Nobody wants to play with me."

### Mentalis 颏肌

The chin's most medial muscle is the mentalis. Bilateral contraction will elevate the skin of the chin and protrude the lower lip to form the universally understood signal of a pout. A *stronger* contraction will dimple the surface of the chin, forming a more sullen expression.

When you see this muscle's effects on the lower lip and chin, be well prepared for a cry of anguish or sadness in infants and some adults.



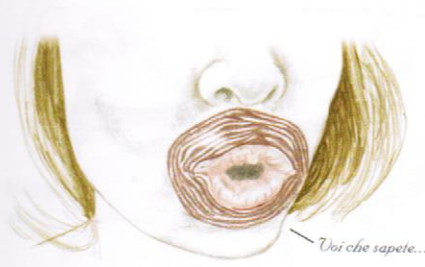
5.96 Locate the mentalis just off the centerline of the chin

## Muscles of the Mouth

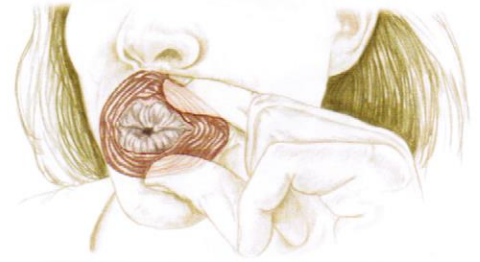
### Orbicularis Oris *orbicularis*

This strong sphincter muscle encircles the mouth. It is responsible for closing the mouth and shaping the lips during speech and eating. The oris is indispensable to brass and woodwind players as well as to an anguished lover protruding his lips to deliver a long-distance kiss. Because its many strands can act separately, the oris can either narrow or protrude the lips, both signaling different states of anger.

See for yourself how necessary the orbicularis oris is for speech by enunciating the "Mary Poppins" phrase, "Supercalifragilisticexpialidocious."



5.97 Look for a busy orbicularis oris during an opera recital



5.98 The oris is located around the lips

There are seven primary facial expressions: anger, contempt, disgust, fear, happiness, sadness and surprise—and few would confuse one with the other. But a minuscule shift of the face can transform these clear signals into something ambiguous. For example, (a) "happiness" raises the corners of the mouth, displays the upper teeth and slightly narrows the eyes. Hold that expression, but now raise the eyebrows (b) and see how happiness becomes excitement. Furrow the eyebrows (c) and the face projects anxiety or confusion. Of course, if there are a hundred different expressions, there are a thousand different interpretations.



a) Happiness



b) Excitement



c) Anxious, confused or both?

### Platysma

The platysma is a thin, superficial sheath spanning the anterior neck from the fascia of the superior part of the pectoralis major to the base of the mandible. It assists in depressing the jaw, drawing down the corners of the mouth and tightening the fascia of the neck. The platysma's claim to fame is its ability to create the infamous "Creature from the Black Lagoon" expression, but more commonly it is seen in moments of extreme fear, terror or rage.

To palpate the platysma on your partner, see p. 257.



5.99 Tightening the fascia of the neck and pulling down the corners of the mouth



5.100 Feeling the platysma on the lateral neck

orbicularis oris  
platysma  
risorius

or-**bik**-u-**la**-ris o-ris  
pla-**tiz**-ma  
ri-**so**-re-us

Grk. plate  
L. to laugh

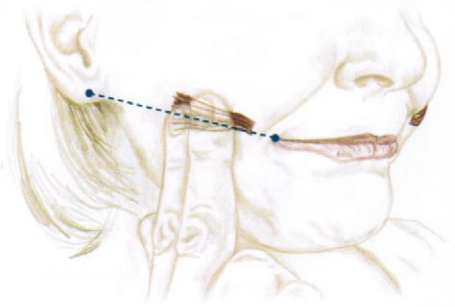
# Muscles of the Mouth



5.101 Yes, she's smiling, but as her eyes and eyebrows are not involved, it's hard to believe she's sincere

## Risorius 笑肌

Although it means "to laugh" in Latin, contraction of this muscle may indicate that there is nothing to laugh about. Positioned horizontally across the cheek, the risorius is superficial to the buccinator (p. 263). It retracts the corner of the mouth laterally and forms an insincere-looking smile. Look for it when someone is suffering through an unfunny joke.



5.102 Locate the risorius by drawing an imaginary line between the corner of the mouth and the ear lobe



5.103 Now here's a genuine smile (note the alliance between the eyes and mouth)

## Zygomaticus Major 颧大肌

This muscle draws the corner of the mouth upward and laterally with bilateral contraction, prominently displaying the upper row of teeth. It is the muscle often associated with joy, pleasure and laughter.

When activated with the eye-squinting orbicularis oculi (p. 268), these muscles generate an authentic smile of enjoyment. However, without the oculi's participation, the zygomaticus' solo "smile" presents a false signal of enjoyment.



5.104 Locate the Z major by drawing a line between the corner of the mouth and the apex of the cheekbone



Nasolabial furrow

5.105 Unlike the joyous smile of the Z major (above), the Z minor forms a more understated and internal expression

## Zygomaticus Minor 颧小肌

Located medial to the zygomaticus major, the minor elevates and protrudes the upper lip. These actions deepen the nasolabial furrow and puff out the top of the cheek. Depending on the circumstances, this facial gesture can produce expressions ranging from a smile to a grimace.

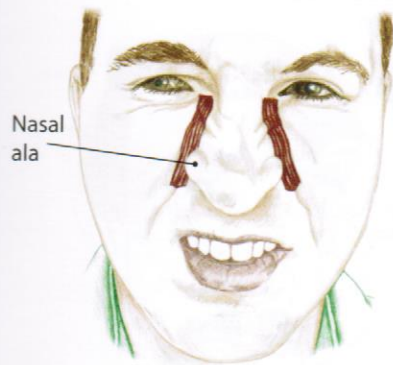


5.106 Locate the Z minor by drawing a line between the corner of the mouth and the corner of the eye

## Muscles of the Nasal Region

There are three muscles responsible for movement of the nose and its surrounding area. Unlike the mouth and eyes

(where humans instinctively look for emotional signals), the movements and positions of the nose are somewhat secondary.



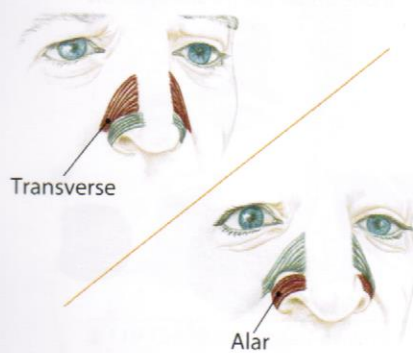
5.107 "Monsieur, you disgust me!"

### Levator Labii Superioris Alaeque Nasi

Aside from having the longest name of any muscle, the LLSAN is a vertical strip along the side of the nose that elevates the nasal ala (flaring the nostril). It also elevates and protrudes the upper lip. A strong, bilateral contraction deepens the nasolabial folds and forms diagonal wrinkles along the bridge of the nose, generating an expression of disgust. Look for it when a person hears an objectionable comment.



5.108 Locate the LLSAN alongside the nose



5.109 The transverse portion contracts at the smell of rotten food; the alar portion flares the nostril for a deep breath of fresh air

### Nasalis

The nasalis consists of two parts. The *transverse* portion, located on the side of the nose, constricts the nostril and draws down the tip of the nose. The *alar* portion wraps around the nasal ala and flares the nostril during forced respiration. Nostril expansion can also be useful when taunting an opponent or, in some cultures, as a discriminating tip-off of one's amorous intentions.



5.110 Accessing the transverse part of the nasalis on the sides of the nose



5.111 Contraction of the procerus can often appear as an expression of anger or concern

### Procerus

This small triangular muscle, located on the forehead, is often more involved with the eyebrows than with the nose. Along with the LLSAN, it wrinkles up the skin of the nose (such as when sneezing) and draws down the skin between the eyebrows (creating horizontal creases over the bridge of the nose). It often acts in conjunction with the corrugator supercillii (p. 268) to produce expressions of concentration or perplexity.



5.112 Locating the procerus between the eyebrows

alaeque a-le-kwe  
levator labii superioris alaeque nasi  
procerus pro-se-rus

L. wing (*ala* of nose)  
L. "lifter of the upper lip and of the wing of the nose"  
L. slender, elongated

## Muscles of the Eyes

These two muscles (as well as the procerus, p. 267) actually control the movement and position of the *eyebrows* and *eyelids*. Aside from protecting the eyeballs, they also convey visual signals about one's emotional

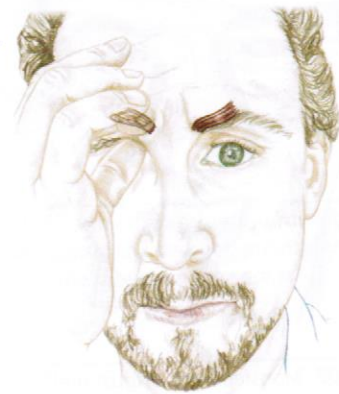
state. This is an effective communication system because we instinctively glance at a person's eye region *first* for a hint of their underlying mood or intention.



5.113 Chronic contraction of the CS can create permanent, vertical "frown lines" between the eyebrows

### Corrugator Supercilii 皱眉肌

Charles Darwin called this the "muscle of difficulty" because of its involvement with anything demanding—emotional, mental or physical. Located beneath the medial portion of the eyebrow, the corrugator draws the eyebrow medially and inferiorly. Bilateral contraction can form vertical wrinkles between the eyebrows, often creating a frown associated with anger, worry or perplexion.



5.114 Locate the CS by squeezing the tissue under the medial eyebrow

### Orbicularis Oculi 眼轮匝肌

This sphincter muscle encircles the eye and is responsible for closing the eyelid. The thicker, outer fibers form the *orbital* part of the muscle. They can squeeze the eyelid together or hold it in a partially closed position of a squint (creating an expression of distrust).

The inner fibers, the *palpebral* part of the muscle, involuntarily close the eyelid during blinking and sleeping.

"Smiling with your eyes" will engage the lateral portion of your oculi, but over time the chronic contraction of this muscle will form radiant creases of your skin called "crow's feet."



5.115 A glass of water in the face will activate the oculi



5.116 Palpate the tissue surrounding the eye to locate the oculi

### Moving your Eyeball

The movements of the human eye are controlled by six muscles, four of which are the *superior*, *inferior*, *medial* and *lateral rectus* muscles. Each rectus inserts on the corresponding side of the eyeball's anterior half. Depending on the position of the eye, the inserting tendon of a rectus muscle can be gently accessed. For example, rolling your eye downward will pull the superior rectus tendon out from under the eye socket and into a palpable position underneath the upper eyelid.

A seventh muscle, *levator palpebrae superioris*, attaches to the undersurface of the upper eyelid and is responsible for raising the eyelid.

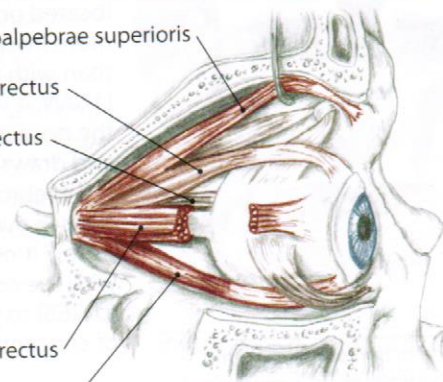
Levator palpebrae superioris

Superior rectus

Medial rectus

Lateral rectus

Inferior rectus

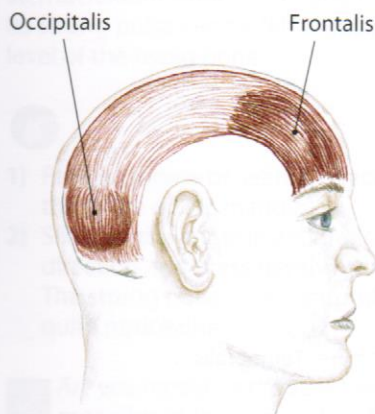


Lateral view of right eye

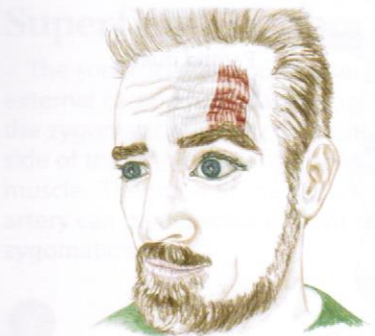
## Muscles of the Scalp

The five muscles of the scalp are present bilaterally on the cranium. All of them are thin sheets that penetrate

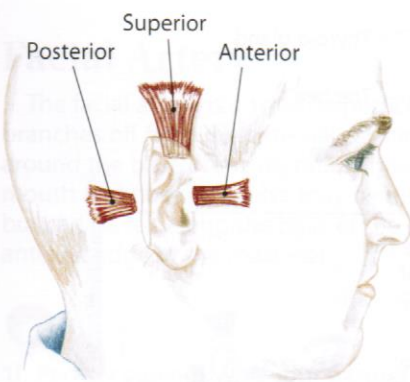
into the galea aponeurotica, a broad sheath of connective tissue which stretches across the top of the cranium.



5.117



5.119 The classic raised-eyebrow expression is formed by the lateral portion of the frontalis



5.121 The three auricularis muscles around the ear (cut)

### Occipitofrontalis (Frontalis & Occipitalis)

Each side of the cranium has an occipitofrontalis muscle consisting of two parts: a *frontalis* and an *occipitalis*. The frontalis is on the forehead while the occipitalis is located on the back of the head. All four muscle bellies are joined by the galea aponeurotica.

The frontalis fibers are responsible for raising the eyebrows and wrinkling the forehead (5.118). Bilateral contraction of the frontalis' *medial* portion pulls up the inner eyebrows and produces an expression of sadness. A unilateral engagement of the *lateral* frontalis fibers can send a signal of skepticism or intimidation (5.119).

The occipitalis bellies anchor and retract the galea posteriorly. To palpate the occipitofrontalis on your partner, see p. 258.



5.118 The frontalis muscles produce a look of surprise



5.120 Accessing the frontalis

### Auricularis Muscles

The three auricularis muscles (*anterior*, *superior* and *posterior*) are located above and alongside the ear on three sides. They are thin, fan-shaped and sheathed in the scalp. Theoretically, they have the capacity to move the ear.

The name of each muscle not only states where it is in respect to the ear, but also in which direction it will pull the ear. For example, the *auricularis posterior* is located posterior to the ear and, if you are coordinated, will move it posteriorly. Strong, alternating contractions of the *anterior* and *posterior* muscles can produce an impressive wiggling of the ear.



5.122 The location of the auricularis superior is just above and in front of the ear (cut)

auricularis  
occipitofrontalis

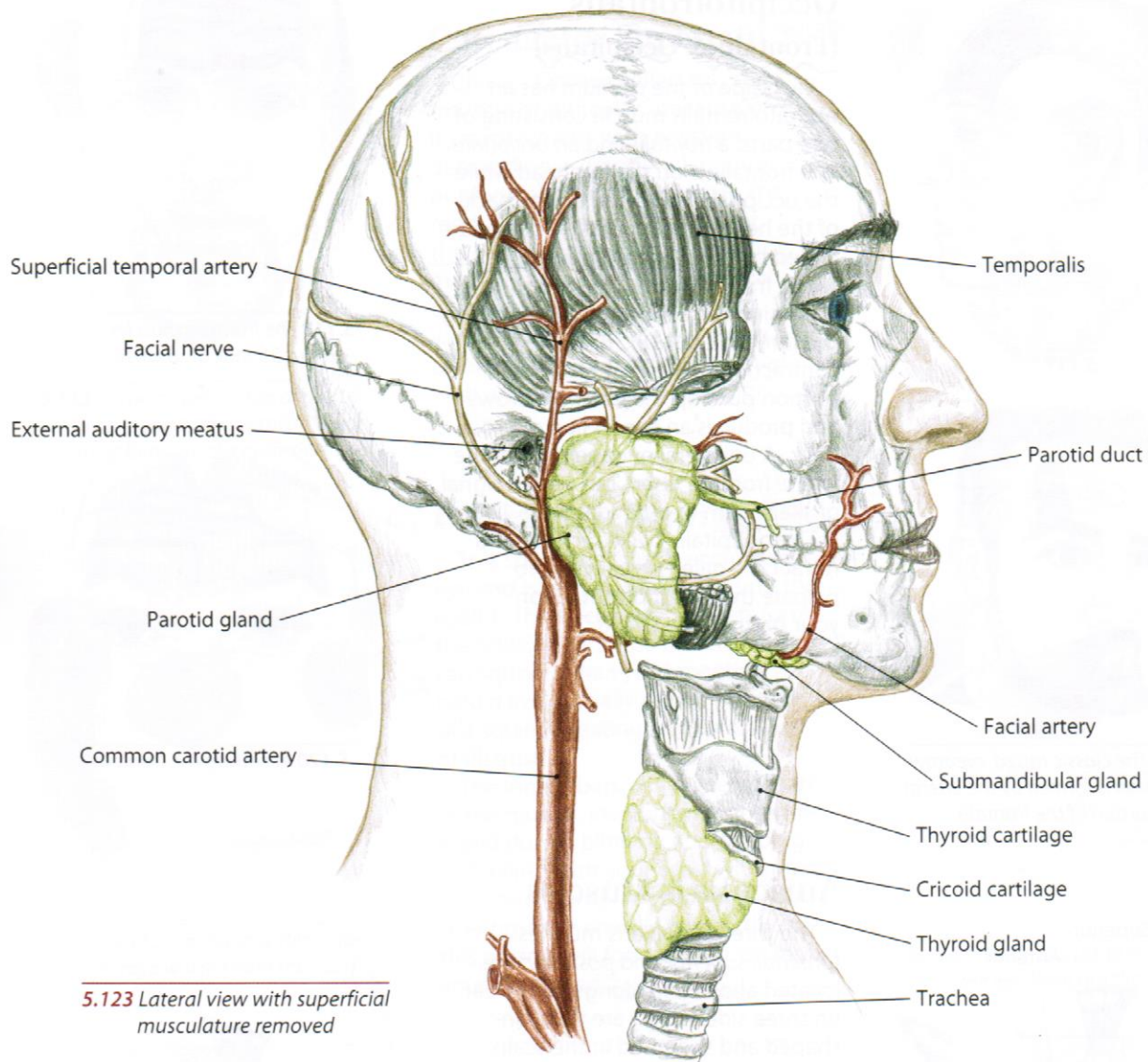
aw-rik-u-la-ris  
ok-sip-i-to-fron-ta-lis

L. little ear

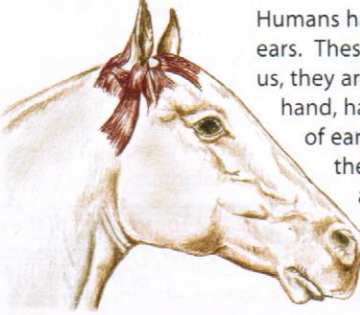


# Other Structures of the Head, Neck and Face

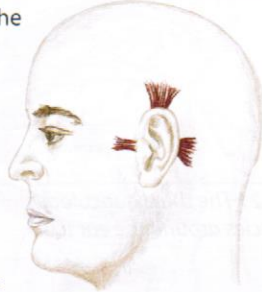
There are several accessible arteries, glands and nerves in the head, neck and face (5.123). Many are superficial and delicate and should therefore be palpated gently. It is advisable to locate and explore these structures on yourself before palpating them on a partner.



5.123 Lateral view with superficial musculature removed



Humans have only three muscles with which to move the ears. These muscles tend to be weak, and on some of us, they are not even functional. Horses, on the other hand, have thirteen muscles that perform a variety of ear movements. Why? Humans communicate their feelings through facial expressions and not by wiggling their ears. Horses, however, display their emotions primarily with their ears, so they need a strong, diverse group of muscles to create specific actions and expressions.



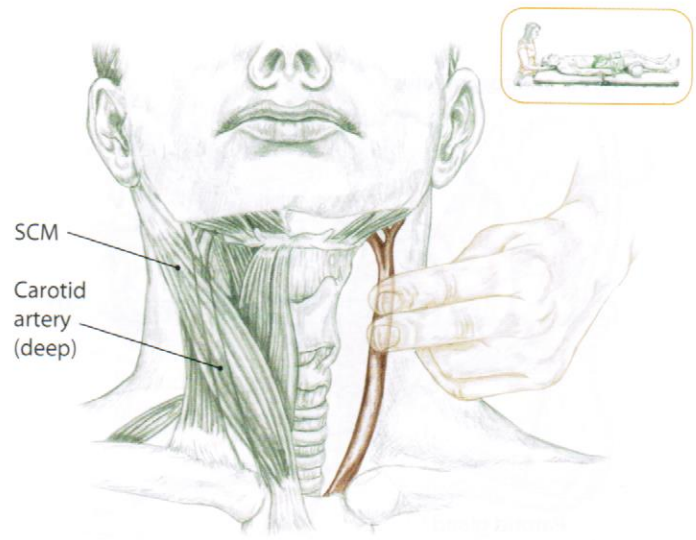
## Common Carotid Artery

The carotid artery is the primary supplier of blood to the head and neck. It ascends the anterior and lateral sides of the neck and lies deep to the sternocleidomastoid (SCM) and infrahyoid muscles. Its strong pulse can be felt medial to the SCM at the level of the hyoid bone.



- 1) Partner supine or seated. Place two fingerpads at the angle of the mandible.
- 2) Slide off the angle in an inferior and medial direction and press gently into the neck (5.124). The strong pulse of the carotid artery should be quite noticeable.

Are you medial to the SCM? Are you under the mandible at the level of the hyoid bone?



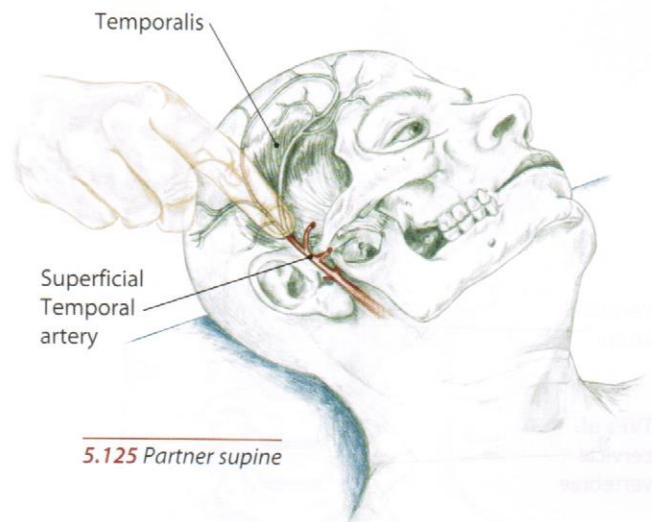
5.124 Partner supine, feeling the pulse of the carotid artery

## Superficial Temporal Artery

The superficial temporal artery branches off the external carotid artery and crosses over the top of the zygomatic arch. It continues superiorly along the side of the cranium, lying superficial to the temporalis muscle. The pulse of the superficial temporal artery can be detected in front of the ear along the zygomatic arch.



- 1) Partner supine or seated. Place your fingerpad in front of the ear at the zygomatic arch (5.125).
- 2) Gently explore and palpate for the artery's pulse. If you do not feel it, adjust your finger position and make sure your pressure is not too deep.



5.125 Partner supine

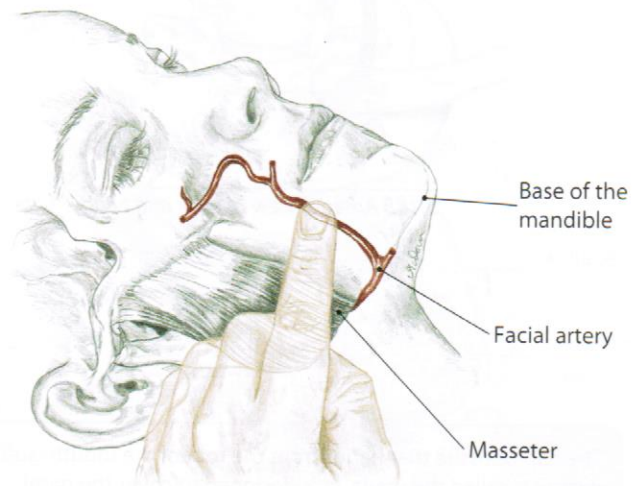
## Facial Artery

The facial artery is a small, superficial vessel that branches off from the external carotid artery and curves around the base of the mandible (jawline) toward the mouth and nose. Its pulse may be difficult to detect, but can be felt along the base of the mandible at the anterior edge of the masseter.



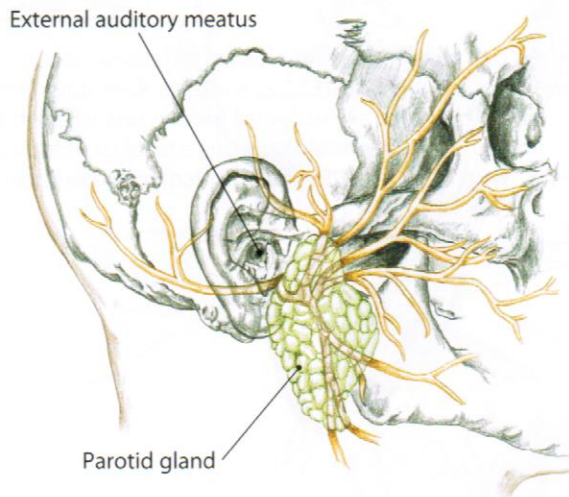
- 1) Partner supine. With your partner clenching her jaw, locate the masseter's anterior edge.
- 2) Position your finger next to the base of the mandible and gently palpate for the pulse of the artery (5.126).

Are you at the base of the mandible, along the anterior edge of the masseter?



5.126

carotid ka-rot-id Grk. causing deep sleep



5.127 Lateral view showing branches of the facial nerve

## Facial Nerve

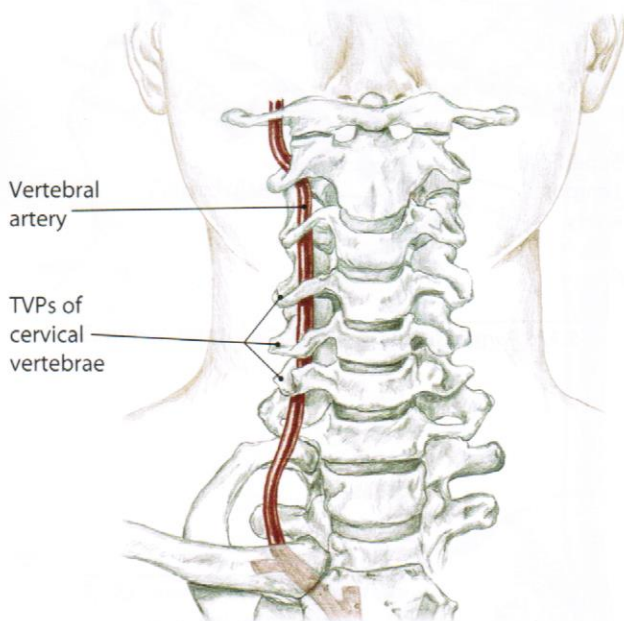
The facial nerve is not a structure you will want to palpate specifically, but, because of its proximity to other palpable structures on the side of the face, you will need to be aware of its location.

The facial nerve (cranial nerve VII) exits from the cranium and emerges superficially just anterior to the mastoid process. As it passes beneath the parotid gland, the nerve branches off and spreads across the face, scalp and neck (5.127). Often two or more branches of the facial nerve cross superficially over the zygomatic arch.

When exploring the parotid gland, masseter or zygomatic arch, be mindful of the facial nerve's presence. Static pressure on the nerve can cause irritation, inflammation or even induce nausea in your partner.

## Vertebral Artery

The vertebral artery branches off the subclavian artery and supplies blood to the brain and spinal cord. It ascends the neck through the transverse foramen of C-6 to C-1 before passing through the foramen magnum of the occiput (5.128). It is inaccessible, of course, but a vital structure to be aware of when palpating and/or passively moving the head and neck.



5.128 Anterior view of neck and head

## Parotid Gland and Duct, Submandibular Gland

There are three salivary glands in the neck and face: the parotid, submandibular and sublingual. All are accessible, but be aware that palpation of the salivary glands can stimulate the production of saliva.

The **parotid gland** is located in front of the earlobe, superficial to the masseter muscle (p. 250). It has a soft, lumpy surface and is penetrated by branches of the facial nerve. The **parotid duct** is a spaghetti-sized tube extending anteriorly from the parotid gland. It tucks around the anterior edge of the masseter to funnel saliva to the mouth.

True to its name, the **submandibular gland** is tucked underneath the base of the mandible. Its round shape can be located anterior to the angle of the mandible.

The flap of tissue that hangs from the roof of the mouth (soft palate) is called the uvula. It is designed to cover the nasal passages during swallowing. When a person sleeps on her back with her mouth open, air passes the uvula and palate,

causing these and other tissues to vibrate. This, of course, produces a snore. The loudest snore ever recorded was 69 decibels—frightening when you consider that a pneumatic drill produces 70 to 90 decibels!

## Parotid gland

- 1) Partner supine. Place your fingerpads in front of the earlobe on the masseter muscle.
- 2) Using gentle pressure along the superficial tissue, palpate between the angle of the mandible and the zygomatic arch for the gland's gelatinous texture (5.129).
- 3) Press deep to the gland in order to feel the striated fibers of the masseter muscle. Compare the different textures of these structures.



## Parotid duct

- 1) Ask your partner to clench her jaw.
- 2) Place your fingerpads below the zygomatic arch, along the anterior edge of the masseter. Roll your finger back and forth (in a superior/inferior direction) and palpate for the mobile, horizontal tube.

*Are you along the anterior edge of the masseter? Is the duct the diameter of a strand of spaghetti, and does it run horizontally?*

## Submandibular gland

- 1) Place a finger along the base of the mandible.
- 2) Move your fingers medially, underneath the base, to palpate the superficial, marble-sized gland (5.130).

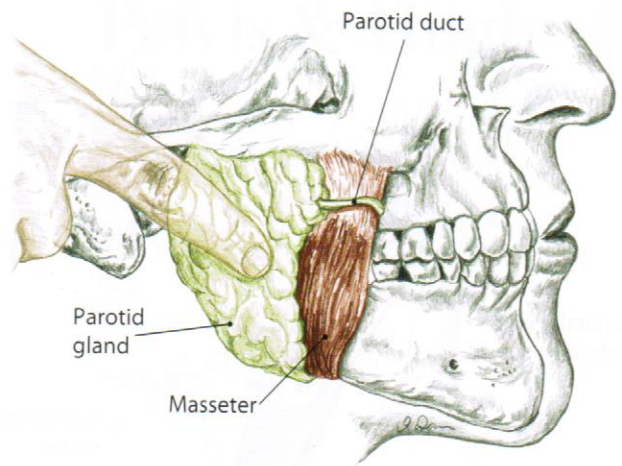
*Can you roll your finger along the surface of the gland, outlining its shape?*

## Thyroid Gland

The left and right lobes of the thyroid gland are located on the anterior surface of the trachea. The gland lies deep to the infrahyoid muscles and has a soft, spongy texture that can be difficult to distinguish from the surrounding tissues.



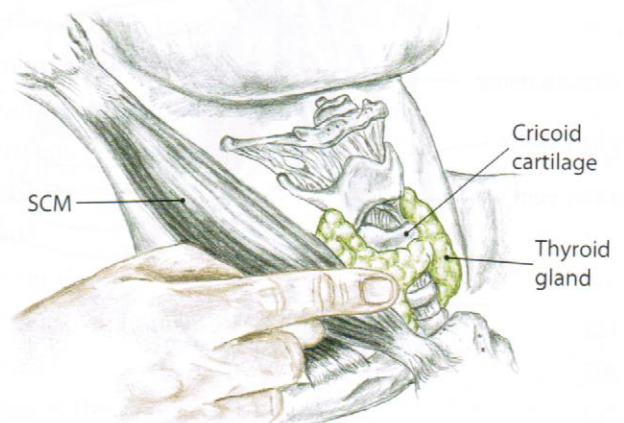
- 1) Partner supine or seated. Using one fingerpad, locate the surface of the trachea between the jugular notch and cricoid cartilage.
- 2) Palpate for the soft texture of the thyroid gland lying on top of the trachea (5.131). Respecting the gland's delicacy, explore gently and briefly.



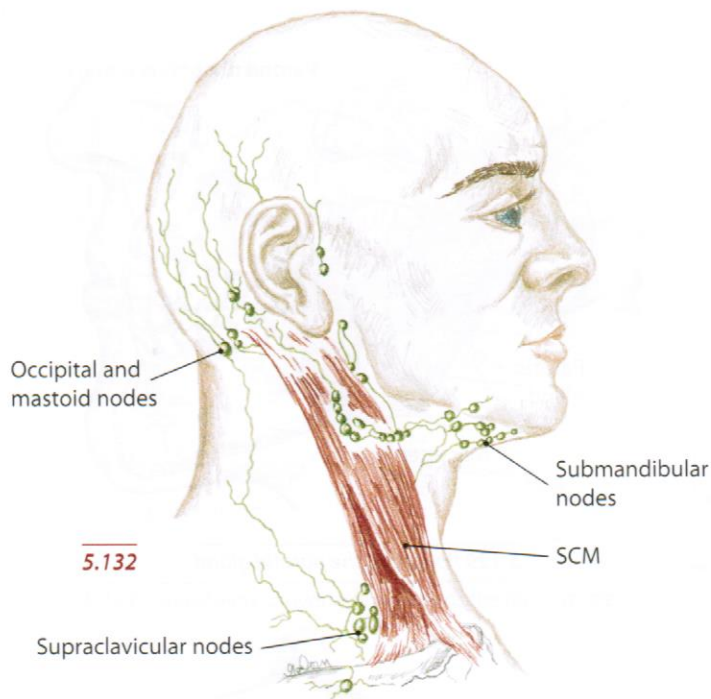
5.129 Palpating the parotid gland



5.130 Accessing under the base of the mandible for the submandibular gland



5.131 Anterior/lateral view



5.132

## Cervical Lymph Nodes

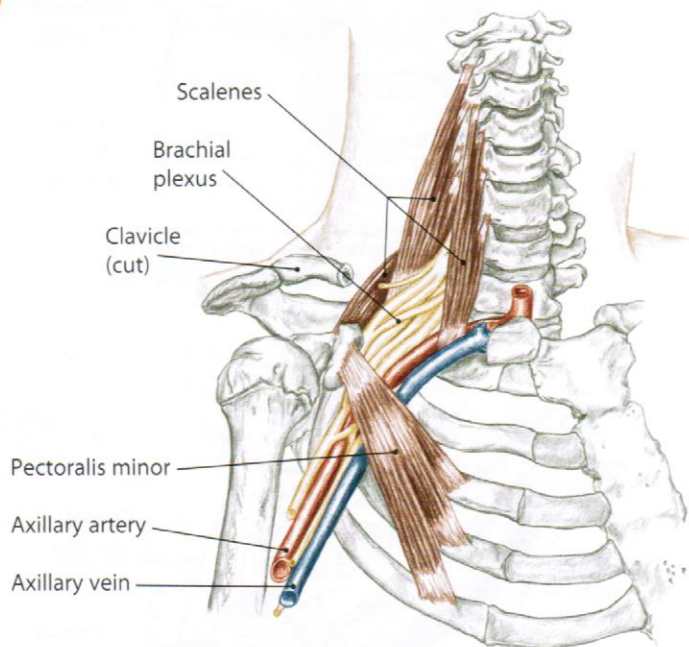
The numerous bundles of lymph nodes in the cervical region are divided into two groups: superficial and deep. The superficial cervical nodes (5.132) are located primarily along the underside of the mandible, posterior and inferior to the earlobe, and in the posterior triangle (p. 226) between the platysma and the deep fascia. The deep cervical nodes are larger and lie beside several large vessels and glands. Both the superficial and deep lymph nodes are slightly movable and have the size and texture of soft lentils or moist raisins. They are often tender on palpation.



- 1) Supine or seated. Place your fingers on the lateral side of the neck. Using your broad fingerpads, gently palpate under the skin for the superficial cervical nodes.
- 2) Explore along the underside of the mandible and in the posterior triangle. Once you have located a node, carefully outline its size and shape.



*Are they slightly movable and the size and texture of soft lentils?*



5.133 Anterior/lateral view of right shoulder and cervical spine

## Brachial Plexus

The brachial plexus is a large bundle of nerves that innervates the shoulder and upper extremity. After exiting from the transverse processes of C-5 to T-1, it squeezes between the anterior and middle scalenes, continues inferiorly and laterally, and ducks underneath the clavicle to the axillary region (5.133).

Although the brachial plexus can be accessed, it is best avoided. Compressing or impinging one of its nerves can create a sharp, shooting sensation down the arm.

Most mammals have a broad, thin sheet of muscle called the panniculus carnosus. It is an integumentary muscle that attaches to the underside of the skin and, in some species, covers the entire thorax. It enables a horse to shake off flies, an armadillo to roll into a ball and a cat to raise the hair on its back (left). For humans, the platysma (p. 257) is believed to be all that remains of the panniculus carnosus.



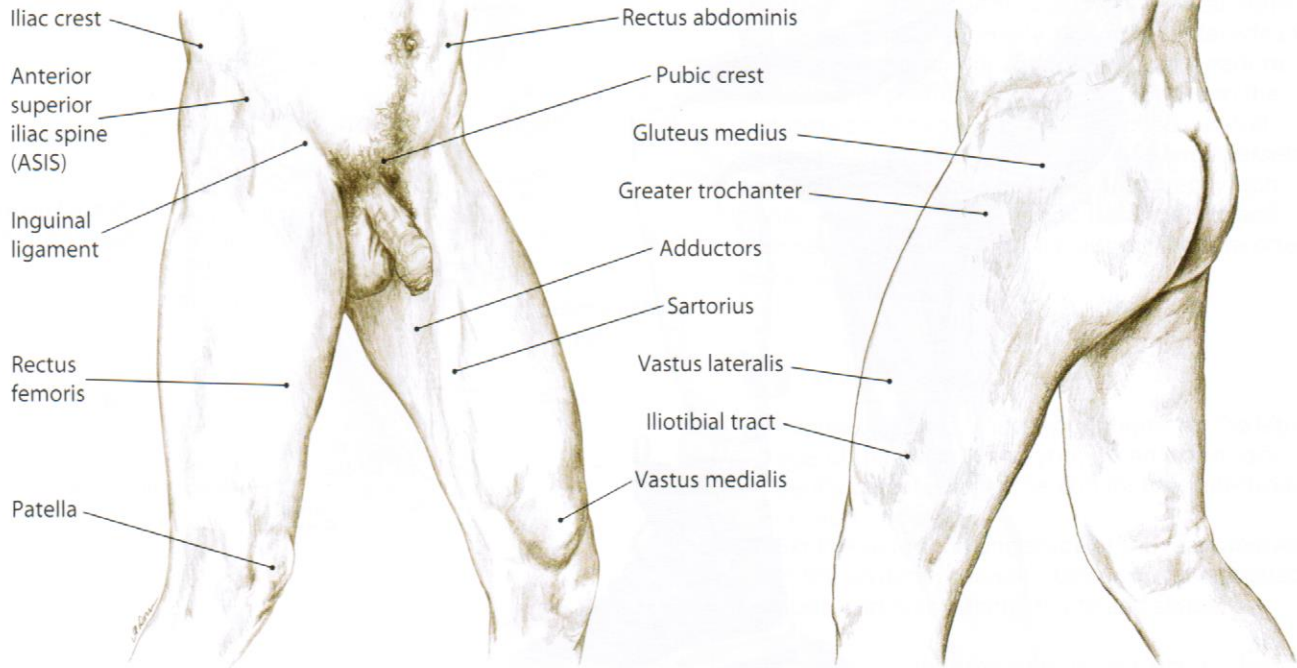
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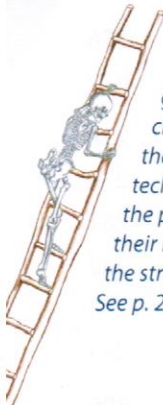


# Topographical Views

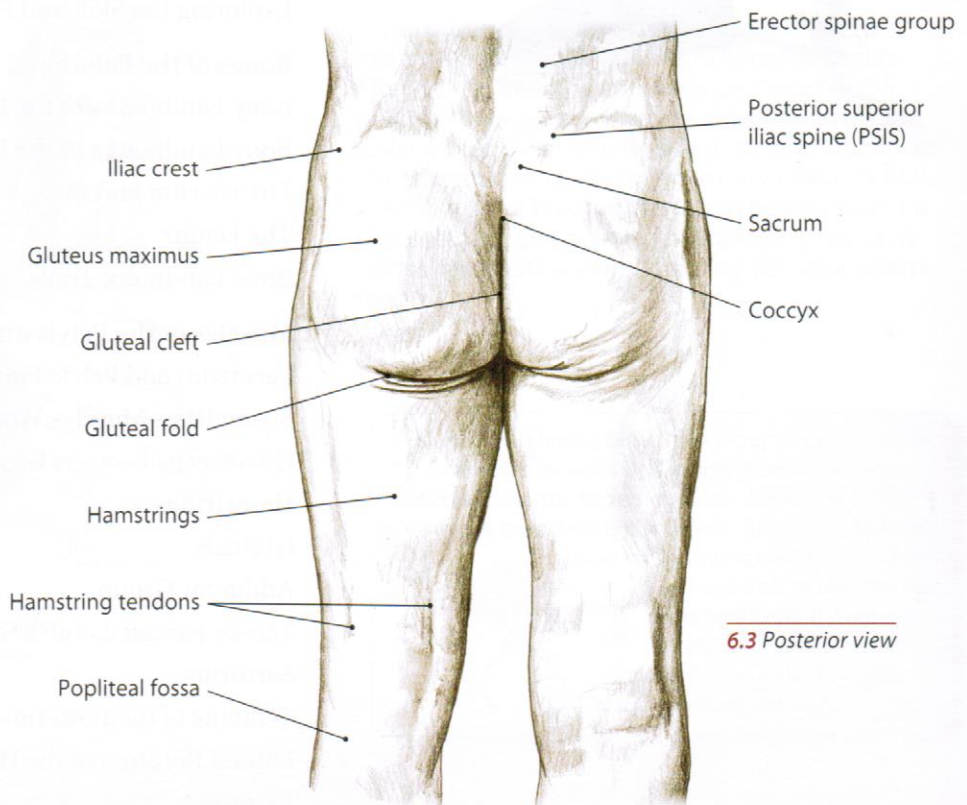


6.1 Anterior/lateral view

6.2 Posterior/lateral view



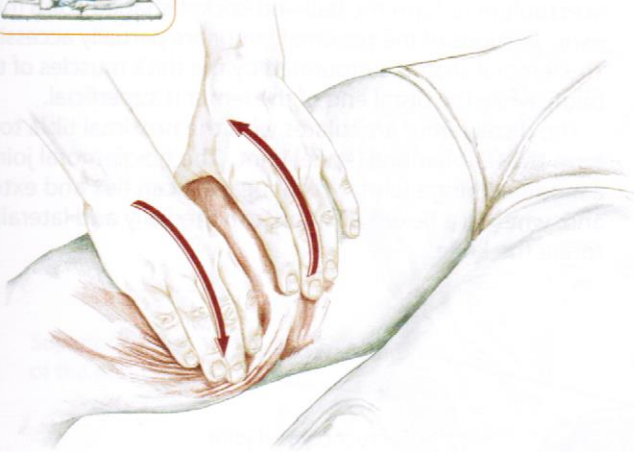
*In this chapter, the male genitals have been included in the illustrations that demonstrate palpatory techniques near the base of the pelvis. This is to clarify their location with respect to the structure you are palpating. See p. 295 for more information.*



6.3 Posterior view



# Exploring the Skin and Fascia



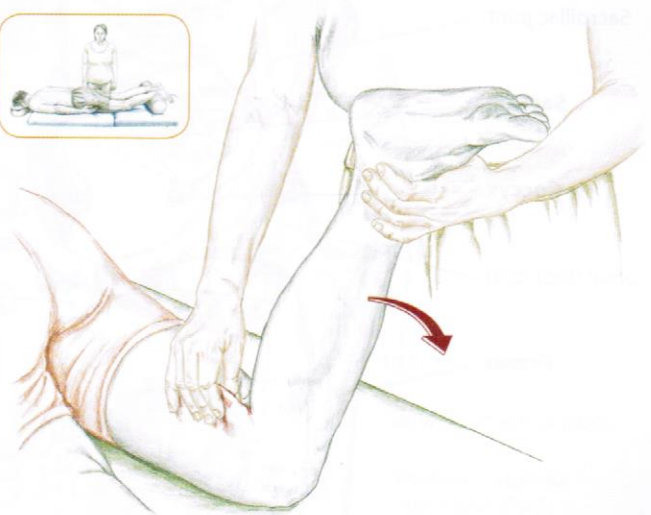
6.4 Partner supine, medial view of right thigh



- 1) Partner supine. Begin by placing your hands on your partner's thigh. Explore from the pelvis to the knee, sensing the temperature of the tissue. Be sure to access the thigh's medial and lateral sides as well.
- 2) Sink your hands into the thigh and gently twist the tissue in opposite directions (6.4). Take particular note of its thickness and elasticity. For example, the skin and fascia just proximal to the knee may be thinner than the tissue near the pelvis.



- 1) Partner prone. Holding the ankle, passively flex the knee. Use your other hand to gently grasp the skin and fascia proximal to the posterior knee. As you roll it between your fingers, note the tissue's pliability and texture.
- 2) Compare what you have felt to the thicker tissue of the medial thigh and the denser fascia of the lateral thigh.
- 3) Still grasping the skin and fascia, passively flex and extend the knee (6.5). Feel the tissue stretch as the knee extends. Continue this same movement while grasping the sides of the thigh. If the tissue is difficult to grasp, you may want to use the flat of your hand to sense the changes in the tissue.



6.5 Partner prone, posterior/medial view of right thigh



- 1) Partner prone. Using the back of your hand, explore the temperature of the posterior and lateral buttocks. It is not uncommon for the tissue to be cooler here than it is on the posterior thigh or low back.
- 2) Since the buttocks are composed of both large muscles and large quantities of adipose, they are a good area for exploring tissue differences. Setting your thumb on the gluteal fold (see 6.3), gently but firmly grasp the tissue of the buttock.
- 3) Try grasping just the superficial skin and fascia, sensing its gelatinous quality. Then grasp a bit deeper and feel the thick, striated mass of the gluteal muscles (6.6).



6.6 Partner prone, superior/lateral view



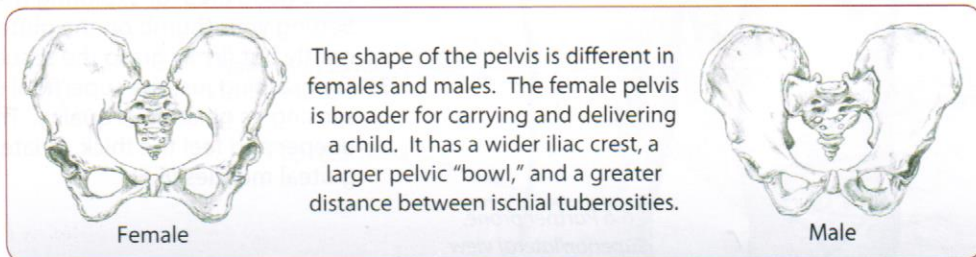
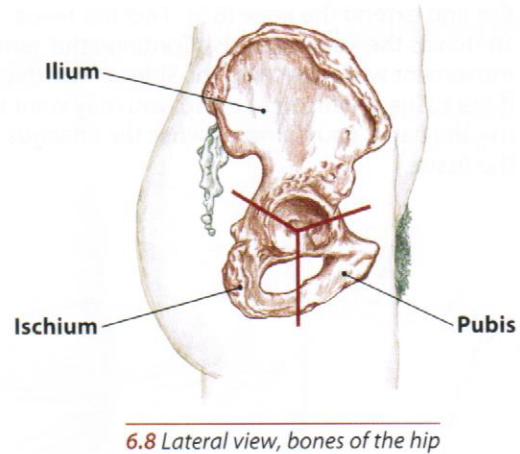
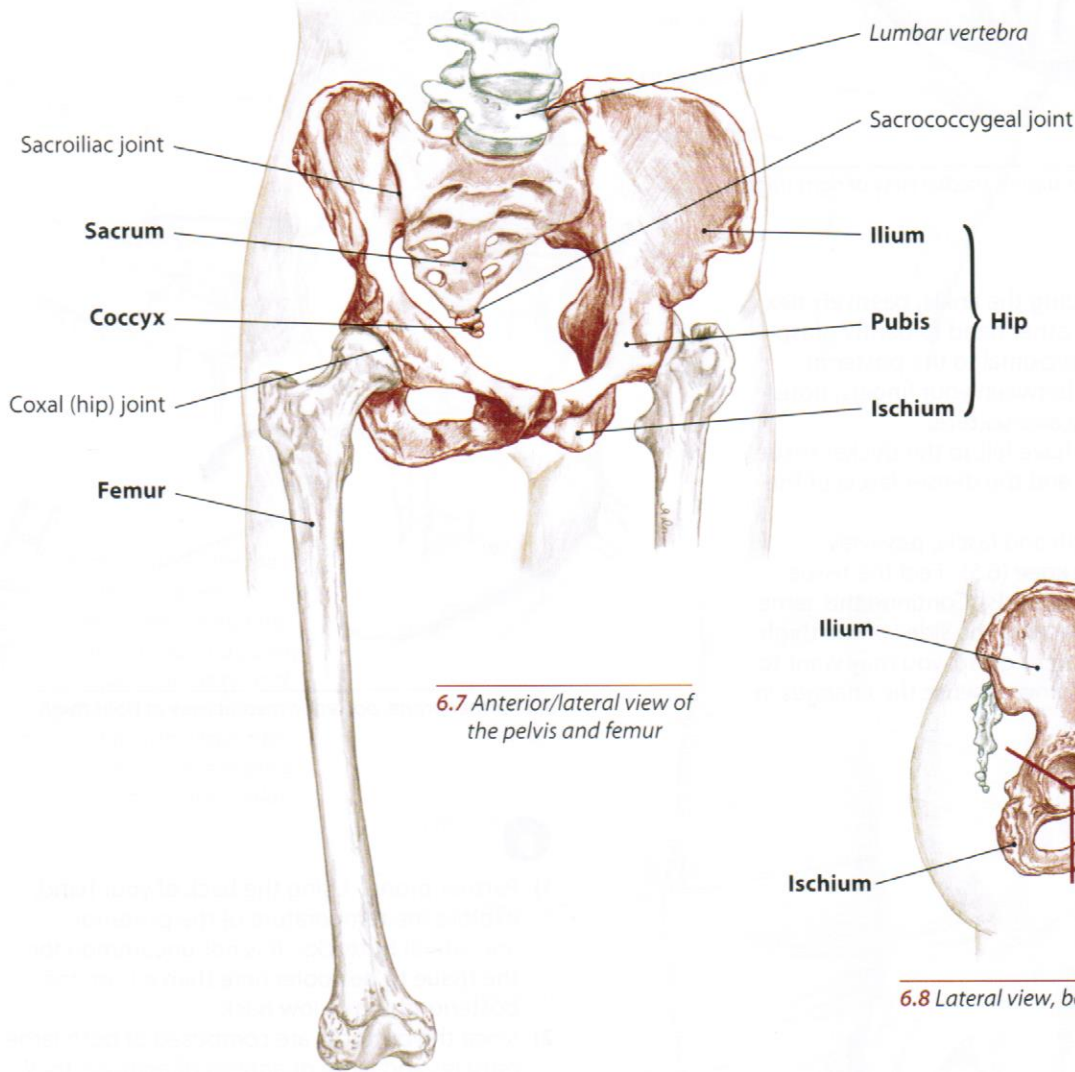
# Bones of the Pelvis and Thigh

The **pelvis** (pelvic girdle) consists of the sacrum, the coccyx and the two hip bones (6.7). Each **hip** (coxal) bone is formed by the fusion of three smaller bones: the **ilium**, **ischium** and **pubis** (6.8). Although the pelvis is deep to surrounding muscles, organs and adipose tissue, aspects of it are easily palpable.

The superficial **sacrum** lies posteriorly between the hip bones. The small **coccyx** extends inferiorly from the sacrum. The sacrum and coccyx, both made up of fused vertebrae, are considered part of the vertebral column.

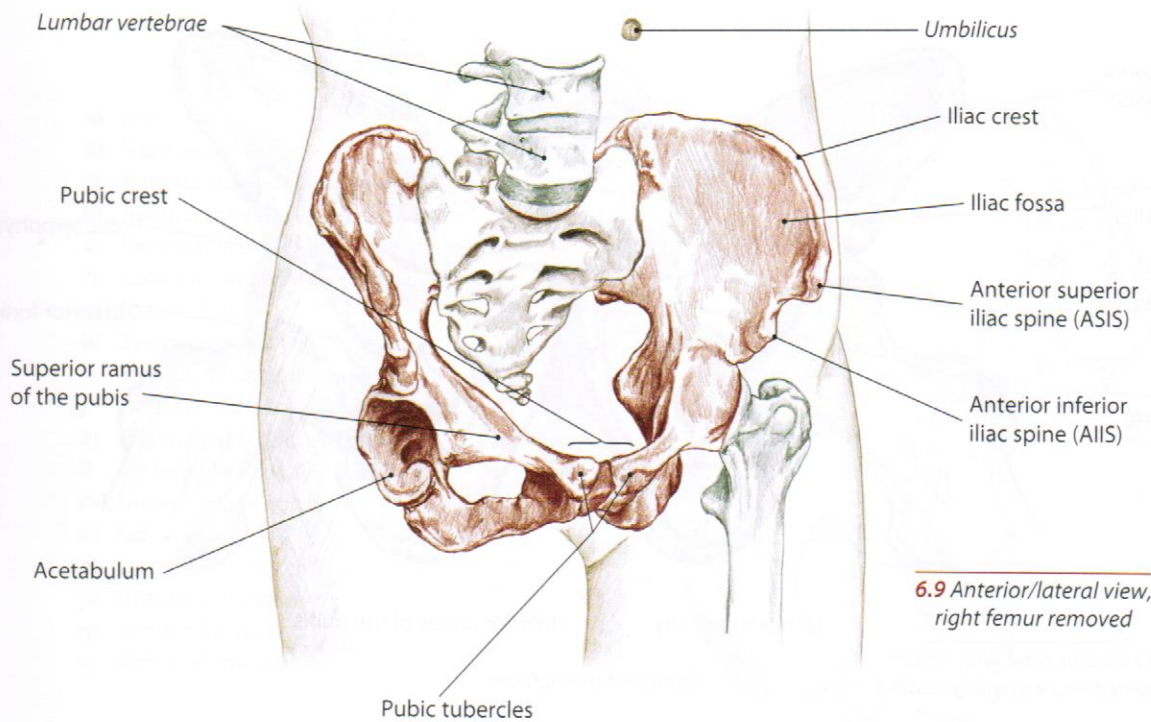
The **femur** is the longest, heaviest and strongest bone in the body. Its proximal end articulates with the hip at the acetabulum to form the ball-and-socket-shaped coxal (hip) joint. Portions of the proximal femur are partially accessible. The femoral shaft is surrounded by the thick muscles of the thigh, while the distal end of the femur is superficial.

The distal femur articulates with the proximal tibia to form the tibiofemoral (knee) joint. The tibiofemoral joint is a modified hinge joint, which means it can flex and extend and, when in a flexed position, can medially and laterally rotate the knee.

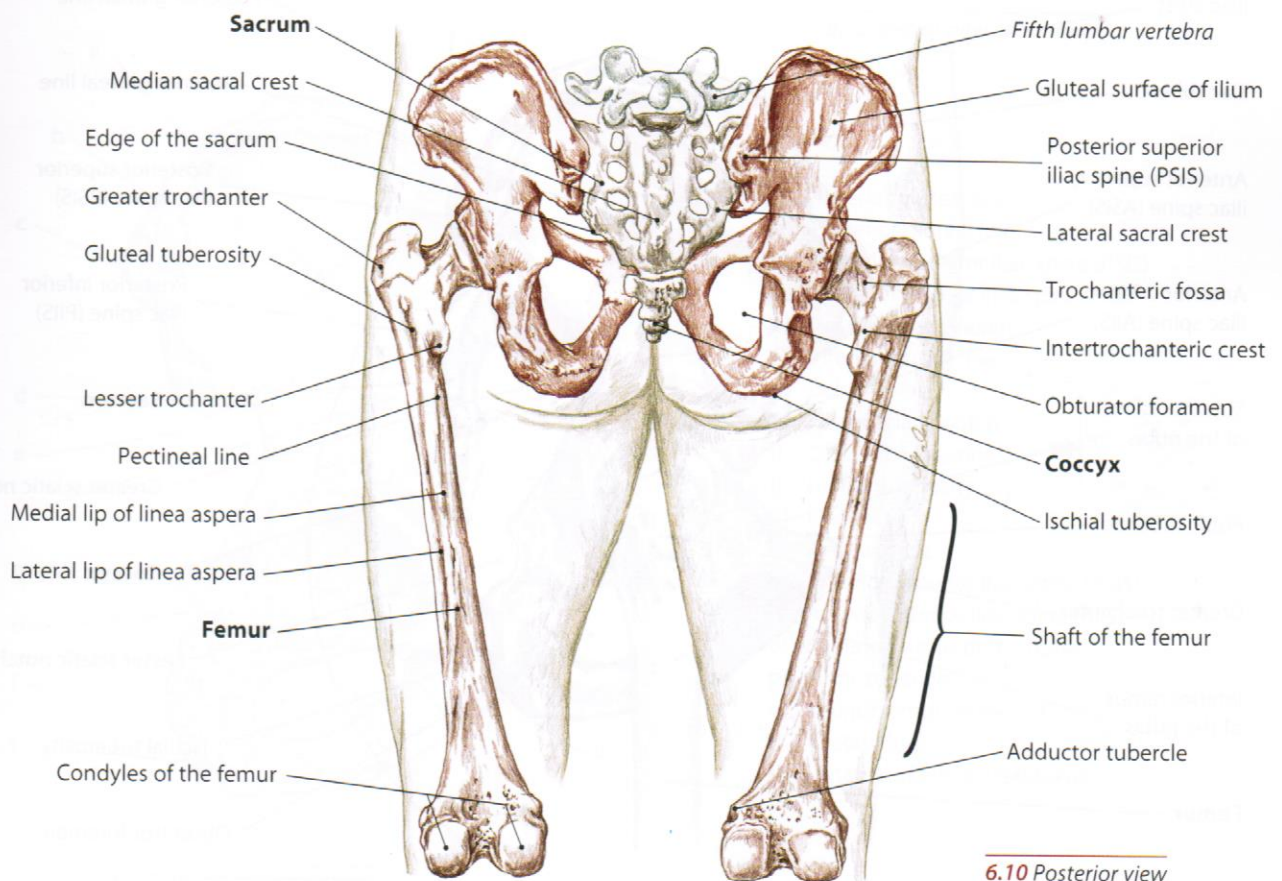


Pelvis & Thigh

# Bony Landmarks of the Pelvis and Thigh



6.9 Anterior/lateral view, right femur removed



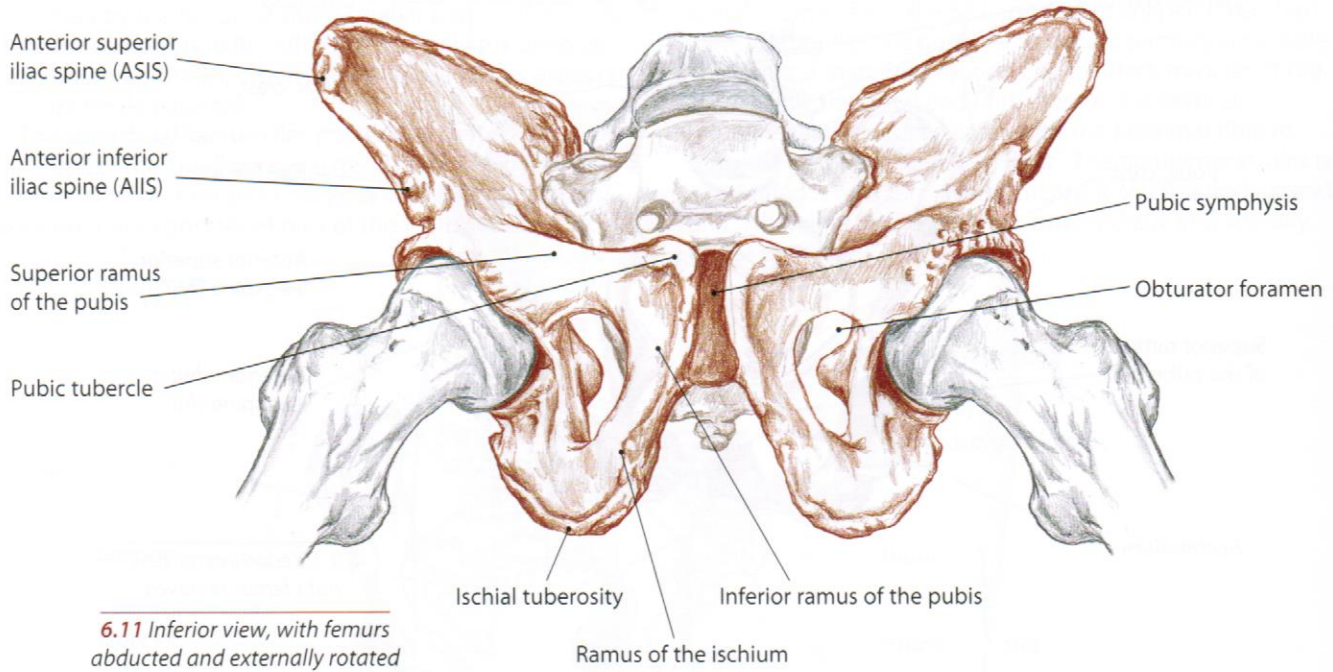
6.10 Posterior view

ischium  
ilium  
pubis

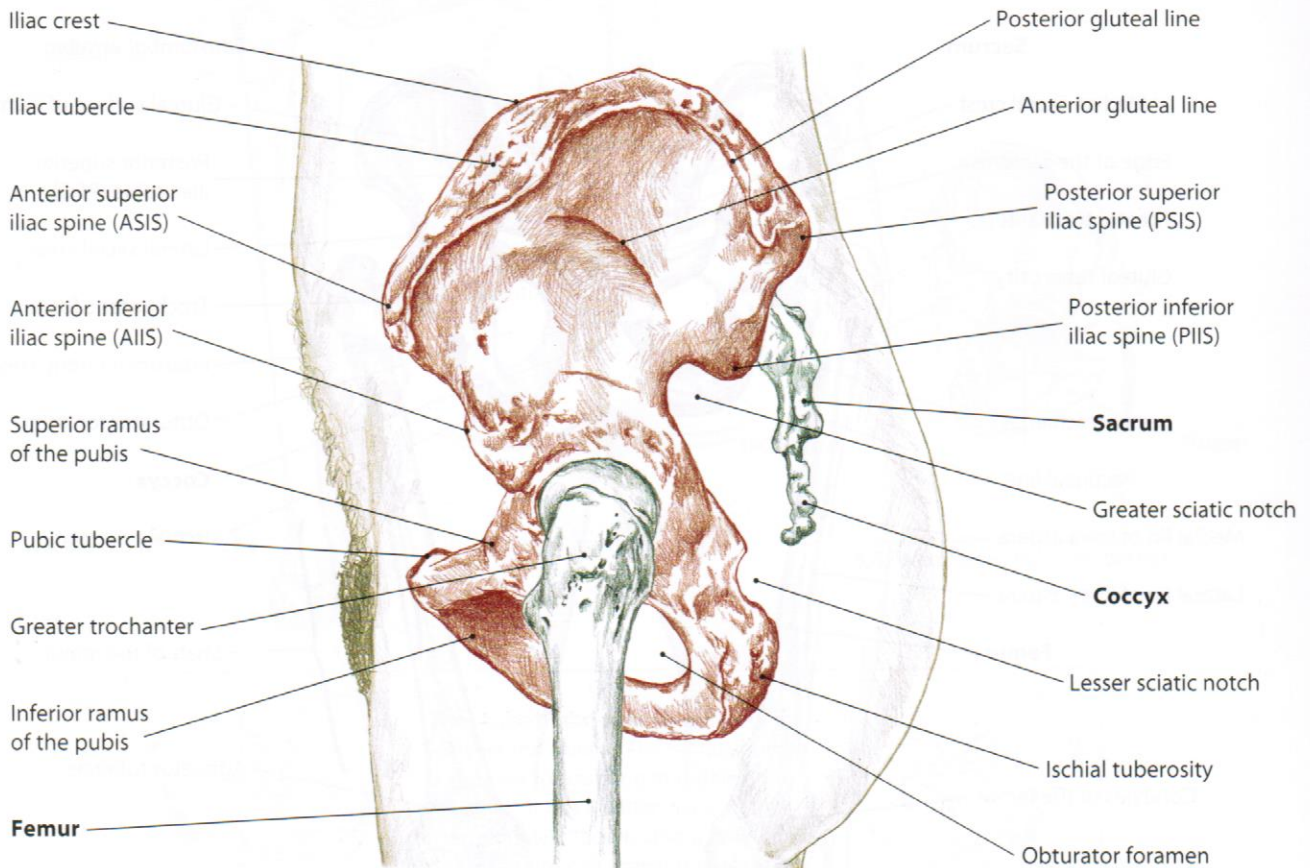
ish-ee-um  
il-ee-um  
pu-bis

Grk. hip  
L. groin, flank  
NL. bone of the groin

# Bony Landmarks of the Pelvis and Thigh



6.11 Inferior view, with femurs abducted and externally rotated



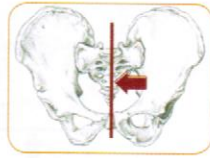
6.12 Lateral view

acetabulum  
foramen  
linea aspera

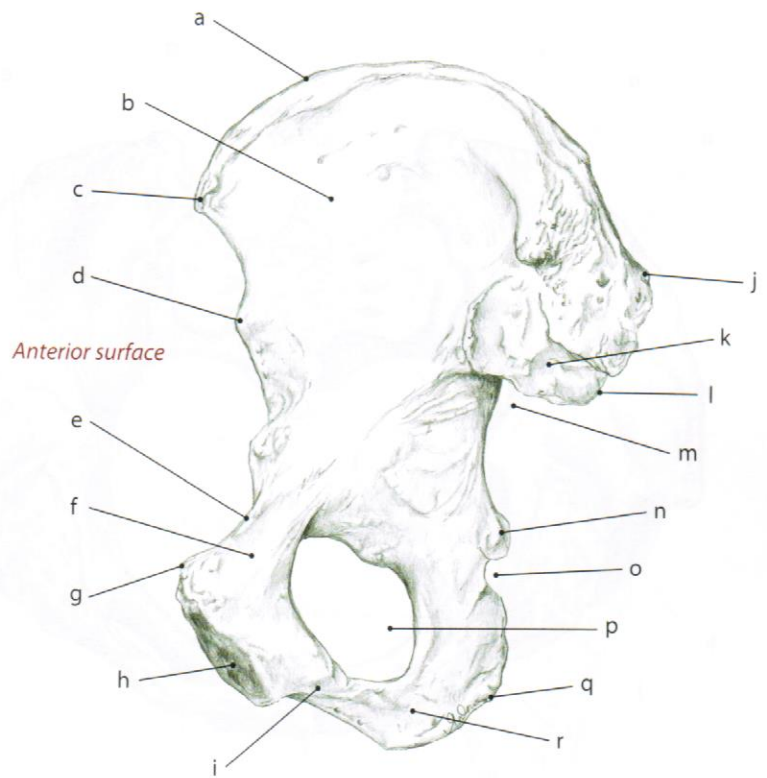
as-e-tab-u-lum  
for-aye-men  
lin-e-a as-per-a

L. a little saucer for vinegar  
L. a passage or opening  
L. rough line

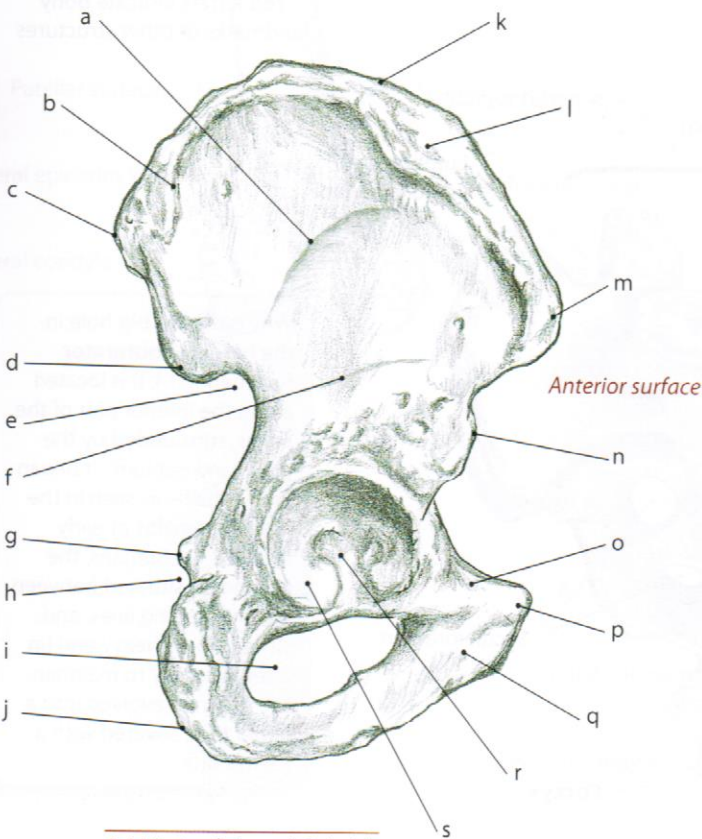
# Bony Landmarks of the Hip



- a) Iliac crest
- b) Iliac fossa
- c) Anterior superior iliac spine (ASIS)
- d) Anterior inferior iliac spine (AIIS)
- e) Pectineal line
- f) Superior ramus of the pubis
- g) Pubic tubercle
- h) Symphyseal surface
- i) Inferior ramus of the pubis
- j) Posterior superior iliac spine (PSIS)
- k) Articular surface for sacrum
- l) Posterior inferior iliac spine (PIIS)
- m) Greater sciatic notch
- n) Ischial spine
- o) Lesser sciatic notch
- p) Obturator foramen
- q) Ischial tuberosity
- r) Ramus of the ischium

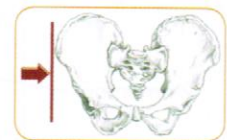


6.13 Medial view of right hip

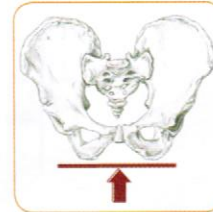
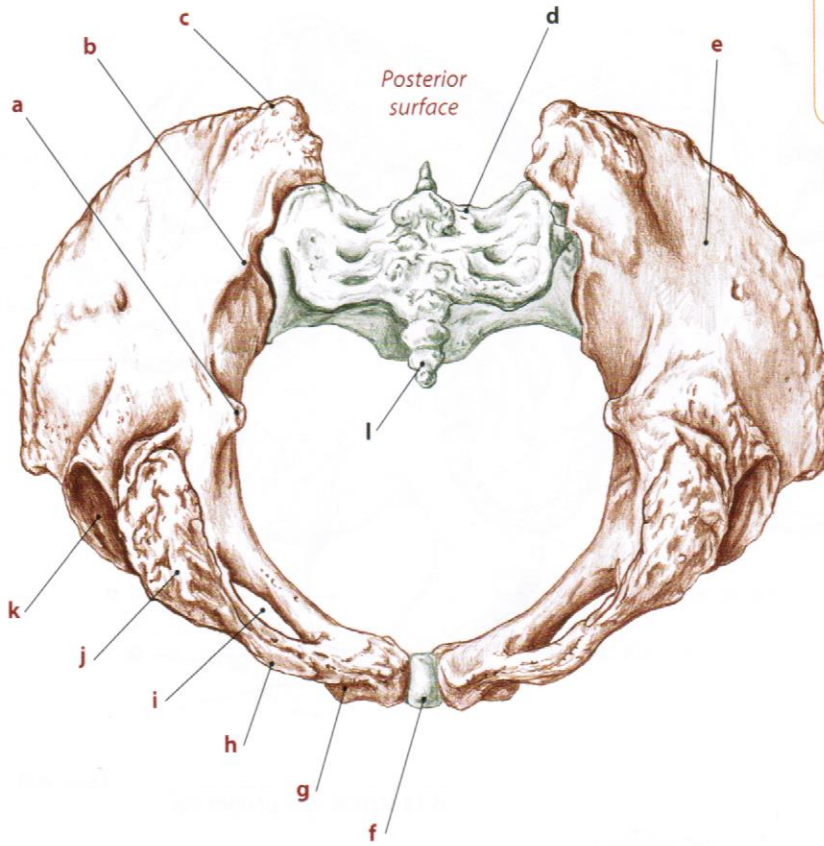


6.14 Lateral view of right hip

- a) Anterior gluteal line
- b) Posterior gluteal line
- c) Posterior superior iliac spine (PSIS)
- d) Posterior inferior iliac spine (PIIS)
- e) Greater sciatic notch
- f) Inferior gluteal line
- g) Ischial spine
- h) Lesser sciatic notch
- i) Obturator foramen
- j) Ischial tuberosity
- k) Iliac crest
- l) Iliac tubercle
- m) Anterior superior iliac spine (ASIS)
- n) Anterior inferior iliac spine (AIIS)
- o) Superior ramus of the pubis
- p) Pubic tubercle
- q) Inferior ramus of the pubis
- r) Acetabulum
- s) Lunate surface of acetabulum



# The Sacrum and Coccyx

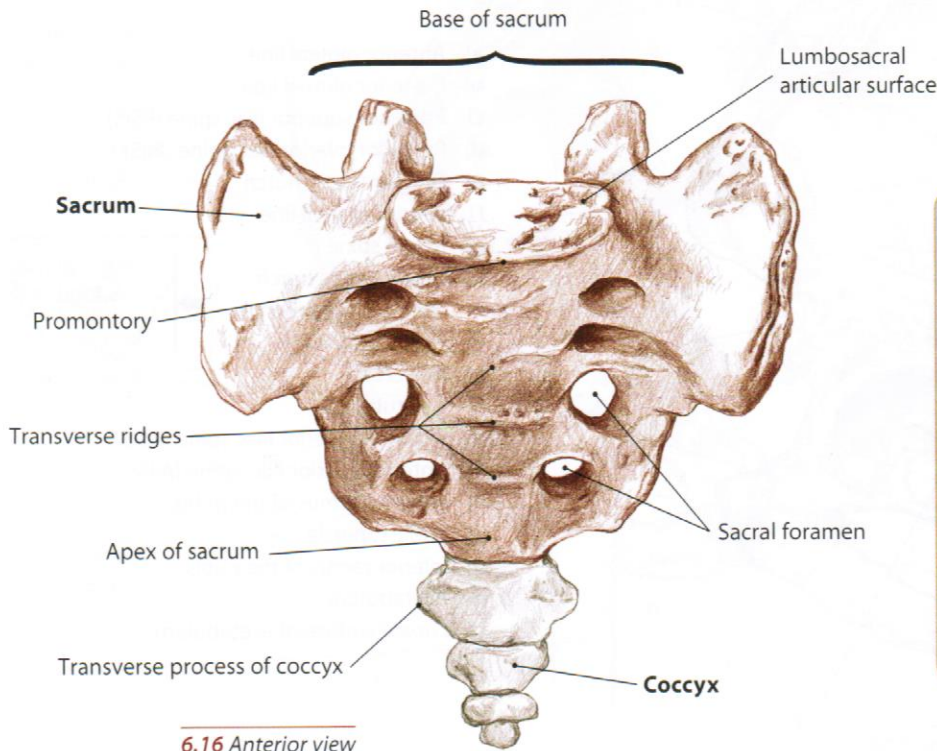


6.15 Inferior view

- a) Ischial spine
- b) Posterior inferior iliac spine (PIIS)
- c) Posterior superior iliac spine (PSIS)
- d) **Sacrum**
- e) Gluteal surface of ilium
- f) Pubic symphysis
- g) Inferior ramus of the pubis
- h) Ramus of ischium
- i) Obturator foramen
- j) Ischial tuberosity
- k) Acetabulum
- l) **Coccyx**

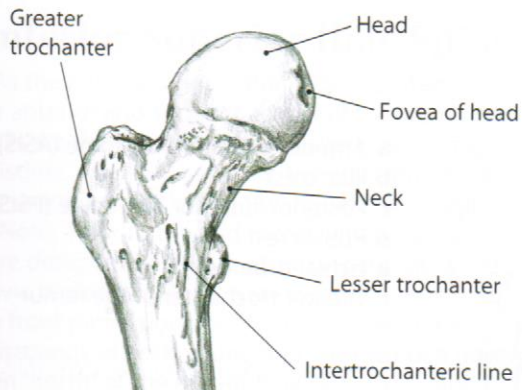


**Black** letters indicate bones;  
**red** letters indicate bony landmarks or other structures

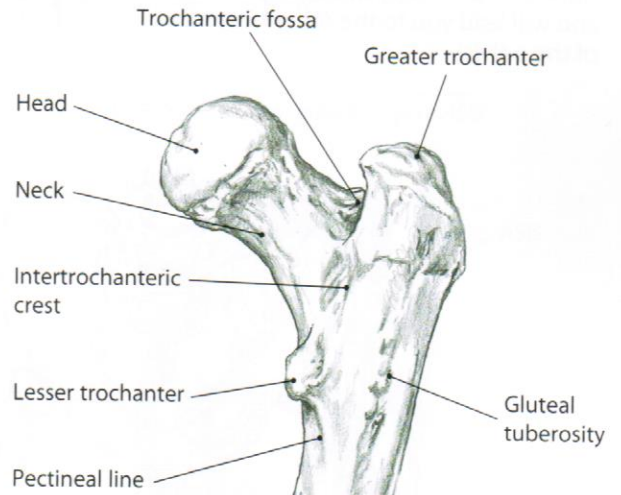
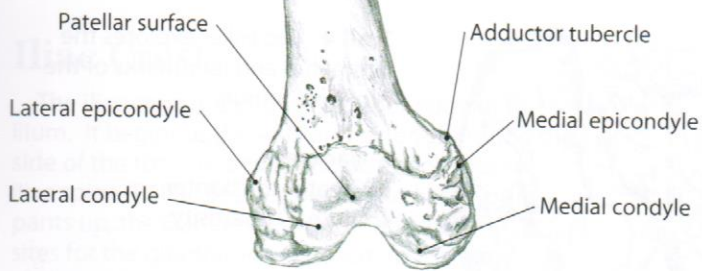


6.16 Anterior view

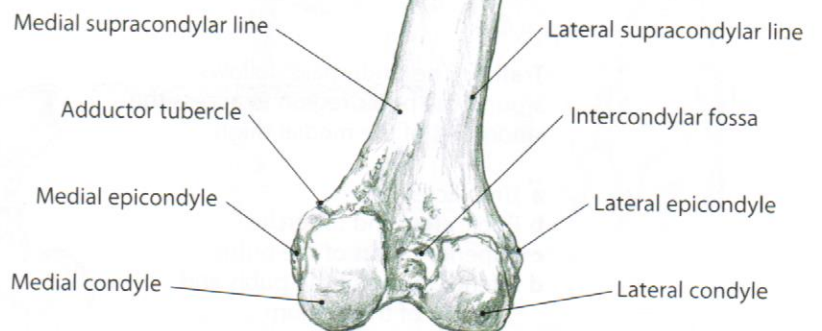
Why is there a big hole in the hip? The **obturator foramen** (6.14, i) is located along the inferior part of the pelvis, surrounded by the pubis and ischium. It began quite small—as seen in the skeletal remains of early reptiles. On humans, the foramen is situated between weight-bearing lines, and, since bone is heavy and (in a sense) costly to maintain, the foramen evolved into a larger hole covered with a membrane.



6.17 Anterior view of right femur



6.18 Posterior view of right femur

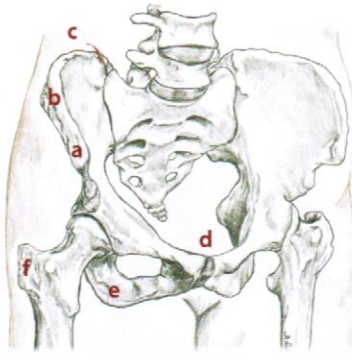




# Bony Landmark Trails

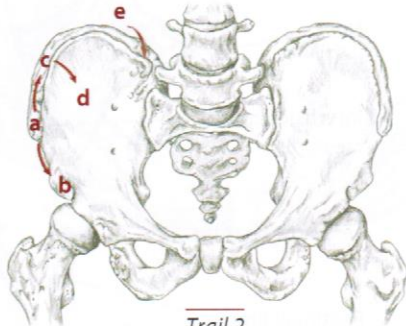
## Trail 1 "Solo Pass"

Due to the pelvis' multifaceted shape and proximity to sensitive areas, palpating your partner's pelvic region may challenge you initially. **Trail 1** is designed to give you an opportunity to access your own pelvic region first. This will generate the confidence needed to palpate effectively on your partner over the next four trails. These six landmarks can be seen as your "base camps"—they are clearly accessible and will lead you to the other landmarks of the pelvis.



- a Anterior superior iliac spine (ASIS)
- b Iliac crest
- c Posterior superior iliac spine (PSIS)
- d Pubic crest
- e Ischial tuberosity
- f Greater trochanter of the femur

Trail 1



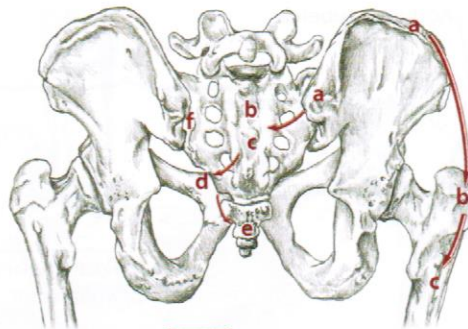
**Trail 2** "Iliac Avenue" travels along the superior aspect of the pelvis on the ilium.

- a Anterior superior iliac spine (ASIS)
- b Anterior inferior iliac spine (AIIS)
- c Iliac crest
- d Iliac fossa
- e Posterior superior iliac spine (PSIS)

Trail 2

**Trail 3** "Tailbone Trail" accesses the bones at the base of the spine.

- a Posterior superior iliac spine (PSIS)
- b Sacrum
- c Median sacral crest
- d Edge of the sacrum
- e Coccyx
- f Sacroiliac joint



Trail 3

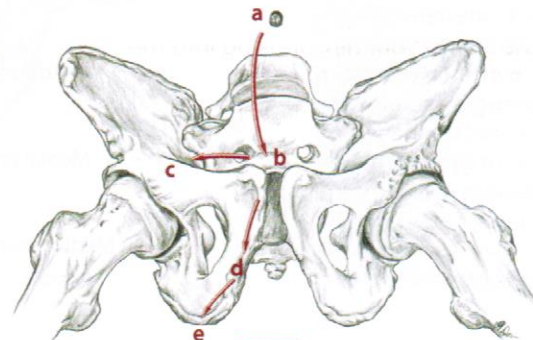
**Trail 4** "Hip Hike" explores the lateral hip and landmarks of the proximal femur.

- a Iliac crest
- b Greater trochanter
- c Gluteal tuberosity

Trail 4

**Trail 5** "The Underpass" follows around the pubic region to access the landmarks of the medial thigh.

- a Umbilicus
- b Pubic crest and tubercles
- c Superior ramus of the pubis
- d Inferior ramus of the pubis and ramus of the ischium
- e Ischial tuberosity



Trail 5



## Trail 1 “Solo Pass”

### Anterior Superior Iliac Spine (ASIS)

As the name suggests, the ASIS is located on the anterior and superior aspect of the ilium. Both ASISs are the superficial tips located below the waistline. The ASIS serves as the attachment site for the sartorius muscle and the inguinal ligament.

(Note: Prior to the mid-1990s, when pants were designed and worn in a manner that fit the pelvic region, the ASISs were located “underneath the front pants’ pockets.” Nowadays, with the waistbands of both young men and women rarely seen “north” of the mid-gluteal cleft, this helpful hint no longer applies.)



Palpate on yourself first



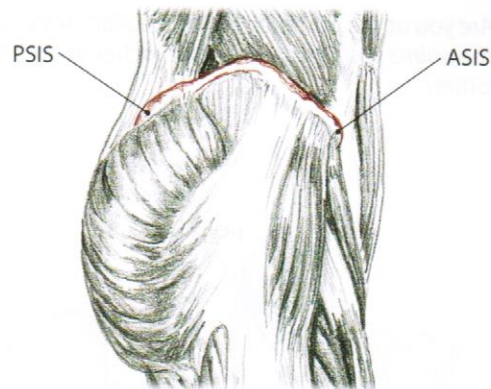
6.19 Anterior view, palpating your ASISs



- 1) Locate both anterior superior iliac spines by placing your hands upon your hips with fingers in front, thumbs behind. Feel for the tip of the pelvis that sticks out anteriorly (6.19).
- 2) Explore these points and the surrounding structures of the ilium. Try palpating them on yourself from a seated position so that the overlying tissue will be soft.



Are the bones you feel just beneath the surface of the skin? Are you inferior to the level of the umbilicus?



6.20 Lateral view of pelvis showing the muscles which surround the iliac crest

### Iliac Crest

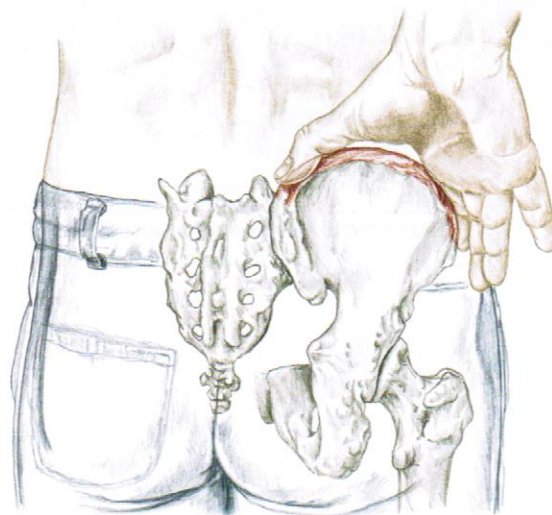
The iliac crest is the long, superior edge of the ilium. It begins at the ASIS and extends around the side of the torso to end at the posterior superior iliac spine (PSIS). Besides helping to keep your pants up, the iliac crests serve as attachment sites for the quadratus lumborum (p. 207) and abdominal muscles. Each crest is superficial and easily palpable as the muscles that attach to it do not cross over its edge (6.20).



- 1) Locate the ASIS. Slowly walk your fingers around the side of your hip, pressing into the wide edge of the crest. Note how the crest rises from the ASIS and soon after may widen laterally (6.21).
- 2) Follow the crest as it continues around to the posterior side of the body and ends at the PSIS.



Can you sink your fingers into the flesh of the abdomen just above the iliac crest?



6.21 Posterior view, sliding your fingers along your iliac crest

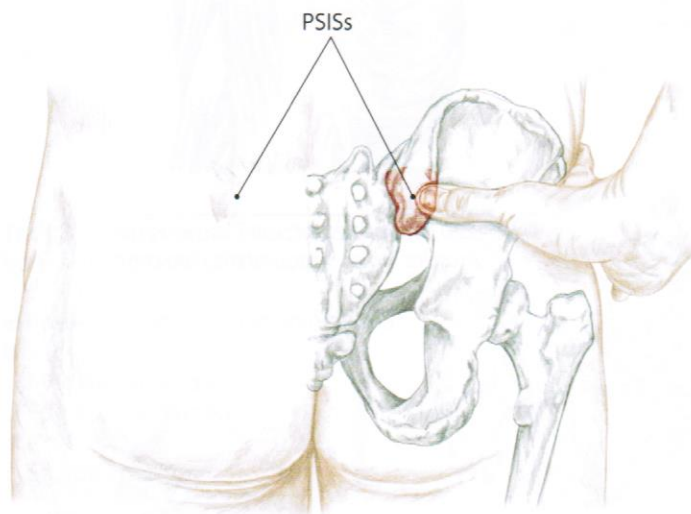
## Posterior Superior Iliac Spine (PSIS)

The superficial PSIS is located at the posterior end of the iliac crest. In most people, both PSISs can be visibly identified by the two small dimples found at the base of the low back. Without the help of a mirror, you might have trouble seeing your own PSISs, but you can still palpate them.



- 1) Place your thumbs upon your iliac crests. Follow the crests around the posterior hip. Note how they descend as you move medially.
- 2) The PSISs might feel like small humps surrounded by thicker tissues and are not as pronounced as the ASISs (6.22).

✓ Are you at the posterior end of the iliac crests? Are the points you feel three to four inches apart from each other?



6.22 Posterior view, locating your PSIS

## Pubic Crest

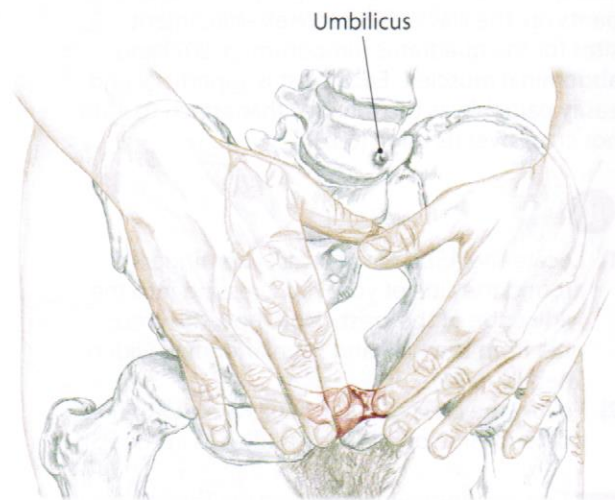
The pubic crest is located directly inferior to the navel and superior to the genitals. Formed by the superior, medial edge of both pubic bones, the horizontal crest is roughly two inches wide and clearly palpable. It is an attachment site for the rectus abdominis muscle (p. 209) and the abdominal aponeurosis.



- 1) Position your fingers at your navel.
- 2) Slowly slide your fingers down the midline of the body toward the pubic region (6.23). You might travel five to eight inches before you feel the firm ridge of the pubic crest. You will be one to two inches superior to the genitals.

✓ Are you at the midline of the body? Are you inferior to the level of the ASISs? Do you feel a solid, horizontal ridge of bone just above the genital region?

◆ Locate the ASIS. Follow the inguinal ligament (p. 339) inferiorly 45° to the midline of the body until you reach the crest.



6.23 Anterior view, accessing your pubic crest

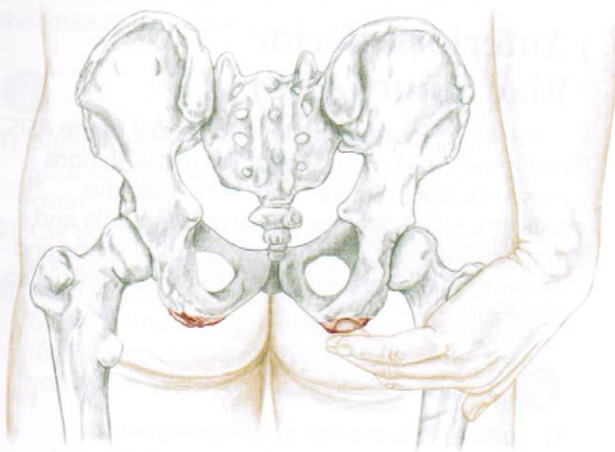
## Ischial Tuberosity

If you have ever sat through a long musical or sporting event on a metal folding chair, then your ischial tuberosities are no stranger to you. The “sits bones” are located on the most inferior aspect of the pelvis at the level of the gluteal fold (the horizontal crease between the buttocks and thigh). The ischial tuberosity serves as an attachment site for the hamstrings, adductor magnus and the sacrotuberous ligament.



- 1) Have a seat on a hard chair or surface and rock side-to-side, feeling your “sits bones.”
- 2) Stand up and palpate the bone you were sitting on—your ischial tuberosity (6.24). Explore in all directions the large surface of the tuberosity.

Do you feel an identical structure between the other buttock and thigh?



6.24 Posterior view, palpating your ischial tuberosity

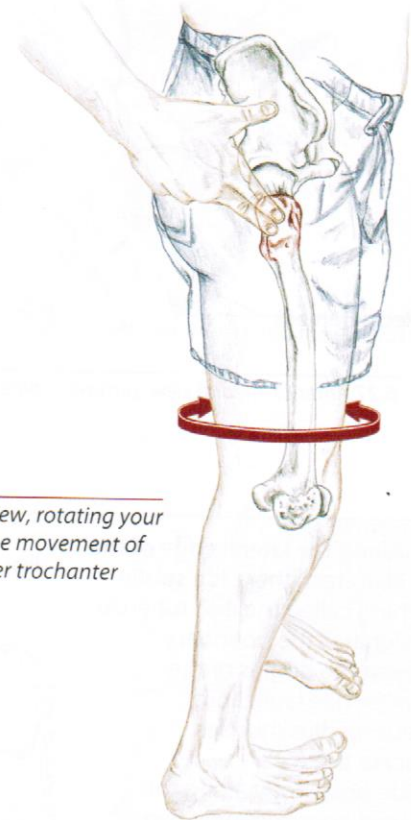
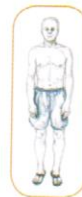
## Greater Trochanter of the Femur

Located distal to the iliac crest, the greater trochanter is the large, superficial mass located on the side of the hip. It is easily palpable and serves as an attachment site for the gluteus medius, gluteus minimus and lateral rotators of the hip.



- 1) Locate the middle of the iliac crest.
- 2) Slide your fingerpads inferiorly four to six inches along the lateral side of the thigh until you reach the superficial mass of the greater trochanter. Explore and sculpt around all sides of its wide hump.

Medially and laterally rotate your hip as you palpate the trochanter. Do you feel its wide, knobby surface swivel back and forth under your fingers (6.25)?

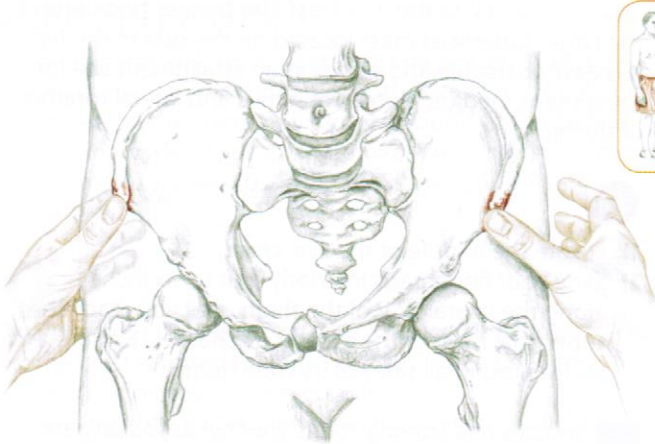


6.25 Lateral view, rotating your hip to feel the movement of the greater trochanter

When exploring the area around the sacrum and posterior iliac crest, it is not uncommon to locate small nodules of fibrofatty tissue. Embedded in the superficial fascia, they may vary in size from a pea to a large marble.



## Trail 2 "Iliac Avenue"



6.26 Partner standing, locating both ASISs

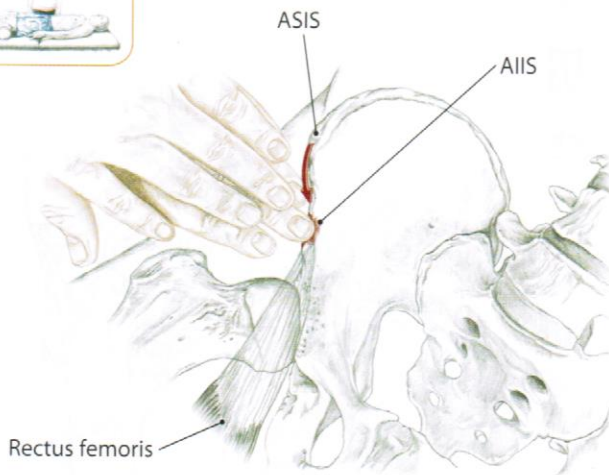
### Anterior Superior Iliac Spine (ASIS)

(Refer to p. 285 for more information)



- 1) Partner standing. Place your hand upon the side of the abdomen, below the level of the umbilicus.
- 2) Gently compress inferiorly until you feel the superficial tip of the ASIS (6.26). Palpate and observe the distance between the two ASISs and their relationship to each other.

Is the bony tip you feel superficial? Are you inferior to the level of the navel? Are you superior to the genital region?



6.27 Anterior/medial view, partner supine, accessing the AIIS


### Anterior Inferior Iliac Spine (AIIS)

The AIIS is located inferior and medial to the ASIS and is the attachment site for the rectus femoris muscle (p. 306). Smaller and flatter than the ASIS, the AIIS is deep to the sartorius muscle and inguinal ligament. Because of its subtle shape and its depth to the sartorius, the AIIS can be difficult to distinguish.

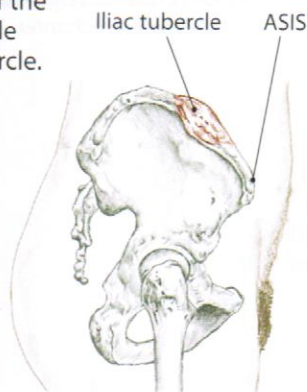


- 1) Supine. Flex the hip by bolstering under your partner's knee to shorten and soften the overlying tissue.
- 2) Locate the ASIS. Slide inferiorly and medially approximately one inch.
- 3) Palpate deep to the overlying tendons and explore for the small mound of the AIIS (6.27).

Are you medial and inferior to the ASIS? If your partner flexes his hip slightly, can you feel the tendon of the rectus femoris tighten under your fingers? (The overlying sartorius tendon will also become taut with this action.)

 Along the lateral edge of the iliac crest, there is a subtle widening called the iliac tubercle. It designates the boundary between the origins of the tensor fasciae latae and gluteus medius muscles.

- 1) Locate the ASIS.
- 2) Slide posteriorly along the iliac crest approximately two inches. Explore the lateral edge of the iliac crest where it swells slightly. This is the iliac tubercle.



## Iliac Crest

(Refer to p. 285 for more information)



- 1) Partner side lying. Locate the ASIS.
- 2) Slide posteriorly along the iliac crest, observing how it widens and rises up along its path.
- 3) Follow the crest as it continues around the posterior side of the body to the PSIS (6.28).



Can you spread the webbing between your finger and thumb along the length of the crest?

## Iliac Fossa

The bowl-shaped iliac fossa is located on the medial surface of the ilium and is an attachment site for the iliacus muscle. The presence of the iliacus and the abdominal contents makes the majority of the fossa inaccessible; however, you can sink your fingers slowly over the iliac crest and into the fossa to palpate it.



- 1) Supine. Flex the hip by bolstering under your partner's knee to shorten and soften the overlying tissue.
- 2) Lay the fingertips of one hand along the iliac crest just posterior and superior to the ASIS.
- 3) Moving slowly and patiently, curl your fingertips over the lip of the iliac crest into the iliac fossa (6.29). Depending on the firmness of the tissue, you might sink in only a small distance.

## Posterior Superior Iliac Spine (PSIS)

(Refer to p. 286 for more information)

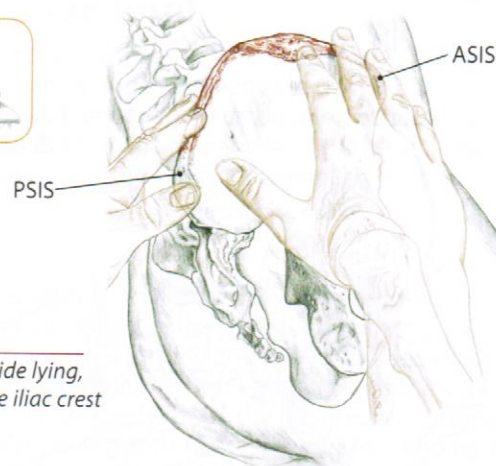


- 1) Partner standing. Follow both iliac crests posteriorly around the waist.
- 2) Follow the crests as they descend toward the sacrum and end at each PSIS (6.30). The PSIS will feel like a shallow hump surrounded by thicker tissues. It is not as pronounced as the ASIS, but is nevertheless accessible.
- 3) If possible, visibly locate the dimples of the low back and explore the surrounding region.



Are you at the posterior end of the iliac crest?  
Are both landmarks roughly horizontal to each other and three to four inches apart?

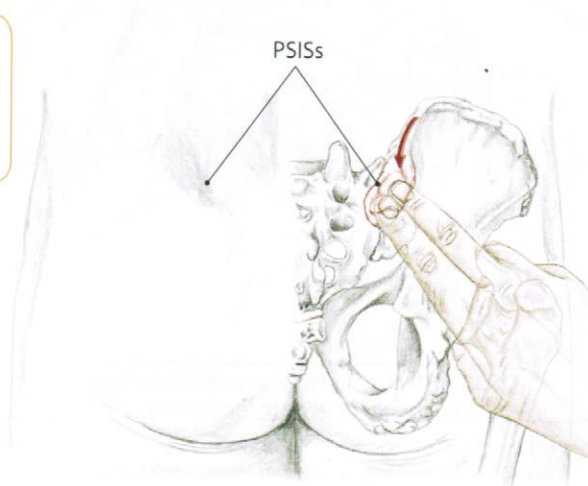
fossa fos-a L. a shallow depression



6.28 Partner side lying, sculpting out the iliac crest



6.29 Partner supine, curling your fingers into the iliac fossa



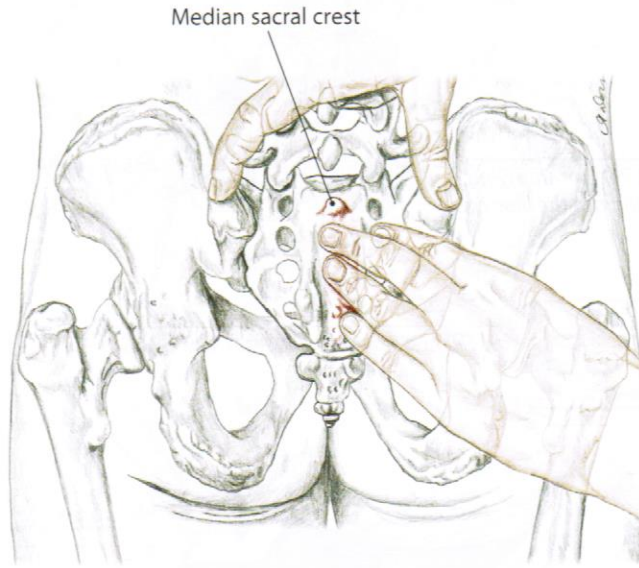
6.30 Posterior view, isolating the PSIS



# Trail 3 “Tailbone Trail”

## Sacrum

Median Sacral Crest  
Edge of the Sacrum



6.31 Posterior view, using the PSISs as guides to locate the median sacral crest of the sacrum

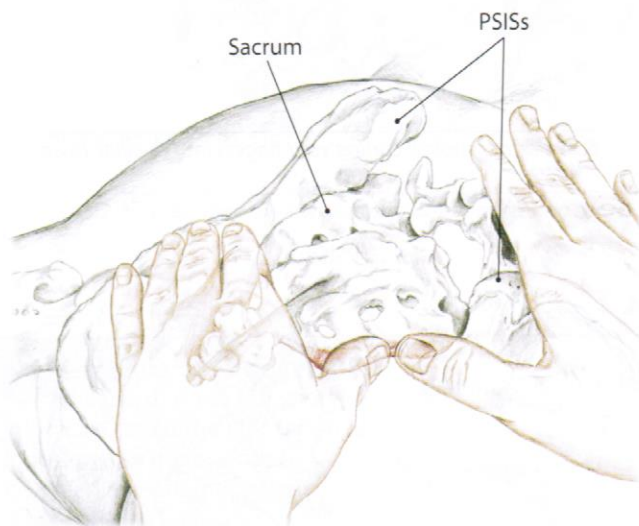
The **sacrum** is a large, triangular bone at the inferior end of the vertebral column. Situated between the overhanging sides of the pelvis, the sacrum is made up of a series of four or five vertebrae that are fused together.

Running down the center of the sacrum and composed of three to four points is the **median sacral crest**. On either side of the median sacral crest is the lateral sacral crest—a smaller series of bony knobs. The **edge of the sacrum** is part of the attachment site for the gluteus maximus and the sacrotuberous ligament. Although the sacrum’s bumpy surface lies deep to the thoracolumbar aponeurosis and sacroiliac ligaments, it is easily accessible.



- 1) Partner prone. Place a thumb and finger upon each PSIS and explore between and below these points for the surface of the sacrum.
- 2) Locate the midline of the sacrum and explore the points of the sacral crest (6.31). Palpate superiorly to the level of the PSIS and just above the coccyx.
- 3) Slide your fingers laterally off the side of the sacrum, pressing your fingertips into its solid edge (6.32). Follow the lateral edge up toward the PSIS and down to the coccyx.

How many small tips can you feel along the sacral crest? Can you follow both lateral edges inferiorly to where they converge at the coccyx? If you move laterally from the outer edge of the sacrum, can you feel the mass of the gluteus maximus (p. 315)?



6.32 Posterior/lateral view, partner prone, exploring the edge of the sacrum

Reptiles and most birds have two sacral vertebrae while mammals have between three and five. Humans in particular have more because, as upright creatures, the entire weight of the upper body is transferred through the sacrum to the pelvis and legs. All that remains of the spinous processes of the sacrum’s vertebrae are the time-worn tips of the median sacral crest.

## Coccyx

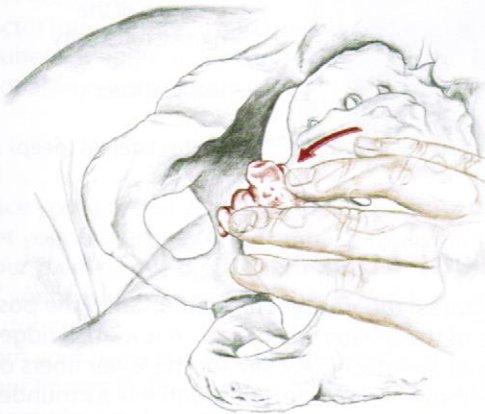
The coccyx is located at the top of the gluteal cleft and attaches to the end of the sacrum. Composed of three or four fused bones, it has a segmented, bumpy contour and can be an inch or more in length. Its tip may curve in toward the body or veer slightly to the left or right.

Because of its proximity to the gluteal cleft, palpating the coccyx may be challenging initially for both you and your partner, so palpate your own coccyx before palpating your partner's.



- 1) Partner prone. Walk your fingers down the median sacral crest toward the gluteal cleft. At the top of the cleft, you will feel the bumpy surface of the coccyx.
- 2) Explore the surface and sides of the coccyx, noting how the wide upper part narrows to a tip (6.33). The tip of the coccyx might not be accessible since it curves into the body.

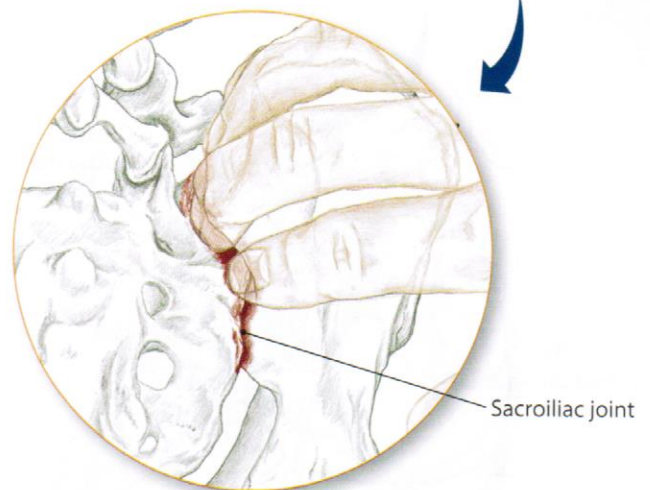
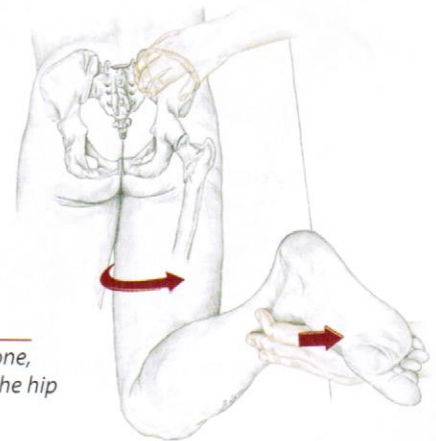
Are you palpating the most inferior aspect of bone in this region? Can you sculpt out the edges of the coccyx and its shape?



6.33 Posterior/lateral view, partner prone, palpating the coccyx



6.34 Partner prone, medially rotating the hip



## Sacroiliac Joint

The sacroiliac joint is the junction between the sacrum and the ilium. It is located medial to the PSIS and is deep to the thoracolumbar aponeurosis and posterior sacroiliac ligaments (p. 340). The ilium overhangs the sacroiliac joint, leaving only the edge of the joint accessible.



- 1) Partner prone. Locate the PSIS. Move slightly inferior and medial to locate the sacroiliac joint.
- 2) Create a small widening at the joint by keeping one hand upon it while the other hand flexes the knee to 90°. Then passively rotate the hip medially, feeling for a small opening at the joint space (6.34). Also try to laterally rotate the hip.

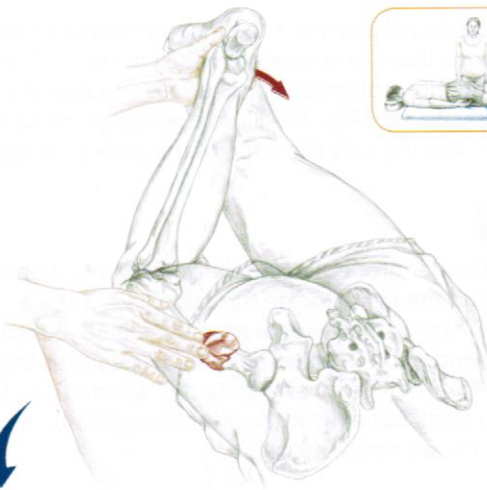
Are you just medial and distal to the PSIS? Can you sculpt out the edge of the ilium as it overlaps the sacrum?

The Greek philosopher Herophilus named the last segments of the vertebral column the "kokkyx" since it resembled a cuckoo's beak. However, during the Renaissance, the French anatomist Jean Riolan thought the term referred to the release of gas from the anus that can sound like the cry

of a cuckoo. The coccyx is also called the "tailbone"—an appropriate term when referring to the human fetus. During early development a small, distinct tail extends off the sacrum, but by the eighth week it disappears, leaving just what is recognizable as the coccyx.



## Trail 4 "Hip Hike"



### Greater Trochanter

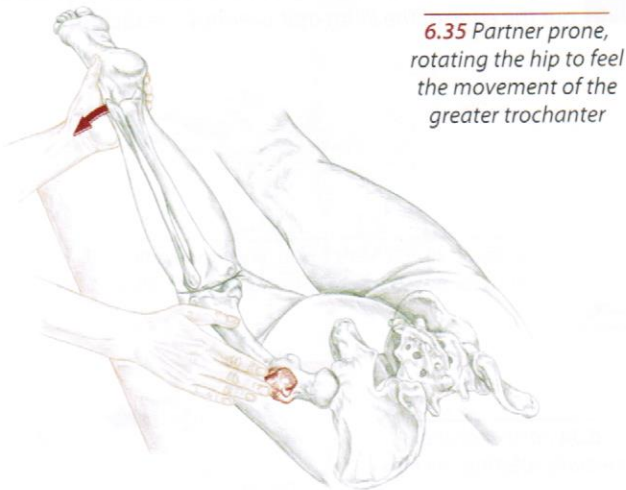
(Refer to p. 287 for more information)



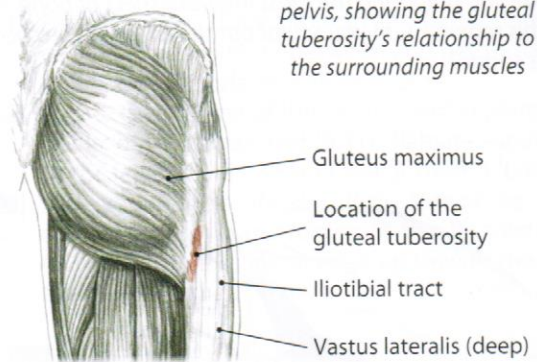
- 1) Partner prone. Locate the middle of the iliac crest.
- 2) Slide your fingerpads distally four or five inches along the side of the thigh. There you will feel the superficial hump of the greater trochanter.
- 3) Sculpt around its two-inch-wide surface and explore all of its sides.



*Holding the ankle, flex the knee to 90°. As your proximal hand palpates the greater trochanter, use the other hand to medially and laterally rotate the hip (6.35). Do you feel the trochanter swivel back and forth under your fingers?*



**6.35** Partner prone, rotating the hip to feel the movement of the greater trochanter



**6.36** Posterior view of pelvis, showing the gluteal tuberosity's relationship to the surrounding muscles

- Gluteus maximus
- Location of the gluteal tuberosity
- Iliotibial tract
- Vastus lateralis (deep)

### Gluteal Tuberosity

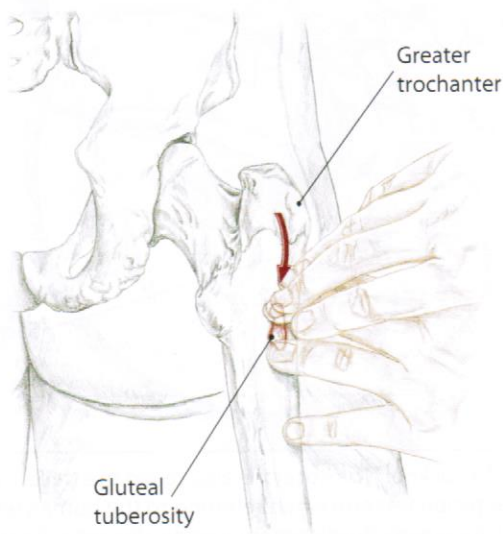
The gluteal tuberosity is located distal to the posterior surface of the greater trochanter. It is a small ridge serving as an attachment site for the lower fibers of the gluteus maximus muscle. Although it is surrounded by the gluteus maximus tendon and the upper fibers of the vastus lateralis muscles (6.36), the gluteal tuberosity is relatively superficial and accessible.



- 1) Partner prone. Locate the posterior surface of the greater trochanter.
- 2) Slide one or two inches distally along the posterior shaft of the femur until you feel the solid surface of the tuberosity (6.37). It might not feel like a ridge, but more like a flat, superficial portion of bone.



*Can you press into the area you are palpating and feel the superficial surface of the femur? Are you directly lateral to the ischial tuberosity (p. 287)?*

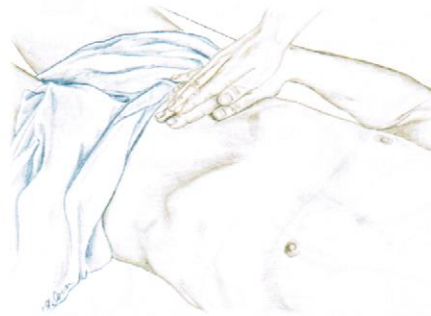


**6.37** Posterior view



# Trail 5 “The Underpass”

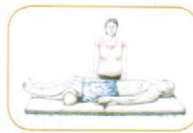
Here are a few suggestions to make sure this route is comfortable for you and your partner: **a)** Explain to your partner what you will be doing and obtain permission to proceed. **b)** If your partner would be more comfortable, use his or her hand to palpate with your hand guiding on top (right).



Partner supine

## Umbilicus

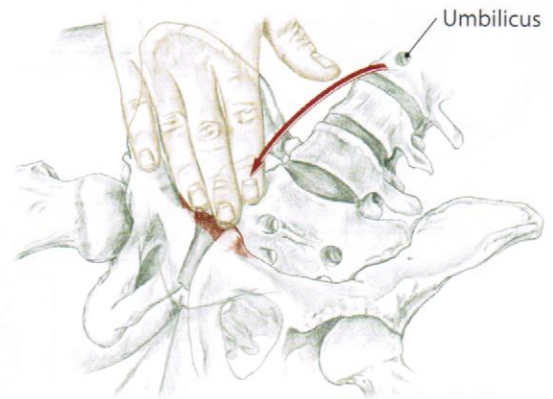
The umbilicus (or navel) will, of course, be visible when the abdomen is undraped. When not exposed, the umbilicus can be felt at the midline of the body, superior to the level of the ASISs.



## Pubic Crest and Tubercles

(Refer to p. 286 for more information)

The pubic tubercles are located on the superior aspect of the pubic crest. Each tubercle is shaped like a small horn and serves as an attachment site for the adductor longus muscle and the inguinal ligament. The tubercles might be one to two inches apart and are not always easy to palpate.



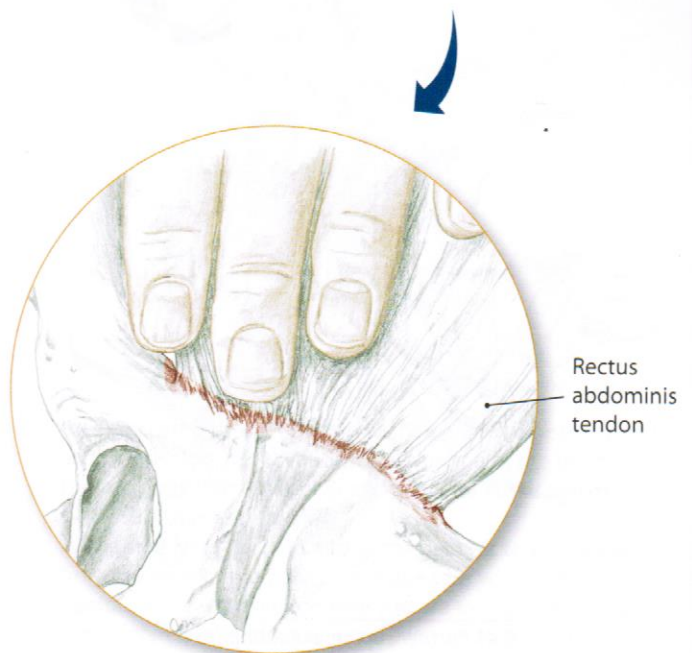
6.38 Anterior/lateral view, partner supine



- 1) Face your partner as he lies supine on the table. Set your fingertips on his umbilicus, allowing your palm to rest on the abdomen. The heel of your hand will be on (or just superior to) the pubic crest.
- 2) Turn your hand and relocate the crest with your fingers (6.38). Explore its horizontal ridge. Remember that the pubic crest is the only horizontal stretch of bone in this vicinity.
- 3) Move laterally and explore for the tips of the pubic tubercles. Palpate both tubercles, noting the distance between them.

Do you feel a firm, bony prominence inferior and medial to the level of the ASIS? With respect to the pubic tubercles, are the bony prominences you feel on the superior part of the pubic crest? Are the tubercles on the same level as the greater trochanters?

Begin at the ASIS and follow the inguinal ligament (p. 339) inferiorly and medially 45° to the pubic tubercle.

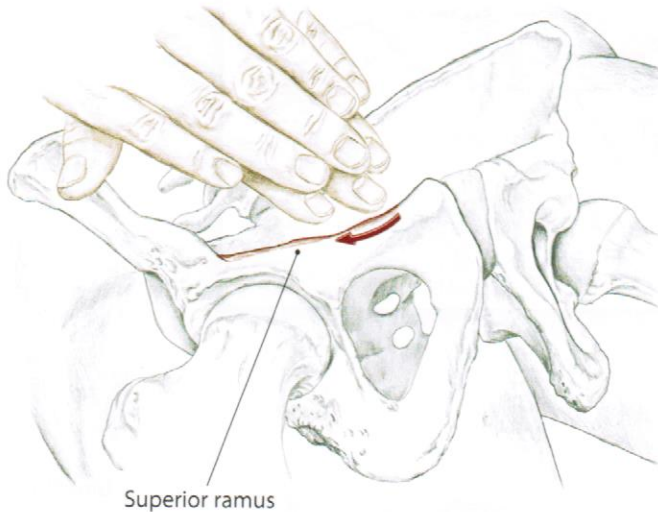


symphysis  
umbilicus

sim-fi-sis  
um-bil-i-kus

Grk. growing together  
L. navel, center

When palpating the superior ramus, be mindful of the pulse of the femoral artery (p. 339).

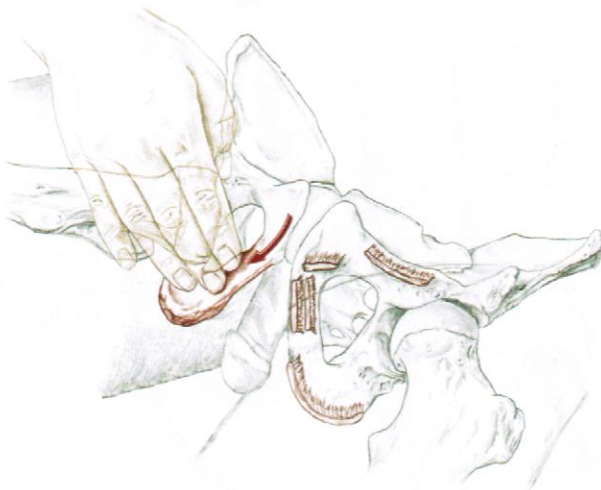


Superior ramus

6.39 Partner supine



6.40 Adductor muscle attachment sites along the rami



6.41 Partner supine, palpating from the rami to the ischial tuberosity

## Superior Ramus of the Pubis

The superior ramus of the pubis spans  $45^\circ$  from the pubic tubercle toward the AIIS. It forms a ridge that serves as an attachment site for the pectineus muscle (p. 319). Since it is deep to the inguinal ligament and a neurovascular bundle, the superior ramus can be challenging to palpate.



- 1) Partner supine. Place your flexed knee under your partner's knee. This position will flex and laterally rotate the hip, allowing for easier palpation.
- 2) Locate the pubic crest. Slide laterally off the crest toward the AIIS. Sink into the tissue, feeling for the buried ridge of the superior ramus (6.39).

✓ Are you lateral and slightly superior to the pubic tubercle? If you cannot feel the edge of the ramus, can you sense its density beneath the superficial tissue?

## Inferior Ramus of the Pubis and Ramus of the Ischium

The two rami are located along the inferior aspect of the pelvis and together form a bridge between the pubic crest and the ischial tuberosity. The ramus of the pubis, the anterior half of the bridge, serves as an attachment site for the gracilis and adductor brevis muscles; both rami are attachment sites for the adductor magnus muscle (6.40). When palpating the rami, use your fingertips, keeping them close to the medial thigh. The angle formed by the rami will be wider on females than males.



- 1) Partner supine. Place your flexed knee under your partner's knee.
- 2) Locate the pubic crest. Then move to the lateral edge of the pubic crest and slide posteriorly around the medial thigh (6.41). Using slow but firm pressure, palpate for the hard ridge of the rami. This "bridge of bone" is the only bony mass in the area, so if you are pressing on a solid line of bone, you have found it.
- 3) Continue around the thigh until you reach the large ischial tuberosity.

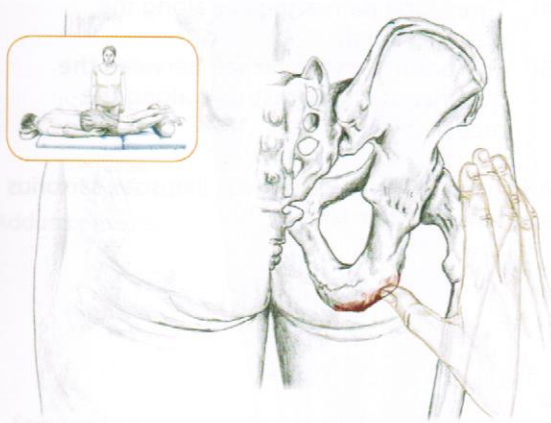
✓ As you follow the rami, do they lead you posteriorly around the inside of the thigh? As you move around the thigh, do you feel the rami widen laterally? Can you feel where any of the adductor tendons (p. 319) attach to the rami?

## Ischial Tuberosity

(Refer to p. 287 for more information)



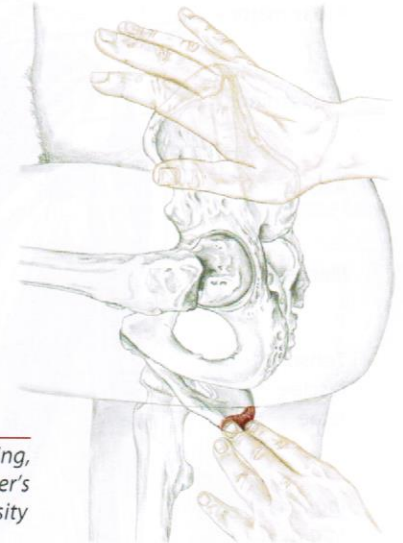
- 1) Prone. Locate the gluteal fold, the horizontal line between the buttock and thigh. Place your fingers at the center of the gluteal fold and press superiorly and medially until your fingertips bump into the large surface of the ischial tuberosity (6.42).
- 2) Explore all sides of its large mass and note its relationship to the greater trochanter.



6.42 Posterior view, locating the ischial tuberosity

✓ Are you palpating between the inferior buttock and proximal thigh? Can you feel the large hamstring tendons attach to the ischial tuberosity?

◆ Partner side lying, with the top hip flexed. Place your hand on the medial thigh. Slide proximally to the gluteal fold and ischial tuberosity (6.43).



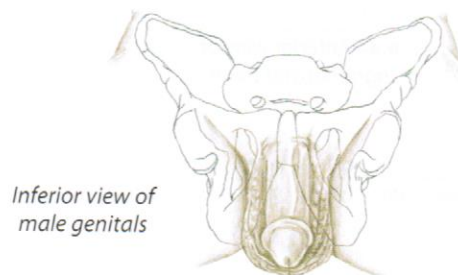
6.43 Partner side lying, locating your partner's right ischial tuberosity

"How do you access bones and muscles that are close to the genitals?" Actually, all of the bony landmarks, tendons and blood vessels in this region can be easily palpated without contacting the genitals (below). If you follow the instructions given, you will maintain your and your partner's comfort.

With that said, it should be obvious that palpation on males



Inferior view of female genitals



Inferior view of male genitals



Partner supine

is complicated by the position of the penis and testicles. In a supine position, flexion and lateral rotation of the thigh will bring it away from the pelvis and allow for easier palpation. (See p. 322, for example.)

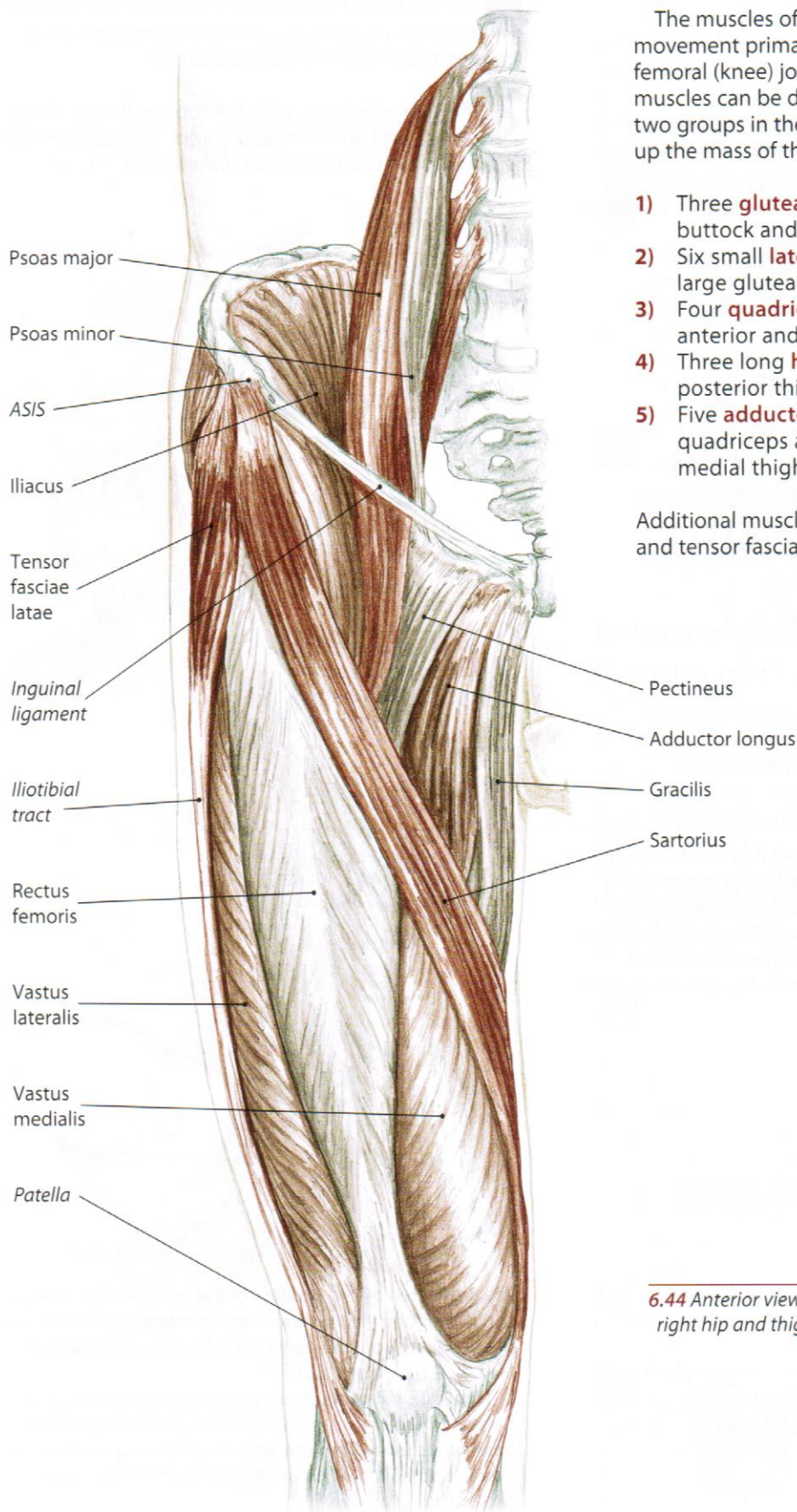
The side lying position allows the genitals to shift away from the base of the pelvis. To make sure your partner's genitals are away from the area you are trying to access, ask him to shift and hold his genitals away from the side you will be contacting (above).

# ✦ Muscles of the Pelvis and Thigh

The muscles of the pelvis and thigh create movement primarily at the coxal (hip) and tibio-femoral (knee) joints. Most of the hip and thigh muscles can be divided into five groups. There are two groups in the buttock region while three make up the mass of the thigh:

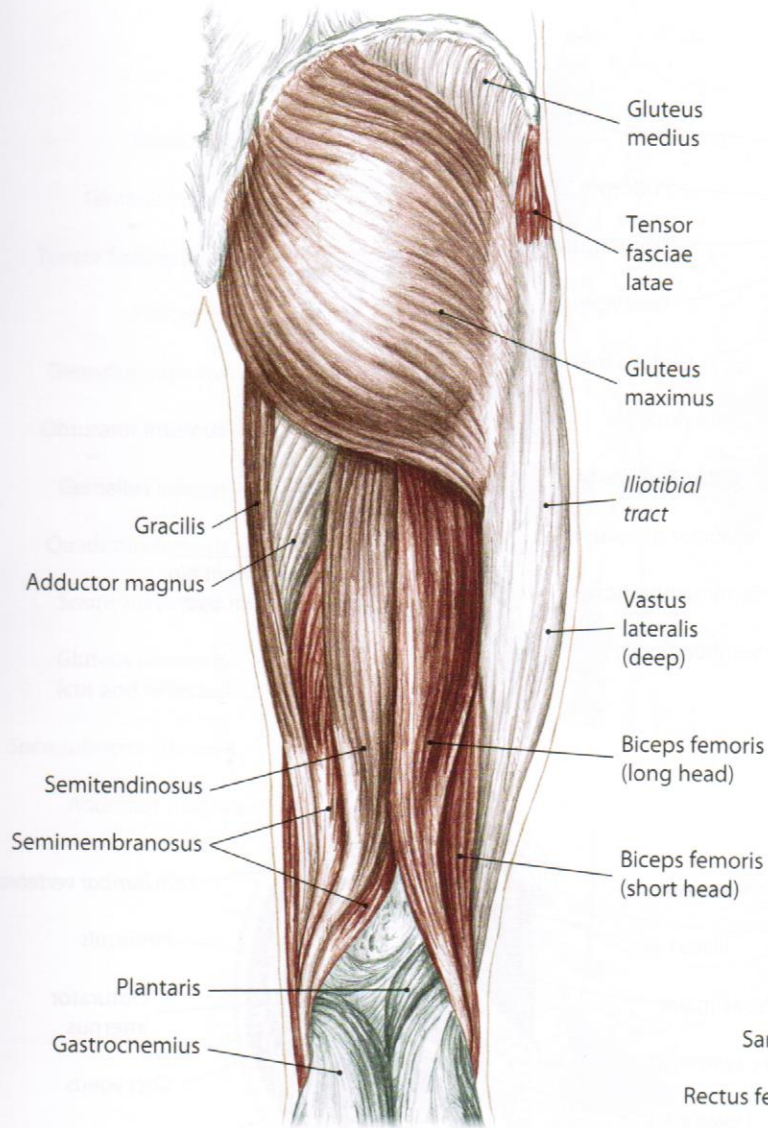
- 1) Three **gluteal** muscles give shape to the buttock and lateral hip.
- 2) Six small **lateral rotators** are deep to the large gluteals.
- 3) Four **quadriceps** are located on the thigh's anterior and lateral surfaces.
- 4) Three long **hamstrings** lie along the posterior thigh.
- 5) Five **adductors** are tucked between the quadriceps and hamstrings along the medial thigh.

Additional muscles include the iliopsoas, sartorius and tensor fasciae latae.

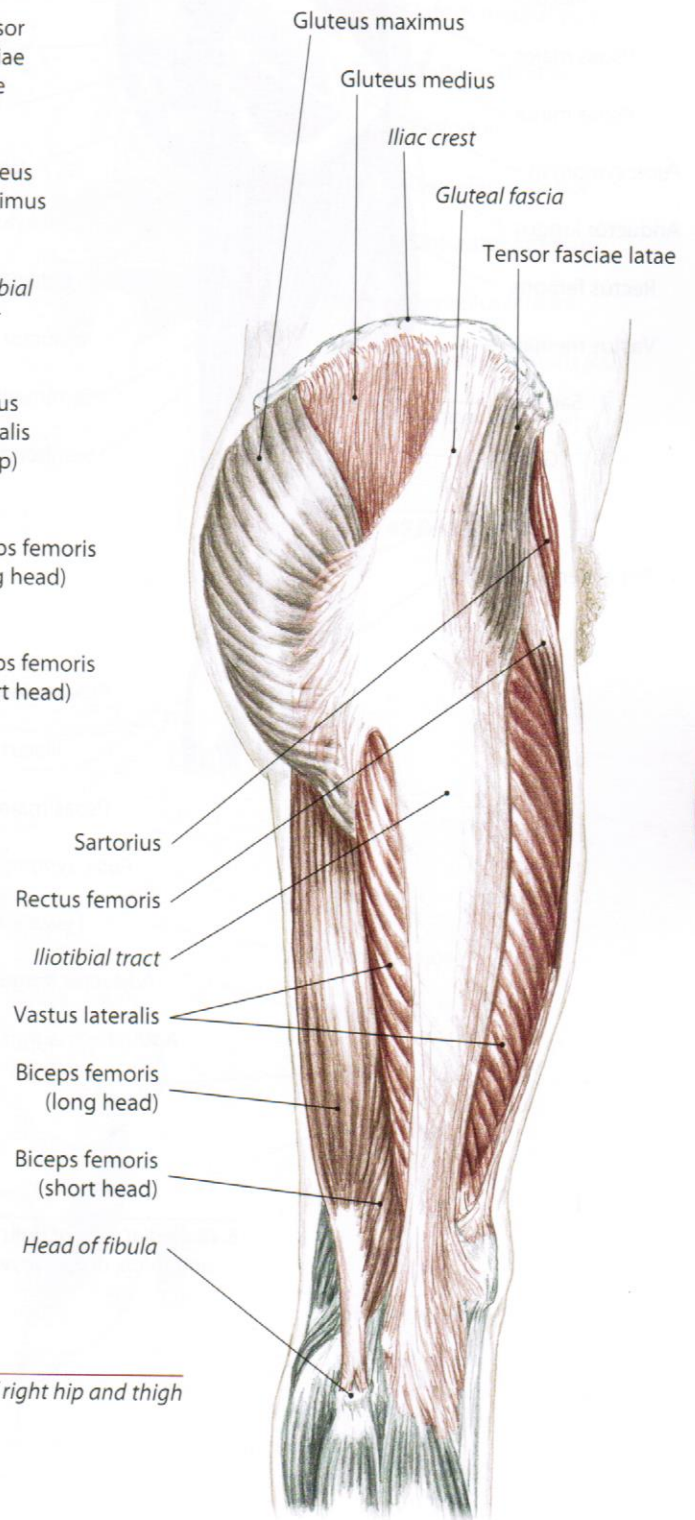


6.44 Anterior view of right hip and thigh

# ✦ Muscles of the Pelvis and Thigh

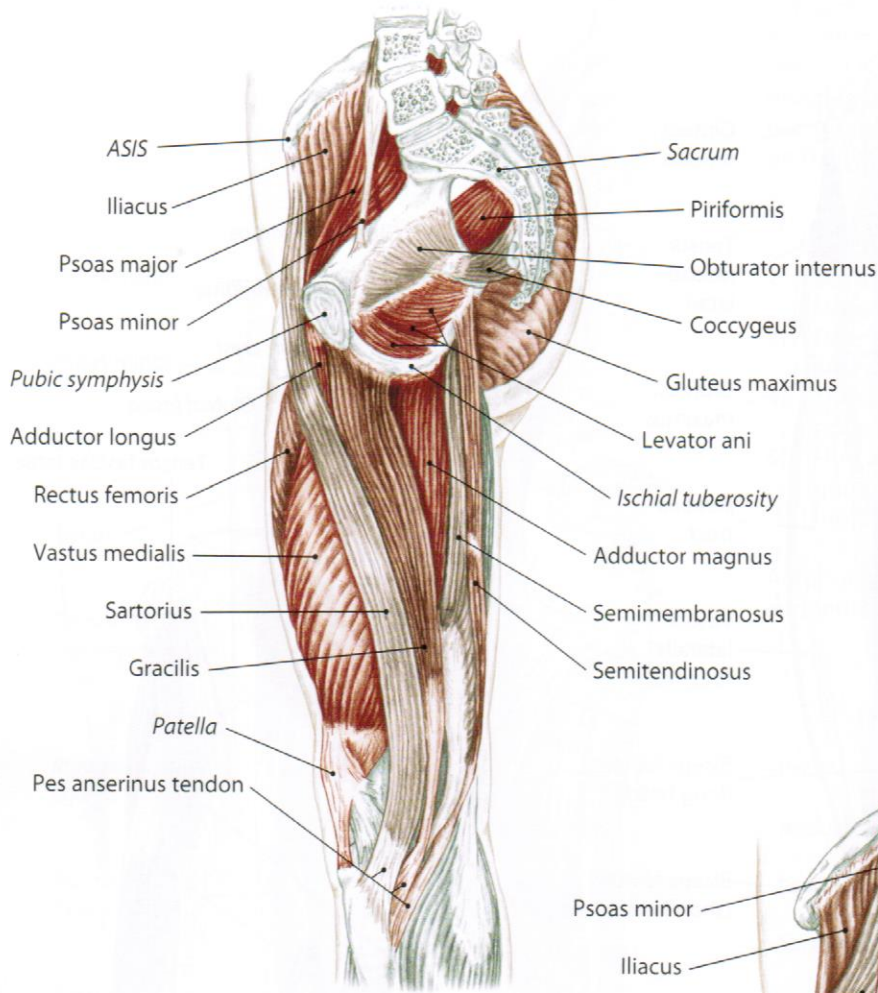


6.45 Posterior view of right hip and thigh

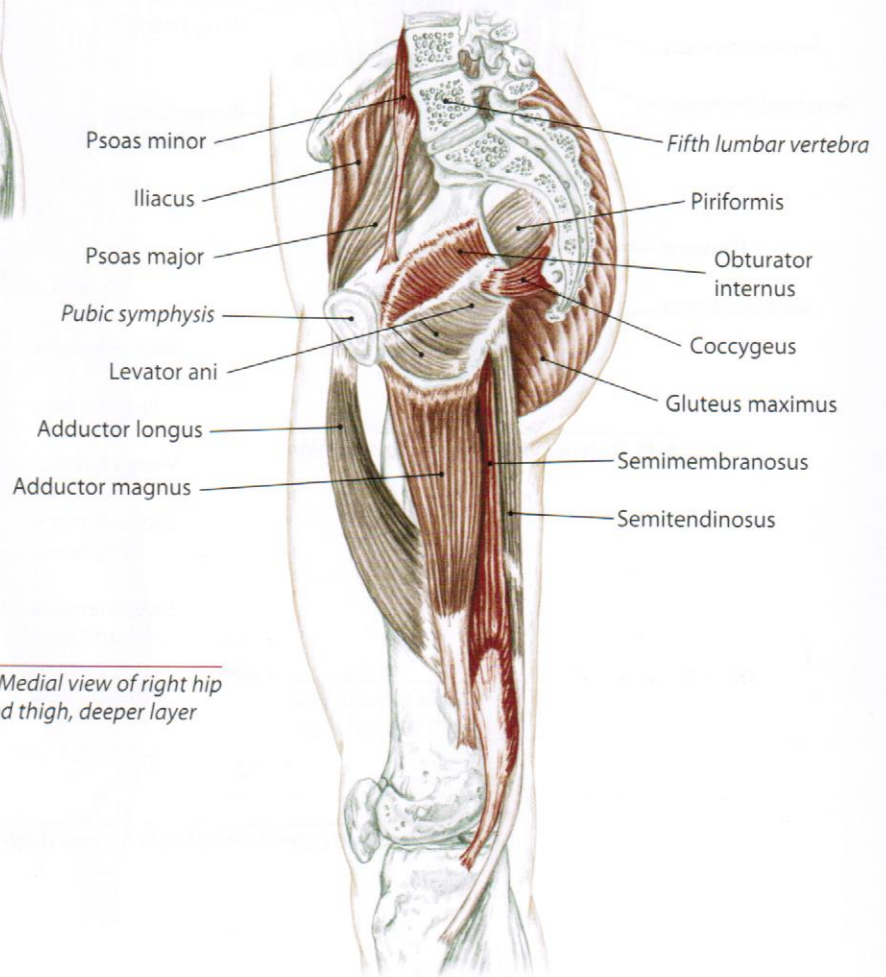


6.46 Lateral view of right hip and thigh

# Muscles of the Pelvis and Thigh

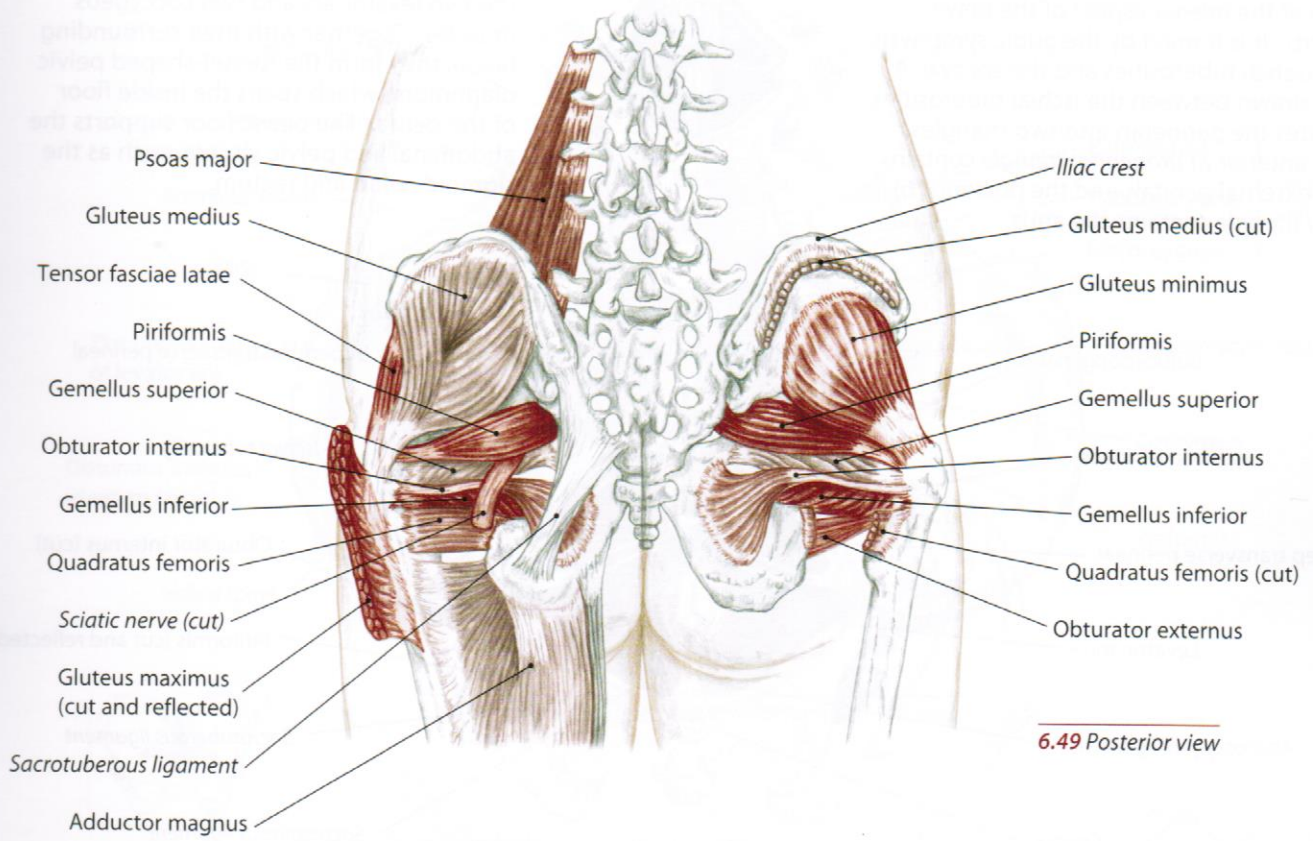


6.47 Medial view of right hip and thigh, superficial layer

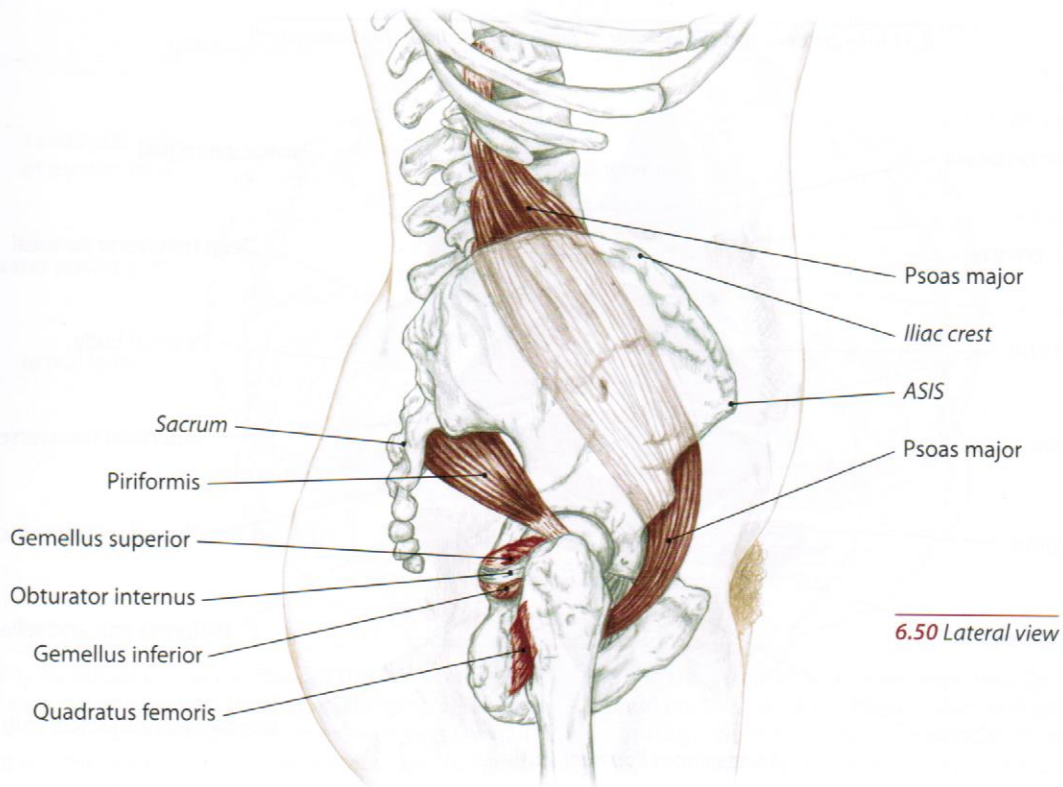


6.48 Medial view of right hip and thigh, deeper layer

# Muscles of the Pelvis and Thigh



6.49 Posterior view

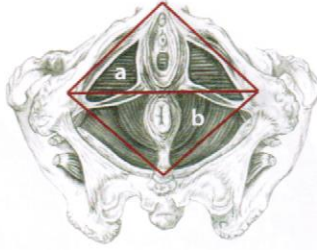


6.50 Lateral view

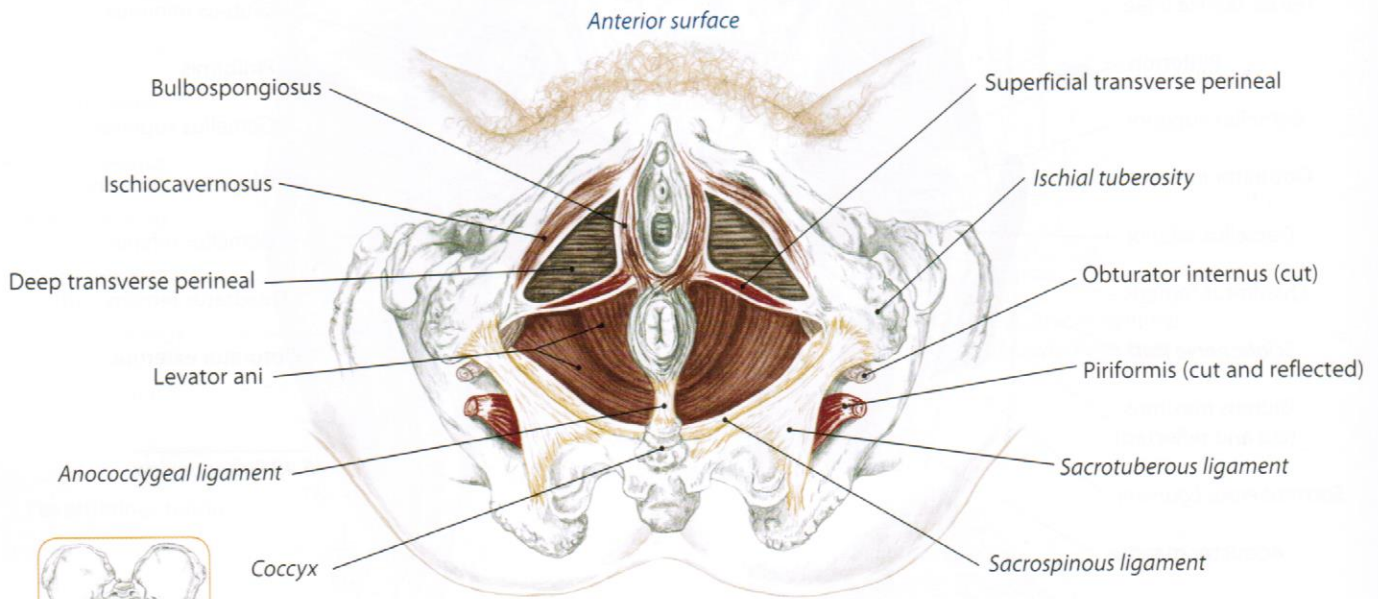
Pelvis & Thigh

# Perineum and Pelvic Floor

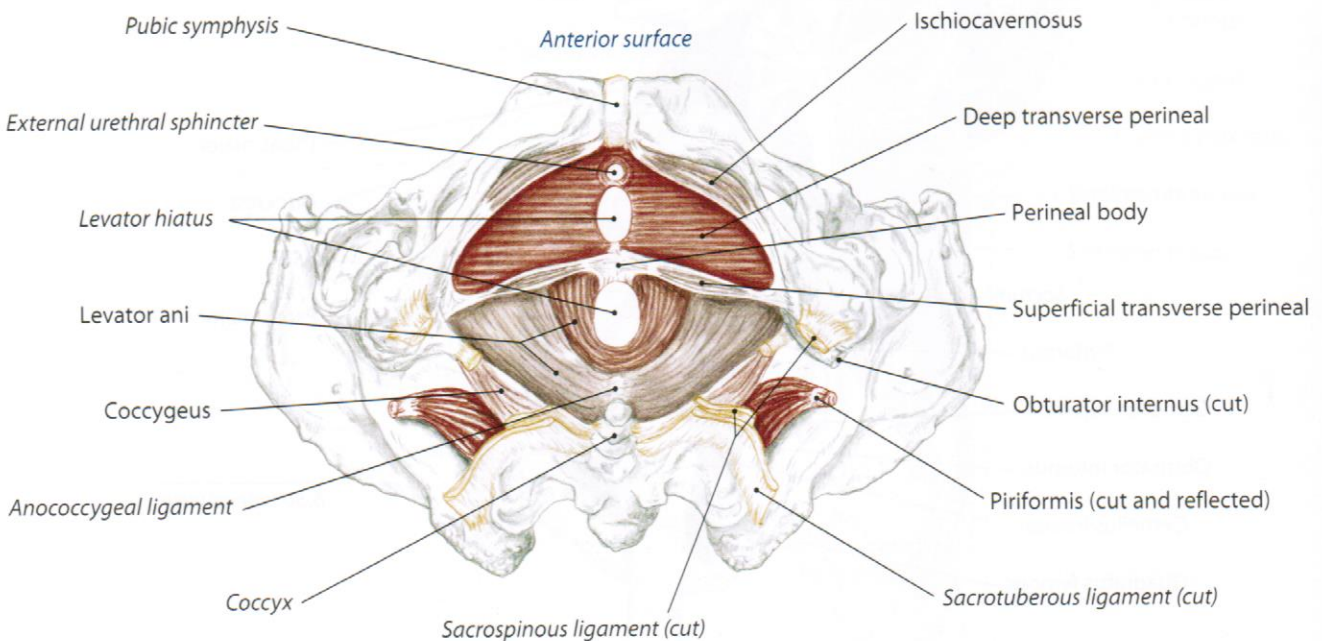
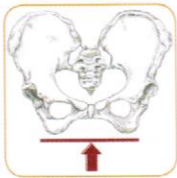
The **perineum** is the diamond-shaped area at the *inferior* aspect of the pelvis (right). It is framed by the pubic symphysis, the ischial tuberosities and the coccyx. A line drawn between the ischial tuberosities divides the perineum into two triangles. The anterior **a**) *urogenital triangle* contains the external genitals and the posterior **b**) *anal triangle* contains the anus.



The **pelvic floor** is formed primarily by the two levator ani and two coccygeus muscles. Together with their surrounding fascia, they form the funnel-shaped pelvic diaphragm, which spans the inside floor of the pelvis. The pelvic floor supports the abdominal and pelvic viscera, such as the sigmoid colon and rectum.

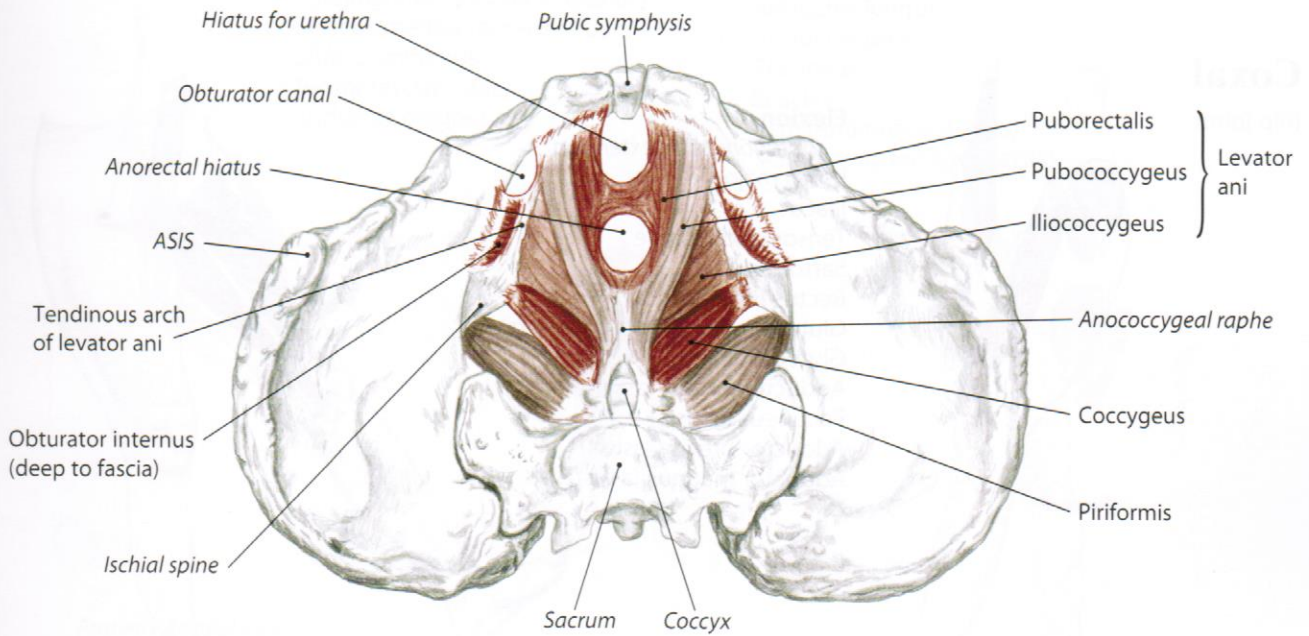


6.51 Inferior view, superficial layer of female pelvic floor (hips abducted)

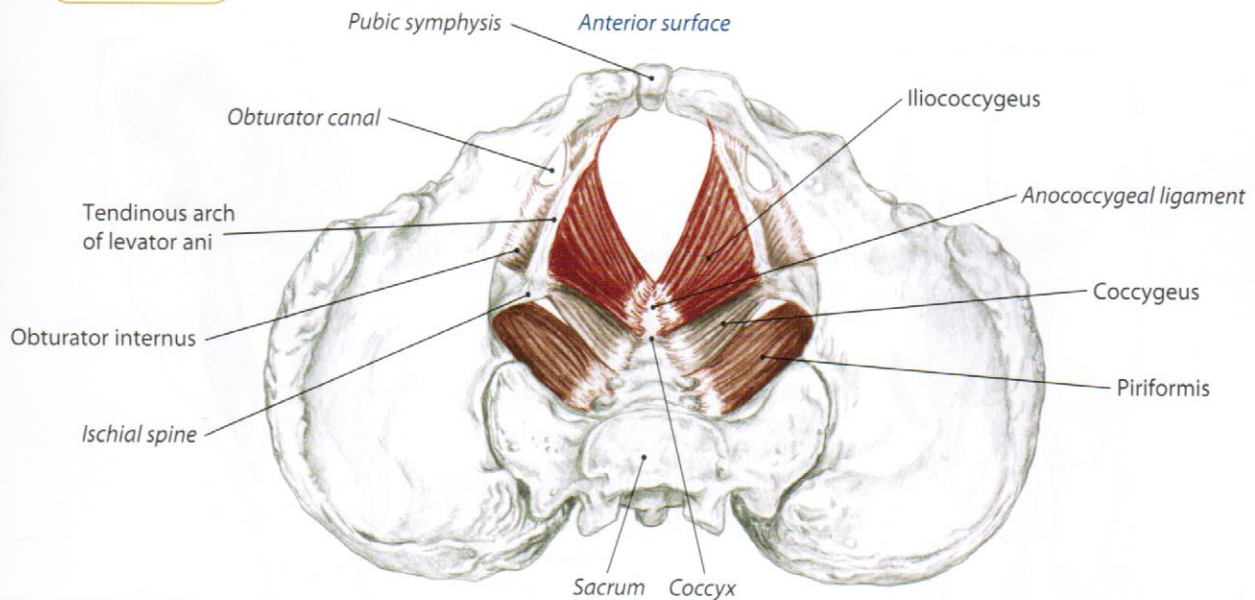


6.52 Inferior view, intermediate layer of female pelvic floor

# Perineum and Pelvic Floor



6.53 Superior view, superficial layer of female pelvic floor



6.54 Superior view, deep layer of female pelvic floor

"Why no palpation instructions for the perineal region?"  
The perineum—as well as other challenging areas such as the mouth, nose and ear cavities—are best learned not in a text such as *Trail Guide*, but at a specific hands-on workshop in the presence of an experienced instructor.

In the meantime, consider exploring the landmarks and muscles of your own perineum and pelvic floor. Initially, you may snicker and be intimidated, but this often-avoided region of the body is as much a part of you as your fingers and toes.

anococcygeal  
bulbospongiosus  
iliococcygeus

a-no-kok-si-je-al  
bul-bo-spon-je-o-sus  
il-ee-o-kok-si-je-us

L. *anus*, anus + Grk. *kokkyx*, coccyx  
L. *blubus*, bulbous root + Gr. *spongus*, sponge

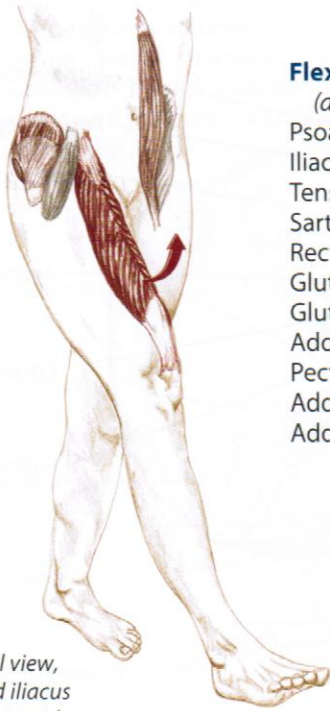


# Synergists—Muscles Working Together

Muscles are listed in the order of their ability to create the movement. Asterisk indicates muscles not shown.

## Coxal

(hip joint)

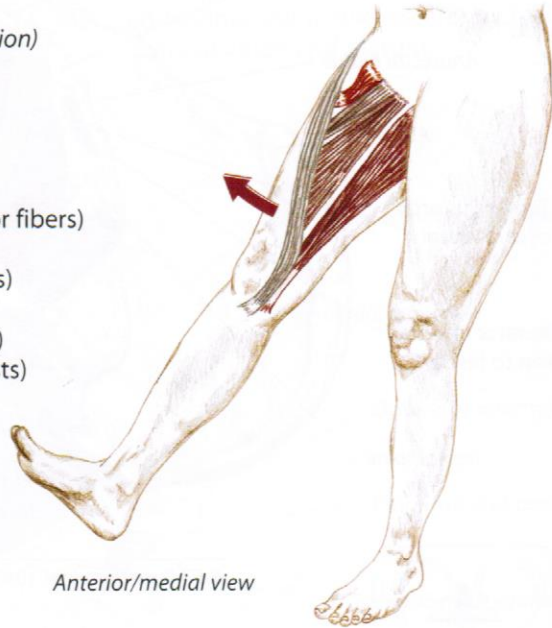


Anterior/lateral view, psoas major and iliacus shown on opposite side

### Flexion

(antagonists on extension)

- Psoas major
- Iliacus
- Tensor fasciae latae
- Sartorius
- Rectus femoris
- Gluteus medius (anterior fibers)
- Gluteus minimus
- Adductor longus (assists)
- Pectineus (assists)
- Adductor brevis (assists)
- Adductor magnus (assists)



Anterior/medial view

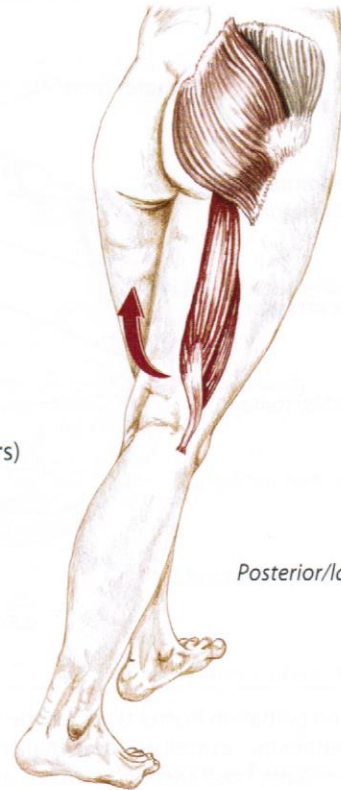


Posterior/medial view

### Extension

(antagonists on flexion)

- Gluteus maximus (all fibers)
- Biceps femoris (long head)
- Semitendinosus
- Semimembranosus
- Adductor magnus (posterior fibers)
- Gluteus medius (posterior fibers)



Posterior/lateral view



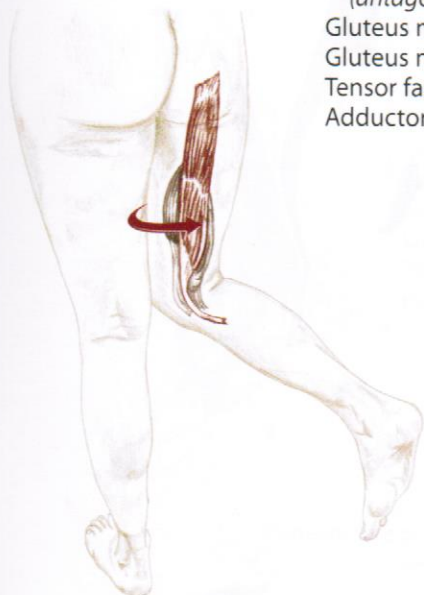
See p. 410 for a complete list of muscles that tilt the pelvis.

**Medial Rotation (internal rotation)**

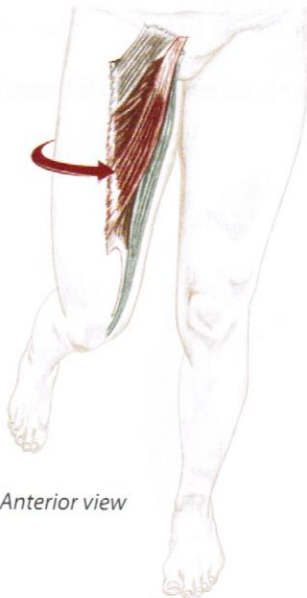
*(antagonists on lateral rotation)*

- Gluteus medius (anterior fibers)
- Gluteus minimus
- Tensor fasciae latae
- Adductor magnus

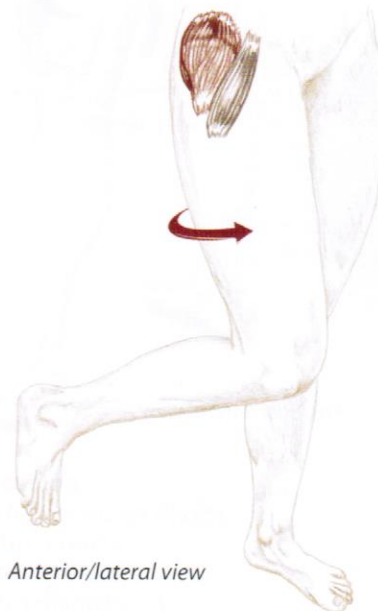
- Adductor longus
- Adductor brevis
- Pectineus
- Gracilis
- Semitendinosus (assists)
- Semimembranosus (assists)



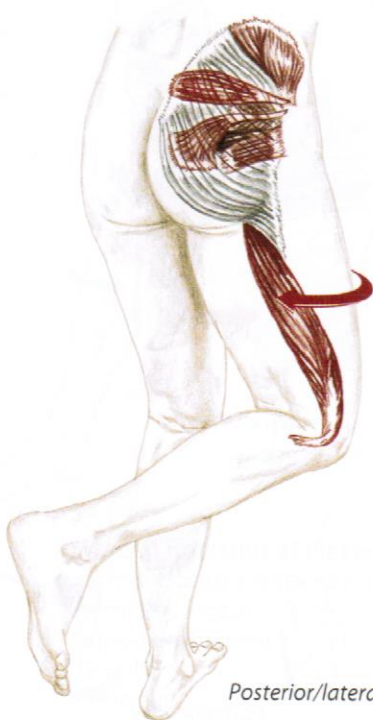
Posterior/medial view



Anterior view



Anterior/lateral view

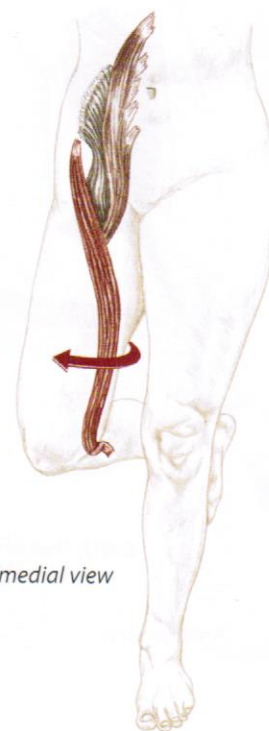


Posterior/lateral view

**Lateral Rotation (external rotation)**

*(antagonists on medial rotation)*

- Gluteus maximus (all fibers)
- Piriformis
- Quadratus femoris
- Obturator internus
- Obturator externus
- Gemellus superior
- Gemellus inferior
- Gluteus medius (posterior fibers)
- Psoas major
- Iliacus
- Sartorius
- Biceps femoris (assists, long head)



Anterior/medial view

# Coxal

(hip joint)



Posterior/lateral view

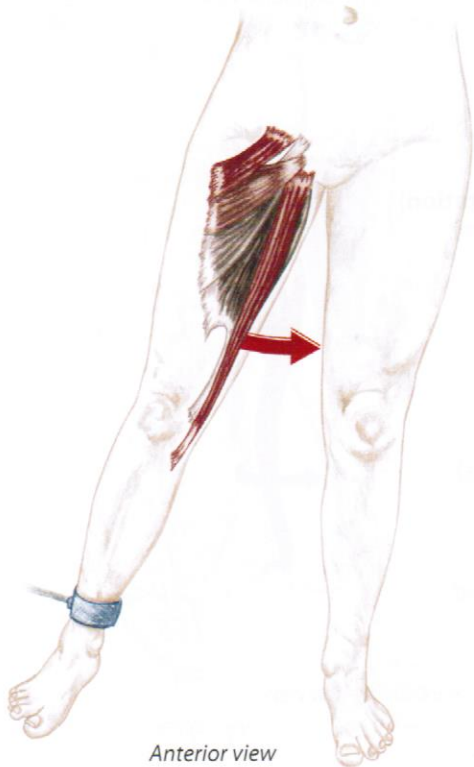
## Abduction

(antagonists on adduction)

- Gluteus maximus (all fibers)
- Gluteus medius (all fibers)
- Gluteus minimus
- Tensor fasciae latae
- Sartorius
- Piriformis (when the hip is flexed)\*



Anterior/lateral view

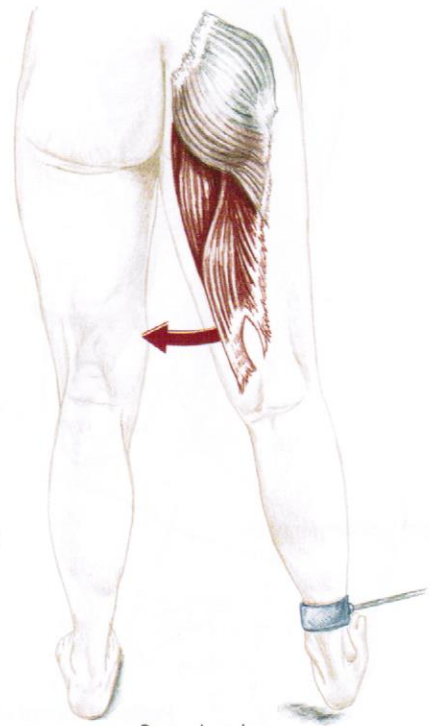


Anterior view

## Adduction

(antagonists on abduction)

- Adductor magnus
- Adductor longus
- Adductor brevis
- Pectineus
- Gracilis
- Gluteus maximus (lower fibers)



Posterior view

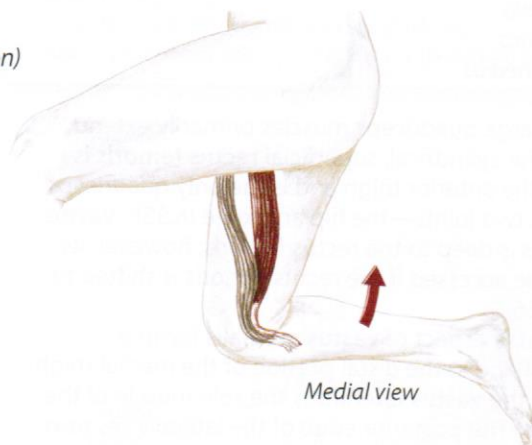


Posterior/lateral view

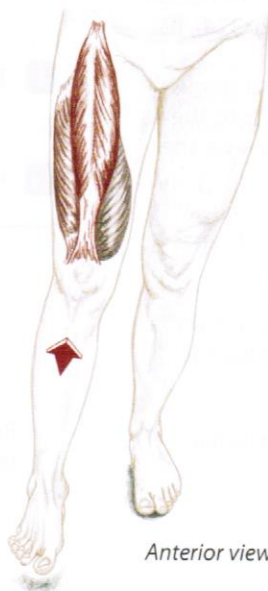
### Flexion

(antagonists on extension)

- Biceps femoris
- Semitendinosus
- Semimembranosus
- Gracilis
- Sartorius
- Gastrocnemius
- Popliteus
- Plantaris (weak)\*



Medial view

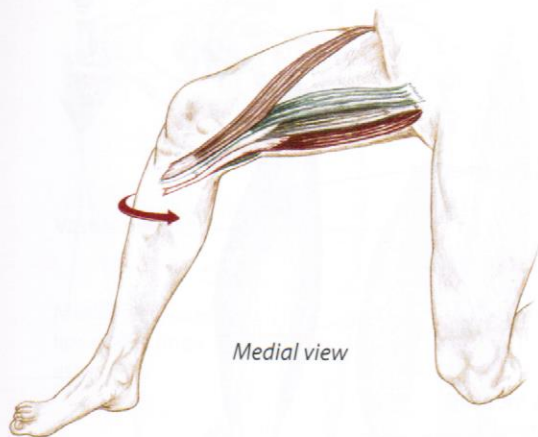


Anterior view

### Extension

(antagonists on flexion)

- Rectus femoris
- Vastus lateralis
- Vastus medialis
- Vastus intermedius\*



Medial view

### Medial Rotation of Flexed Knee

(antagonists on lateral rotation)

- Semitendinosus
- Semimembranosus
- Gracilis
- Sartorius
- Popliteus\*



Lateral view

### Lateral Rotation of Flexed Knee

(antagonist on medial rotation)

- Biceps femoris

# Quadriceps Femoris Group

Rectus Femoris  
Vastus Medialis  
Vastus Lateralis  
Vastus Intermedius

The four large quadriceps muscles primarily extend the knee. The cylindrical, superficial **rectus femoris** is located on the anterior thigh and is the only quadriceps that crosses two joints—the hip and knee (6.55). **Vastus intermedius** is deep to the rectus femoris; however, its edges can be accessed if the rectus femoris is shifted to the side (6.56).

The palpable aspect of **vastus medialis** forms a “teardrop” shape at the distal portion of the medial thigh (6.57) while the **vastus lateralis** is the sole muscle of the lateral thigh. The posterior edge of the lateralis lies next to the biceps femoris, one of the hamstrings. Although vastus lateralis is deep to the iliotibial tract (p. 324), its fibers are easily accessible (6.58).

All four quadriceps muscles converge into a single tendon above the knee. The tendon connects to the top and sides of the patella before attaching—via the patellar ligament—to the tibial tuberosity.

**A** All:  
**Extend** the knee (tibiofemoral joint)

Rectus Femoris:  
**Flex** the hip (coxal joint)

**O** Rectus Femoris:  
Anterior inferior iliac spine (AIIS)

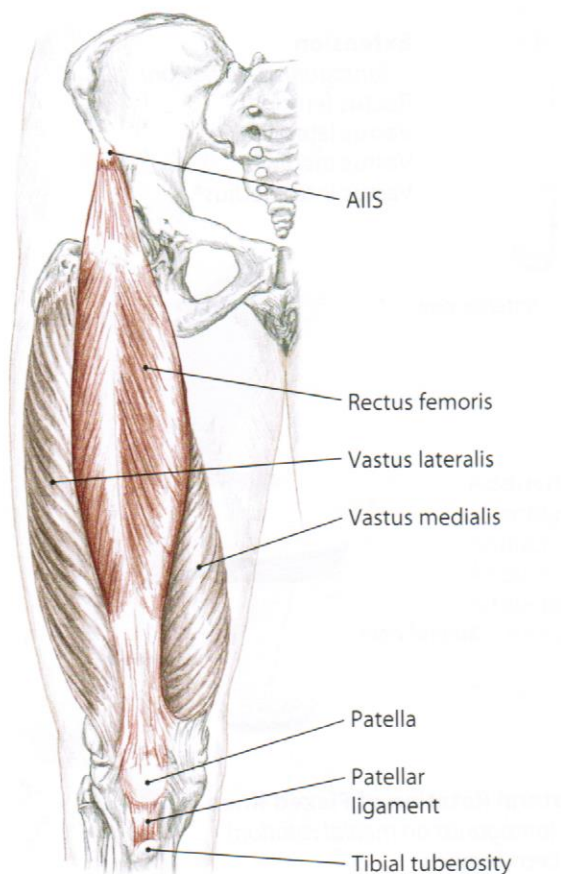
Vastus Medialis:  
Medial lip of linea aspera

Vastus Lateralis:  
Lateral lip of linea aspera, gluteal tuberosity  
and greater trochanter

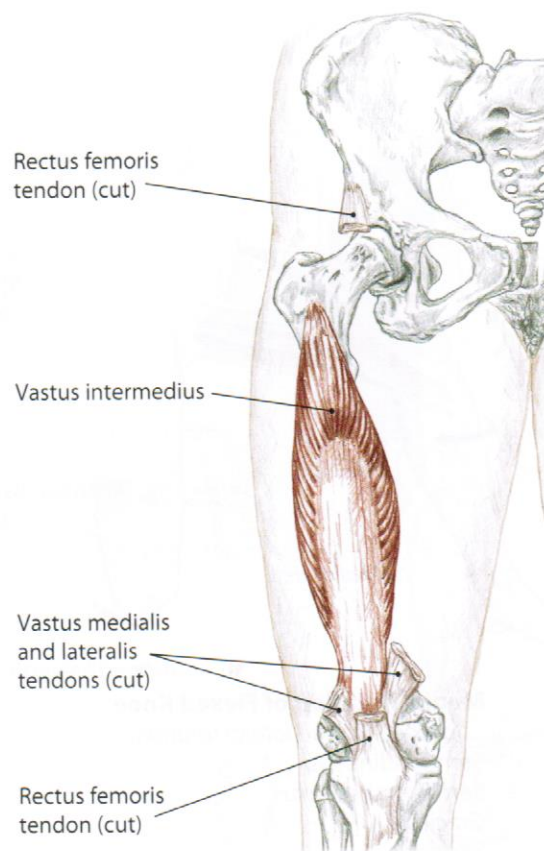
Vastus Intermedius:  
Anterior and lateral shaft of the femur

**I** Tibial tuberosity (via the patella and patellar ligament)

**N** Femoral L2, 3, 4



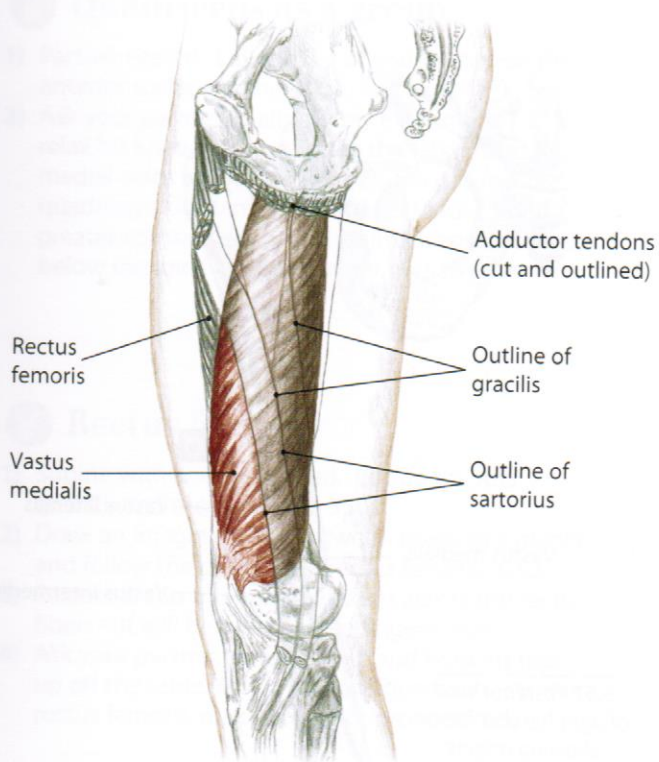
6.55 Anterior view of right hip and thigh



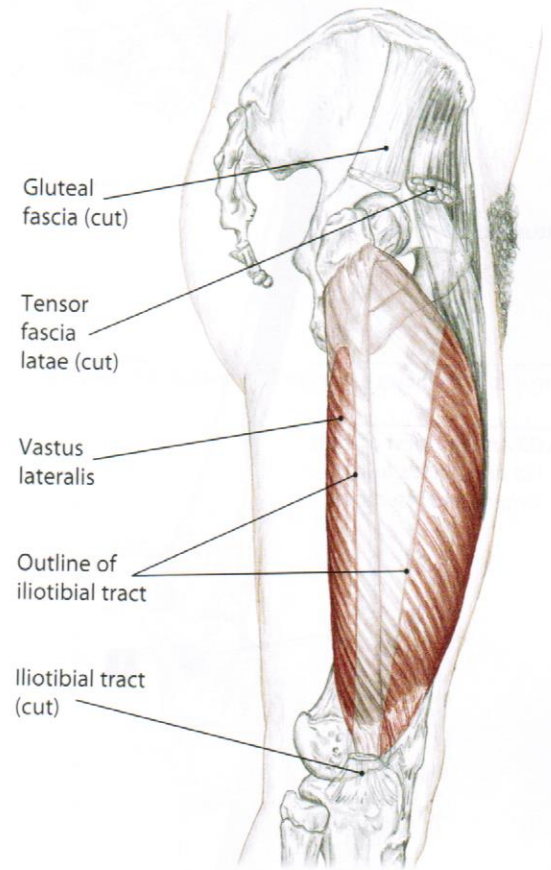
6.56 Anterior view of right hip and thigh

### When Do You Use Your Quadriceps?

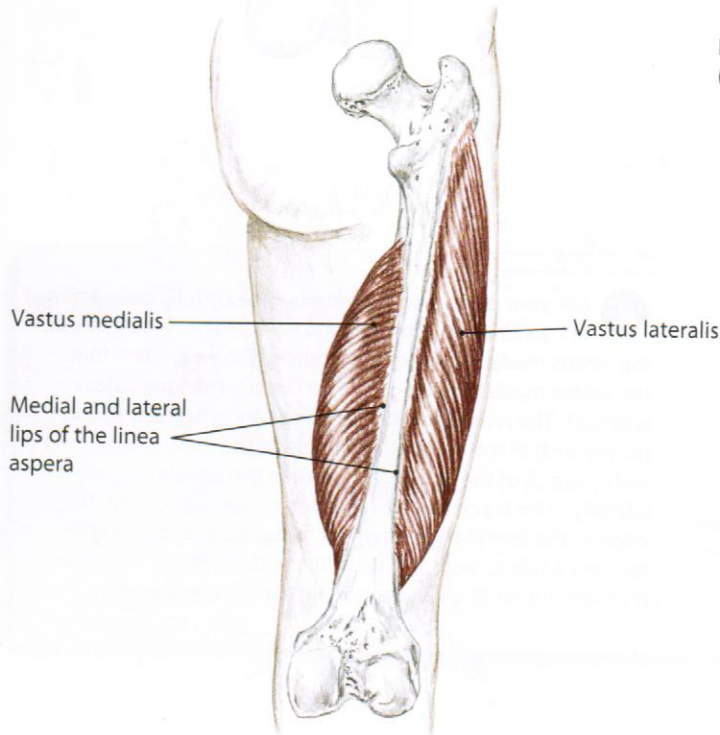
- Kicking a soccer ball
- Stabilizing yourself in a stationary squat position
- Raising your knee quickly into a bad guy's cojones (rectus femoris)



6.57 Medial view of right thigh

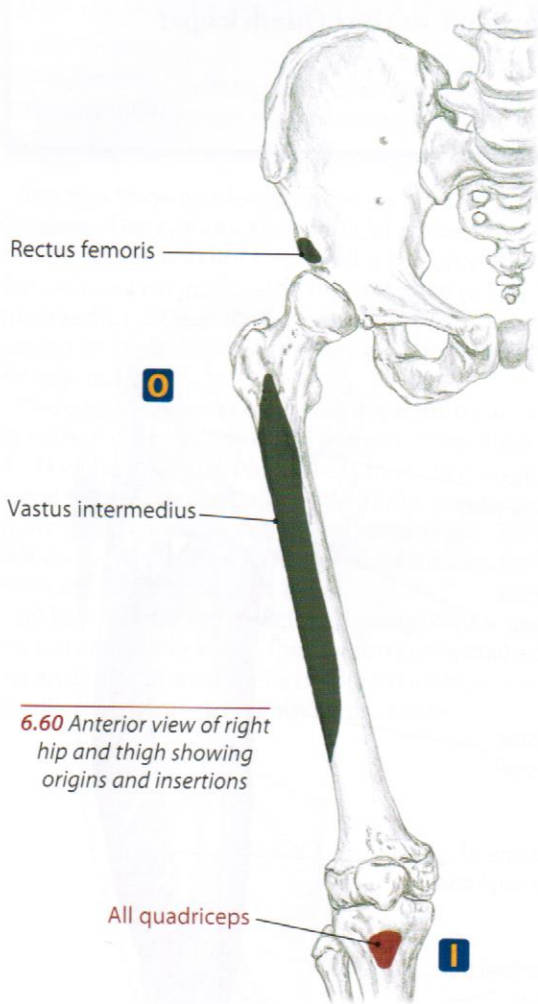


6.58 Lateral view of right hip and thigh

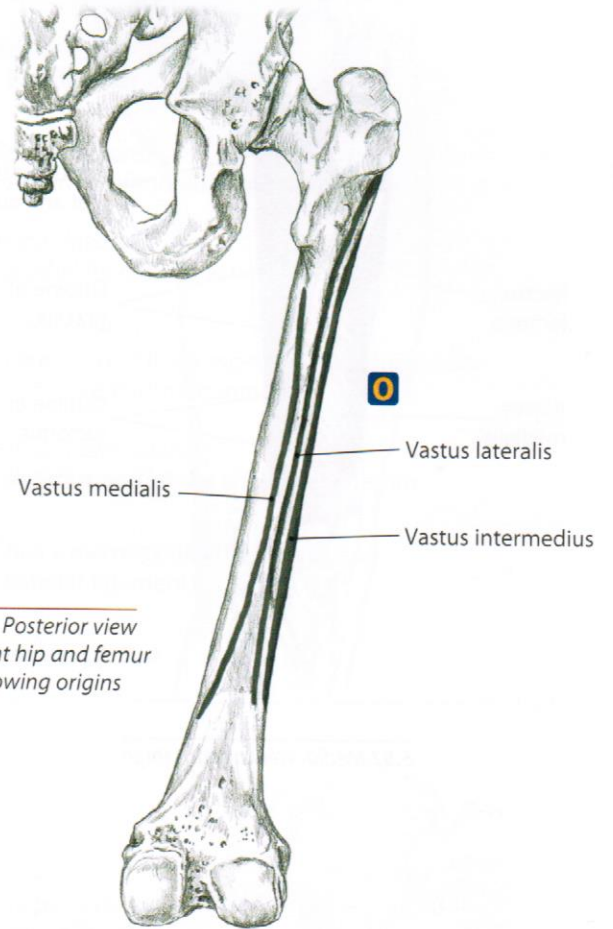


6.59 Posterior view of right femur

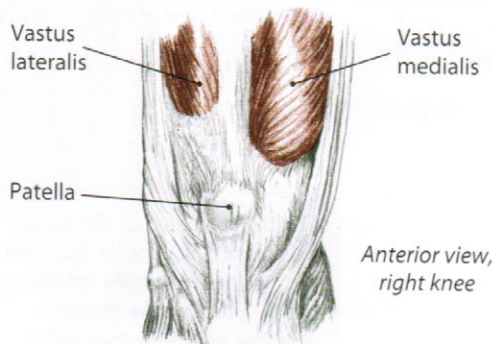
The distal tendon of the quadriceps and the patellar ligament are one and the same structure (6.55). Because the tendon attaches one bone to another (the patella to the tibia), it is actually considered a ligament.



6.60 Anterior view of right hip and thigh showing origins and insertions



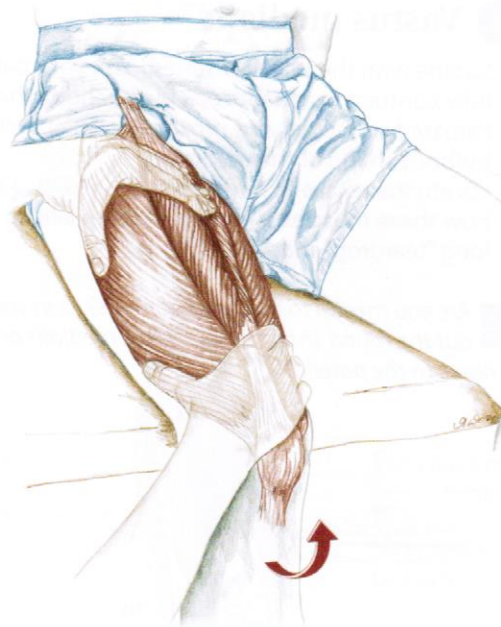
6.61 Posterior view of right hip and femur showing origins



Ask your partner to extend his knee by fully contracting his quadriceps. Observe and palpate the distal ends of the vastus medialis and vastus lateralis. Do you notice that the vastus medialis extends farther distally than the vastus lateralis? The reason for this variance concerns the tracking (or movement) of the patella. The angle of the femur, combined with the pull of the quadriceps, causes the patella to track laterally. This is prevented, however, in two ways: First, the edge of the lateral condyle of the femur (p. 352) is elevated, forming a lateral wall; and second, the distal fibers of vastus medialis are set at an angle, pulling the patella medially.

## Quadriceps as a group


- 1) Partner seated. Lay the flat of your hands on the anterior surface of the thigh.
- 2) Ask your partner to alternately extend and relax his knee slowly. Explore the lateral and medial sides of the thigh (6.62). Do you feel the quadriceps tighten as the knee extends? For greater contraction, provide a little resistance below the knee as your partner tries to raise it.

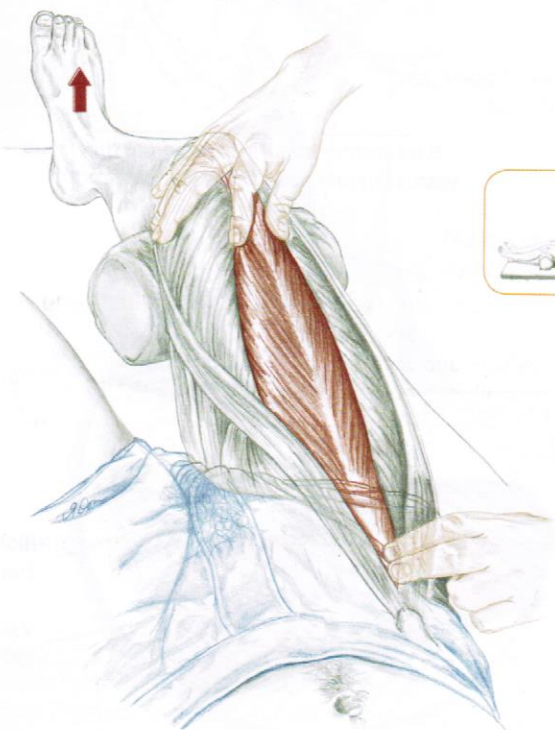


6.62 Partner seated, palpating the quadriceps as a group

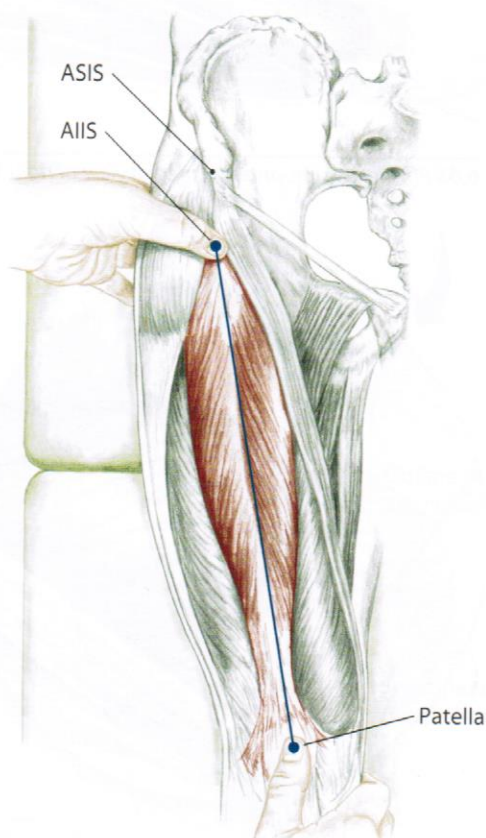
## Rectus femoris

- 1) Supine with knee bolstered. Locate the AIIS (p. 288) and the patella (p. 350).
- 2) Draw an imaginary line between these two points and follow the path of the rectus femoris (6.63).
- 3) Palpate along this line and strum across the rectus fibers. (It will be two to three fingers wide.)
- 4) Ask your partner to flex his hip and hold his foot up off the table (6.64). This position contracts the rectus femoris, making it more pronounced.

 Are you on the anterior surface of the thigh?  
Can you follow the muscle belly to the patella and toward the AIIS? Can you shift it to the side and feel the density of vastus intermedius beneath it?




6.64 Locating the rectus femoris as your partner flexes his hip and holds his foot off the table

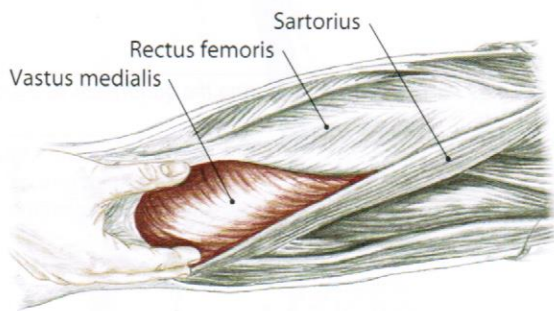


6.63 Anterior view, drawing a line between the AIIS and patella to isolate the rectus femoris

## Vastus medialis

- 1) Supine with the knee bolstered. Ask your partner to fully contract his quadriceps by extending his knee. Palpate just medial and proximal to the patella for the bulbous shape of the medialis.
- 2) Locate the rectus femoris and sartorius (p. 326), noting how these muscles surround the medialis to form its long “teardrop” shape (6.65).

 Are you medial to the rectus femoris? Can you make out the round shape of the vastus medialis and follow its fibers to the patella?




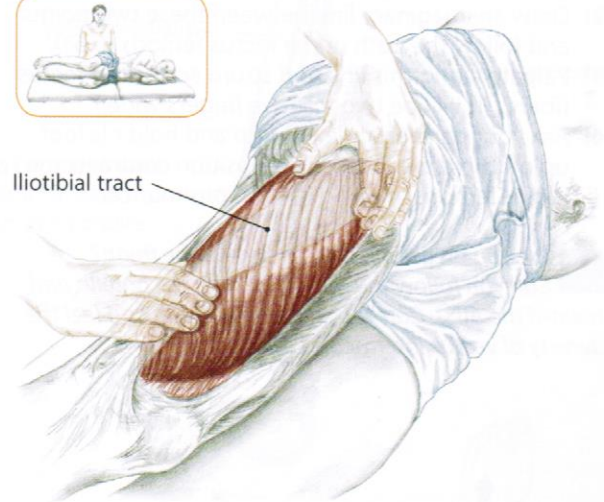
6.65 Partner supine, anterior/medial view of right thigh



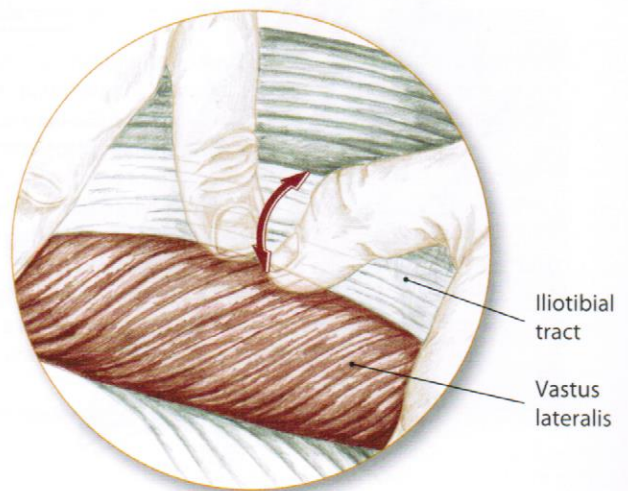
## Vastus lateralis

- 1) Partner side lying. Place the flat of your hand on the lateral side of the thigh while your partner slowly extends and relaxes his knee (6.66). Notice the vastus lateralis contracting and relaxing.
- 2) Palpate its entire belly—posteriorly to the biceps femoris (p. 311) and proximally to the greater trochanter. With the thigh relaxed, identify the direction and depth of the lateralis fibers and the superficial iliotibial tract (p. 324).

 Can you follow its fibers to the patella? Can you differentiate between the vertical fibers of the iliotibial tract and the deeper, oblique fibers of the lateralis (6.67)?



6.66 Partner side lying, palpating the vastus lateralis deep to the iliotibial tract



6.67 Partner side lying, lateral view, rolling your fingers across the fibers of the vastus lateralis

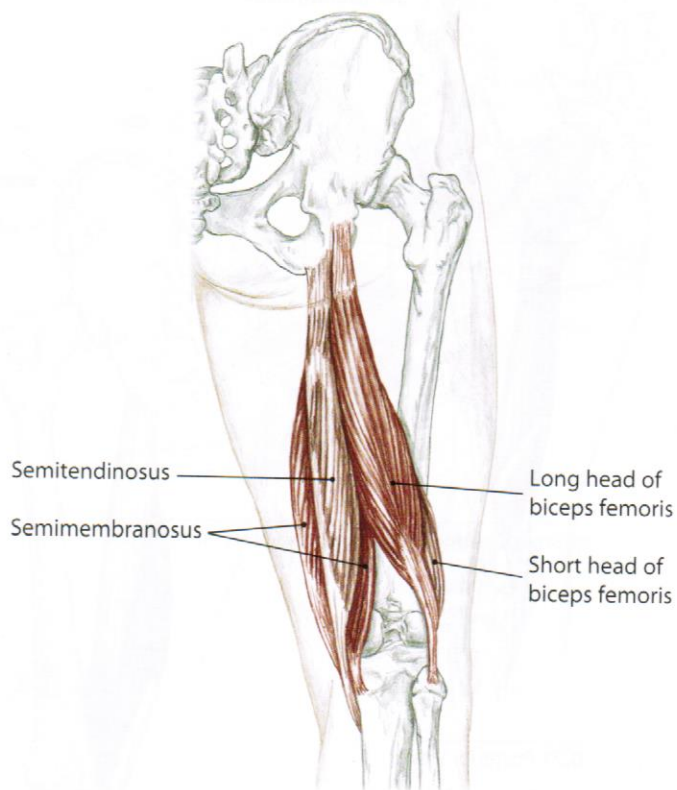
# Hamstrings



*Biceps Femoris*  
*Semitendinosus*  
*Semimembranosus*

The hamstrings are located along the posterior thigh between the vastus lateralis and adductor magnus (6.68). Comparatively, the hamstrings are not as massive as the quadriceps femoris group, but are nonetheless strong hip extensors and knee flexors. All three hamstrings have a common origin at the ischial tuberosity. Their tubular bellies extend superficially down the thigh before becoming long, thin tendons that stretch across the posterior knee. As a group, the hamstrings and their distal tendons are easily palpable.

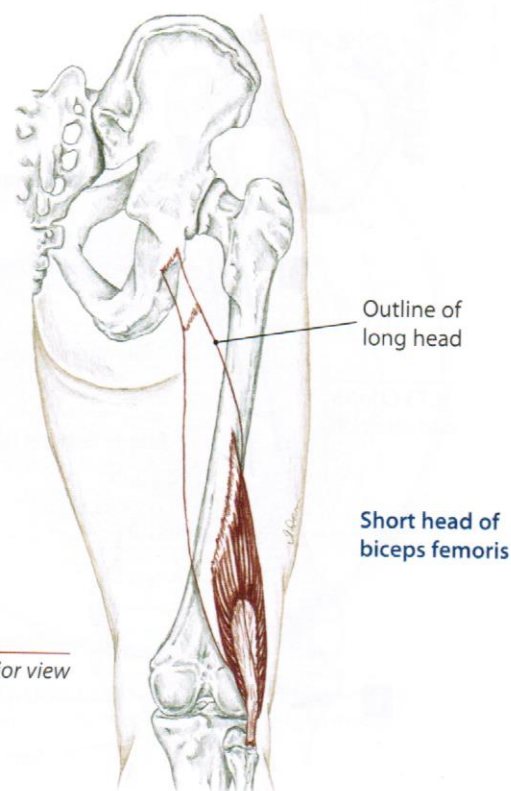
**Biceps femoris** is the lateral hamstring. It has two heads—a superficial long head and a deeper, indiscernible short head (6.69, 6.70). The medial hamstrings include the two “semi” muscles. The **semitendinosus** lies superficial to the wider and deeper **semimembranosus** (6.71, 6.72).



6.68 Posterior view of right thigh showing superficial hamstrings



6.69 Posterior view



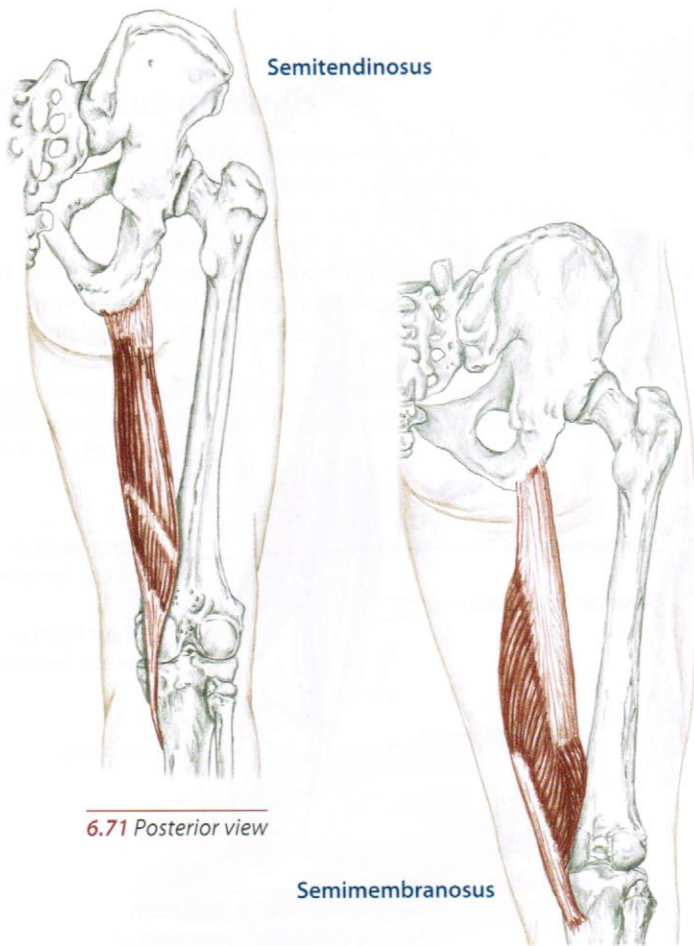
6.70 Posterior view

The term “hamstring” originated in eighteenth-century England. Back then, butchers would display pig carcasses in their shop windows by hanging them from the long tendons at the back of the knee.

semimembranosus  
 semitendinosus

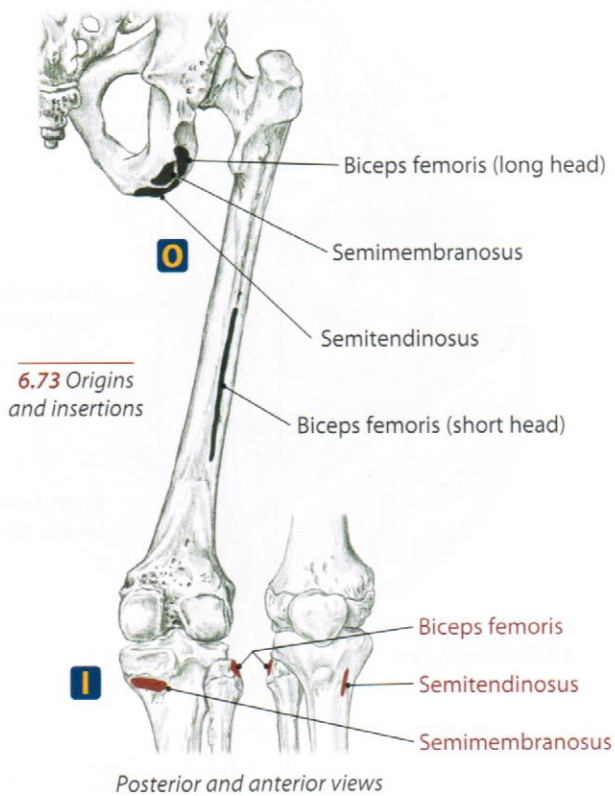
sem-eye-mem-bra-no-sus  
 sem-eye-ten-di-no-sus

L. half membranous  
 L. half tendinous



6.71 Posterior view

6.72 Posterior view



6.73 Origins and insertions

Posterior and anterior views

## Biceps Femoris

- A** Flex the knee (tibiofemoral joint)
- Laterally rotate** the flexed knee (T/F joint)
- Long head:** Extend the hip (coxal joint)
- Long head:** Assist to **laterally rotate** the hip (coxal joint)
- Tilt** the pelvis posteriorly
- O** **Long head:** Ischial tuberosity
- Short head:** Lateral lip of linea aspera
- I** Head of the fibula
- N** **Long head:** Sciatic (tibial branch) L5, S1, 2, 3
- Short head:** Sciatic (peroneal branch) L5, S1, 2

## Semitendinosus

- A** Flex the knee (tibiofemoral joint)
- Medially rotate** the flexed knee (T/F joint)
- Extend** the hip (coxal joint)
- Assist to **medially rotate** the hip (coxal joint)
- Tilt** the pelvis posteriorly

- O** Ischial tuberosity
- I** Proximal, medial shaft of the tibia at pes anserinus tendon
- N** Sciatic (tibial branch) L4, 5, S1, 2

## Semimembranosus

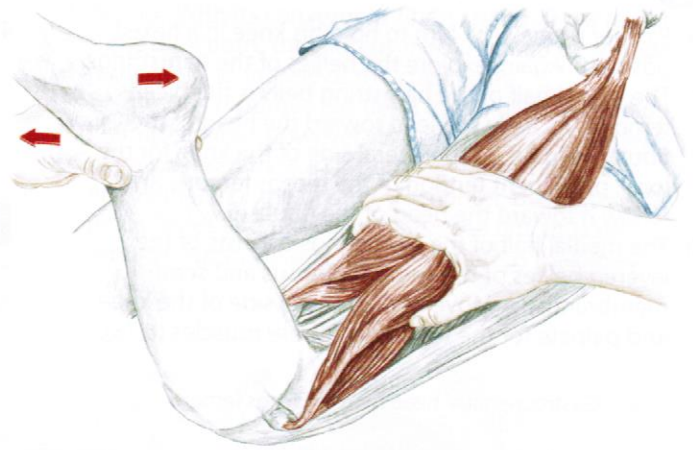
- A** Flex the knee (tibiofemoral joint)
- Medially rotate** the flexed knee (T/F joint)
- Extend** the hip (coxal joint)
- Assist to **medially rotate** the hip (coxal joint)
- Tilt** the pelvis posteriorly

- O** Ischial tuberosity
- I** Posterior aspect of medial condyle of tibia
- N** Sciatic (tibial branch) L4, 5, S1, 2

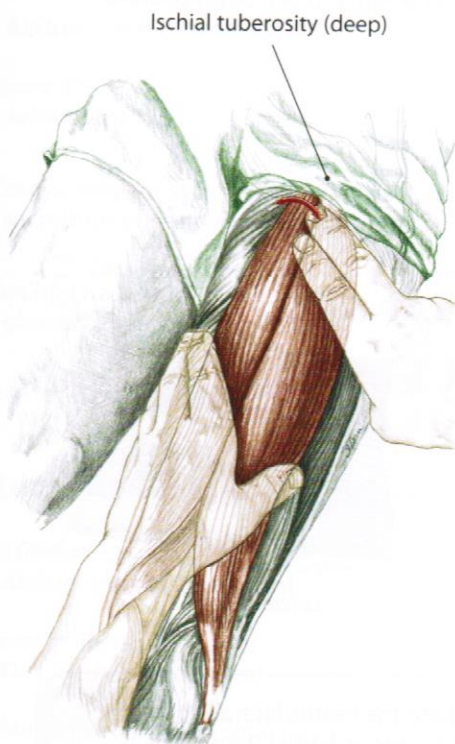
## 👉 Hamstrings as a group

- 1) Prone. Place a hand on the posterior thigh between the buttocks and knee. Ask your partner to flex his knee, holding his foot off the table. As the hamstrings contract, explore their mass and width (6.74).
- 2) Locate the ischial tuberosity. Slide your fingertips distally one inch and strum across the large, solid tendon of the hamstrings (6.75).
- 3) Follow the tendon distally as it spreads out into the separate bellies of the hamstrings.

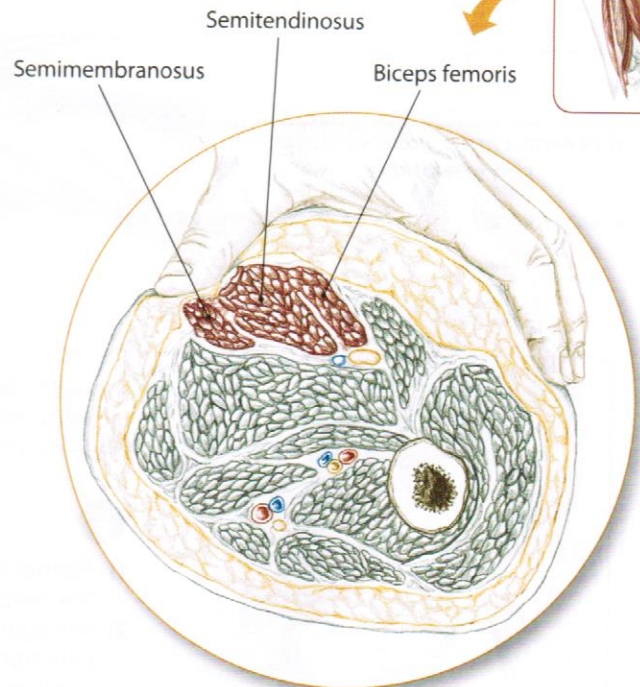
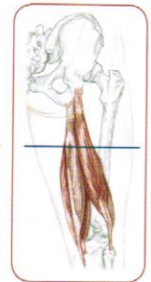
✓ Follow the bellies proximally. Do they attach to the ischial tuberosity? Follow the bellies distally. Do you feel their skinny tendons along the posterior knee?



6.74 Partner prone, grasping the hamstrings group



6.75 Partner prone, isolating the hamstrings tendon at the ischial tuberosity



6.76 Superior view, cross section of right thigh, sinking your thumb into the medial edge of the hamstrings

### When Do You Use Your Hamstrings?

- Running, cycling, swimming, climbing stairs
- Stabilizing your hip while bending over to tie your shoes
- Scraping mud off your boots (extension of the hip)

biceps femoris  
pes anserinus

bi-seps fe-mor-is  
pes an-ser-i-nus

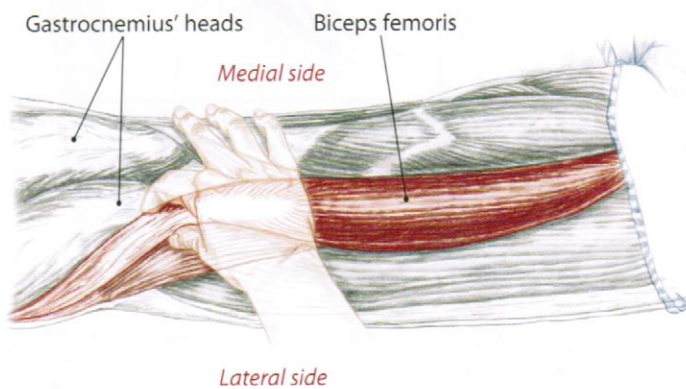
Grk. the two-headed (muscle) of the thigh  
L. *pedis*, foot; *anserinus*, geese-like

## Individual bellies and distal tendons

- 1) Partner prone. Ask him to hold his knee in a flexed position. Again, explore the bellies of the hamstrings.
- 2) The lateral half of the hamstring belly is the biceps femoris. Its belly will lead toward the head of the fibula. Palpate on the lateral side of the knee for the long, prominent tendon of the biceps femoris and follow it toward the head of the fibula (6.77).
- 3) The medial half of the hamstrings consists of the layered bellies of the semitendinosus and semimembranosus. Move to the medial side of the knee and palpate for the tendons of these muscles (6.78).

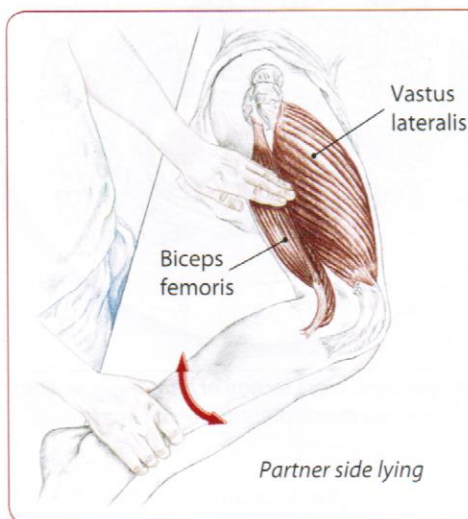
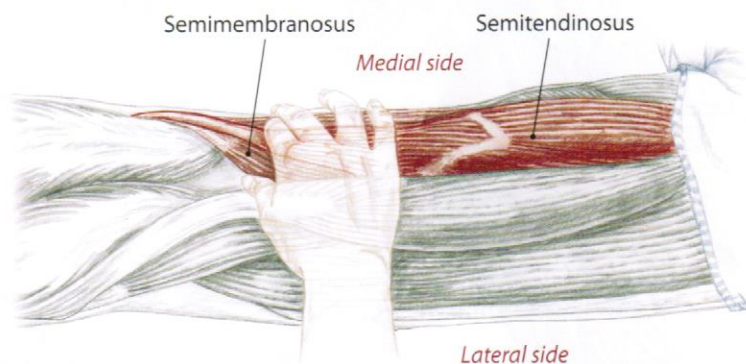
- 4) The most superficial tendon will be the semitendinosus. Turn your partner supine and follow it distally as it merges with the pes anserinus tendon. The semimembranosus is tucked deep to the semitendinosus and is often difficult to isolate.

✓ *Are the tendons along the back of the knee slender and superficial? Does the biceps femoris tendon lead to the head of the fibula? Can you follow the "semis" as they seem to disappear into the medial knee?*



6.77 Partner prone, posterior/lateral view of right knee

6.78 Partner prone, posterior/lateral view of right knee



"How do you differentiate the vastus lateralis from the biceps femoris on the posterior, lateral thigh?" Have these muscles do what comes naturally—be antagonists.



- 1) Partner side lying. Bend the top knee to 90° and clasp the ankle. Lay your other hand on the lateral thigh.
- 2) Ask your partner to alternate between flexing and extending his knee ever so slightly against your resistance. Sense how the vastus lateralis contracts upon extension while the biceps femoris remains lax. The opposite will happen when flexing the knee.
- 3) Often there will be a palpable dividing line or depression between the edges of these muscles.

## Gluteals

*Gluteus Maximus, Medius and Minimus*

The three gluteal muscles are located in the buttock region, deep to the surrounding adipose tissue. The large, superficial **gluteus maximus** is the most posterior of the group and has fibers that run diagonally across the buttock (6.79).

The **gluteus medius** is located on the lateral side of the hip and is also superficial, except for the posterior portion

which is deep to the maximus (6.80). Both the gluteus maximus and medius are strong extensors and abductors of the hip. With its convergent fibers that pull the femur in multiple directions, the gluteus medius could be thought of as the "deltoid muscle of the coxal joint."

The **gluteus minimus** lies deep to the gluteus medius and is inaccessible; however, its dense fibers can be felt beneath the medius (6.81). Because it attaches to the anterior surface of the greater trochanter, the gluteus minimus flexes and medially rotates the hip, thus performing the opposite actions of the gluteus maximus.

### Gluteus Maximus

**A** All fibers:  
**Extend** the hip (coxal joint)

**Laterally rotate** the hip (coxal joint)

**Abduct** the hip (coxal joint)

Lower fibers:

**Adduct** the hip (coxal joint)

**O** Coccyx, edge of sacrum, posterior iliac crest, sacrotuberous and sacroiliac ligaments

**I** <sup>IT band.</sup> Iliotibial tract (upper fibers) and gluteal tuberosity (lower fibers)

**N** Inferior gluteal L5, S1, 2

### Gluteus Medius

**A** All fibers:  
**Abduct** the hip (coxal joint)

Anterior fibers:  
**Flex** the hip (coxal joint)

**Medially rotate** the hip (coxal joint)

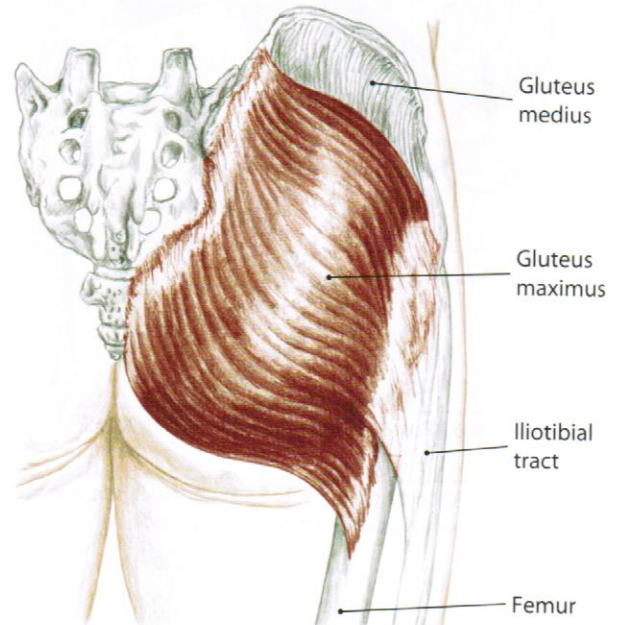
Posterior fibers:  
**Extend** the hip (coxal joint)

**Laterally rotate** the hip (coxal joint)

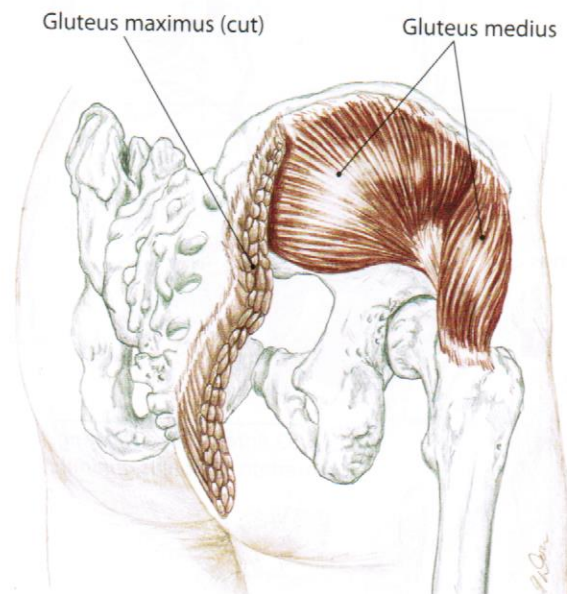
**O** Gluteal surface of ilium, between posterior and anterior gluteal lines, just below the iliac crest

**I** Lateral aspect of greater trochanter

**N** Superior gluteal L4, 5, S1



6.79 Posterior view of right buttock



6.80 Posterior/lateral view of right buttock

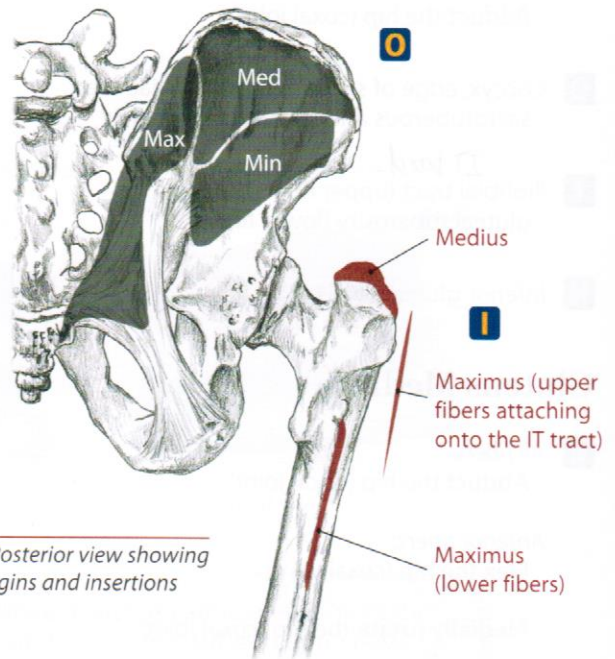
gluteus **gloo-te-us** Grk. *gloutos*, buttocks, which in turn is Anglo-Saxon for *buttuic*, meaning end



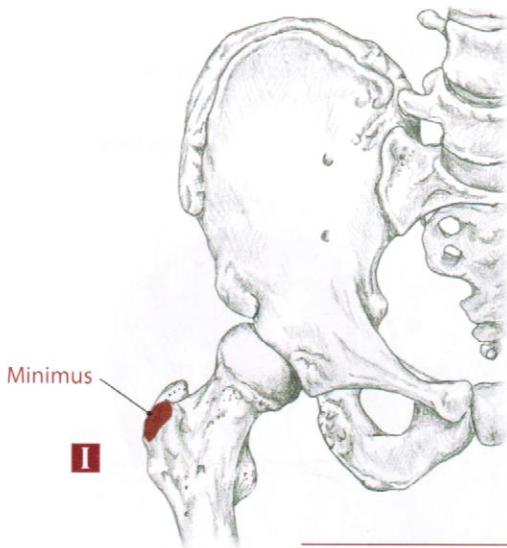
6.81 Posterior/lateral view of right buttock

## Gluteus Minimus

- A** **Abduct** the hip (coxal joint)
- Medially rotate** the hip (coxal joint)
- Flex** the hip (coxal joint)
- O** Gluteal surface of the ilium between the anterior and inferior gluteal lines
- I** Anterior aspect of greater trochanter
- N** Superior gluteal L4, 5, S1



6.82 Posterior view showing origins and insertions




6.83 Anterior view showing insertion of gluteus minimus

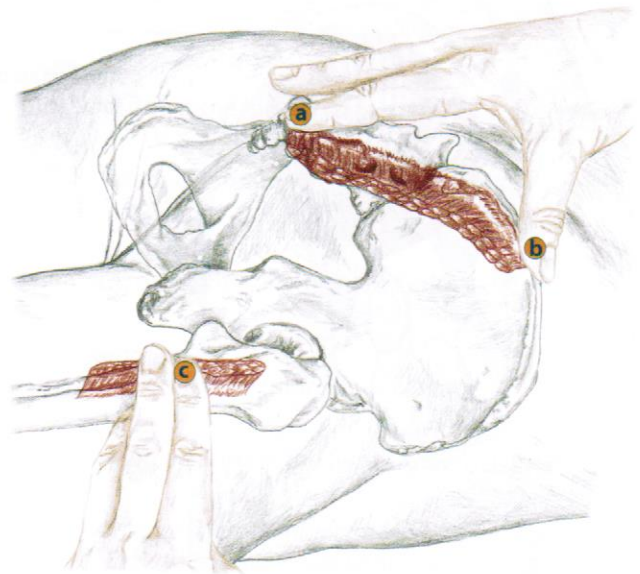
### When Do You Use Your Gluteals?

- Climbing stairs (maximus, especially)
- Running, cycling, swimming, skating
- Latin dancing (lots of lateral rotation of the hip)

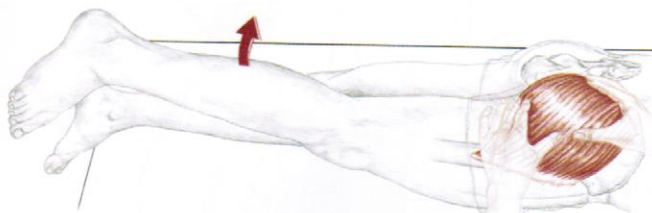
## Gluteus maximus

- 1) Partner prone. Locate the coccyx, the edge of the sacrum, the PSIS and the posterior two inches of the iliac crest to isolate the landmarks that form the origin of the maximus (6.84).
- 2) Locate the insertion of the maximus at the gluteal tuberosity.
- 3) Connect its origin to its insertion by drawing the fiber direction on your partner. Then palpate its thick, superficial fibers. Also notice differences in texture and depth between the adipose tissue of the buttock and the muscle fibers of the maximus. The adipose is superficial to the maximus and often has a soft, gel-like consistency.

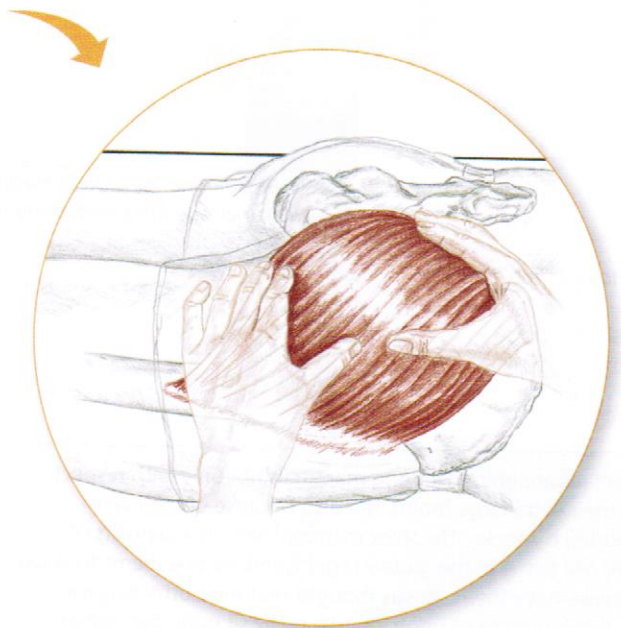
 Ask your partner to extend his hip (6.85). Palpate the bulging fibers that lead to the gluteal tuberosity. If this is difficult with the knee extended for your partner while prone, try palpating with the knee flexed or with your partner standing.

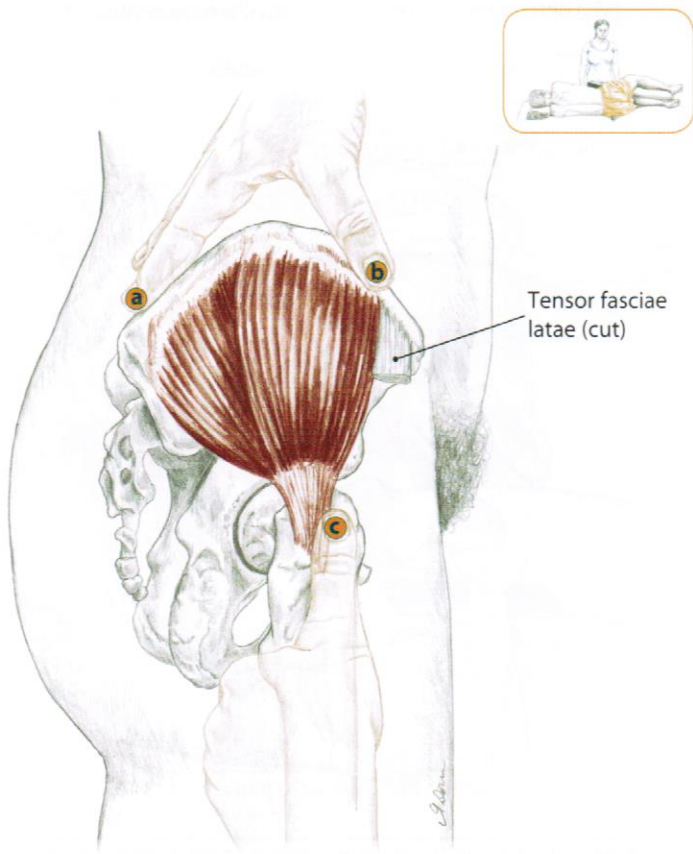


6.84 Partner prone, isolating the borders of the gluteus maximus: a) coccyx, b) posterior iliac crest, c) gluteal tuberosity



6.85 Partner prone, extending his hip by contracting his gluteus maximus



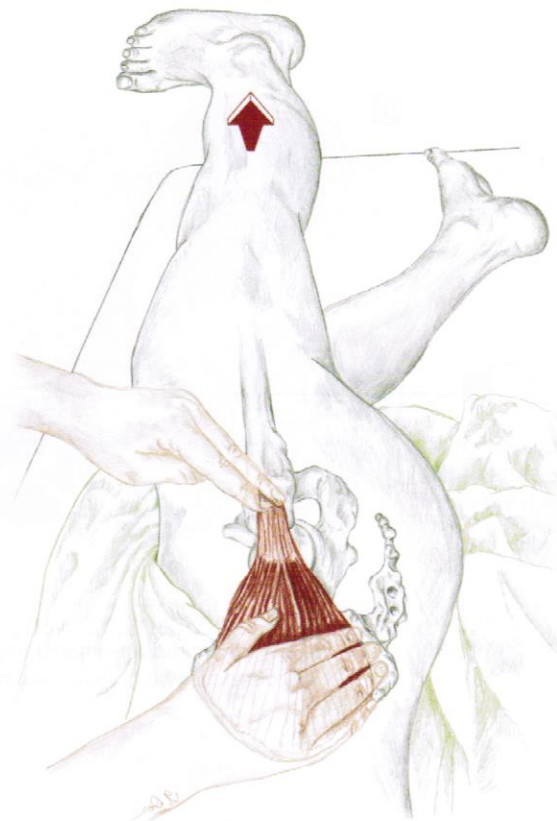


6.86 Partner side lying, isolating the borders of the gluteus medius: **a)** PSIS, **b)** iliac crest, **c)** greater trochanter

## Gluteus medius and minimus

- 1) Side lying. Isolate the shape of the gluteus medius by placing the webbing of one hand along the iliac crest (from PSIS to nearly the ASIS) while the other hand locates the greater trochanter.
- 2) Your hands will form a shape that looks like a slice of pie. This is the outline of the gluteus medius (6.86).
- 3) Palpate in this area from just below the iliac crest to the greater trochanter for the dense fibers of the gluteus medius.
- 4) Sink your fingers deep to the gluteus medius to explore for the density and mass of the gluteus minimus.

✓ Ask your partner to abduct his hip slightly (6.87). Do you feel the medius contract?



6.87 Isolating the gluteus medius with partner side lying, abducting the hip

Humans are unique among mammals not only with respect to their extra-large brains, but also because of their well-padded buttocks. No other mammal has such deposits of adipose tissue in the gluteal region, and no one seems to know why we have them. It was thought that the buttocks gave us something to sit upon, but we really sit upon our ischial tuberosities. And for good reason: If we did not, the gluteus maximus and gluteal fascia would be compressed beneath

us. Since women typically have larger buttocks than men, it was conjectured that the buttocks served as fat-storage sites during pregnancy. Not so.

One thing is known: The gluteal fold—the crease between the buttock and thigh—helps localize the subcutaneous adipose at the top of the thigh. Biomechanically, it is easier to swing the thigh back and forth when walking with the tissue situated proximally rather than dispersed down the thigh.

# Adductor Group



- Adductor Magnus
- Adductor Longus
- Adductor Brevis
- Pectineus
- Gracilis

The five adductors are located along the medial thigh between the hamstrings and quadriceps femoris muscles (6.88). Their proximal tendons attach at specific locations along the base of the pelvis. Together these tendons form a connective tissue drape that extends from the superior ramus of the pubis to the ischial tuberosity (6.89, 6.95).

When the thigh is viewed anteriorly, the muscle bellies of the adductors lie in three layers. The **pectineus** and **adductor longus** are most anterior (6.90). Behind them is the **adductor brevis** (6.91), and most posterior is the **adductor magnus** (6.92). The broad span of adductor magnus, known as the “floor of the adductors,” lies anterior to the hamstrings (6.93). These four muscles tuck posteriorly to the quadriceps femoris group and insert on the posterior femur. The fifth adductor, **gracilis**, lies superficially on the medial thigh. It is the only adductor that crosses the knee (6.90).

Although their individual bellies can be challenging to isolate, as a group, the adductors are easy to locate. When palpating the adductor tendons near the pubic bone, there will be a prominent tendon that extends off of or

near the pubic tubercle. The source of this superficial tendon is either the gracilis or adductor longus; in some cases, it is a merging of both tendons.

In either case, the tendon can serve as an important guidepost for locating not only gracilis and adductor longus, but also pectineus and adductor magnus. The pectineus will be located on the anterior side of this tendon while the adductor magnus will be located posterior to it.

**A** All:  
**Adduct** the hip (coxal joint)

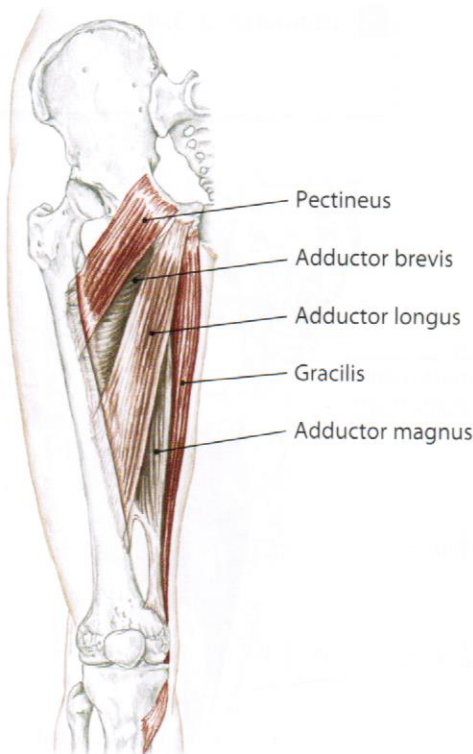
**Medially rotate** the hip (coxal joint)

All, except *Gracilis*:  
 Assist to **flex** the hip (coxal joint)

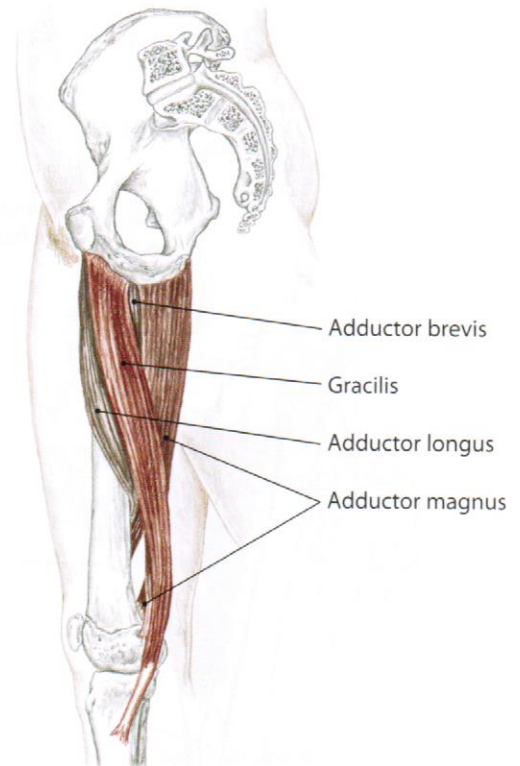
*Gracilis*:  
**Flex** the knee (tibiofemoral joint)

**Medially rotate** the flexed knee (T/F joint)

Posterior fibers of *Adductor Magnus*:  
**Extend** the hip (coxal joint)



6.88 Anterior view of right hip and thigh

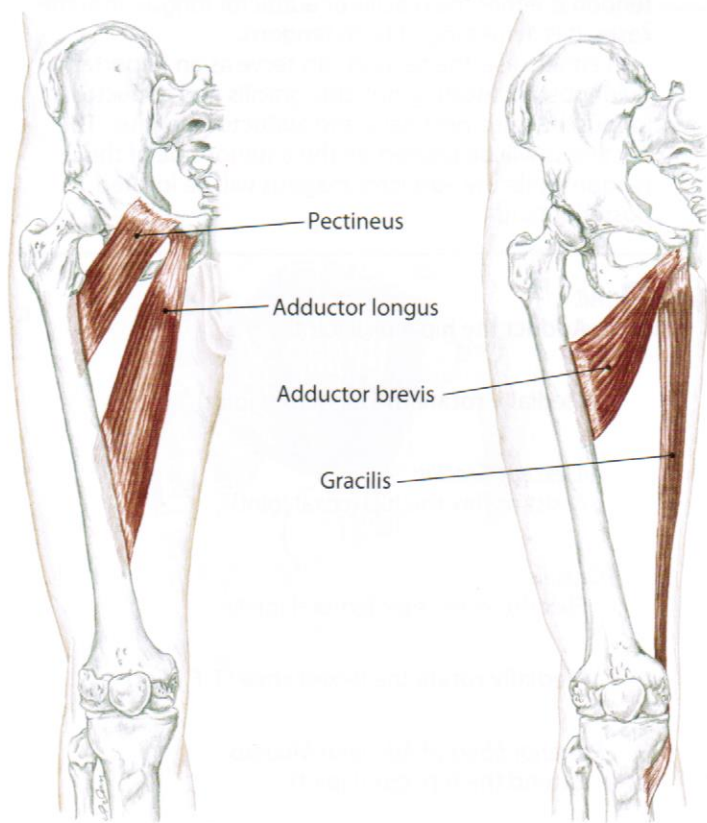


6.89 Medial view of right hip and thigh

brevis  
 gracilis  
 pectineus

**breh**-vis  
 gra-**cil**-is  
 pek-**tin**-e-us

L. short  
 L. slender, graceful  
 L. comblike



6.90, 6.91 Anterior views of right hip and thigh

## Adductor Magnus

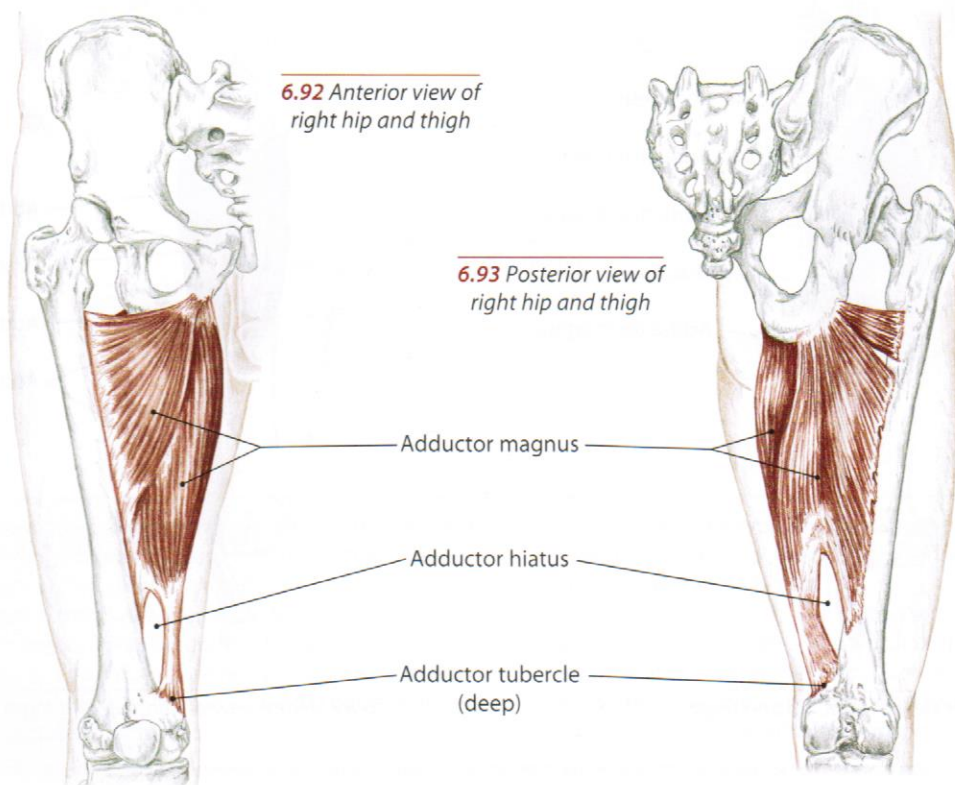
- O** Inferior ramus of the pubis, ramus of ischium and ischial tuberosity
- I** Medial lip of linea aspera and adductor tubercle
- N** Obturator L2, 3, 4 and Sciatic L4, 5, S1

## Adductor Longus

- O** Pubic tubercle
- I** Medial lip of linea aspera
- N** Obturator L2, 3, 4

## Adductor Brevis

- O** Inferior ramus of pubis
- I** Pectineal line and medial lip of linea aspera
- N** Obturator L2, 3, 4

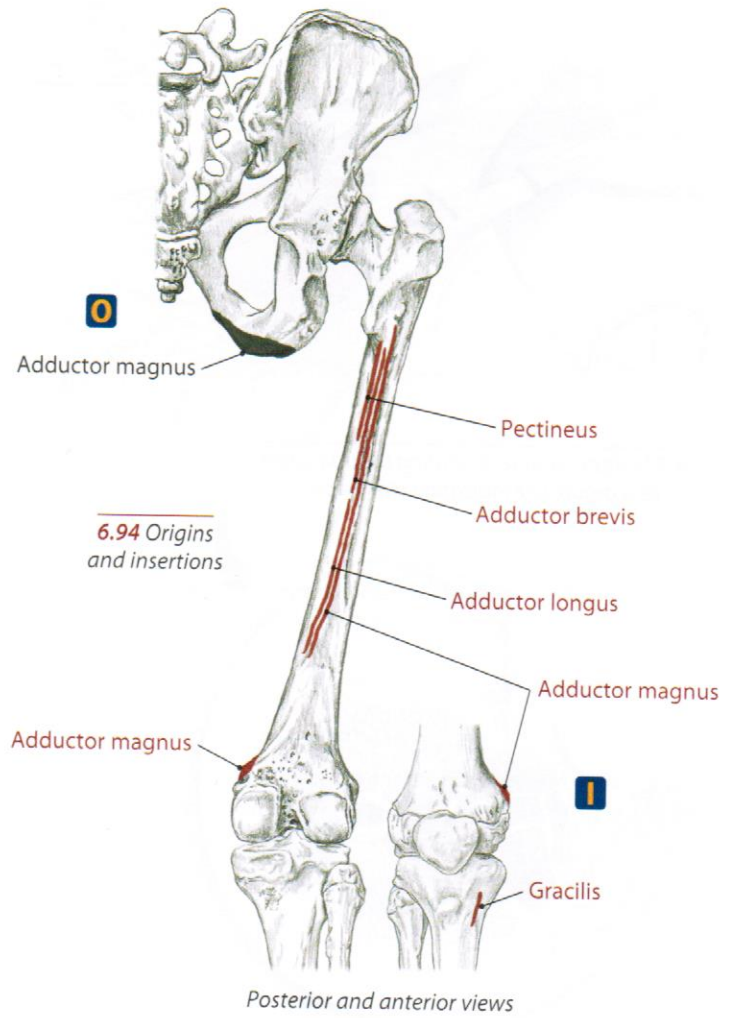


## Pectineus

- O** Superior ramus of pubis
- I** Pectineal line of femur
- N** Femoral and Obturator L2, 3, 4

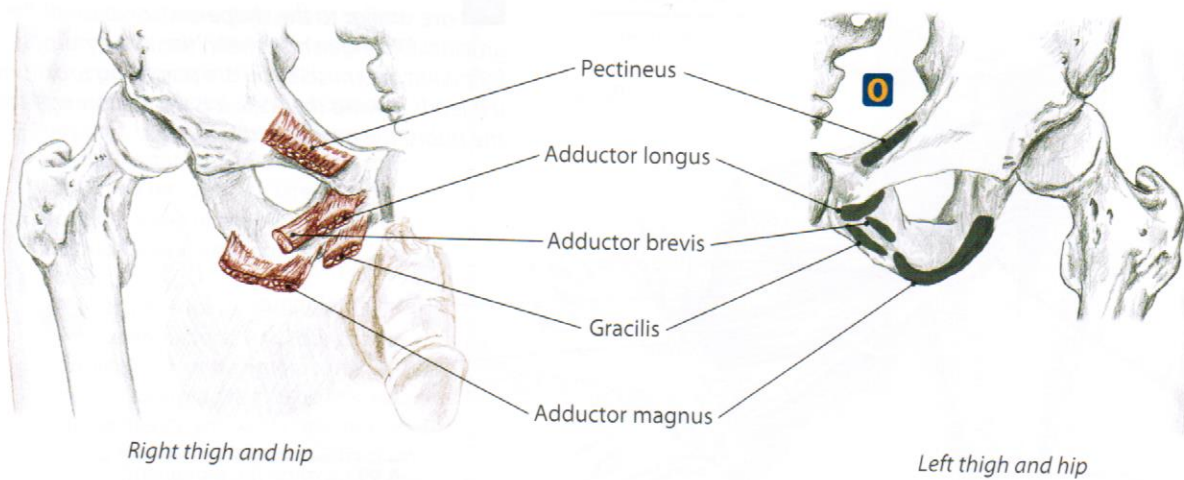
## Gracilis

- O** Inferior ramus of pubis
- I** Proximal, medial shaft of tibia at pes anserinus tendon
- N** Obturator L2, 3, 4

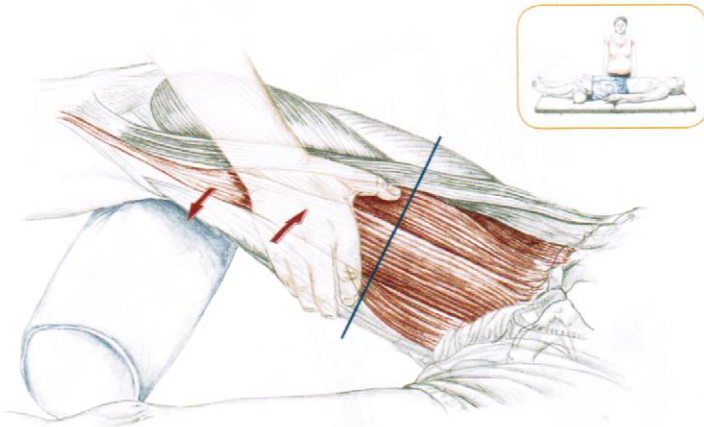


### When Do You Use Your Adductors?

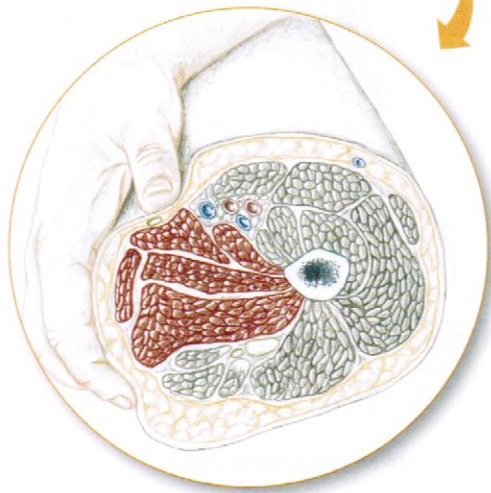
- Ice skating (doing a cross-over step when turning)
- Gripping a horse with your thighs when riding
- Stabilizing your pelvis when walking



6.95, 6.96 Anterior views showing the origins of the adductors



6.97 Partner supine, palpating the adductors as a group, line indicating cross section



6.98 Inferior view, cross section of right thigh, grasping the highlighted adductors

## 👉 Adductors as a group

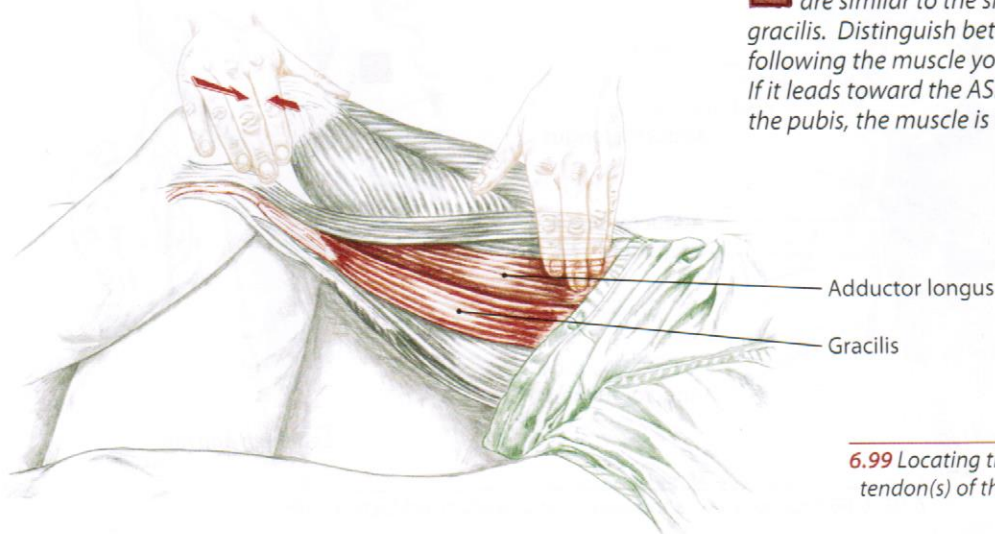
- 1) Partner supine with the hip slightly flexed and laterally rotated. Place your hand along the medial thigh and ask your partner to adduct his hip against your resistance (6.97). Do you feel the adductors tighten?
- 2) Ask your partner to alternately adduct and relax as you palpate proximally to the adductor tendons. Then move distally, exploring anterior and posterior to the edges of the adductor bellies.

✓ *Are you on the medial side of the thigh? Explore either side of the adductors to determine if you are between the hamstrings and quadriceps femoris group (6.98). You should be.*

## 👉 Gracilis and adductor longus

- 1) Partner supine with the hip slightly flexed and laterally rotated. Place the flat of your hand at the middle of the medial thigh. Ask your partner to adduct his hip slightly.
- 2) While your partner contracts, slide your fingers proximally to the pubic bone and locate the taut, prominent tendon(s) of the gracilis and adductor longus extending off of (or near) the pubic tubercle.
- 3) Strum your fingertip across this tendon and follow it distally as it develops into muscle tissue (6.99). If the muscle belly slowly angles into the medial thigh, you are palpating adductor longus. If the belly is slender and continues down the medial thigh toward the knee, you are accessing gracilis.


✓ *The shape and location of the sartorius (p. 326) are similar to the shape and location of the gracilis. Distinguish between the two by simply following the muscle you are palpating proximally. If it leads toward the ASIS, it is the sartorius; if toward the pubis, the muscle is the gracilis.*

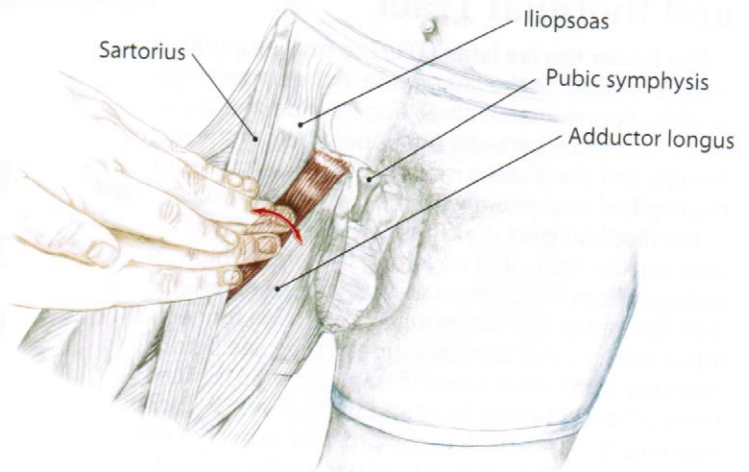


6.99 Locating the prominent tendon(s) of the adductors

## Pectineus

- 1) Partner supine with the hip slightly flexed and laterally rotated. Place the flat of your hand on the middle of the medial thigh and ask your partner to adduct his hip slightly.
- 2) Locate the prominent tendon of the adductor longus or gracilis. Slide off the tendon laterally toward the ASIS. Slowly sink into the belly of pectineus (6.100). You should be inferior to the superior ramus of the pubis (p. 294).
- 3) Ask your partner to alternately adduct and relax his hip and feel the fibers of pectineus contract.

 Are you just anterior to the prominent adductor tendon? Do the fibers you are palpating contract upon adduction?

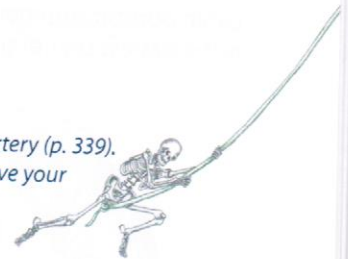


6.100 Partner supine, rolling your fingers across the pectineus

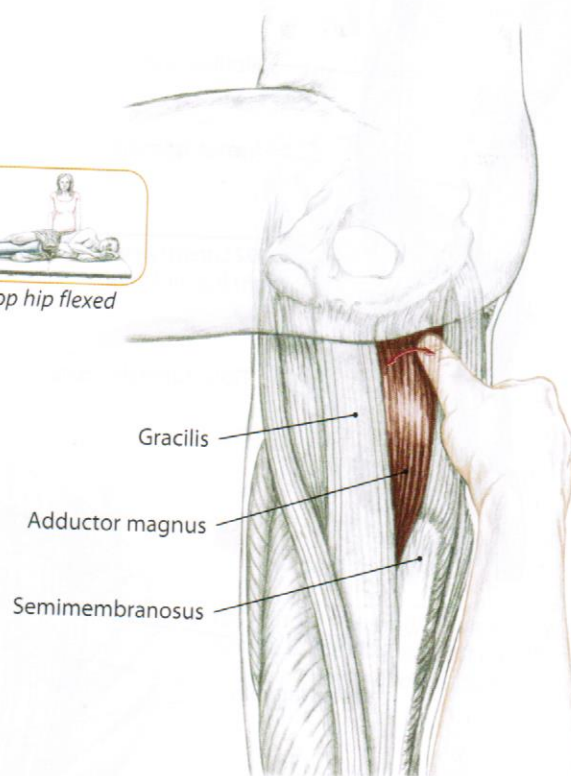
## Adductor magnus

- 1) Partner side lying with his top hip flexed. Begin by locating the ischial tuberosity.
- 2) Ask your partner to adduct his hip slightly. Shifting anteriorly, locate the prominent tendon of adductor longus or gracilis. Then slide off the tendon posteriorly. Palpate the wide tendon of adductor magnus as it stretches to the ischial tuberosity (6.101).
- 3) Follow the fibers of adductor magnus distally by strumming your fingers across its belly. It is difficult to differentiate magnus fibers from semimembranosus fibers. Nevertheless, the thin, distal tendon of the magnus is distinguishable and can be accessed where it attaches onto the adductor tubercle (p. 353).

Be alert to the pulse of the femoral artery (p. 339). If you feel it under your fingers, remove your pressure and shift to one side.




Top hip flexed



6.101 Partner side lying, accessing the adductor magnus

Because the adductors attach on the posterior femur, you might assume that they would rotate the coxal joint *laterally* rather than *medially*. In anatomical position, however, the adductors will medially rotate the femur. With that said, if the femur is in a laterally rotated position, some of the adductors will produce lateral rotation.

 Partner supine. Lay your hand on the adductors. Ask your partner alternately to rotate his hip medially and laterally. Grasping the ankle to create a little resistance will verify this movement. Do you feel the adductors contract on medial rotation? What do they do when the hip is laterally rotated?

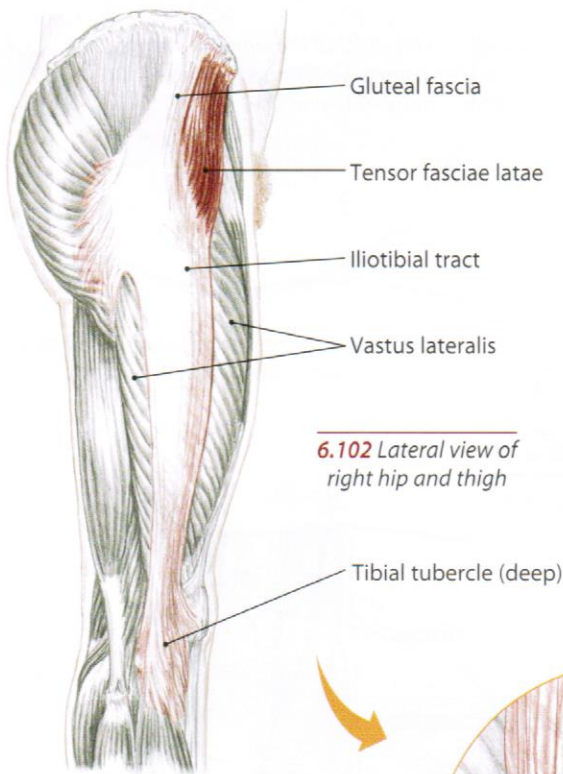
# Tensor Fasciae Latae and Iliotibial Tract



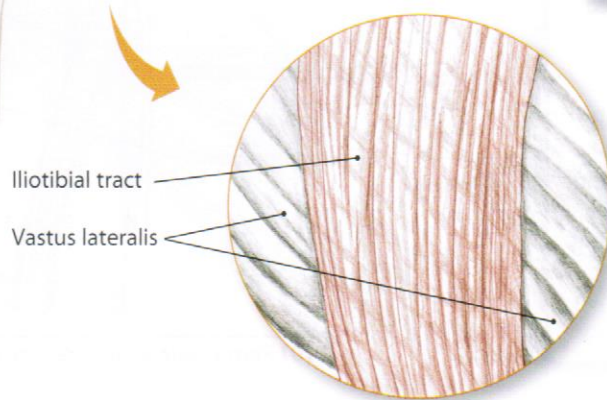
The **tensor fasciae latae** (TFL) is a small, superficial muscle located on the lateral side of the upper thigh (6.102). Approximately three fingers wide, the TFL is easily accessible between the upper fibers of the rectus femoris and the gluteus medius. The TFL attaches to the iliotibial tract along with the gluteus maximus.

The **iliotibial tract** is a superficial sheet of fascia with vertical fibers that run along the lateral thigh. It emerges from the gluteal fascia, is wide and dense over the vastus lateralis muscle (p. 306) and funnels into a strong cable along the side of the knee before inserting at the tibial tubercle (see box, p. 351). The fibers of tensor fasciae latae and some fibers of gluteus maximus (p. 315) attach to the proximal aspect of the iliotibial tract. The iliotibial tract has a thick, matted texture (similar to packing tape) that makes it a strong stabilizing component of the hip and knee.

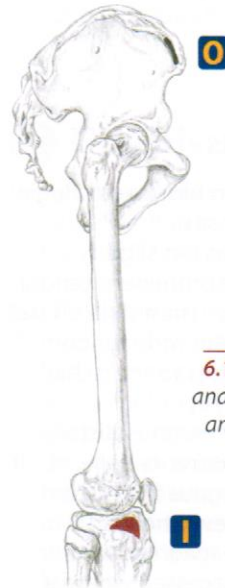
The iliotibial tract is entirely accessible. The distal cable portion, anterior to the biceps femoris tendon, is the easiest part of the iliotibial tract to isolate.



6.102 Lateral view of right hip and thigh



- A** Flex the hip (coxal joint)
- M** Medially rotate the hip (coxal joint)
- A** Abduct the hip (coxal joint)
- O** Iliac crest, posterior to the ASIS
- I** Iliotibial tract
- N** Superior gluteal L4, 5, S1



6.103 Lateral view of right hip and femur showing origin of TFL and insertion of iliotibial tract

### When Do You Use Your TFL?

- Running, bicycling, squatting at the hips
- Raising your leg to climb into a car (flex, medially rotate and abduct the hip)
- The windup for a karate kick to the side—again, all three movements (see *Fist of Fury* with Bruce Lee for examples)


latae  
tensor  
tract

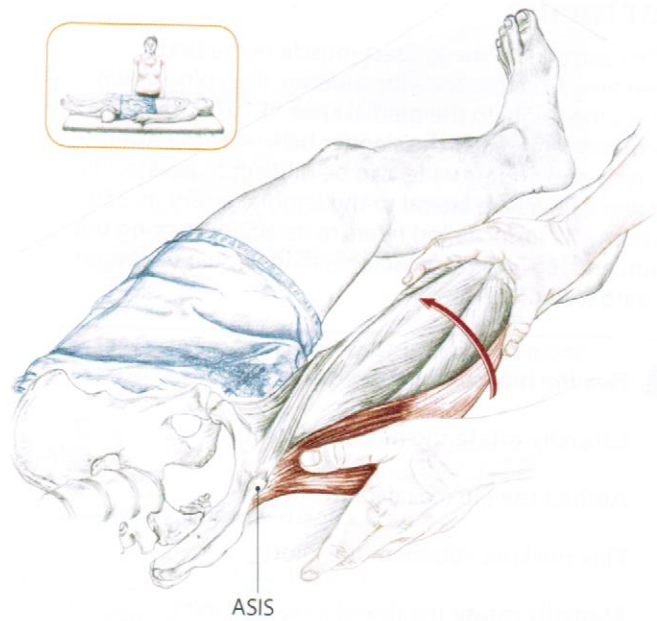
la-ta  
ten-sor

L. broad  
L. a stretcher  
L. extent, drawn out

## Tensor fasciae latae

- 1) Supine. Locate the ASIS. Place the flat of your hand posterior and distal to the ASIS and iliac crest.
- 2) Ask your partner to alternate medial rotation with relaxation of the hip. Upon medial rotation, the TFL will contract into a solid, oval mound beneath your hand (6.104).
- 3) Palpate its vertical fibers, outline its width and follow it distally until the TFL blends into the iliotibial tract.


 Are you posterior and distal to the anterior iliac crest? If you ask your partner to rotate the hip laterally, does the TFL contract? It should not.

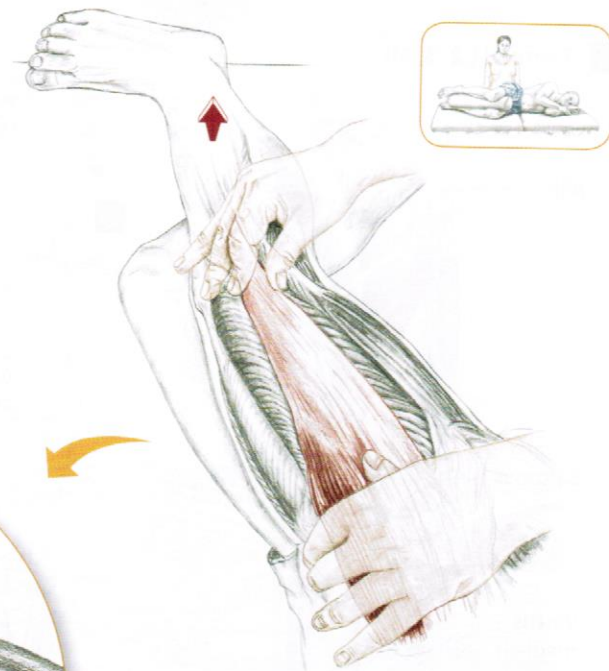
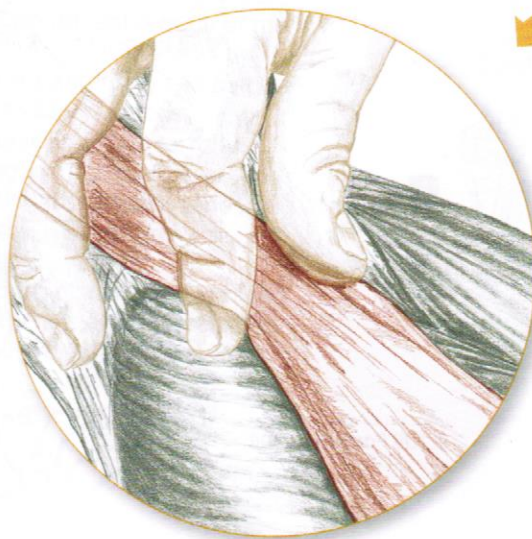


6.104 Partner supine, feeling the TFL contract as your partner medially rotates his hip

## Distal end of the iliotibial tract

- 1) Side lying. Locate the biceps femoris tendon (p. 311) just proximal to the back of the knee.
- 2) Slide anteriorly from the biceps femoris tendon to the lateral thigh. Roll your fingers horizontally across the fibers of the iliotibial tract and explore for its tough, superficial quality. Its most distal aspect may feel similar in size and shape to the biceps femoris tendon.
- 3) Follow it distally as it disappears toward the tibial tubercle. Explore proximally and note how it becomes broader and thinner as it progresses up the thigh. Feel the tension of the iliotibial tract change by asking your partner to alternately abduct and relax his hip (6.105).

 Are the fibers you feel superficial and stringy compared to the deeper, fleshier vastus lateralis fibers? Do the fibers run vertically down the thigh and converge into a thin, cablelike tendon at the tibial tubercle?



6.105 Partner side lying, palpating the distal end of the iliotibial tract and TFL as your partner abducts his hip

# Sartorius

The sartorius is the longest muscle in the body, stretching from the anterior superior iliac spine (ASIS), across the thigh, to the medial knee (6.107). Though it is entirely superficial, the slender belly of the sartorius, roughly two fingers wide, can be difficult to isolate. Its proximal fibers are lateral to the femoral artery (p. 339). Its name (L. *sartor*, tailor) refers to its ability to bring the thigh and leg into the position a tailor would use when sewing (6.106).

- A** Flex the hip (coxal joint)
- Laterally rotate** the hip (coxal joint)
- Abduct** the hip (coxal joint)
- Flex** the knee (tibiofemoral joint)
- Medially rotate** the flexed knee (T/F joint)

- O** Anterior superior iliac spine (ASIS)
- I** Proximal, medial shaft of the tibia at pes anserinus tendon
- N** Femoral L2, 3, (4)



6.106



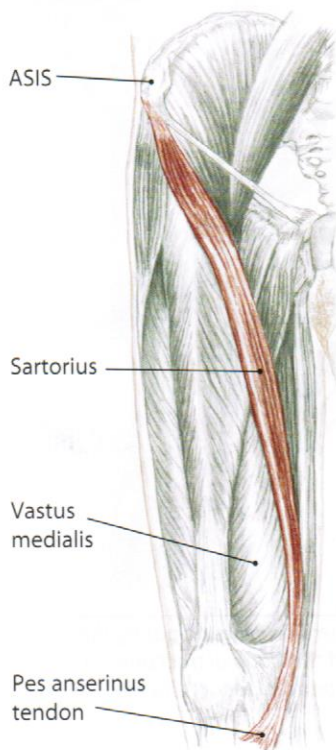
- 1) Partner supine. Ask your partner to position his foot so it is resting on his opposite knee. The hip will be flexed and laterally rotated.
- 2) Place your hand along the middle of the medial thigh. Ask your partner to raise his knee toward the ceiling (contracting the sartorius).
- 3) Strum your fingers across the slender sartorius, following it proximally to the ASIS and distally to the medial tibia (6.109).
- 4) Maintain your hand placement and ask your partner to relax his hip. Continue to palpate, noticing how the sartorius curves from the ASIS to the medial side of the thigh.

**✓** Is the muscle belly you feel roughly two fingers wide and superficial? When distal to the ASIS, can you strum across its tendon? Are you medial to the vastus medialis belly? The sartorius and gracilis are slender, superficial muscles along the medial thigh. Differentiate between them by following their respective bellies proximally: The sartorius will lead toward the ASIS, the gracilis toward the pubic tubercle.

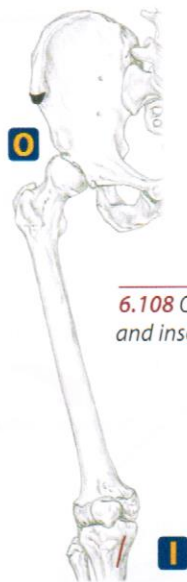
### When Do You Use Your Sartorius?

- Folding your hips into a lotus position for meditation
- Sitting in a tailor position (common among men, 6.106)
- Crossing and uncrossing your legs (common among both genders)

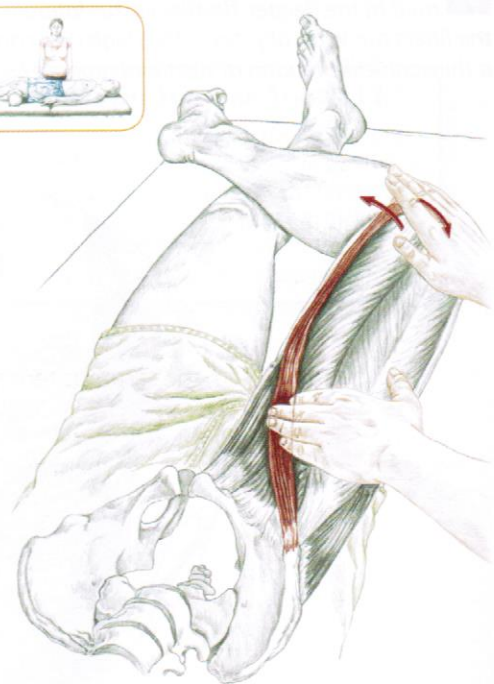
Pelvis & Thigh



6.107 Anterior/medial view of right hip and thigh



6.108 Origin and insertion

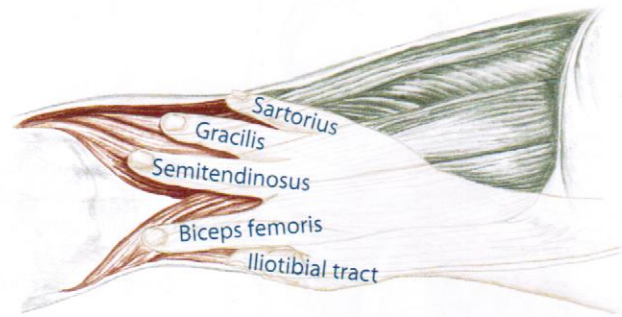


6.109 Partner supine

## Tendons of the Posterior Knee

There are five distinct tendons located on the posterior aspect of the knee (6.110). Biceps femoris and the iliotibial tract are located on the lateral/posterior knee; sartorius, gracilis and semitendinosus are bundled together on the medial/posterior knee. These three tendons merge distally at the proximal, medial shaft of the tibia to become the pes anserinus tendon.

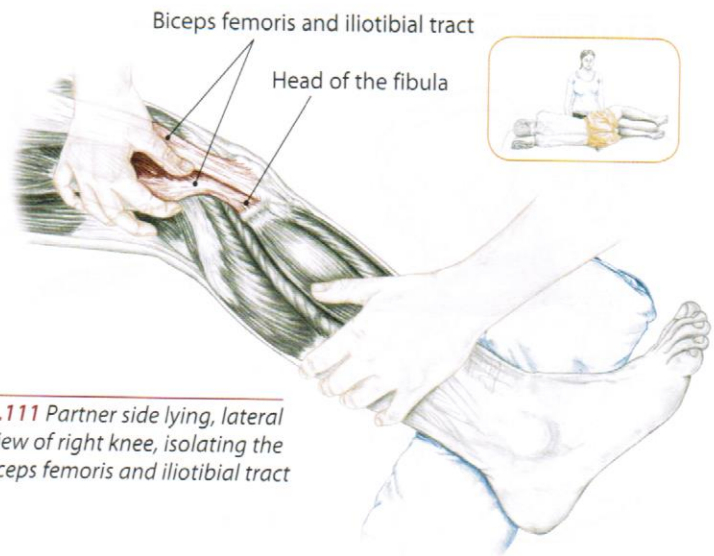
Where is the semimembranosus tendon? Its distal tendon is very short and deep to the semitendinosus and gracilis. The distal aspect of semimembranosus can be accessed by palpating between the tendons of semitendinosus and gracilis.



6.110 Posterior view of right thigh with partner prone; fingers on the posterior knee showing location of distal tendons

### Lateral tendons

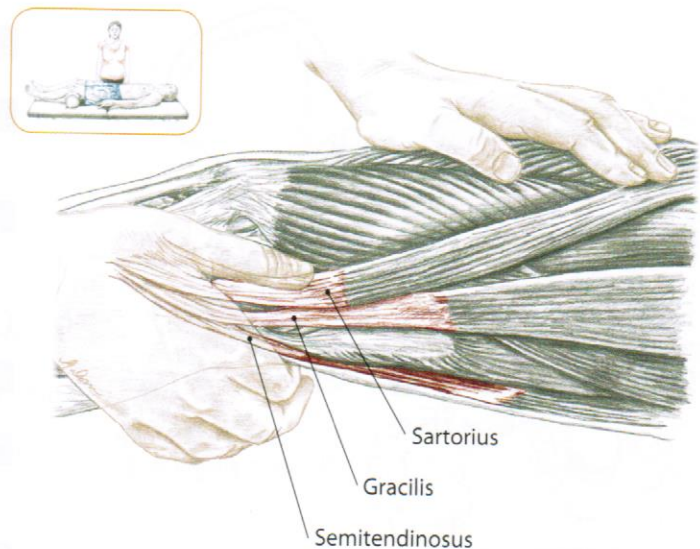
- 1) Side lying. Ask your partner to flex and hold his knee at 45°. The tendons will become taut in this position. For greater clarity, place your hand on the ankle and give your partner some resistance.
- 2) The most prominent tendons will be biceps femoris and semitendinosus. Follow the slender biceps femoris tendon as it extends down to the head of the fibula (6.111).
- 3) Move laterally approximately one inch from the biceps tendon and palpate the iliotibial tract. Unlike the biceps femoris, the iliotibial tract is broader and located on the lateral side of the thigh.



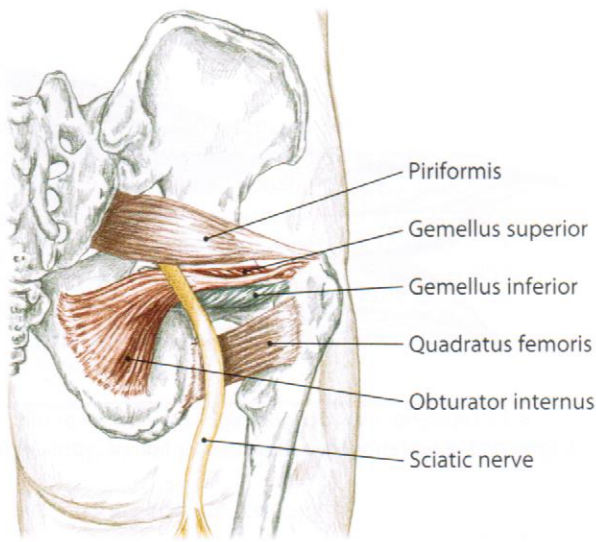
6.111 Partner side lying, lateral view of right knee, isolating the biceps femoris and iliotibial tract

### Medial tendons

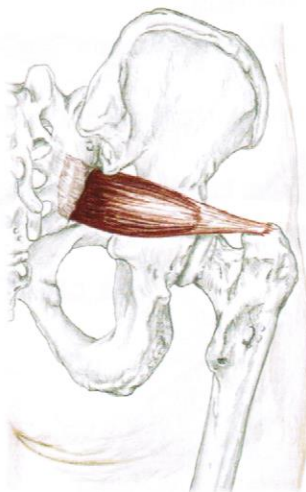
- 1) Supine. Move to the medial side of the knee and palpate the thin, prominent tendon of the semitendinosus.
- 2) Slide off semitendinosus anteriorly and palpate the equally slender tendon of gracilis.
- 3) Situated anterior to gracilis will be sartorius. Compared to the long, skinny tendons of semitendinosus and gracilis, the sartorius tendon is wider (6.112). For this reason, it may be challenging to isolate.
- 4) Follow the three tendons distally as they blend together to become the pes anserinus tendon which attaches on the proximal, medial shaft of the tibia.



6.112 Partner supine, medial view of right knee, isolating the medial tendons

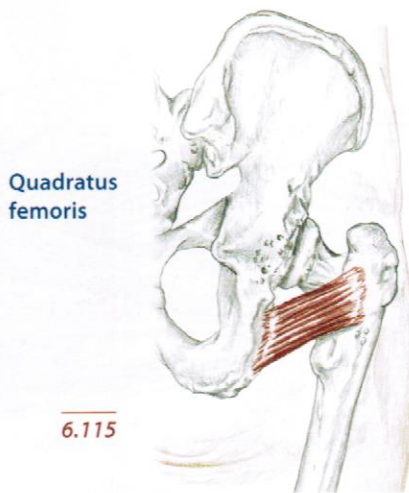


6.113 Posterior view of right hip with gluteals removed



Piriformis

6.114



Quadratus femoris

6.115

The obturator membrane, one of the origins of the obturator internus, is a fibrous wall of connective tissue that forms a partial covering of the obturator foramen.

## Lateral Rotators of the Hip



*Piriformis & Quadratus Femoris*  
*Obturator Internus & Obturator Externus*  
*Gemellus Superior & Gemellus Inferior*

Sometimes known as the “deep six,” these small muscles are located deep to the gluteus maximus and create lateral rotation of the hip. All attach to aspects of the greater trochanter and fan medially to attach to the sacrum and pelvis (6.113–6.119).

All of the lateral rotators are deep to the large sciatic nerve (p. 341), except for the piriformis. The piriformis lies superficial to the sciatic nerve and, if overcontracted, can compress it. Nevertheless, the lateral rotators are accessible as a group, with the piriformis and quadratus femoris being the most discernible.

### Piriformis

- A** Laterally rotate the hip (coxal joint)
- A** Abduct the hip when the hip is flexed
- O** Anterior surface of sacrum
- I** Superior aspect of greater trochanter
- N** Sacral plexus L(5), S1, 2

### Quadratus Femoris

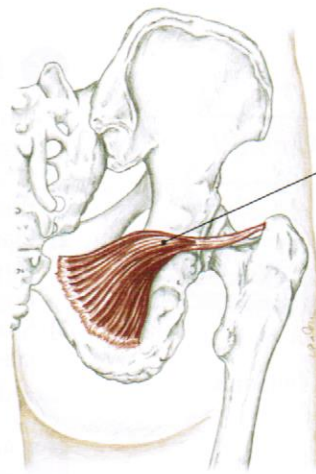
- A** Laterally rotate the hip (coxal joint)
- O** Lateral border of ischial tuberosity
- I** Intertrochanteric crest, between the greater and lesser trochanters
- N** Sacral plexus L4, 5, S1, (2)

### Obturator Internus

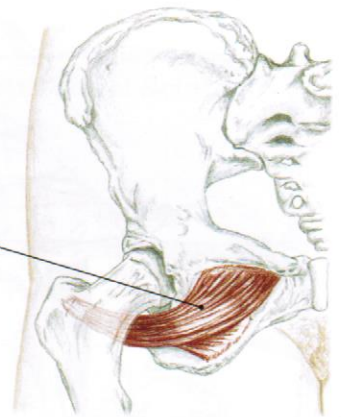
- A** Laterally rotate the hip (coxal joint)
- O** Obturator membrane and inferior surface of obturator foramen
- I** Medial surface of greater trochanter
- N** Sacral plexus L5, S1, 2

## Obturator Externus

- A** Laterally rotate the hip (coxal joint)
- O** Rami of pubis and ischium, obturator membrane
- I** Trochanteric fossa of femur
- N** Obturator L3, 4



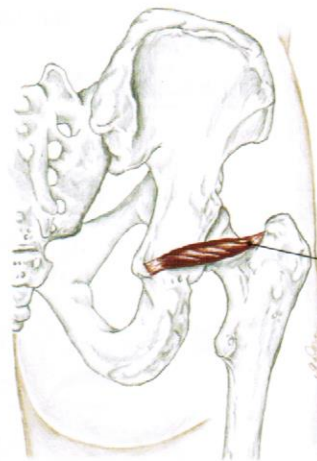
6.116 Posterior view of right hip



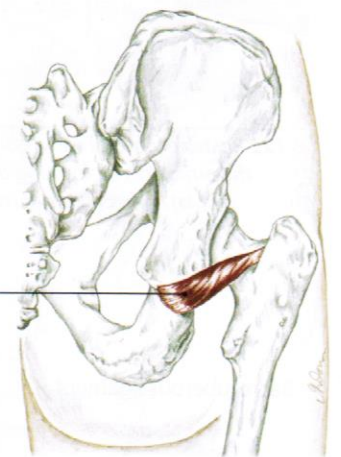
6.117 Anterior view of right hip

## Gemellus Superior

- A** Laterally rotate the hip (coxal joint)
- O** Ischial spine
- I** Medial surface of greater trochanter
- N** Sacral plexus L5, S1, 2

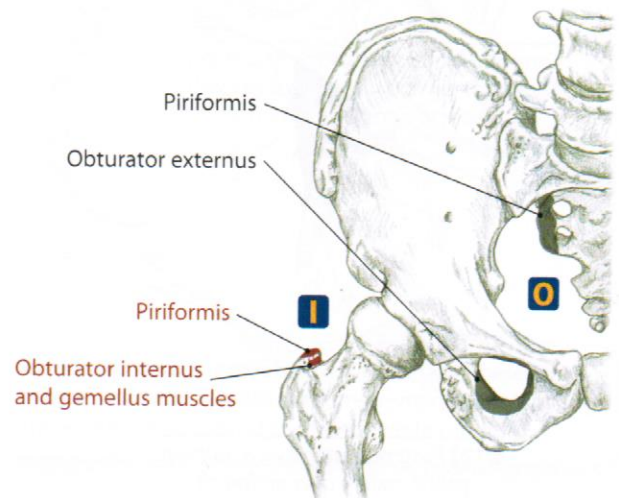
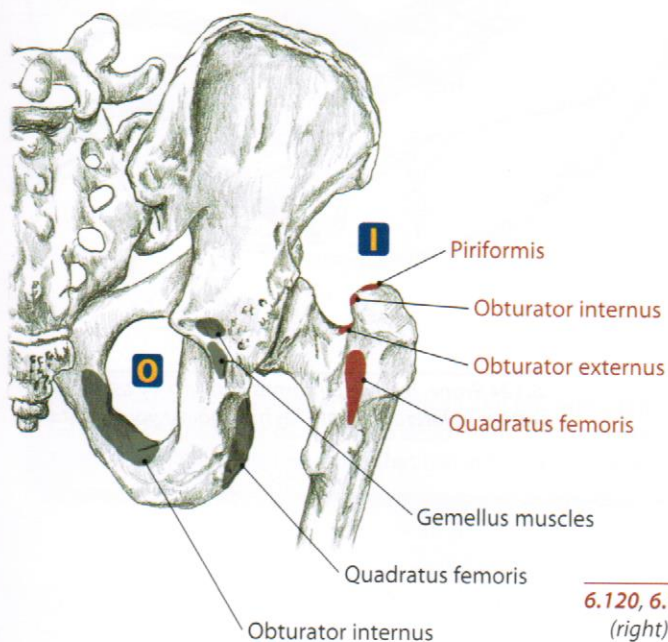


6.118, 6.119 Posterior views of right hip

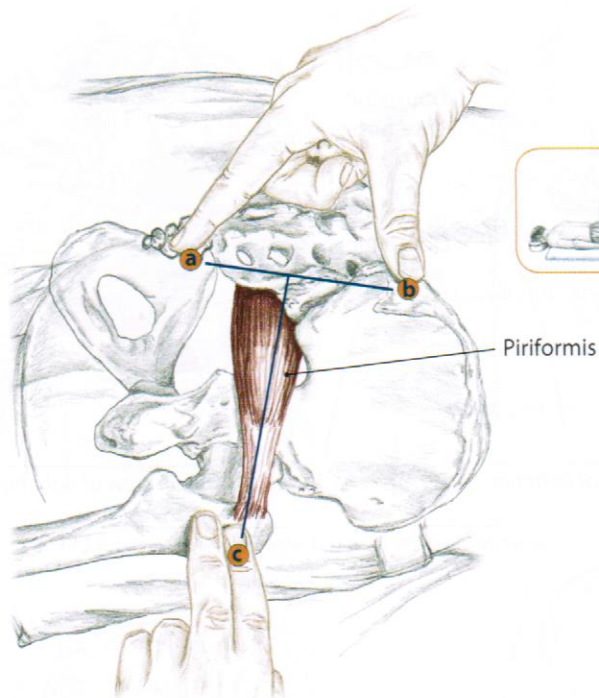


## Gemellus Inferior

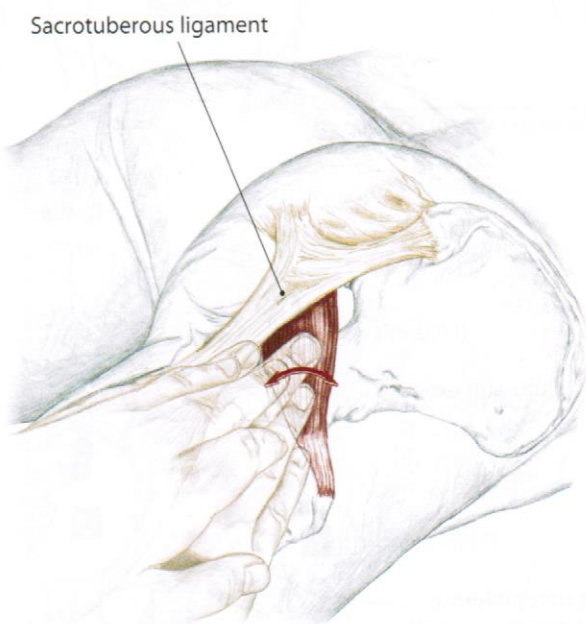
- A** Laterally rotate the hip (coxal joint)
- O** Ischial tuberosity
- I** Medial surface of greater trochanter
- N** Sacral plexus L4, 5, S1, (2)



6.120, 6.121 Posterior (left) and anterior (right) views, origins and insertions



6.122 Posterior/lateral view, partner prone, isolating the piriformis by forming a "T," a) coccyx, b) PSIS, c) greater trochanter



6.123 Posterior/lateral view, partner prone, rolling over piriformis

## Piriformis

- 1) Prone. Locate the coccyx, PSIS and greater trochanter. Together, these landmarks form a "T". The piriformis is located along the base of the "T" (6.122).
- 2) Place your fingers along this line. Working through the thick gluteus maximus, roll your fingers across the belly of the slender piriformis.
- 3) Strum across the belly to clarify its location, staying mindful of the deeper sciatic nerve (6.123).


✓ Are you compressing through the thick gluteus maximus fibers? With your fingers on the piriformis, bend the knee to 90° and ask your partner to rotate his hip laterally against your gentle resistance (6.124). You may feel gluteus maximus contract, but can you feel piriformis contract beneath it?



6.124 Prone, feel the piriformis contract by asking your partner to laterally rotate his hip against your resistance

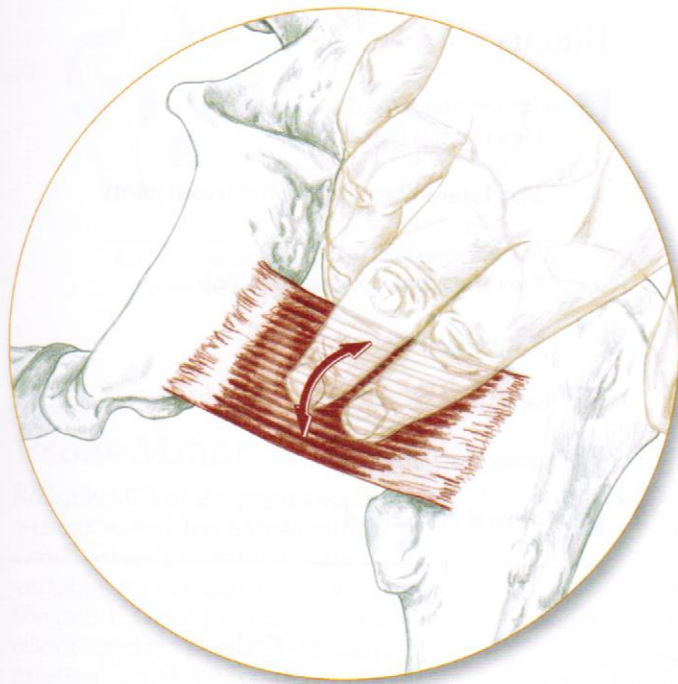
## Quadratus femoris

- 1) Partner prone. Locate the distal, posterior aspect of the greater trochanter and the ischial tuberosity. Place your fingerpads between these two landmarks.
- 2) Pressing firmly through the gluteus maximus fibers, strum vertically across the fibers of the rectangle-shaped quadratus femoris.

 Does the belly stretch between the ischial tuberosity and the distal trochanter? Rolling your fingers over the belly, can you feel its horizontal fibers? Flex the knee to 90° and passively rotate the hip medially and laterally. Can you sense changes in the muscle's tension as it shortens and lengthens (6.125)?

### When Do You Use Your Lateral Rotators?

- Stabilizing the pelvis while standing
- Walking, running, hiking, climbing, biking
- Piriformis: Controlling rapid medial rotation of the hip during the early phase of walking and running



**6.125** Prone, sense the quadratus femoris contract by asking your partner to laterally rotate his hip against your resistance

Compared to its evolutionary precursors, the piriformis is a remnant of its former glory. It is a descendant of the great caudofemoral elevator muscles that can still be seen today

extending from a reptile's femur to its tail. These large muscles provide reptiles with the tremendous thrusting force needed to extend the femur while running.

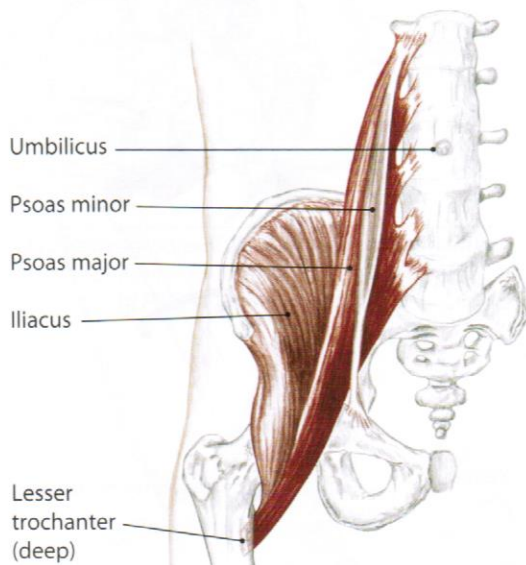
# Iliopsoas



*Psoas Major & Iliacus*

The iliacus and psoas major, together called the iliopsoas, are important hip flexors and low back stabilizers (6.126). Best known to your local butcher as “tenderloin” or “filet mignon,” the long, slender **psoas major** is located deep to the abdominal contents (6.127). It stretches from the lumbar vertebrae, underneath the inguinal ligament, to the lesser trochanter.

The stockier **iliacus** is located deep to the abdomen in the iliac fossa (6.128). Because of their respective locations, these muscles are only partially accessible and may be challenging to palpate.



6.126 Anterior view of spine and right hip



6.127 Anterior view of spine and right hip

## Psoas Major

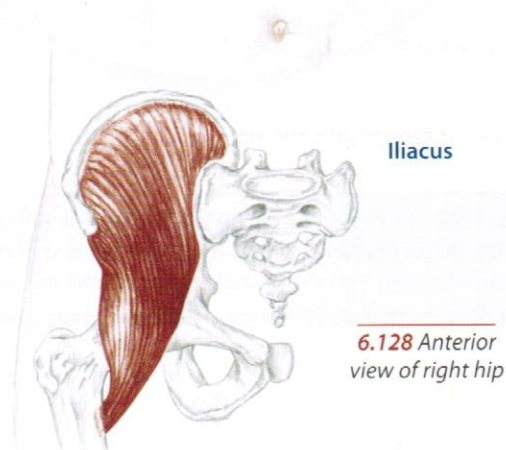
- A** *With the origin fixed:*  
**Flex** the hip (coxal joint)  
  
May **laterally rotate** the hip (coxal joint)
- With the insertion fixed:*  
**Flex** the trunk toward the thigh  
  
**Tilt** pelvis anteriorly
- Unilaterally:*  
Assist to **laterally flex** the lumbar spine

- O** Bodies and transverse processes of lumbar vertebrae
- I** Lesser trochanter
- N** Lumbar plexus L1, 2, 3, 4

## Iliacus

- A** *With the origin fixed:*  
**Flex** the hip (coxal joint)  
  
May **laterally rotate** the hip (coxal joint)
- With the insertion fixed:*  
**Flex** the trunk toward the thigh  
  
**Tilt** pelvis anteriorly

- O** Iliac fossa
- I** Lesser trochanter
- N** Femoral L(1), 2, 3, 4



6.128 Anterior view of right hip

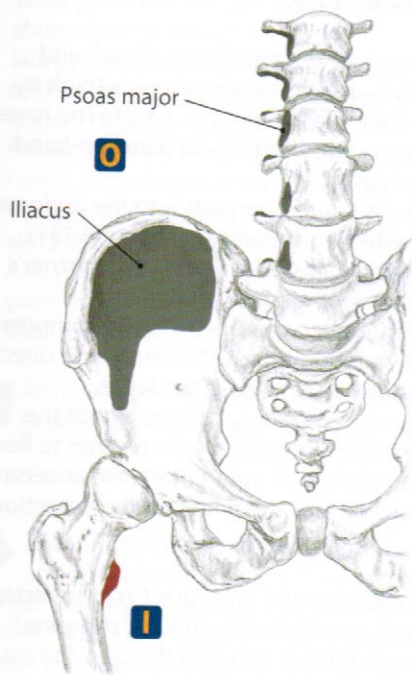
iliacus  
psoas

i-lee-a-cus  
so-as

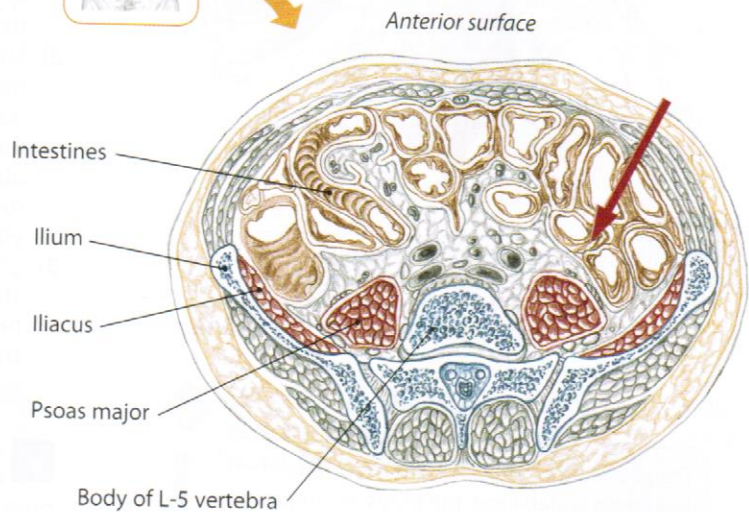
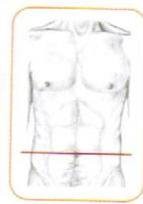
L. pertaining to the loin  
Grk. muscle of the loin

### When Do You Use Your Iliopsoas?

- Hiking, climbing or walking up an incline
- Getting up from a reclined position (the movement of a small sit-up)
- Reaching up, against gravity, to untie the ropes around your ankles that suspend you upside down from a tree limb (It could happen!)



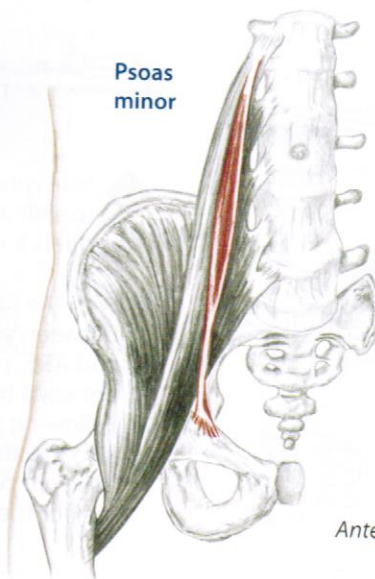
6.129 Anterior view of spine and right hip showing origins and insertions



6.130 Cross section of the trunk at the level of L-5, arrow showing direction of fingers when accessing the psoas major

### Psoas Minor

Roughly 40% of the population has a psoas minor. It is a small muscle which extends from the lumbar vertebrae to the superior ramus of the pubis. When present, the psoas minor assists in posterior tilt (upward rotation) of the pelvis—the opposite action of the psoas major (see box, p. 334). Interestingly, the psoas minor is an important muscle of locomotion on a dog or cat because of the relationship of the pelvis to the vertebrae in quadrupeds. In a human biped, however, the psoas minor is a relatively insignificant muscle, except when doing the horizontal rumba.



Anterior view of right hip

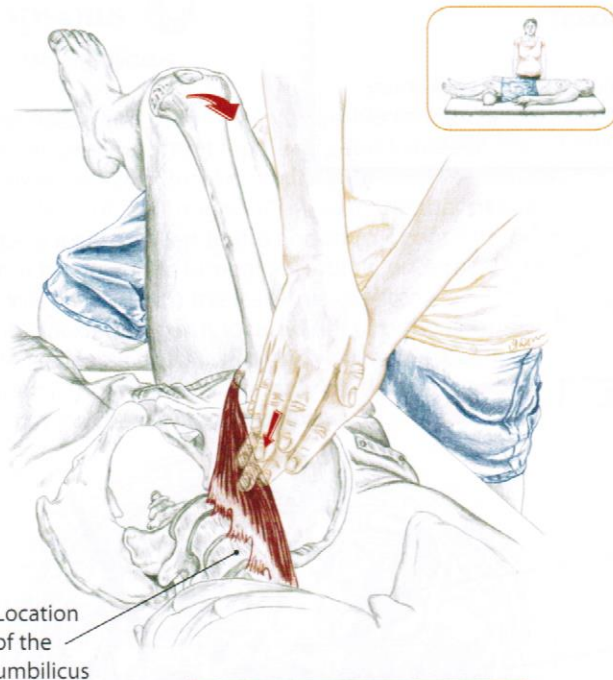
**A** Assist to **create** lordotic curvature in the lumbar spine

**Tilt** pelvis posteriorly

**O** Body and transverse process of first lumbar vertebra

**I** Superior ramus of pubis

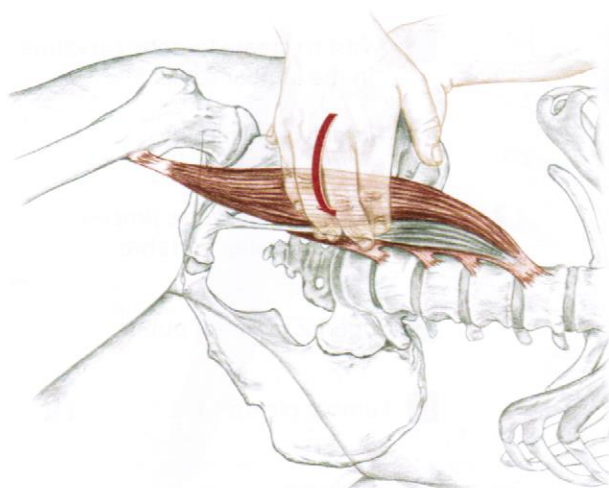
**N** Lumbar plexus L1, 2



Location of the umbilicus

6.131 Partner supine, accessing the psoas while your partner flexes his hip

Psoas major primarily flexes the hip. But when the femur is stabilized, the psoas, in conjunction with iliacus, can increase the lordotic curvature in the lumbar spine and create anterior tilt (downward rotation) of the pelvis. It has also been theorized that only the superficial fibers of the psoas increase the lordotic curve, whereas the deeper fibers may decrease it.




6.132 Partner side lying with hips flexed, curling your fingers into the abdomen


## Psoas major

When accessing either the psoas or iliacus, palpate slowly and communicate with your partner. If at any point he does not feel comfortable or safe, slowly remove your hands. The psoas major lies just lateral to the abdominal aorta (p. 219). If you feel a strong pulse directly beneath your fingers when accessing the muscle, realign them more laterally.

- 1) Partner supine, with the hip slightly flexed and laterally rotated. Support your partner's thigh by placing your thigh underneath it. Locate the navel and ASIS, placing your fingerpads hand-on-hand between these points.
- 2) Slowly compress your fingerpads into the abdomen, moving only when your partner exhales (6.131). (Compressing in small circles upon your partner's initial exhalations will assist in moving the abdominal contents to the side.) As you compress further, keep your fingerpads stationary and direct your fingers downward toward the table.
- 3) Check that you are palpating the psoas, not the surrounding tissues, by asking your partner to flex his hip ever so slightly. If your fingers are accessing the psoas, you will feel a definite, solid contraction (6.131).

 Are you between the ASIS and navel? Is the direction of your fingers at a slight angle toward the spine? Have you compressed slowly, allowing the overlying tissue to relax? If you did not feel the muscle contract, try again with the fingers repositioned farther inferiorly.





 Side lying position allows the abdominal contents to shift away from the psoas and, oftentimes, offers a less invasive position for your partner.

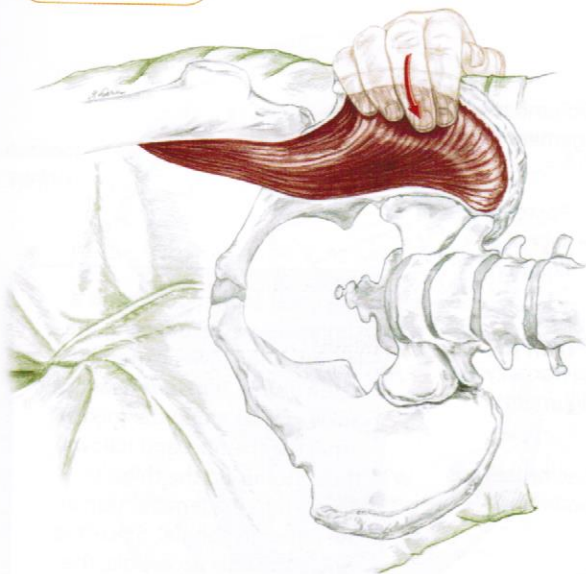
- 1) With the hips in a flexed position, place a bolster between your partner's knees. Locate the navel and ASIS, placing your fingerpads hand-on-hand between these points (6.132).
- 2) Following your partner's breath, curl your fingers into the abdomen and onto the surface of the psoas. Ask your partner to flex his hip slightly so you can feel for the psoas' contraction.

## Iliacus

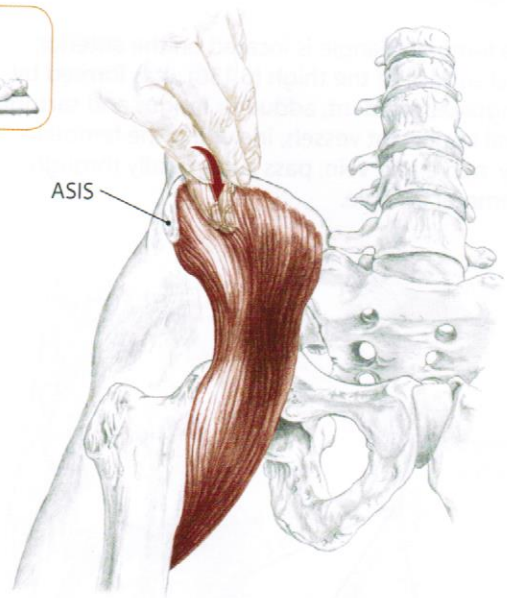
- 1) Partner supine, with the hip slightly flexed and laterally rotated. Support your partner's thigh by placing your thigh underneath it.
- 2) Locate the anterior portion of the iliac crest and place your fingerpads hand-on-hand an inch medial to its ridge. (Beginning medially will allow you to penetrate more easily through the abdominal muscles.)
- 3) Slowly curl your fingers into the iliac fossa, moving only when your partner exhales (6.133). Your fingers might sink only a short distance into the tissue. Here's a hint: The intention of your touch needs to go beyond the superficial abdominal muscles and be directed toward the anterior surface of the ilium.
- 4) Ask your partner to flex his hip slightly, with your fingers in place. You will feel the strong iliacus contract.

 Are you in the iliac fossa? Have you compressed slowly, allowing the overlying tissue to relax?


 As with the psoas, side lying position allows the abdominal contents to fall away from the iliacus and can be a more comfortable position for your partner. With the hips in a flexed position, place a bolster between your partner's knees and follow the instructions above (6.134).



6.134 Partner side lying with hips flexed, curling your fingers into the abdomen



6.133 Anterior/inferior view, partner supine, curling your fingers around the iliac crest to access the iliacus

 Following the above procedure, access the iliacus from the opposite side of the table. Try curling into the iliac fossa with your thumbs (6.135).

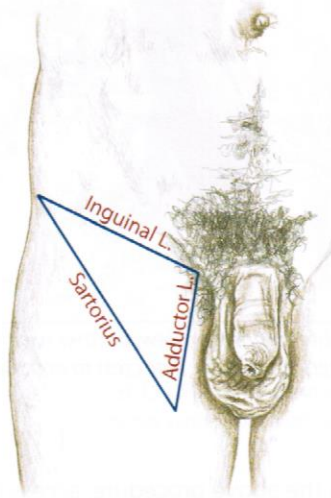


6.135 Palpating with your partner side lying

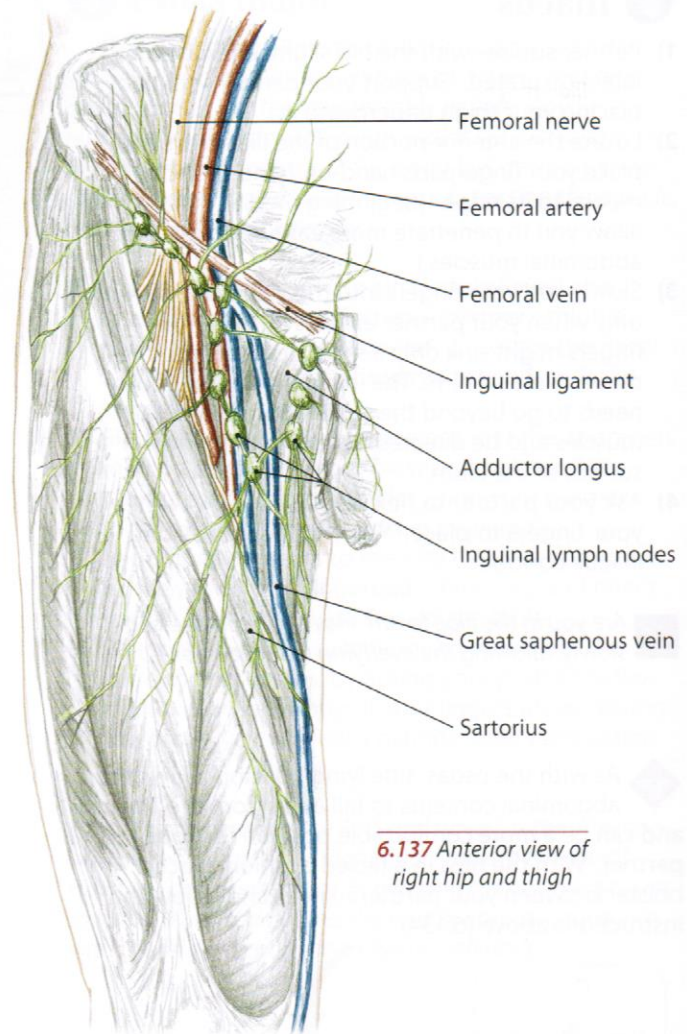


# Other Structures of the Pelvis and Thigh

The femoral triangle is located on the anterior, medial surface of the thigh (6.136). It is formed by the inguinal ligament, adductor longus and sartorius. Several important vessels, including the femoral artery, nerve and vein, pass superficially through the femoral triangle.

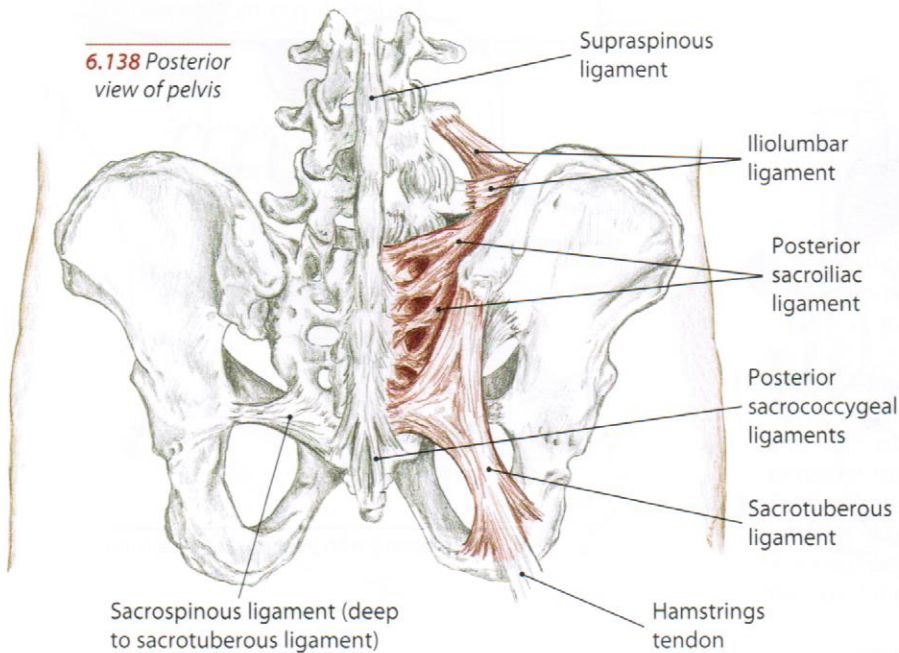


6.136 The three borders of the femoral triangle



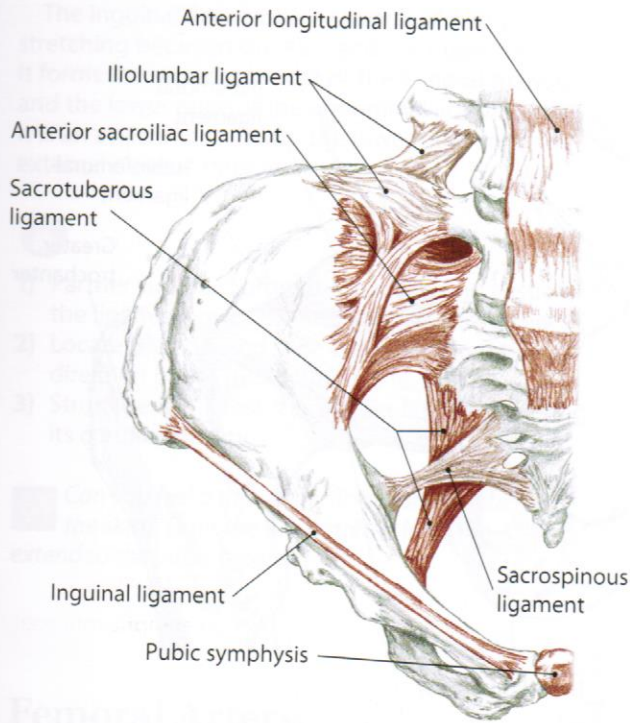
6.137 Anterior view of right hip and thigh

6.138 Posterior view of pelvis

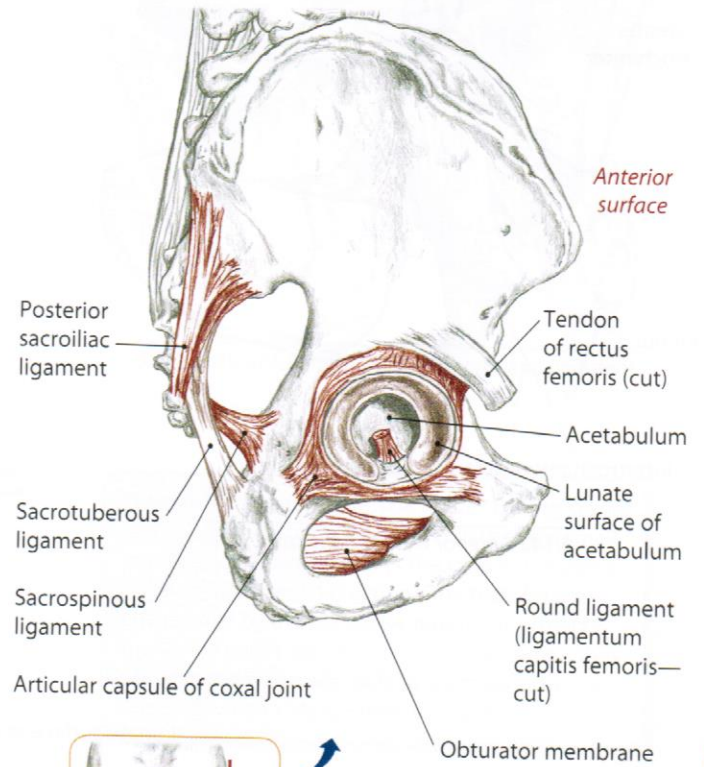


The great saphenous vein is a superficial vessel traveling the length of the lower extremity. Often visible, it begins near the ankle, passes along the medial aspect of the tibia and follows the sartorius up the thigh to empty into the femoral vein at the femoral triangle. Since it is long and easily accessible, the saphenous vein is often used for grafts in coronary bypass surgery.

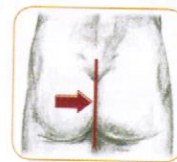
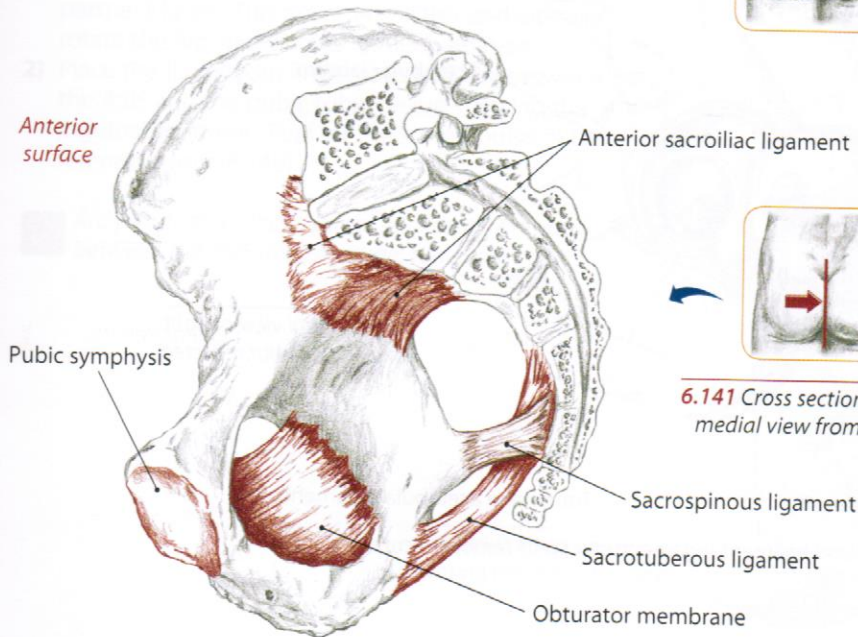
# Ligaments of the Pelvis



6.139 Anterior view of right hip



6.140 Lateral view of right hip

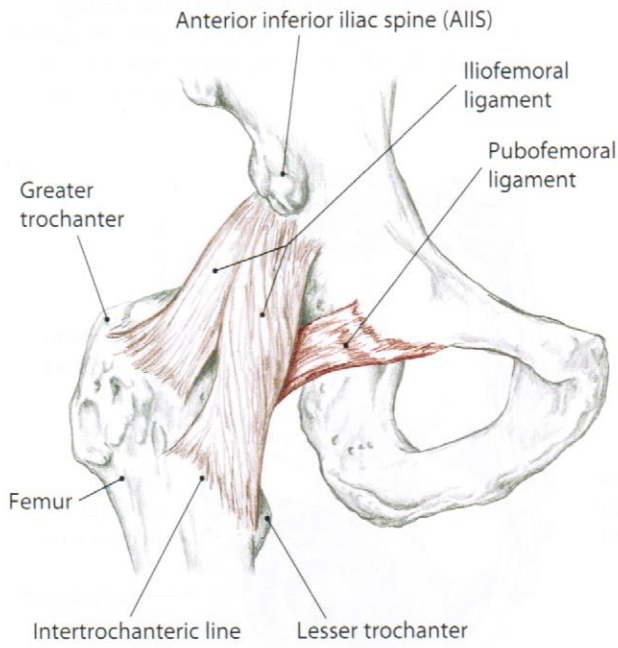


6.141 Cross section of pelvis, medial view from midline

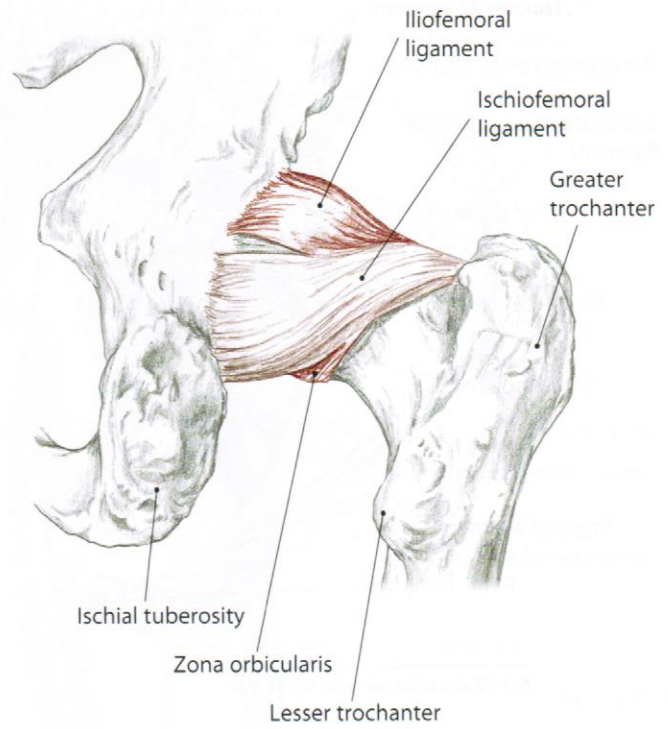
sacrococcygeal  
sacrotuberous

sa-kro-kok-sij-e-al  
sa-kro-tu-ber-us

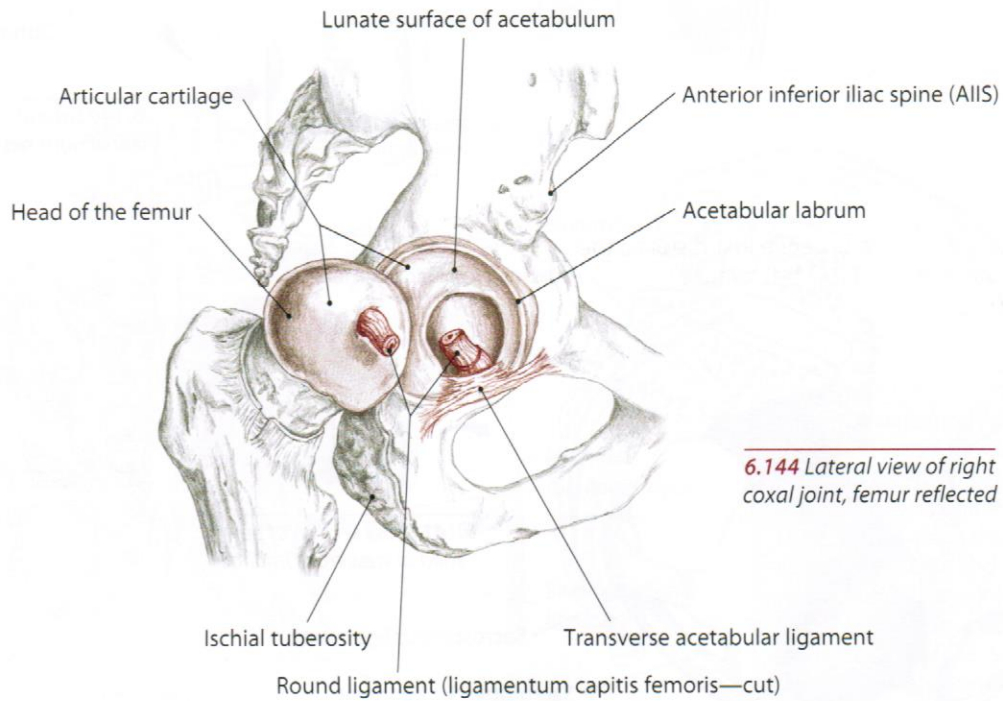
# Ligaments of the Coxal Joint



6.142 Anterior view of right coxal joint



6.143 Posterior view of right coxal joint



6.144 Lateral view of right coxal joint, femur reflected

## Inguinal Ligament

The inguinal ligament is a superficial band stretching between the ASIS and the pubic tubercle. It forms the superior border of the femoral triangle and the lower edge of the abdominal aponeurosis. It is an attachment site for the lower portion of the external oblique muscle.



- 1) Partner supine. Soften the surrounding tissue of the ligament by bolsting your partner's knee.
- 2) Locate the ASIS and slide diagonally in the direction of the pubic tubercle (6.145).
- 3) Strum gently across the slender ligament, feeling its cordlike quality.

Can you feel a thin, superficial band just beneath the skin? Does the band stretch from the ASIS and extend to the pubic tubercle?

Feel this!



## Femoral Artery, Nerve and Vein

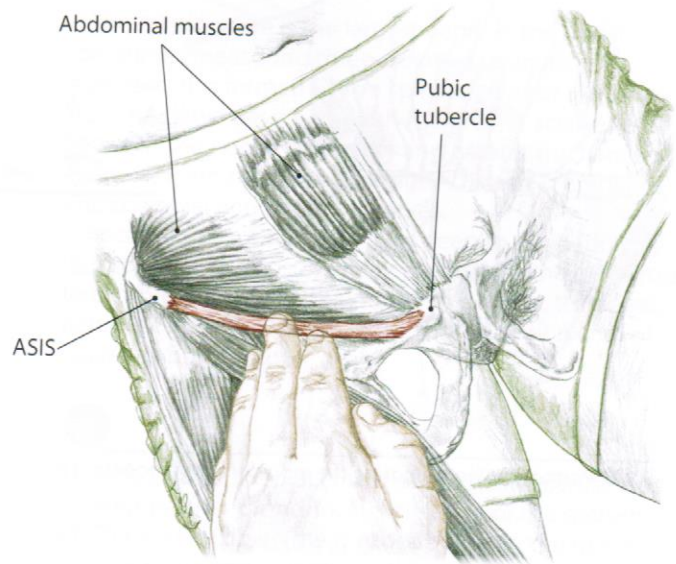
The femoral artery, nerve and vein form a neurovascular bundle that courses through the femoral triangle. These vessels lie beneath the inguinal ligament and extend distally into the tissue of the thigh. The bundle is relatively superficial; the pulse of the femoral artery can be easily felt.

### Pulse of the femoral artery

- 1) Partner supine. Slide your flexed knee behind your partner's knee. This position will flex and laterally rotate the hip, allowing for easier palpation.
- 2) Place the flat of your fingerpads halfway between the ASIS and the pubic tubercle just distal to the inguinal ligament. Feel for the strong pulse of the femoral artery (6.146).

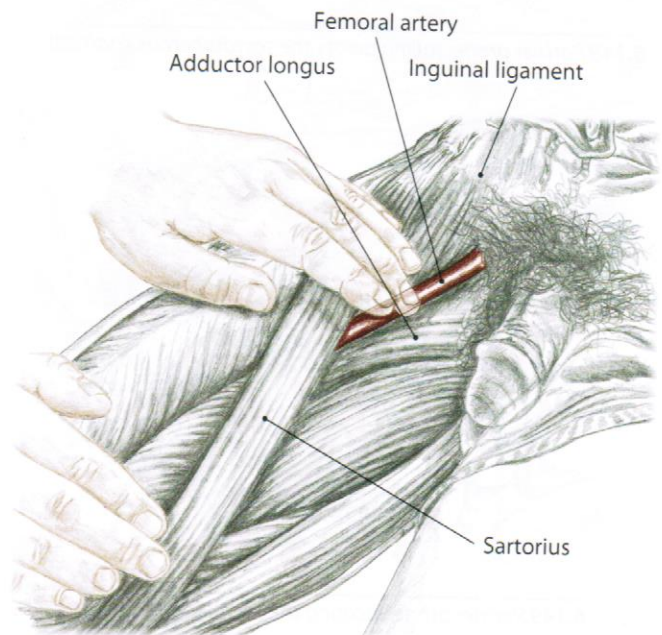
Are you distal to the inguinal ligament? Are you between the ASIS and the pubic tubercle?

6.146 Partner supine, locating the femoral artery



6.145 Partner supine, locating the inguinal ligament

The penis contains no muscle tissue. During sexual arousal, the arteries of the penis dilate and a small muscle (ischiocavernosus) at the base of the penis helps to maintain an erection. The testicles are enveloped by the cremaster muscle. It protects the sperm inside by lowering the testes when they become too warm and pulling them up closer to the body when they become too cold.



inguinal  
penis

ing-gwi-nal

L. of the groin  
L. tail



6.147 Partner supine, palpating the inguinal lymph nodes

## Inguinal Lymph Nodes

Distal to the inguinal ligament, the superficial inguinal lymph nodes are easily palpable. They number between eight and ten and vary in size from a small lentil to a raisin.



- 1) Partner supine, with the knee bolstered. This position will flex and laterally rotate the hip, allowing for easier palpation.
- 2) Locate the inguinal ligament. Slide inferiorly and explore for the superficial nodes (6.147).

## Sacrospinous Ligament

This broad, solid ligament stretches between the ischial tuberosity and the edge of the sacrum. Although it is deep to the gluteus maximus muscle, it is distinctly palpable and might feel like a span of bone.



- 1) Partner prone. Locate the ischial tuberosity. Locate the edge of the sacrum (p. 290).
- 2) Slide your fingertips off the tuberosity toward the edge of the sacrum. Using firm pressure, palpate through the gluteus maximus belly and strum broadly across the ligament (6.148).

Are you deep to the gluteus maximus fibers? Is the structure you are rolling over roughly an inch wide and inflexible? Does it stretch from the ischial tuberosity toward the sacrum?

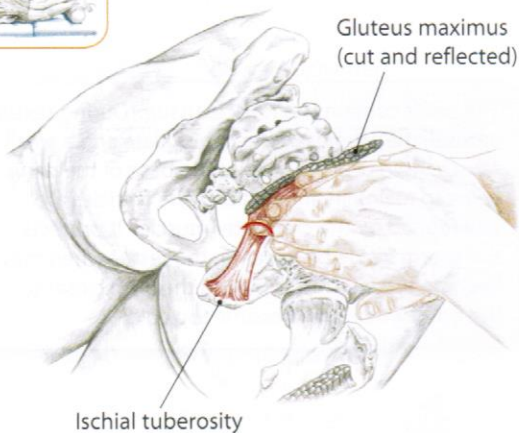
## Posterior Sacroiliac Ligaments

Superficial to the sacroiliac joint, the dense sacroiliac ligaments support the union of the posterior sacrum and the ilium. It has several segments which attach from the sacrum to the area around the PSIS. The ligaments are deep to the thoracolumbar aponeurosis, and their oblique fibers may be difficult to distinguish.

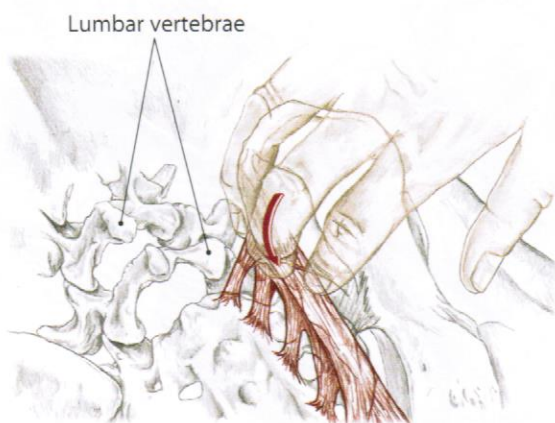


- 1) Partner prone. Locate the surface of the sacrum.
- 2) Using firm pressure, strum your fingertips across the dense fibers of the sacroiliac ligaments (6.149).

Are you medial to the PSIS, on top of the sacroiliac joint space (p. 291)?



6.148 Partner prone, rolling across the sacrospinous ligament



6.149 Partner prone, locating the sacroiliac ligaments

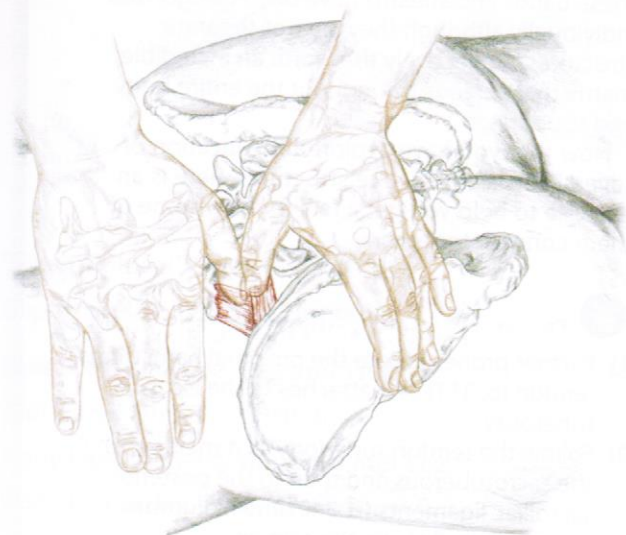
## Iliolumbar Ligament

The iliolumbar ligament is located between the transverse processes of the fourth and fifth lumbar vertebrae and the posterior iliac crest. The strong, horizontal fibers of the ligament are important in stabilizing L-4 and L-5. The ligament is difficult to palpate, being deep to the thoracolumbar aponeurosis, the thick multifidi (p. 200) and the quadratus lumborum (p. 207). However, its location and density can be determined.



- 1) Partner prone. Locate the PSIS.
- 2) Slide your thumb straight superior from the PSIS to the level of L-4 and L-5. Your thumb should be between the iliac crest and the transverse processes of the lumbar vertebrae.
- 3) Using firm pressure, sink into the dense muscles of the low back and attempt to roll vertically across the ligament's taut fibers (6.150).

✓ Can you palpate its dense, horizontal fibers?



6.150 Posterior/lateral view, partner prone, sinking your thumb onto the iliolumbar ligament

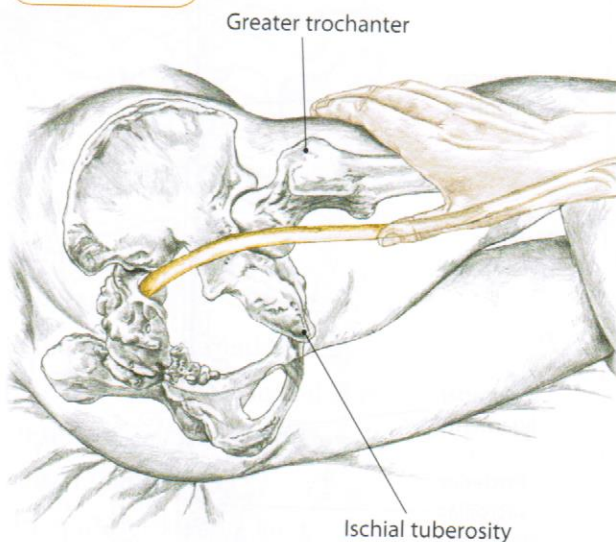
## Sciatic Nerve

The sciatic nerve is the largest nerve in the body—sometimes measuring three-quarters of an inch in diameter. It is formed by the spinal nerves of L-4 through S-3. The nerve passes through the greater sciatic notch, between the ischial tuberosity and greater trochanter, and extends down the posterior thigh. Distally, it branches into the tibial and peroneal nerves.

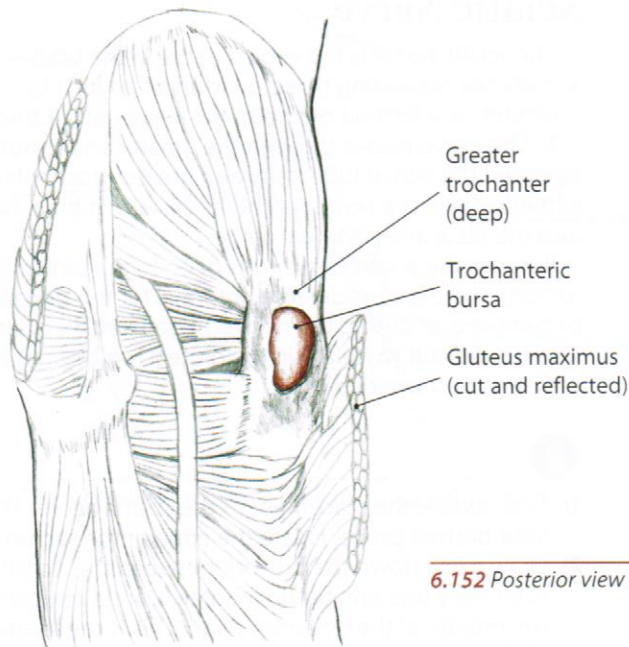
Because the sciatic nerve runs deep to the piriformis (p. 328), there is considerable potential for the piriformis to compress or entrap the nerve. In general, the sciatic nerve is difficult to isolate in the gluteal region and, of course, is best avoided.



- 1) First, *outline* the placement of the sciatic nerve. With your partner prone, locate the edge of the sacrum.
- 2) Draw a line down the buttock between the ischial tuberosity and greater trochanter. Continue down the middle of the posterior thigh. This is the location of the nerve.
- 3) To *access* the sciatic nerve, turn your partner side lying and flex the hip. Locate the ischial tuberosity and greater trochanter.
- 4) Palpate between these landmarks for the pathway of the sciatic nerve (6.151). You can avoid pinching the nerve by palpating with the pad of your thumb.



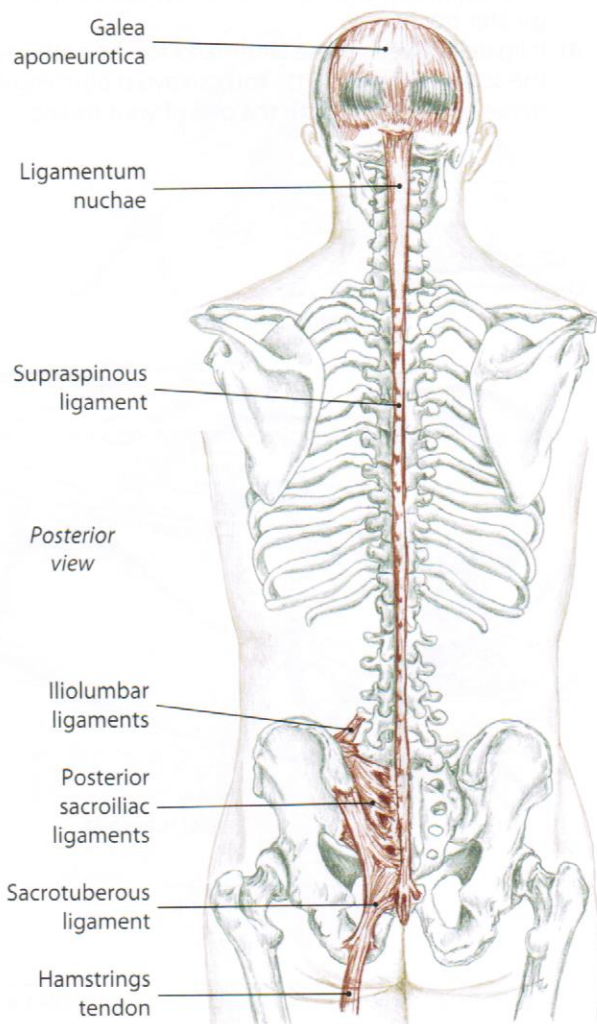
6.151 Partner side lying



6.152 Posterior view of right hip

## Trochanteric Bursa

Positioned along the posterior/lateral aspect of the greater trochanter, this large bursa reduces friction between the trochanter and the gluteus maximus (6.152). Other bursae are located along the lateral and anterior sides of the trochanter and separate it from the gluteus medius and minimus. Unless they are inflamed or distended, the bursae will be impalpable.



Ligaments, tendons, fasciae and retinacula are all forms of connective tissue. They are composed of virtually the same ingredients (collagen, elastin and ground substance) differing only in the proportions of these materials. For anatomical purposes, these bands and sheaths have been categorized individually although they are not separate structures. Collectively they form an incredible matrix that spreads throughout the entire body and supports it.

Now that you have explored the location of several connective tissue structures, here is an exercise to help you get a feel for how some of them connect together.



- 1) Partner prone. Locate the proximal hamstrings tendon (p. 311) as it attaches to the ischial tuberosity.
- 2) Follow the tendon superiorly as it melds into the sacrotuberous and then to the posterior sacroiliac ligaments (p. 340) and iliolumbar ligaments (p. 341) on the sacrum.
- 3) Continue superiorly as the sacroiliac ligaments blend into the thoracolumbar aponeurosis (p. 220) and the supraspinous ligament (p. 219) between the spinous processes of the vertebrae.
- 4) Ultimately, follow the supraspinous ligament all the way up the spine to the ligamentum nuchae (p. 218) and, finally, to the galea aponeurotica (p. 262) surrounding the cranium.

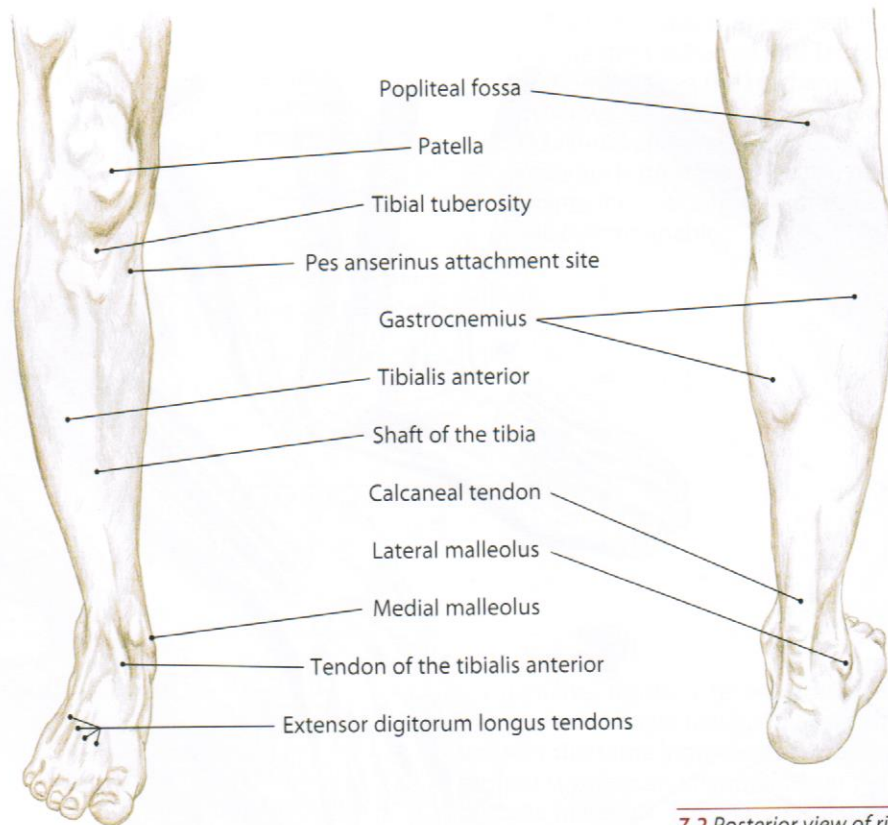
# Leg & Foot 7



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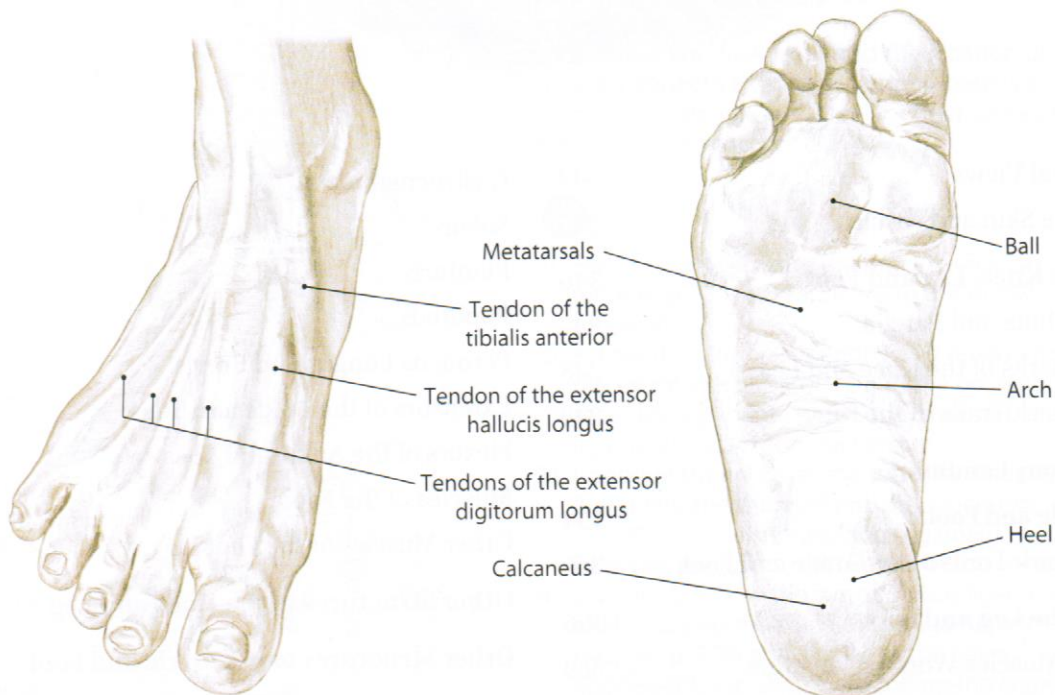


# Topographical Views



7.1 Anterior view of right leg

7.2 Posterior view of right leg



7.3 Dorsal view of right foot

7.4 Plantar view of right foot

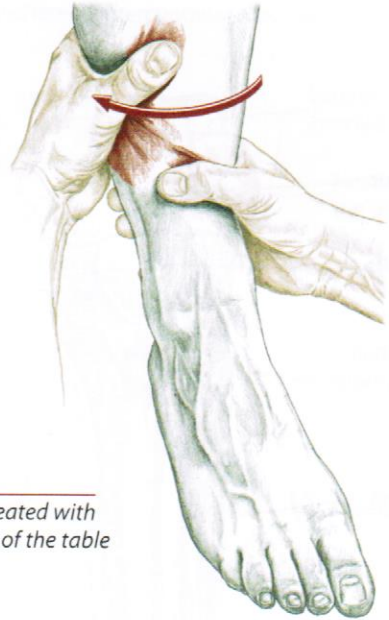
Leg & Foot



# Exploring the Skin and Fascia



- 1) Partner seated. Using one hand to stabilize the leg, use your other hand to gently twist the skin and fascia around the leg's shaft (7.5). Note the tissue's mobility or resistance as you pull it in opposite directions.
- 2) Now try to tug the skin superiorly and inferiorly. Oftentimes the tissue has less mobility when moving in the vertical direction than in the horizontal direction.



7.5 Partner seated with leg off the end of the table



- 1) Partner seated. Place your hands on the foot's dorsal and plantar surfaces and sense their respective temperatures. Is one side warmer than the other?
- 2) Explore the dorsal surface by shifting the skin from side to side (7.6). Note the thin, delicate quality of its skin and fascia. Now palpate the plantar surface and note the tissue's thick, tough quality.



7.6



- 1) Partner prone. Here is an opportunity to feel the skin and fascia stretch upon passive movement. Grasp the tissue of the posterior ankle and passively plantar flex and dorsiflex the ankle (7.7). Feel how supple the tissue is when the ankle is plantar flexed. When you dorsiflex the ankle, however, the skin might be pulled out from between your fingers.
- 2) Continue to move the ankle while grasping the tissue on all sides of the leg. Now ask your partner to actively move his ankle and toes while you grasp the skin and fascia. Encourage him to move slowly. Play with isolating specific actions—such as plantar flexion of the ankle versus flexion of the toes—to feel how the tissue shifts upon different movements.



7.7 Partner prone, with foot off the end of the table

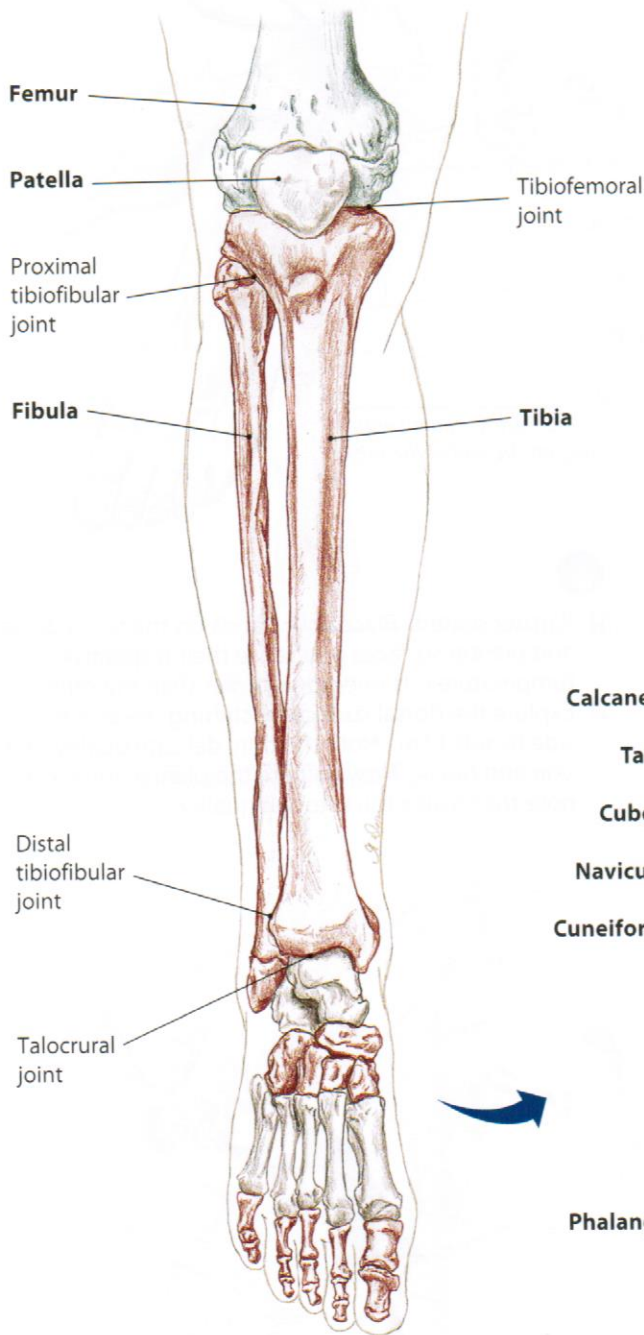


# Bones of the Knee, Leg and Foot

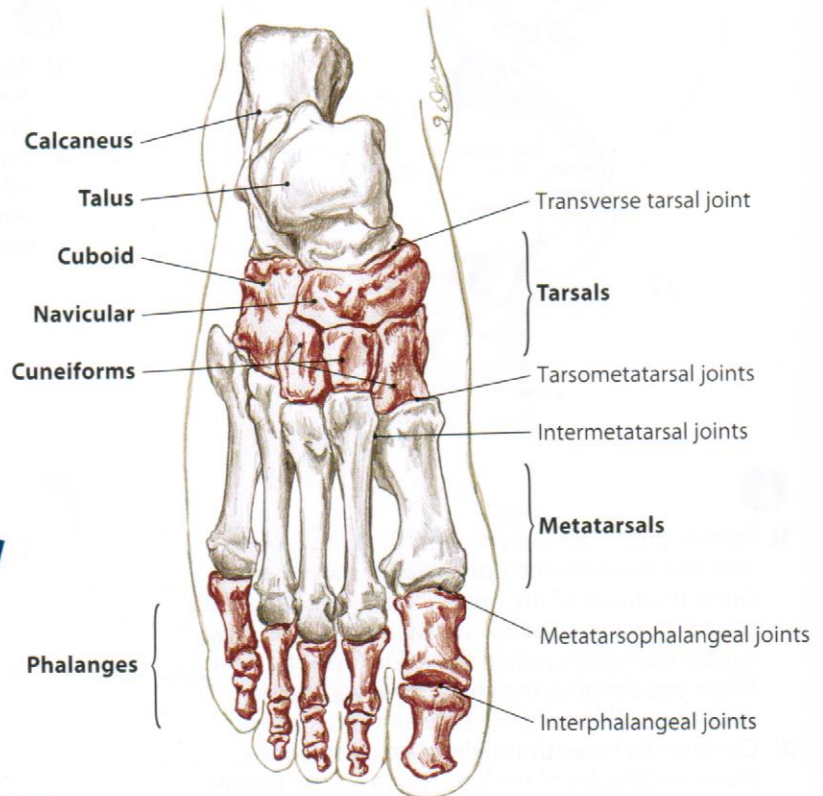
The knee is formed by the articulation of the distal femur and proximal tibia (7.8). The tibiofemoral (knee) joint, the largest synovial joint in the body, is a modified hinge joint. It is capable of flexion and extension; and when the knee is in a flexed position, it can medially and laterally rotate the knee (p. 348).

The region of the knee also includes the small **patella** ("kneecap") and the proximal fibula. The bony surfaces of the knee are superficial and easily accessible.

The **tibia** and **fibula** are the bones of the leg. The tibia ("shinbone") runs superficially from the knee to the ankle just as the ulna runs superficially from the elbow to the wrist. The fibula's relationship to the tibia is also similar to the radius' relationship to the ulna: It is lateral to the tibia and virtually deep to the surrounding muscles. The fibula bears only ten percent of the body's weight and rightfully so: It is the thinnest bone in the body in proportion to its length.



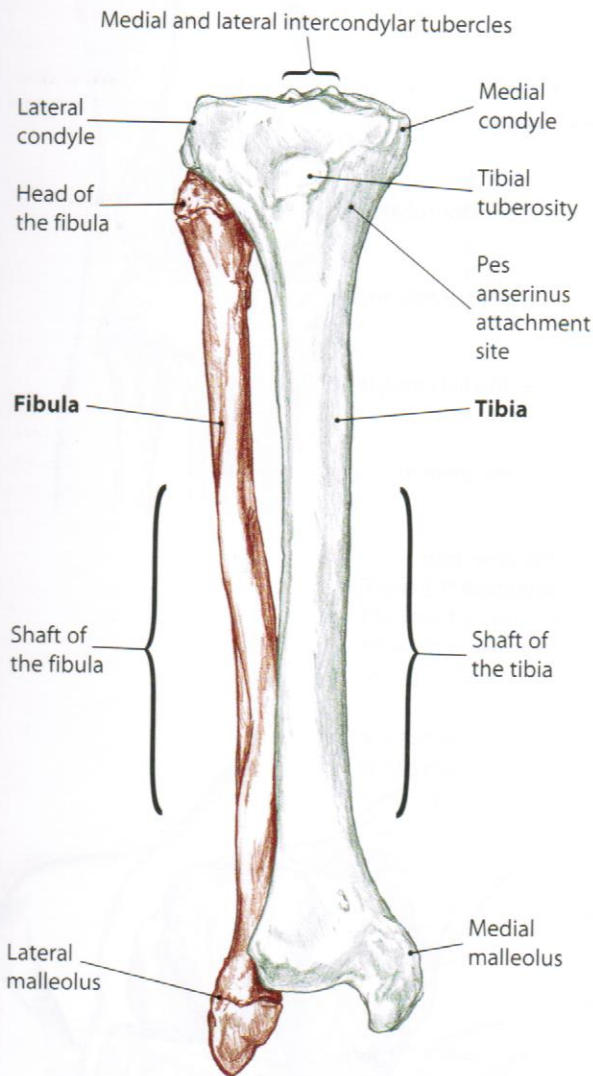
7.8 Anterior view of right leg and foot, foot plantar flexed



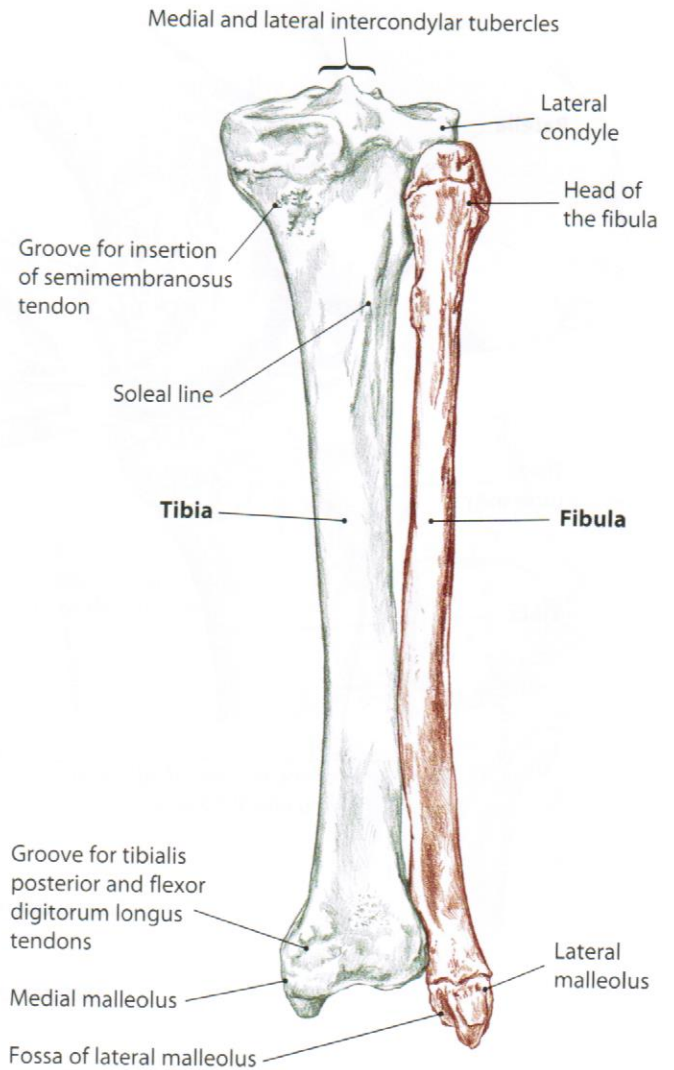
7.9 Dorsal view of right foot

Leg & Foot

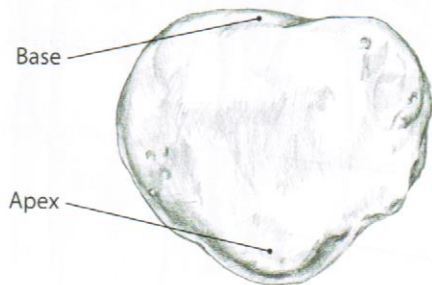
# The Tibia, Fibula and Patella



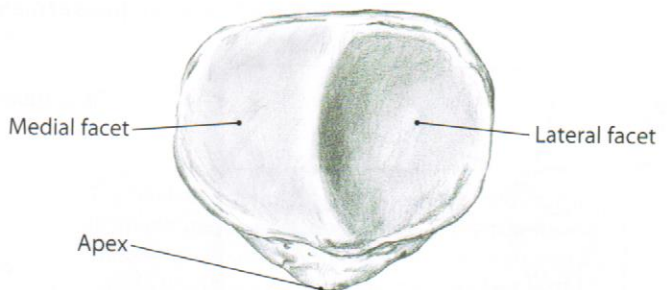
7.10 Anterior view of right tibia and fibula



7.11 Posterior view of right tibia and fibula

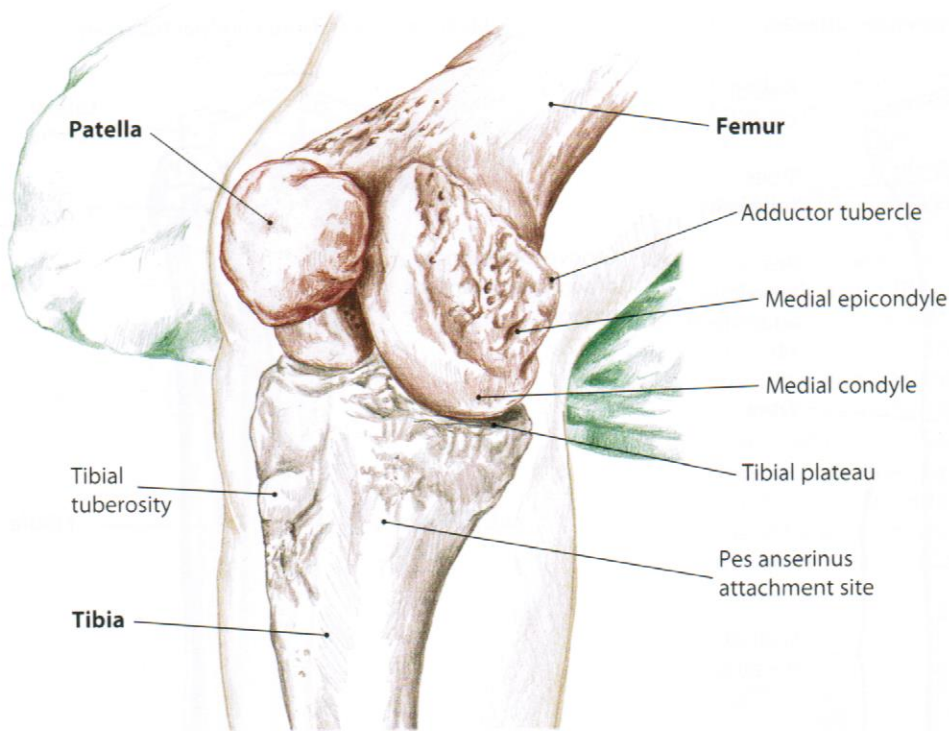


7.12 Anterior view of right patella

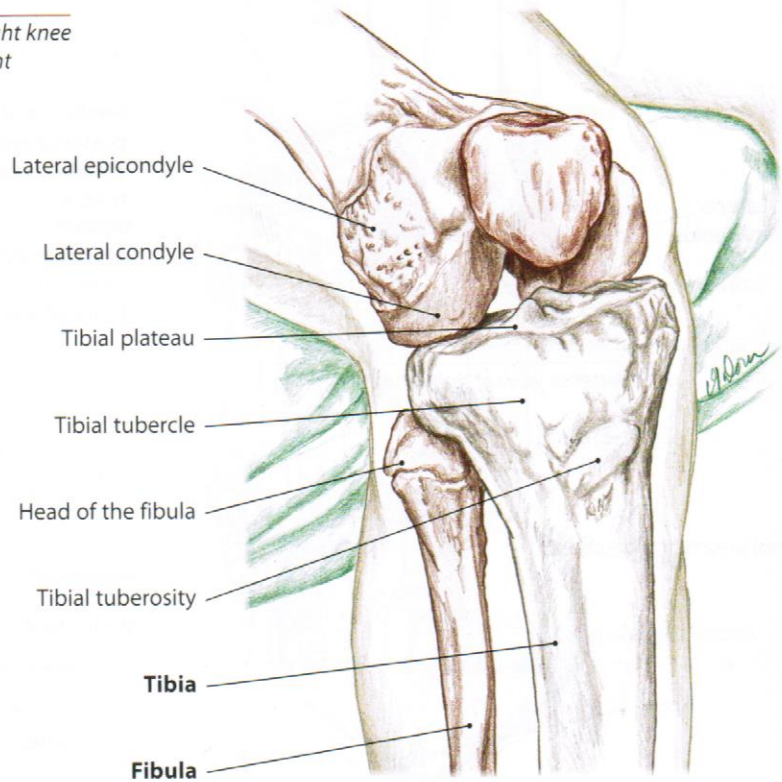


7.13 Posterior view of right patella

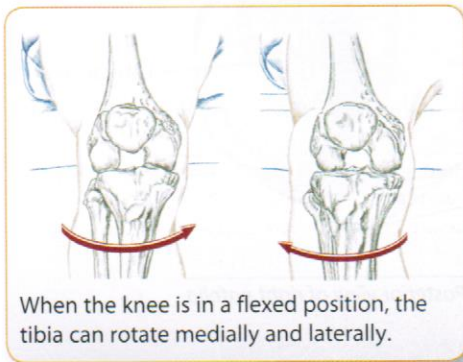
# Bony Landmarks of the Knee and Leg



7.14 Anterior/medial view of right knee showing tibiofemoral joint

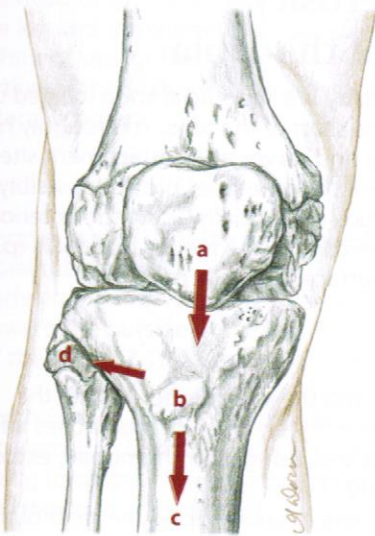


7.15 Anterior/lateral view of right knee showing tibiofemoral joint





# Bony Landmark Trails of the Knee

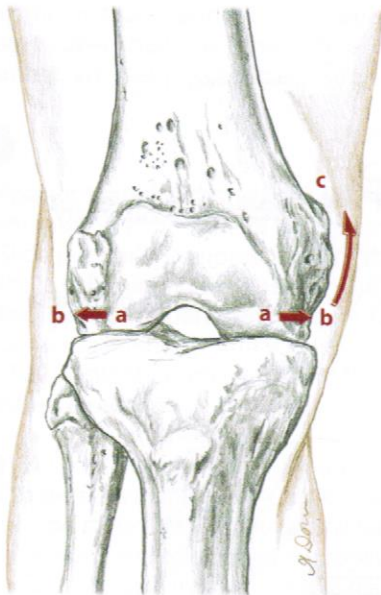
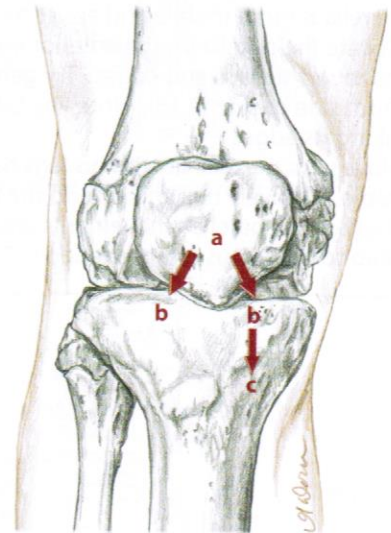


**Trail 1** "Landmark Trail" links together the most prominent landmarks of the knee.

- a Patella
- b Tibial tuberosity
- c Shaft of the tibia
- d Head of the fibula

**Trail 2** "Waddle Walk" has two paths exploring the medial and lateral aspects of the proximal tibia. It ends at the pes anserinus ("goose foot" in Latin) attachment site.

- a Patella
- b Medial and lateral tibial plateaus
- c Pes anserinus attachment site



Patella removed

**Trail 3** "Hills on Both Sides" explores the bumps of the distal end of the femur.

- a Edges of the medial and lateral femoral condyles
- b Medial and lateral epicondyles of the femur
- c Adductor tubercle

The thickest layering of cartilage in the body can be found on the posterior surface of the patella. This eighth-of-an-inch-thick coating protects the patella from the incredible pressure applied by the quadriceps when the knee is flexed. Simply walking up or down stairs can place as much as six hundred pounds of pressure on the patella.



# Trail 1 "Landmark Trail"

## Patella

The patella is located on the anterior surface of the knee. It is superficial and round with an apex that points distally. The largest sesamoid bone in the body, the patella is an attachment site and junction point for the quadriceps femoris tendon (p. 306) and patellar ligament. When the knee is flexed, the patella seems to disappear, sinking into the space between the proximal tibia and femoral condyles.



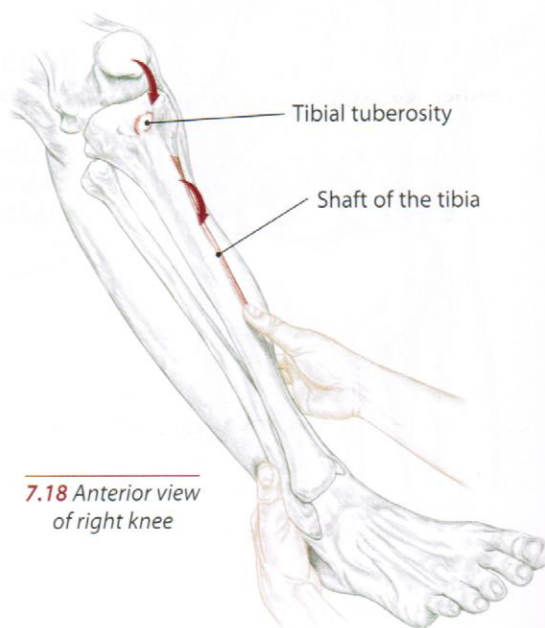
- 1) Partner supine with the knee extended. In this position the quadriceps tendon is shortened and the patella is more mobile and easier to access.
- 2) Locate the patella on the anterior knee and palpate its round surface and edges. Try gently shifting it from side to side (7.16). Note any bumps or crevices along its edges.
- 3) Have your partner sit with his legs hanging off the table. Passively flex and extend the knee as you explore the patella's movements and its relationship to the rectus femoris tendon (7.17).



7.17 Feeling the patella shift as the knee is flexed and extended



7.16 Anterior/medial view of extended right knee



7.18 Anterior view of right knee

## Tibial Tuberosity and Shaft of the Tibia

The **tibial tuberosity** is a superficial knob located distal to the patella on the shaft of the tibia. It is roughly half an inch in diameter and serves as an attachment site for the patellar ligament. It sometimes protrudes visibly. The **shaft of the tibia** runs superficially along the anterior leg. From the tibial tuberosity to the medial malleolus (p. 357), its edges and flat surface are easily palpable.



- 1) Partner seated with the knee flexed. Locate the patella. Slide your fingers three or four inches inferior from the patella and, using your thumbpad, explore for the tuberosity (7.18).
- 2) Continue to palpate inferiorly along the shaft of the tibia. Determine the width of the shaft by palpating along its edges. Follow it down to the medial malleolus.

With your fingers at the tibial tuberosity, ask your partner to extend his knee slightly. With this action, the patellar ligament will tighten, and you will be able to feel where it attaches to the tibial tuberosity. When palpating the tibial shaft, can you feel its distinct edges leading toward the medial ankle?

Leg & Foot



## Head of the Fibula

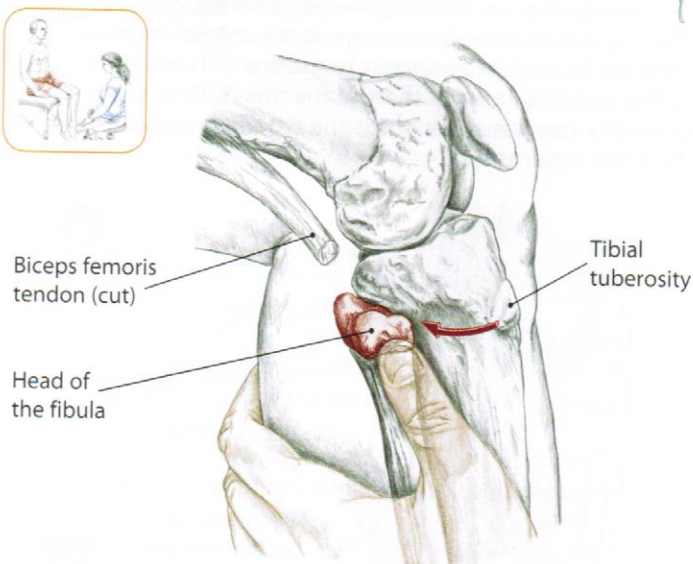
The head of the fibula is located on the lateral side of the leg and sometimes protrudes visibly. It is the attachment site for the biceps femoris muscle and a portion of the soleus muscle as well as the fibular collateral ligament.



- 1) Partner seated with the knee flexed. Locate the tibial tuberosity.
- 2) Slide your fingers laterally three to four inches toward the outside of the leg. Palpate for the head of the fibula (7.19). Explore its inch-wide tip.

*Is the knob you are palpating lateral to the tibial tuberosity? Can you sculpt a circle around it, outlining its shape? Does the biceps femoris tendon lead to the head of the fibula?*

*With your partner prone, bend the knee to 90° and follow the biceps femoris tendon (p. 311) distally to where it inserts at the head of the fibula.*



7.19 Lateral view of flexed right knee



## Trail 2 “Waddle Walk”

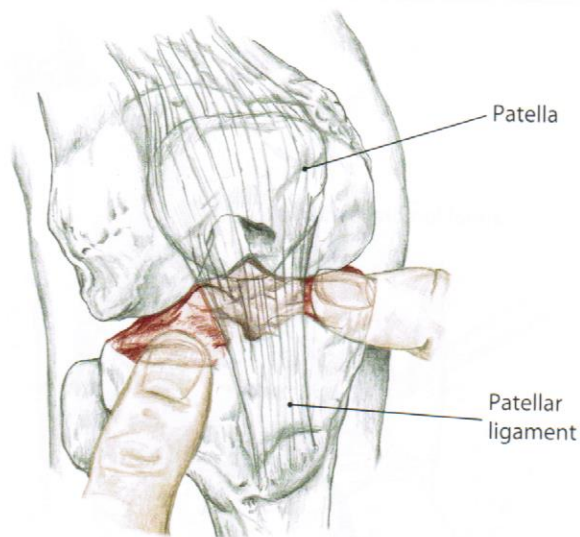
### Tibial Plateaus

The medial and lateral plateaus are located on the proximal end of the tibia. Situated inside the knee joint, the plateaus cannot be palpated, but their edges, located superficially on either side of the patellar ligament, are easily accessible.



- 1) Partner seated with the knee flexed. Place your thumbs on either side of the patella.
- 2) Slide inferiorly, compressing into the tissue. You will feel a softening in the knee as your thumbs sink into the joint space between the femur and tibia.
- 3) Continue inferiorly until you feel the plateau edges (7.20). Palpate both edges and follow them in either direction.

*Can you follow the edges of both plateaus horizontally to the sides of the knee? Can you feel the soft joint space superior to them? If you passively extend the knee with one hand while palpating the edges with the other, can you feel the edges move closer to the patella?*



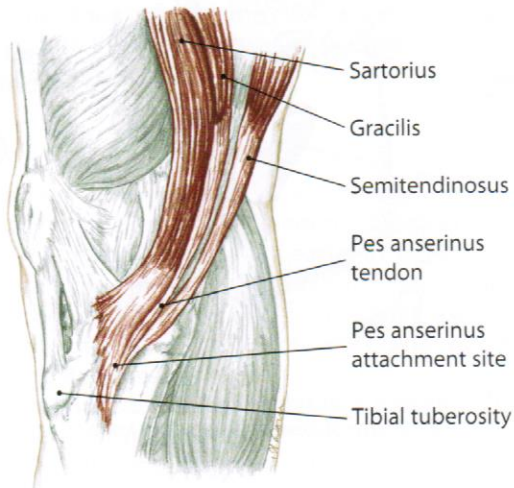
7.20 Anterior view of flexed right knee, accessing the tibial plateaus



Distal to the lateral plateau is a swelling of bone called the tibial tubercle (7.15) which is the attachment site for the iliotibial tract (p. 324). Slide distally off the lateral plateau and explore the tubercle's girth. When the knee is extended, the tubercle usually lies between the patella and the head of the fibula.

## Pes Anserinus Attachment Site

Three tendons of the thigh—the sartorius, gracilis and semitendinosus—converge at the medial knee to form the larger pes anserinus tendon, which attaches to the proximal, medial shaft of the tibia (7.21). More generally, the pes anserinus is the flat area medial to the tibial tuberosity.



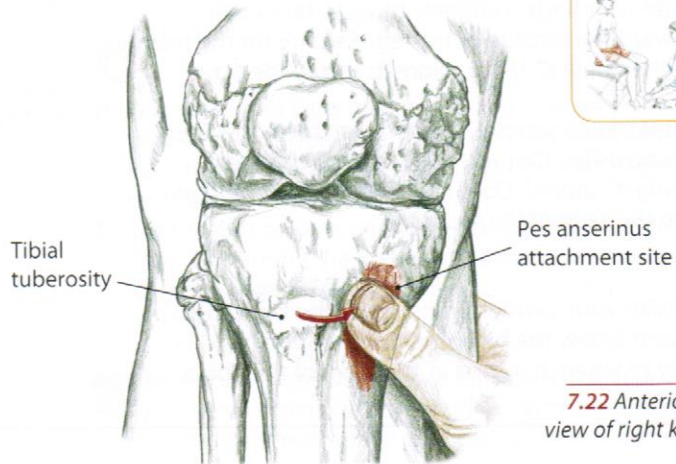
7.21 Medial view of right knee



- 1) Partner seated with the knee flexed. Locate the tibial tuberosity.
- 2) Slide medially one inch and explore its flat surface and any palpable tendons (7.22).



Is the region you are isolating medial to the tibial tuberosity? Is it on the anterior/medial shaft of the tibia?



7.22 Anterior view of right knee



## Trail 3 “Hills on Both Sides”

### Edges of Femoral Condyles

The two large, round femoral condyles are mostly inaccessible; however, their edges, located on either side of the patella, are easily accessible. The edges of the femoral condyles play an important role in the tracking of the patella when the knee is flexed and extended.

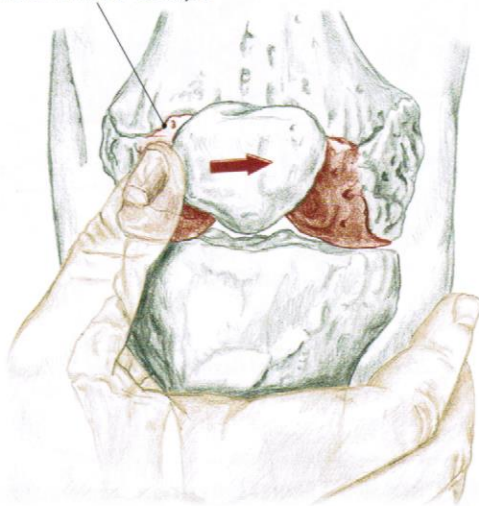


- 1) Partner supine with the knee fully extended. Locate the sides of the patella.
- 2) Shift the patella medially and slide off of it onto the lateral condyle. Explore the condyle’s distinct edge (7.23) and follow it distally as it continues toward the joint space.
- 3) Palpate the edge of the medial condyle in the same manner. Compare the size and height of the two edges and the relationship of both to the patella.



Are the edges slightly underneath the patella? Can you follow them distally toward the joint space of the knee?

Lateral femoral condyle



7.23 Anterior view of right knee

## Epicondyles of the Femur

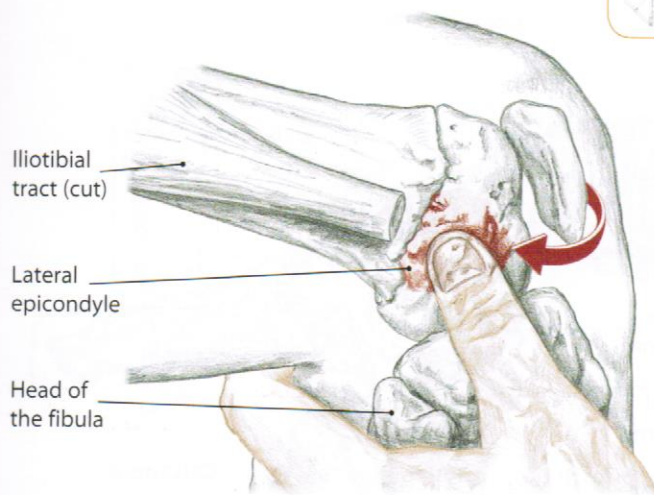
The lateral epicondyle is a bald, knobby area located on the lateral surface of the knee. It serves as an attachment site for the fibular collateral ligament. It is deep to the iliotibial tract and anterior to the biceps femoris tendon.

The medial epicondyle is deep to the tendon of the sartorius, distal to the vastus medialis muscle and serves as an attachment site for the tibial collateral ligament.



- 1) Partner seated with the knee flexed. Locate the patella.
- 2) Slide directly lateral from the patella to the outside of the knee. Explore this region, noting the lateral epicondyle's location proximal to the head of the fibula (7.24).
- 3) Return to the patella and slide to the medial epicondyle on the inside of the knee. Note the epicondyle's superficial quality and round surface, as well as its location superior to the tibiofemoral joint.

*Is the head of the fibula distal to the lateral epicondyle? Can you palpate the vastus medialis (p. 306) proximal to the medial epicondyle?*



7.24 Lateral view of right knee

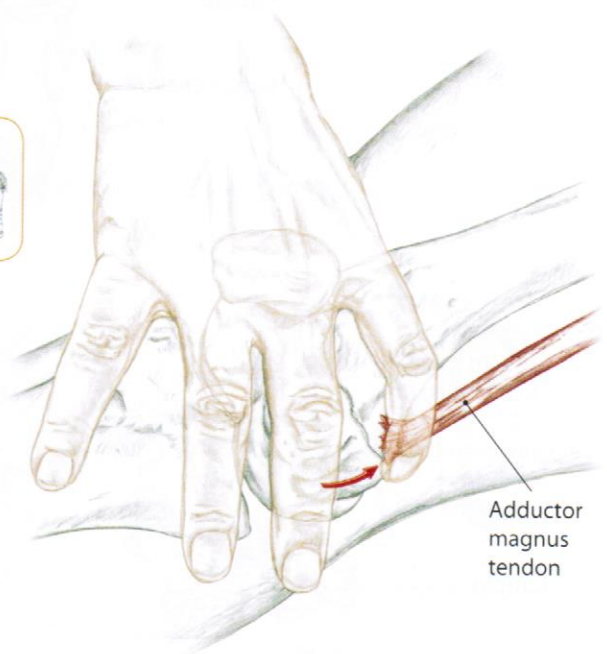
## Adductor Tubercle

The adductor tubercle is located proximal to the medial epicondyle, between the belly of the vastus medialis and the hamstring tendons. Its small tip sticks out from the top of the medial epicondyle and is an attachment site for the adductor magnus tendon (p. 319). It is often tender to the touch.



- 1) Partner seated with the knee flexed. Locate the medial epicondyle of the femur.
- 2) Slide superiorly along the medial side of the femur. As the outline of the femur drops off into the soft tissue, explore for the small point of the tubercle (7.25).
- 3) Strum across the adductor magnus tendon by rubbing your thumbpad anteriorly and posteriorly.

*Are you directly proximal to the medial epicondyle? With your thumb on the proximal aspect of the tubercle (on the adductor magnus tendon), have your partner gently adduct his hip. Does the tendon of the magnus become taut and press into your finger?*



7.25 Anterior/medial view of right knee



# Bones and Bony Landmarks of the Ankle and Foot

The foot contains twenty-six bones (7.9, 7.26–7.30). The hindfoot is the union of the talus and calcaneus. The **talus** articulates with the tibia and fibula to form the talocrural, or ankle, joint. The large, chunky **calcaneus** is the bone at the heel of the foot.

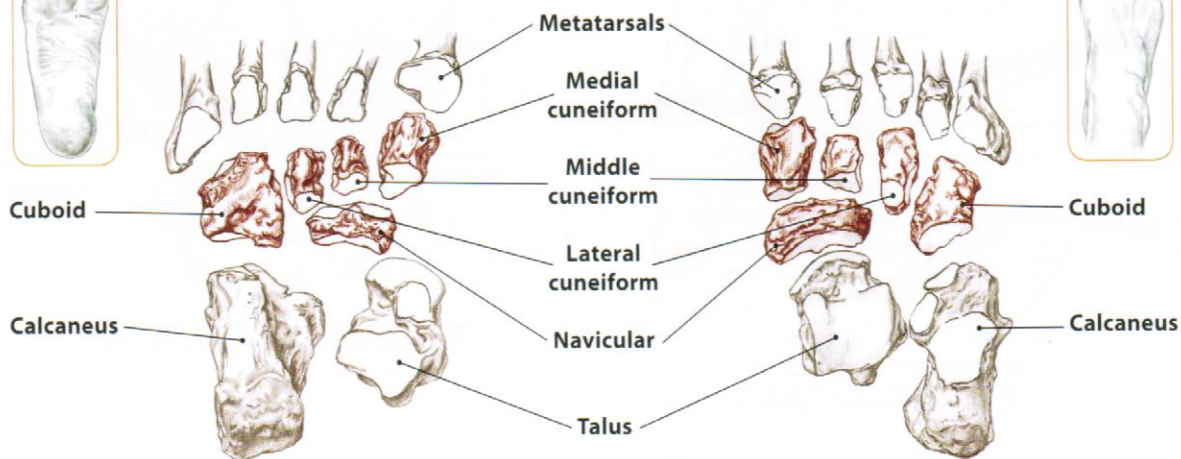
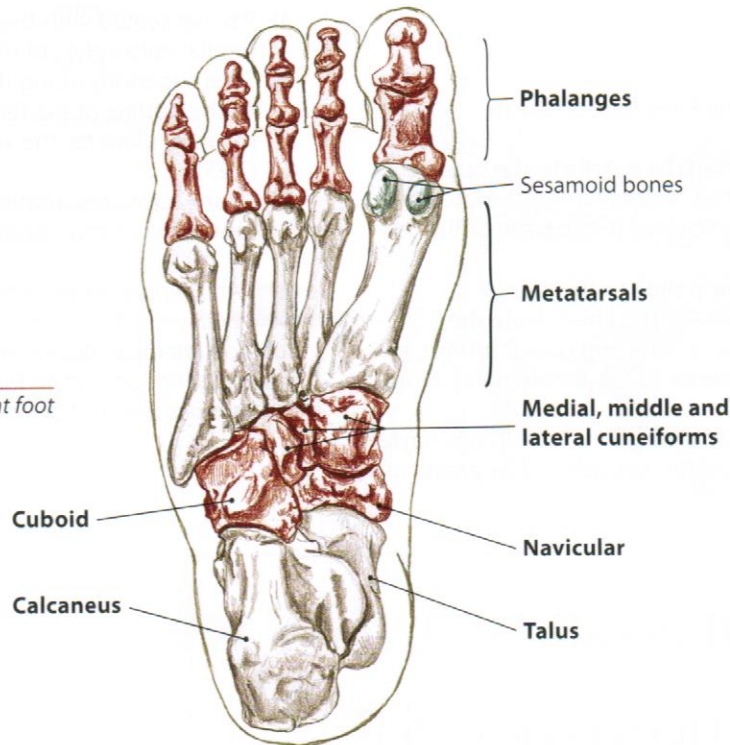
The midfoot is composed of five tarsals. Small and uniquely shaped, like the carpal bones of the wrist, the

**tarsals** are tightly wedged together. They are most accessible along the dorsal surface of the foot.

The forefoot is formed by the long, superficial metatarsals and phalanges. Similar to a metacarpal, each **metatarsal** consists of a proximal base, a shaft and a distal head. The first toe is formed by two sizable **phalanges**; the remaining toes have three phalanges each. The phalanges are accessible on all sides.



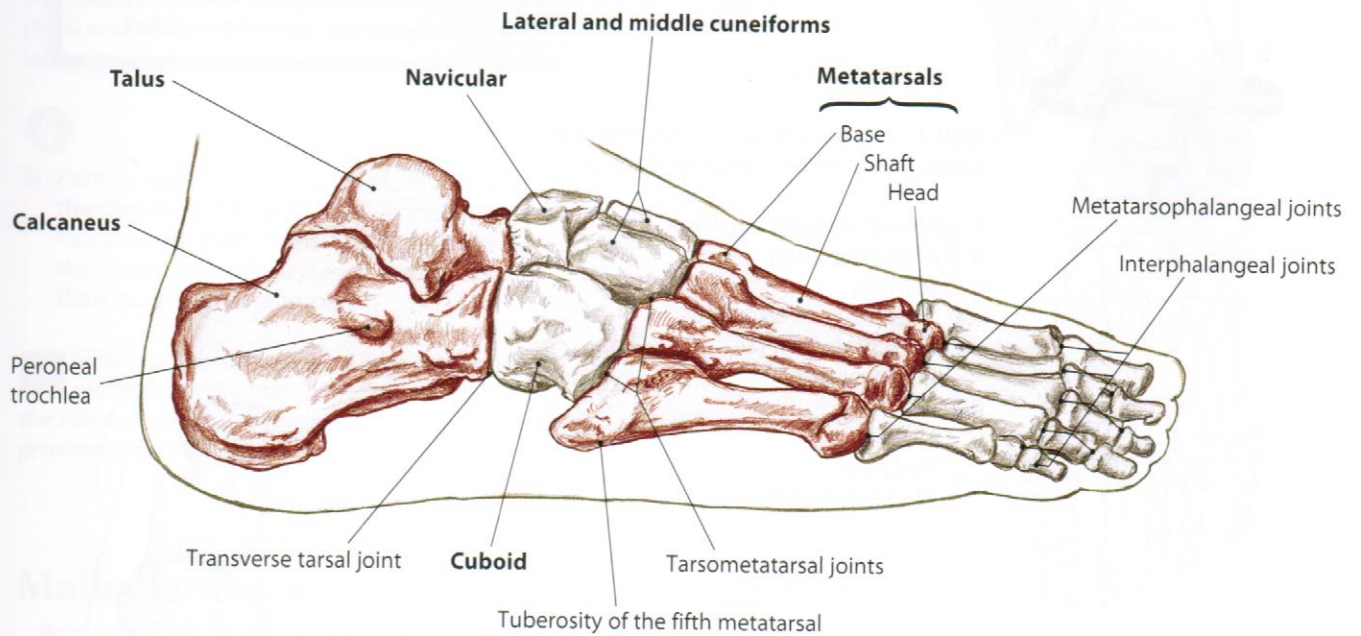
7.26 Plantar view of right foot



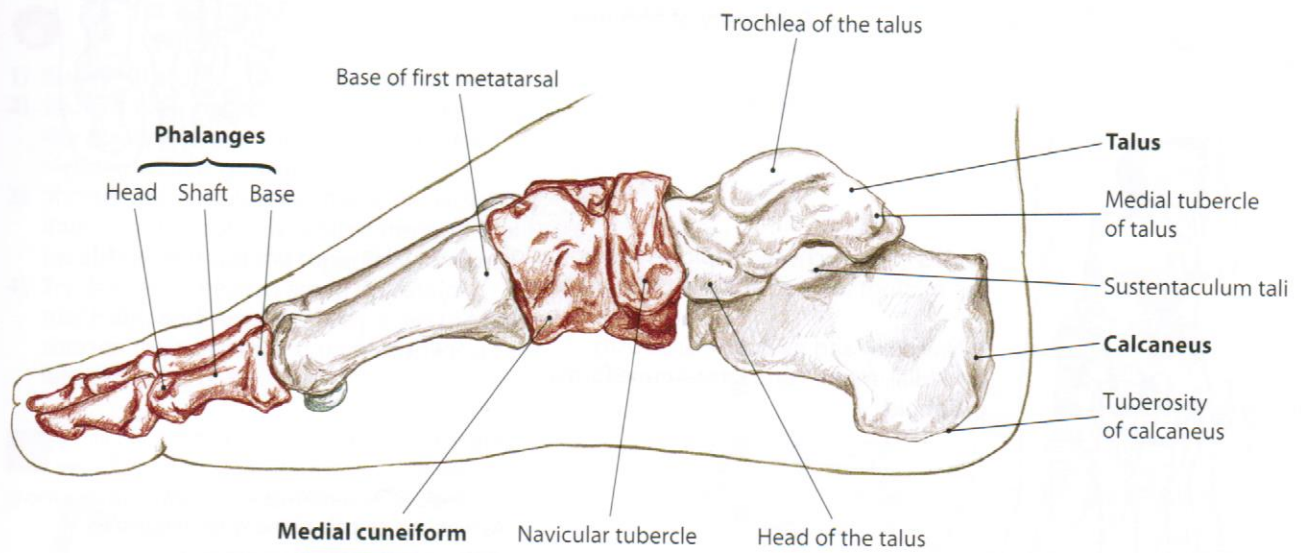
7.27 Plantar view of right foot, bones separated



7.28 Dorsal view of right foot, bones separated



7.29 Lateral view of right foot



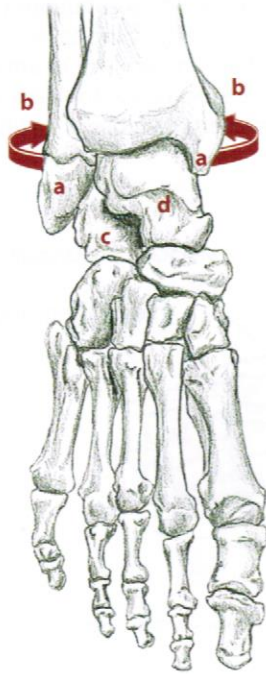
7.30 Medial view of right foot



# Bony Landmark Trails of the Ankle and Foot

Foot

The Bony Landmark Trails of the Foot present the hindfoot and forefoot first, followed by the more challenging structures of the midfoot.

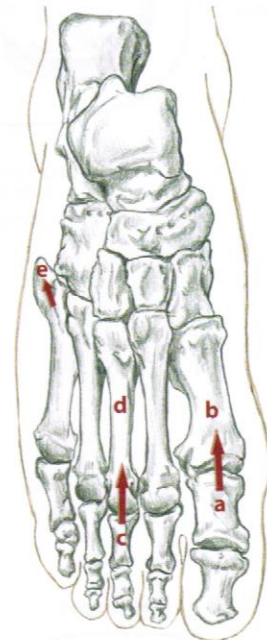


**Trail 1** "The Back Road" locates the bones and landmarks of the hindfoot and ankle.

- a** Lateral and medial malleoli
- b** Malleolar grooves
- c** Calcaneus
  - Tuberosity of calcaneus
  - Sustentaculum tali
  - Peroneal trochlea
- d** Talus
  - Head
  - Trochlea
  - Medial tubercle

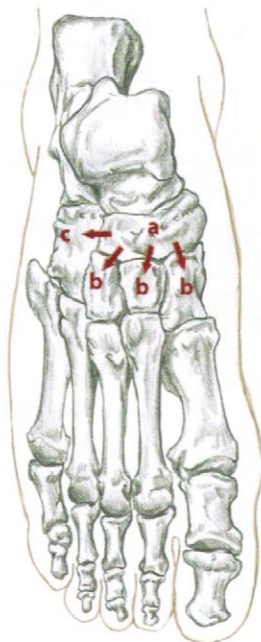
**Trail 2** This route, "Little Piggies," palpates the bones and joints of the toes and forefoot.

- a** Hallucis
- b** First metatarsal
- c** Second through fifth phalanges
- d** Second through fifth metatarsals
- e** Tuberosity of fifth metatarsal



**Trail 3** "The Archway" explores the bones of the midfoot located at the arch of the foot.

- a** Navicular and navicular tuberosity
- b** Medial, middle and lateral cuneiforms
- c** Cuboid



As with the carpals of the wrist, the names of the tarsals speak for themselves:

<i>cuboid</i>	L. cube-shaped
<i>cuneiform</i>	L. wedge-shaped
<i>navicular</i>	L. boat-shaped

Leg & Foot

metatarsal  
phalanges  
tarsal

**met-a-tar-sal**  
**fa-lan-jeez**  
**tar-sul**

Grk. *meta*, after or beyond  
Grk. closely knit row, line of battle  
Grk. wicker basket



## Lateral and Medial Malleoli

The lateral and medial malleoli are the large, conspicuous knobs on either side of the ankle. The broader medial malleolus is located at the distal end of the tibia while the more slender lateral malleolus protrudes from the distal fibula.



- 1) Partner seated or supine. Explore and compare the shapes and sizes of the two malleoli. Palpating all sides of their surfaces, note how the lateral malleolus extends further distally than its medial counterpart (7.31).

*Sliding proximally, can you connect the medial malleolus to the shaft of the tibia and then to the tibial tuberosity? Is the medial malleolus more proximal than the lateral?*



7.31 Palpating the level of each malleolus

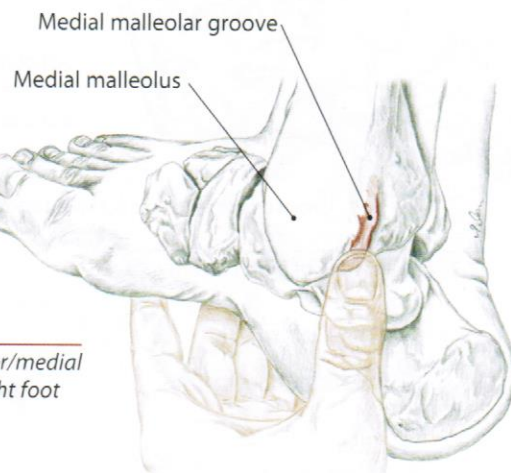
## Malleolar Grooves

Both the medial and lateral malleoli have small vertical grooves carved into their posterior surfaces. These grooves are designed to offer stability and leverage to tendons that bend around the ankle. Because these tendons lie either inside the groove or beside it, it can be difficult to feel the actual depression of the groove.

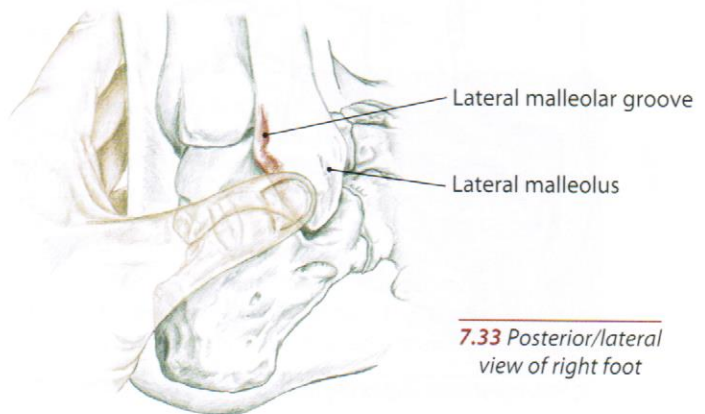


- 1) Supine or seated. Locate the medial malleolus.
- 2) Slide roughly half an inch posteriorly to palpate the posterior aspect of the malleolus for a slender, vertical groove (7.32).
- 3) Shorten the surrounding tissue by passively inverting the foot and explore the length of the medial groove and the superficial tendons.
- 4) Try this same method along the lateral malleolus, only now, passively evert the foot to shorten the surrounding tissue and locate the lateral groove (7.33).

*Since each groove runs vertically, can you roll your finger horizontally across each vertical groove to determine its location and shape?*



7.32 Posterior/medial view of right foot



7.33 Posterior/lateral view of right foot

calcaneus  
malleolus

kal-kay-nee-us  
mal-e-o-lus

L. heel  
L. little hammer

# Calcaneus

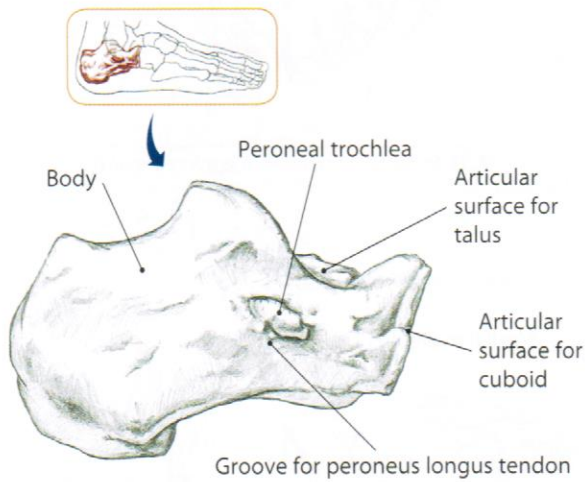
*Tuberosity, Sustentaculum Tali and Peroneal Trochlea*

The large, solid **calcaneus** forms the heel of the foot. It is situated beneath the talus and projects two inches posteriorly from the malleoli. The medial and lateral sides of the calcaneus are deep to tendons, yet easily palpable. The **tuberosity** of the calcaneus is a rounded region located along its posterior surface. The calcaneal tendon attaches to the superior aspect of the tuberosity.

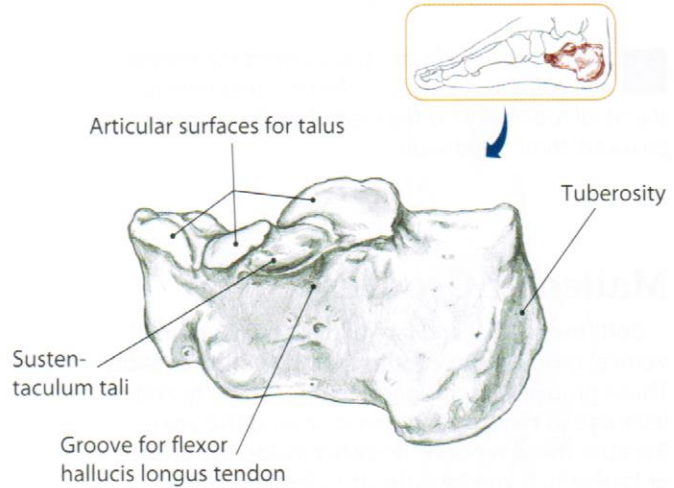
The **sustentaculum tali** is located on the medial side of the calcaneus, roughly one inch distal to the medial malleolus (7.35). Shaped like a plank, the

sustentaculum supports the talus on the calcaneus. It is also an attachment site for the deltoid ligament (p. 401) and is deep to the flexor tendons. Only its small tip is accessible.

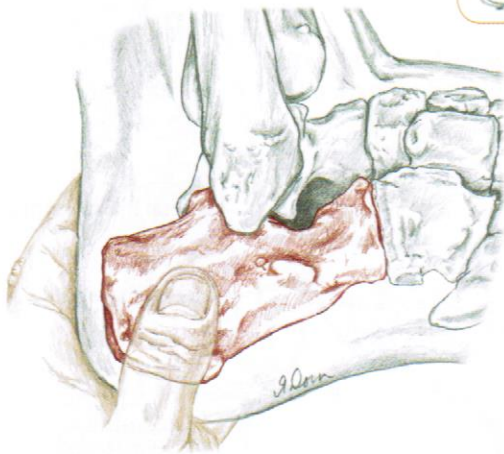
The **peroneal trochlea** is located on the lateral side of the foot (7.34). Roughly an inch distal to the lateral malleolus, the trochlea is a small, superficial prominence that protrudes from the calcaneal surface to help stabilize the peroneal muscles (p. 376).



7.34 Lateral view of right calcaneus




7.35 Medial view of right calcaneus



7.36 Lateral view, exploring the calcaneus

## Tuberosity of calcaneus

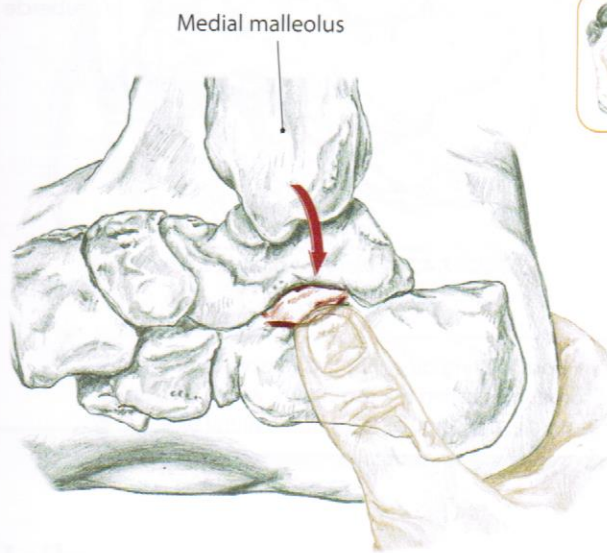
- 1) Partner supine or seated. Walk your fingers distally from the malleoli down to the heel. Palpate and explore the shape and girth of the posterior calcaneus.
- 2) Move to the plantar surface to isolate the tuberosity at the base of the heel (7.36). The tuberosity will feel more like a flat region than a distinct bump.

 Place one hand at the malleoli and the other at the tuberosity. Note how far the calcaneus extends posteriorly.

## Sustentaculum tali

- 1) Supine or seated. Place the ankle in a neutral position and locate the medial malleolus.
- 2) Slide approximately one inch distal to the small tip of the sustentaculum (7.37). Passively inverting the foot will soften the surrounding tissues.
- 3) Sculpt around its sides noting the soft tissues just distal to it.

Are you distal to the medial malleolus? If you slide distally off the sustentaculum tali, do you feel the thick tissues at the sole of the foot?

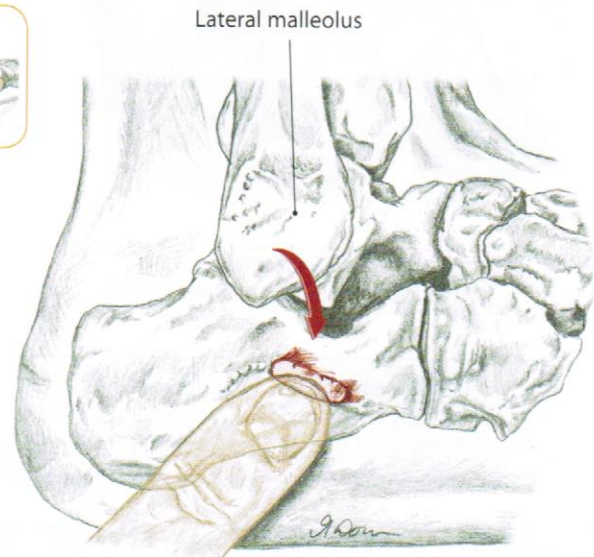


7.37 Medial view of right ankle, locating the sustentaculum tali

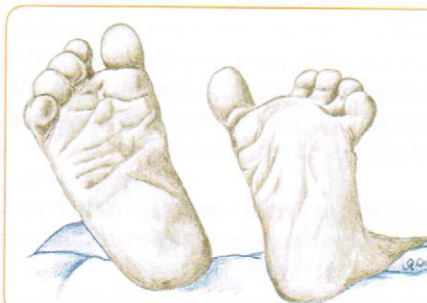
## Peroneal trochlea

- 1) Supine or seated. With the ankle in a dorsiflexed position, locate the lateral malleolus.
- 2) Slide roughly an inch inferiorly and explore for the small, superficial trochlea. It may feel like a short ridge on the surface of the calcaneus (7.38). Passively everting the foot will soften the surrounding tissues.
- 3) Sculpt around its edges, noting the soft tissues just distal to the trochlea.

Are you distal to the lateral malleolus? If you slide off the trochlea distally, do you feel the thick tissues of the foot? Ask your partner to alternately evert and relax her foot. Do the peroneal tendons pass along either side of the trochlea?



7.38 Lateral view of right ankle, isolating the peroneal trochlea



Of the two hundred different kinds of primates in the world, humans are the only ones with a nongrasping first toe. Since we are no longer tree climbers, our foot has lost its handlike capabilities in order to become a platform for an upright body.

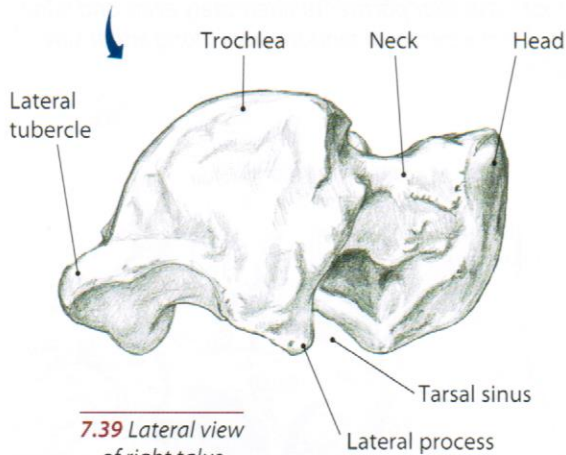
This does not mean, however, that the toes were designed to be inactive. An infant's foot has twenty times the toe-grasping capacity of a shoe-wearing adult. And in shoeless cultures, people retain the prehensile abilities of their feet throughout adulthood, using them for sewing and even threading needles.

# Talus

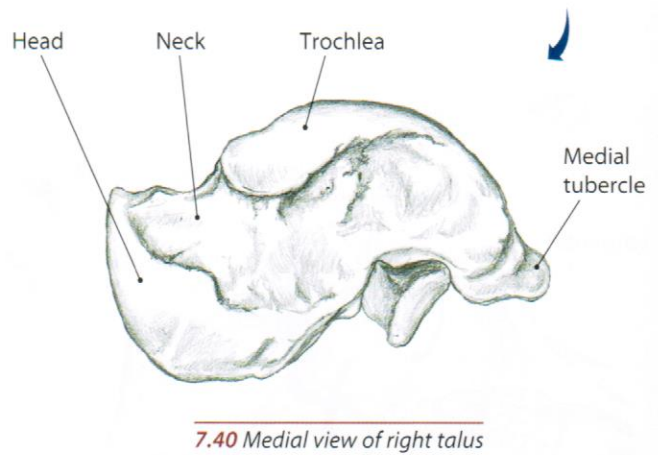
## Head, Trochlea and Medial Tubercle

The **talus** has three accessible landmarks. The **head** is the round, anterior portion that articulates with the navicular (7.39). The medial aspect of the head is accessible posterior to the navicular tubercle (p. 365). The **trochlea**, the large, superior prominence of the body of

the talus, is wedged between the distal ends of the fibula and tibia (7.40). The anterior part of the trochlea is located between the malleoli. Finally, the small **medial tubercle** of the talus is posterior to the medial malleolus and serves as an attachment site for the deltoid ligament (p. 401).



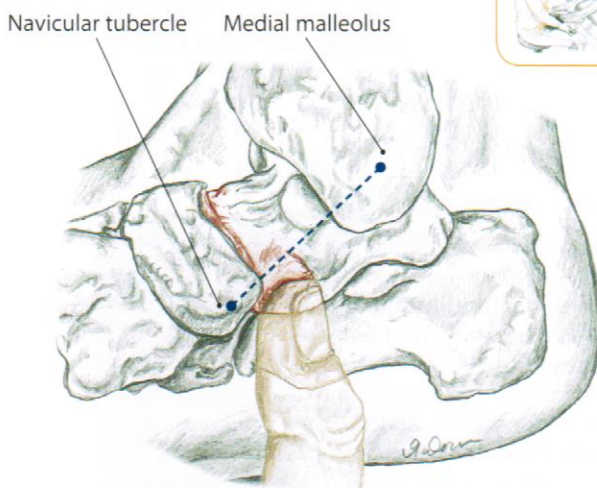
7.39 Lateral view of right talus



7.40 Medial view of right talus

The calcaneus, talus and cuboid bones are all roughly cube-shaped. The soldiers of ancient Rome used these bones (probably from horses) to

carve out playing dice. For this reason, the talus is sometimes called the astragalus, which in Latin means *die*, the singular form of the plural *dice*.



7.41 Medial view of right ankle, drawing a line between the navicular tubercle and medial malleolus to access the head of the talus

### Head of the talus

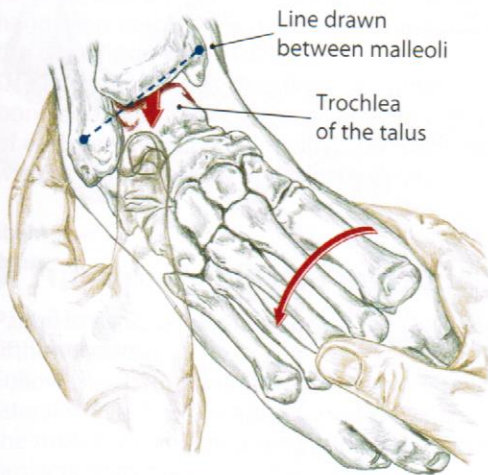
- 1) Partner supine or seated, with the ankle in a neutral position. Locate the navicular tubercle (p. 365).
- 2) Slide proximally off the tubercle to the head of the talus. The head may feel like a depression in comparison to the tubercle.
- 3) Passively invert and evert the foot to distinguish clearly between these two landmarks. When the foot is inverted, the navicular tubercle will become more prominent; when the foot is everted, the talar head will be more pronounced.

✓ If you draw a line between the medial malleolus and navicular tubercle, the head of the talus will be located along that line (7.41).

## Trochlea of the talus

- 1) Partner supine. Passively invert and plantar flex the foot.
- 2) Draw a horizontal line connecting the malleoli and drop inferiorly off the center of the line, looking for a bony prominence. The trochlea will be deep to the overlying tendons and more prominent near the lateral malleolus (7.42).

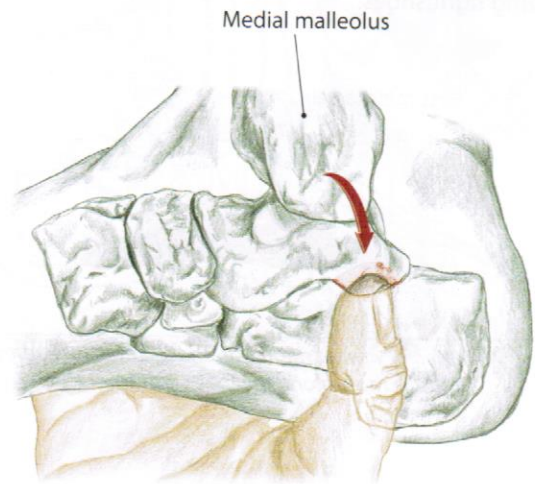
✓ *Is the tissue you are palpating hard and immovable like bone, or firm and mobile like tendon? If you passively move the foot back to neutral, does the bony mound you are palpating seem to disappear into the ankle?*



7.42 Dorsal/lateral view of right foot, with foot inverted and plantar flexed

## Medial tubercle

- 1) Partner supine. Locate the medial malleolus. Instead of sliding straight distally for the sustentaculum tali (7.37), slide posteriorly just off the malleolus at a 45° angle to locate the medial tubercle (7.43).
- 2) Passively dorsiflex and plantar flex the ankle, noting how the tubercle seems to slide around the malleolus.



7.43 Medial view of right foot, contacting the medial tubercle

## Hallucis

The hallucis (big toe) is composed of two phalanges. The joint between the phalanges, the interphalangeal, is a hinge joint wrapped in supportive ligaments. The first metatarsophalangeal joint is located at the ball of the foot. It is an ellipsoid joint with a large, bulbous shape.

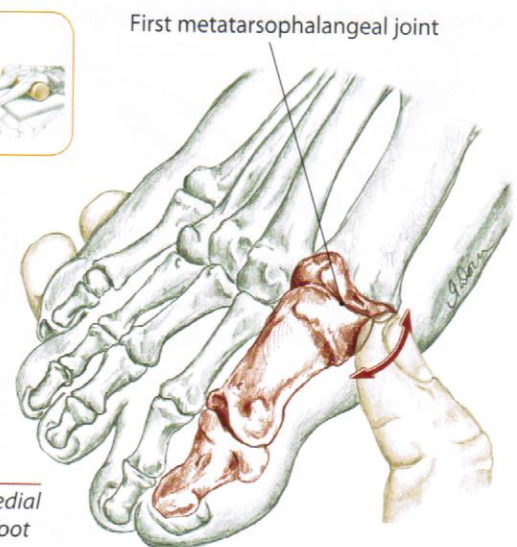


- 1) Partner seated or supine. Palpate the entire surface of the first toe, noting the differences in thickness and texture between its dorsal and plantar surfaces (7.44).
- 2) Explore the surface of each joint by passively moving it through its range of motion.

✓ *Is the proximal phalanx nearly twice as long as its distal counterpart?*



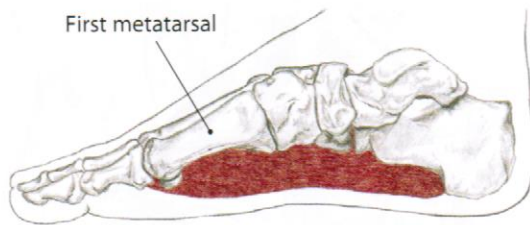
## Trail 2 “Little Piggies”



7.44 Dorsal/medial view of right foot

## First Metatarsal

Unlike the long, slender metatarsals of toes two through five, the first metatarsal is short and stocky. Its dorsal and medial sides are superficial and easily accessible; its plantar surface is deep to several thick muscles (7.45). The proximal end of the first metatarsal flares to articulate with the medial cuneiform. This articulation often forms a visible crest on the top of the foot that can be irritated by wearing tight shoes.



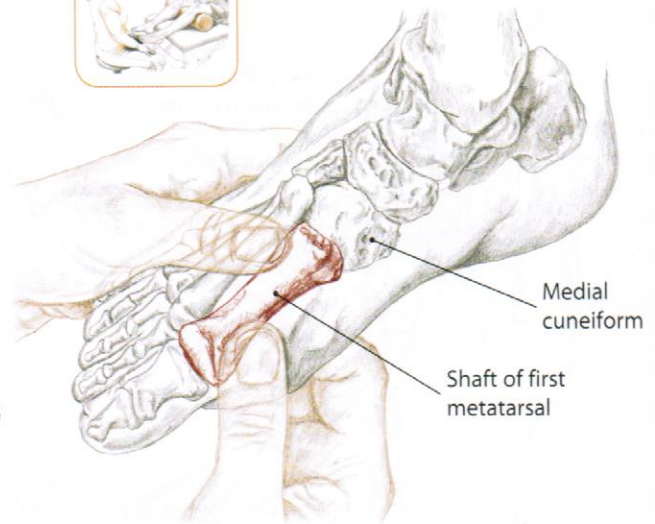
7.45 Medial view of right foot, shaded area indicating muscle mass along the foot's plantar surface



- 1) Partner seated or supine. Locate the metatarsal shaft along the medial side of the foot.
- 2) Explore the shaft's size and length by sliding across its entire surface. Palpate the junction and crest at the metatarsal head and medial cuneiform (7.46).



Are the head and base broader than the shaft of the metatarsal? Can you feel the cylindrical shape of the shaft?



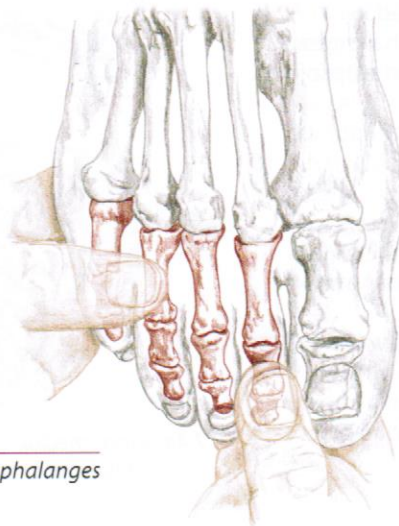
7.46 Dorsal/medial view of right foot

## Phalanges

Unlike the hallux, the second through fifth toes contain three phalanges each. In each toe there are two articulations, the proximal interphalangeal (or "pip" joint) and the distal interphalangeal (or "dip" joint).



- 1) Seated or supine. Palpate along all surfaces of the toes, noting the thin tissue along their inner sides. Explore one toe at a time, slowly moving each one through its range of motion (7.47).

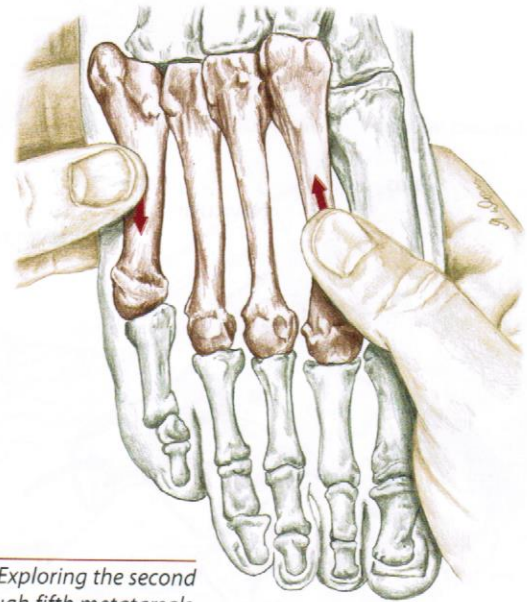


7.47 Exploring the phalanges

## Second through Fifth Metatarsals

Each of the long, slender bones of the second through fifth metatarsals has an enlarged base and head. The bases are set close together in articulation with the tarsals. The spaces between the metatarsals are filled with the small intrinsic muscles of the toes and are easily palpated on the dorsal surface of the foot.

The tuberosity of the fifth metatarsal is a superficial knob that extends laterally off the base of the metatarsal and is the attachment site for the peroneus brevis (p. 376).



7.48 Exploring the second through fifth metatarsals

### Metatarsals

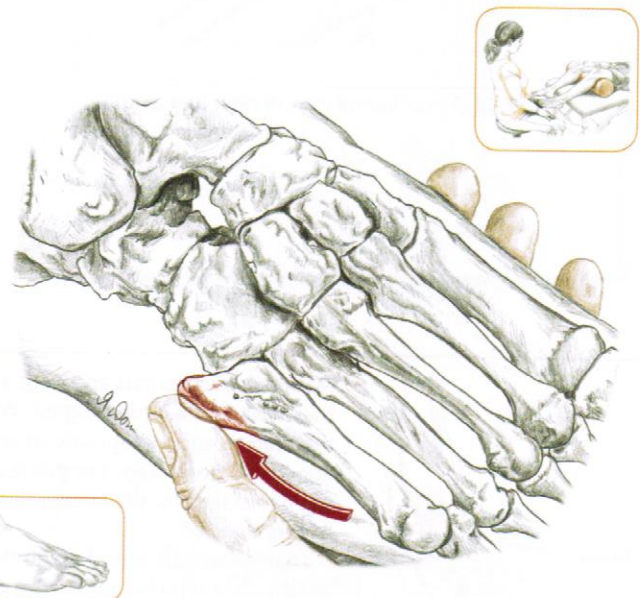
- 1) Partner seated or supine. Grasp the foot with both hands and palpate the head of each metatarsal on the dorsal side of the foot.
- 2) Use both thumb tips to explore the length of each bone and its surrounding spaces. Follow the shaft of each metatarsal proximally (7.48). Note how it widens to form the base of the metatarsal.

### Tuberosity of fifth metatarsal

- 1) Partner seated or supine. Locate the shaft of the fifth metatarsal.
- 2) Follow the shaft proximally to where the base bulges laterally (7.49). Explore the superficial shape of the tuberosity and its surrounding landmarks as it projects from the side of the foot.

✓ *When the ankle is dorsiflexed, are you roughly two inches distal (anterior) to the lateral malleolus? Is the tip you are palpating connected to the fifth metatarsal?*

While strapping on shoes has certainly protected our feet and reduced the number of sprained ankles, it has also wreaked havoc on our arches. With the external support of shoes, our arches no longer need to adapt to varying terrain, and so the normally supportive musculature weakens. Eventually, the arch on the medial side of the foot collapses, resulting in a condition commonly known as "flat foot."



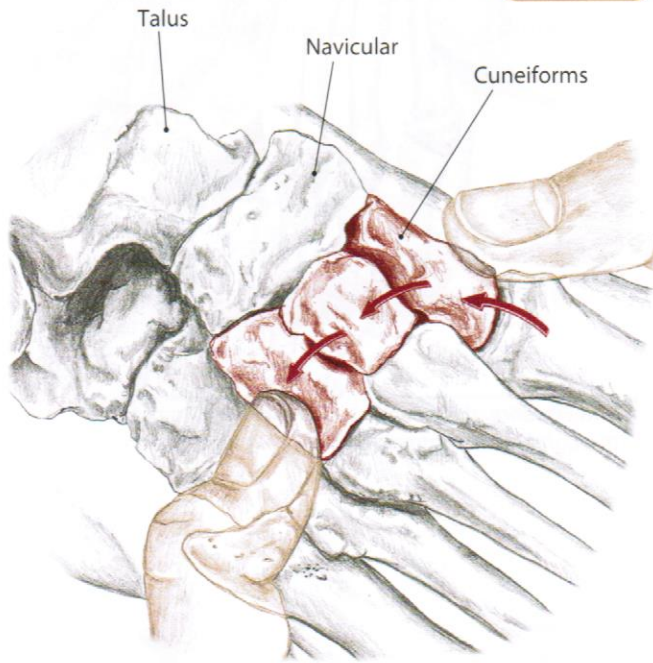
7.49 Dorsal/lateral view of right foot, accessing the tuberosity of the fifth metatarsal



# Trail 3 “The Archway”

## Medial, Middle and Lateral Cuneiforms


The three cuneiforms lie in a row between the navicular and metatarsals. The medial cuneiform serves as an attachment for the tibialis anterior and tibialis posterior muscles. It can be isolated along its dorsal and medial surfaces. The middle and lateral cuneiforms, sandwiched between the medial cuneiform and the cuboid, are accessible on their dorsal surfaces.




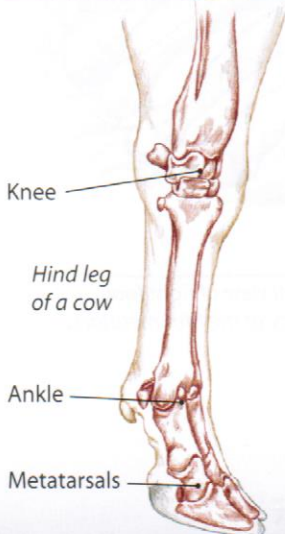
7.50 Dorsal/lateral view of right foot



- 1) Partner seated or supine. Locate the base of the first metatarsal.
- 2) Glide proximally to the skinny ditch of the first tarsometatarsal joint. Continue proximally onto the surface of the medial cuneiform.
- 3) Slide laterally from the medial cuneiform along the dorsal surface of the foot and explore the surfaces of the middle and lateral cuneiforms (7.50).

 Are you proximal to the base of the first metatarsal and can you isolate the joint between these two bones? If you follow the tibialis anterior tendon, does it lead to the same location at which you were palpating the medial cuneiform?

 The tibialis anterior tendon (p. 378) runs superficially down the dorsal surface of the ankle and leads directly to the medial side of the medial cuneiform. Have your partner dorsiflex his foot and follow the tendon distally as it blends into the medial cuneiform.



Hind leg of a cow

Mammals such as cats and dogs are called digitigrades, meaning they walk on their toes (digits). When digitigrades are standing, their tarsals and metatarsals are off the ground, forming what appears to be the leg. For this reason, the ankle of a dog or cat is often mistaken for the knee, while the actual knee appears to be hyperextended.

Digitigrades are raised up on their toes this way for additional height. The extra height enhances sensory perception and increases stride length.

Hoofed animals, call unguligrades, go a step further than digitigrades in lifting themselves up on all their phalanges except the distal one. With this wide, four-point stance, these animals literally walk on the tips of their toes all the time.

Walking “tippy-toe” will quickly tell you that neither of these designs work for humans. We are plantigrades, meaning we walk on the soles of our feet. As we are also bipeds, we must spread our feet out, pressing all of our foot bones firmly on the ground in order to keep our balance.



Knee

Hind leg of a dog

Ankle

Metatarsals

## Navicular

The bean-shaped navicular is sandwiched between the medial and middle cuneiforms and the talus. Its dorsal and medial surfaces are superficial and palpable. The superficial tuberosity bulges out of the medial side of the foot and is an attachment site for the tibialis posterior muscle (p. 381) and the spring ligament (p. 401).



- 1) Partner seated or supine. Locate the base of the first metatarsal.
- 2) Sliding along the foot's medial side, move proximally across the surface of the medial cuneiform and the slender joint between the medial cuneiform and the navicular.
- 3) As you move onto the surface of the navicular, explore the shape and size of the navicular tuberosity (7.51). The tuberosity will lie approximately one to two inches distal to the medial malleolus.

**✓** Does the bone you are palpating project more medially than the surfaces of the other bones on the medial foot? If you place a finger on the tuberosity of the fifth metatarsal and the navicular tuberosity simultaneously, does the metatarsal tuberosity lie slightly distal to the navicular tuberosity? (See box to the right.)

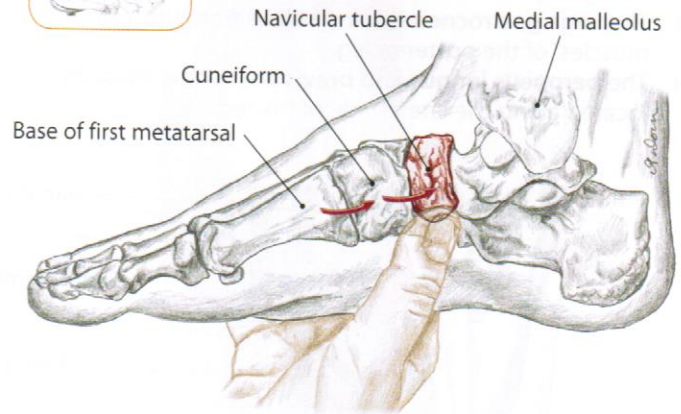
## Cuboid

As the translation of its name suggests, the cuboid is cube-shaped. It is surrounded on three of its four sides by the fourth and fifth metatarsals, the lateral cuneiform and the calcaneus. The cuboid's dorsal surface is partially covered by the belly of the extensor digitorum brevis (p. 387). Because of its cramped location and the covering of the brevis, the cuboid is only partially accessible.



- 1) Partner seated or supine. Draw an imaginary line from the tuberosity of the fifth metatarsal to the lateral malleolus.
- 2) Following this line, the cuboid is roughly half an inch from the tuberosity (7.52).

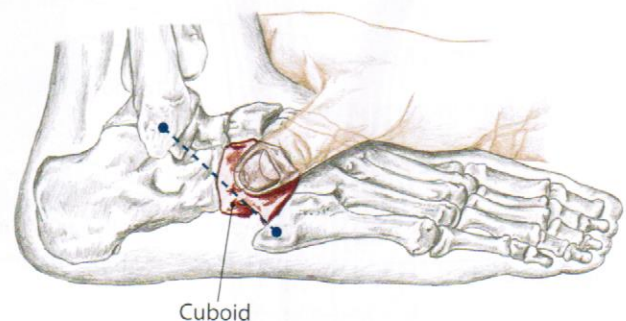
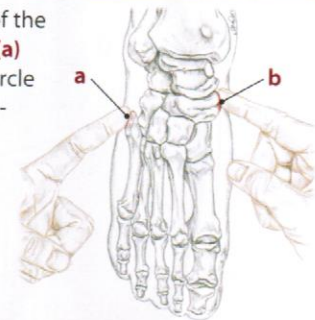
**✓** Are you proximal to the tuberosity of the fifth metatarsal? With the foot dorsiflexed, are you roughly an inch dorsal/distal to the lateral malleolus?



7.51 Medial view of right foot



The tuberosity of the fifth metatarsal (a) and the navicular tubercle (b) can be helpful landmarks. Palpate both structures and notice how the tuberosity of the fifth metatarsal is further distal than the navicular.



7.52 Lateral view of right foot, drawing a line between the lateral malleolus and tuberosity of fifth metatarsal to access the cuboid

navicular  
cuboid

na-**vik**-u-lar  
ku-boyd

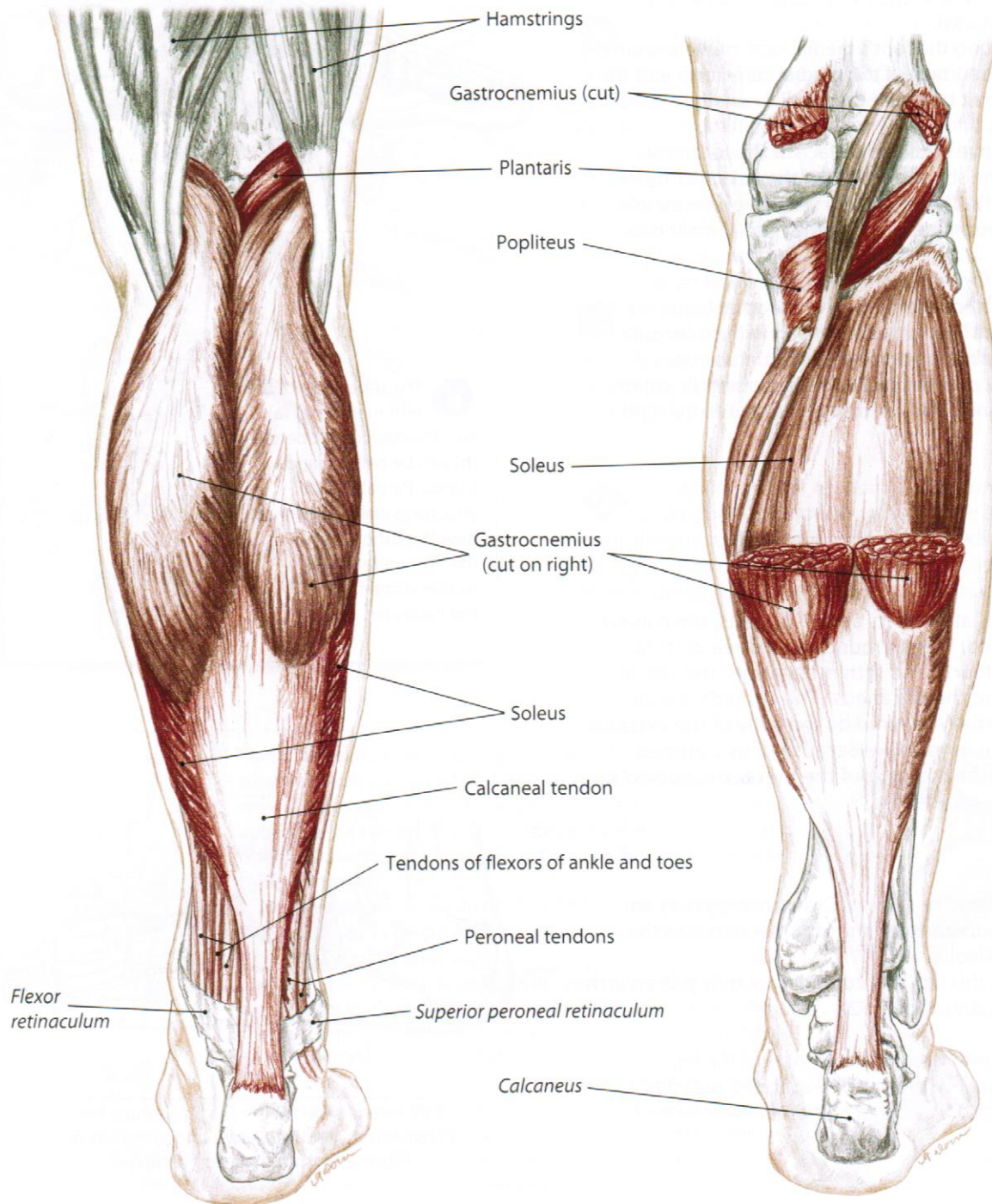
L. boat-shaped  
Grk. cube-shaped

## Muscles of the Leg and Foot

Like the forearm and hand, the leg and foot feature numerous muscles. Most are directly or partially accessible, and their names reveal a great deal about their actions. Most of the muscles of the leg can be divided into four groups:

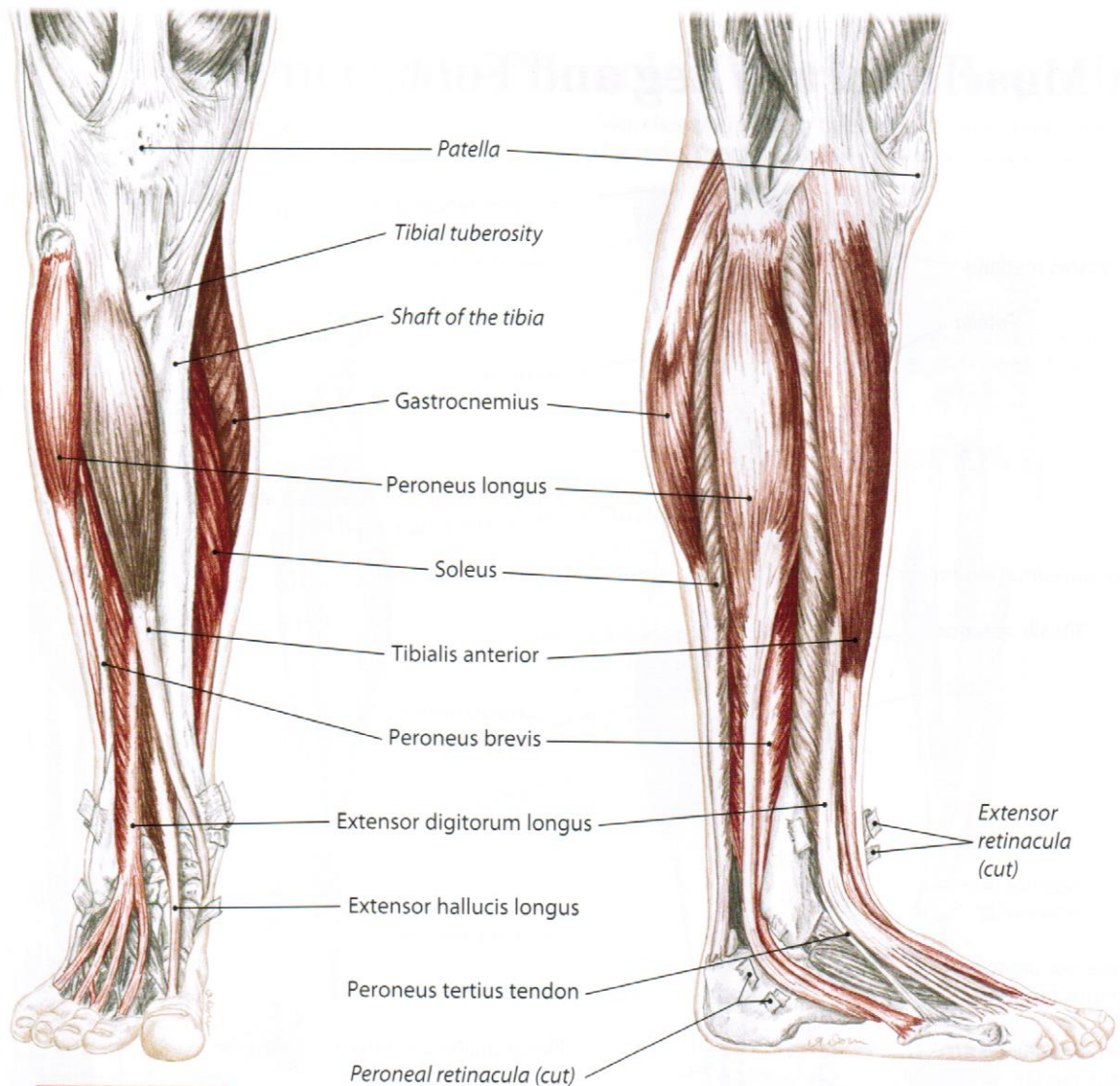
- a) The large **gastrocnemius** and **soleus** form the "calf muscles" of the posterior leg.
- b) The **peroneus longus and brevis** are slender muscles located along the lateral side of the leg.

- c) The **extensors** of the ankle and toes (tibialis anterior, extensor digitorum longus and extensor hallucis longus) are layered together on the anterior leg and the dorsum of the foot.
- d) The small **flexors** of the ankle and toes include tibialis posterior, flexor digitorum longus and flexor hallucis longus. They are deep to the gastrocnemius and soleus on the posterior leg.



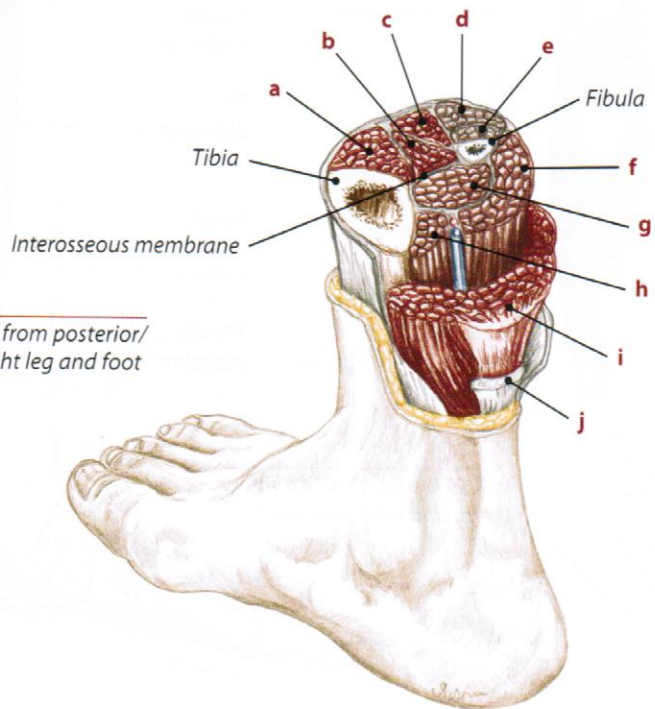
7.53 Posterior view of right leg showing superficial muscles

7.54 Posterior view of right leg showing deeper muscles



7.55 Anterior view of right leg and foot

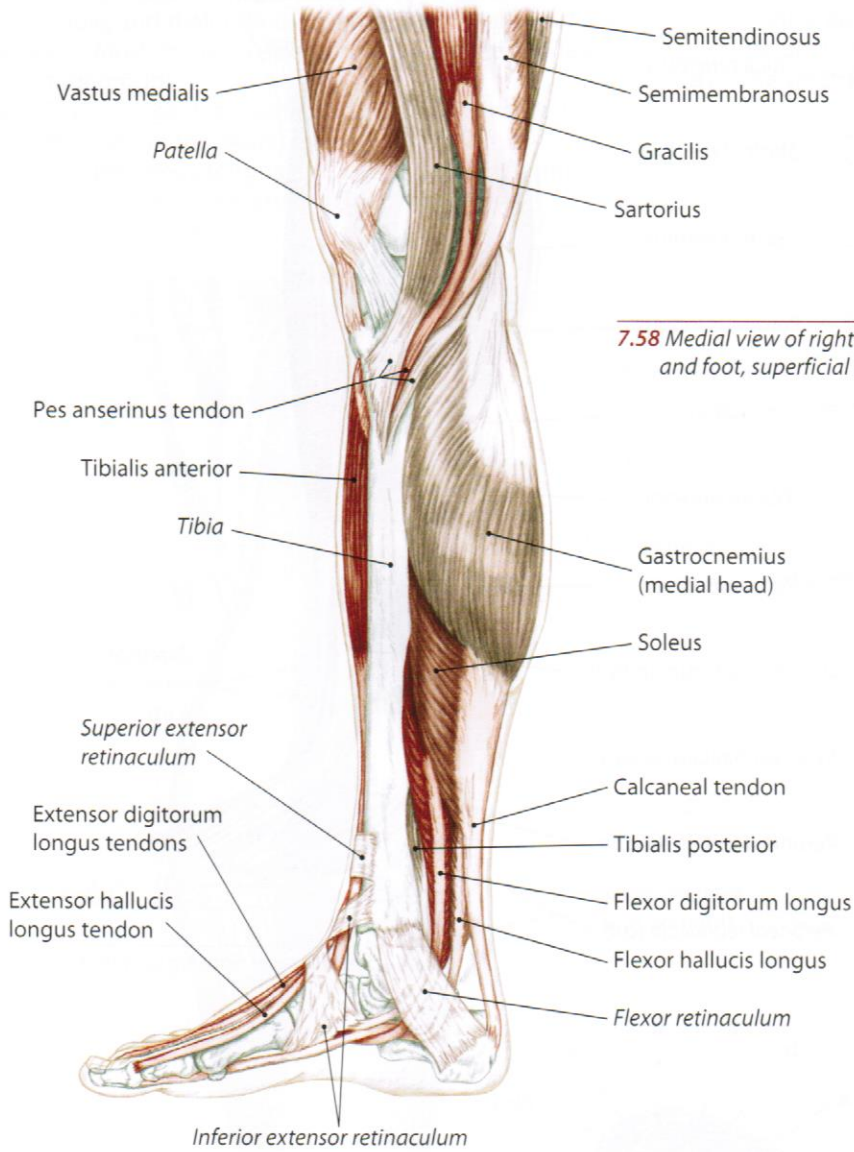
7.56 Lateral view of right leg and foot



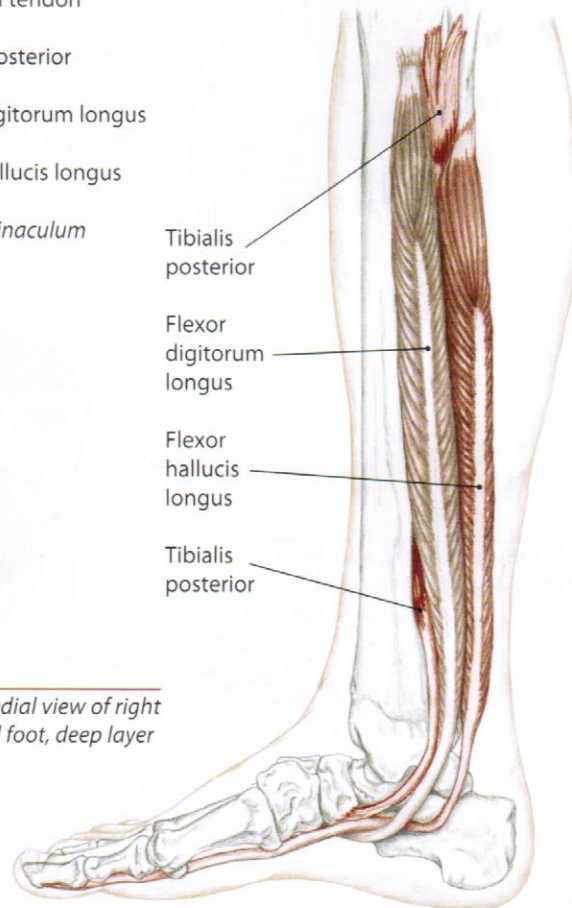
7.57 Cross section from posterior/medial view of right leg and foot

- a) Tibialis anterior
- b) Extensor hallucis longus
- c) Extensor digitorum longus
- d) Peroneus longus
- e) Peroneus brevis
- f) Flexor hallucis longus
- g) Tibialis posterior
- h) Flexor digitorum longus
- i) Soleus
- j) Calcaneal tendon

# Muscles of the Leg and Foot



7.58 Medial view of right knee, leg and foot, superficial layer



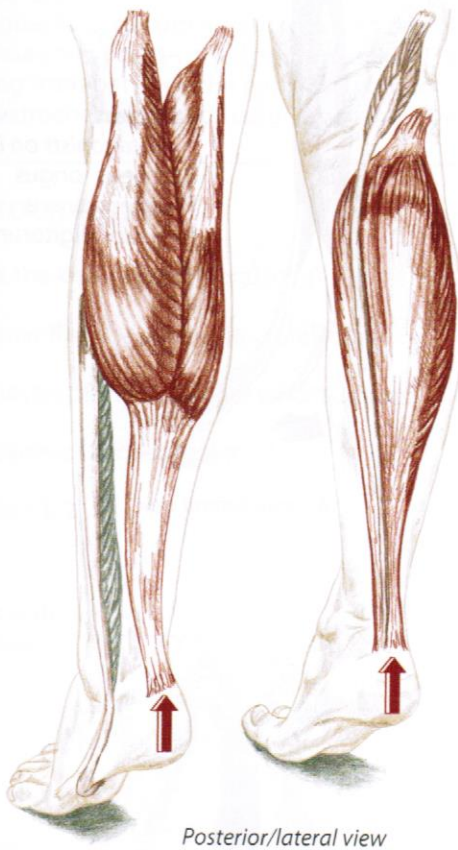
7.59 Medial view of right leg and foot, deep layer

# ☉ Synergists—Muscles Working Together

Muscles are listed in the order of their ability to create the movement. Asterisk indicates muscles not shown.

## Ankle

(talocrural joint)



Posterior/lateral view

### Plantar Flexion

(antagonists on dorsiflexion)

- Gastrocnemius
- Soleus
- Tibialis posterior
- Peroneus longus (assists)
- Peroneus brevis (assists)
- Flexor digitorum longus (weak)
- Flexor hallucis longus (weak)
- Plantaris (weak)

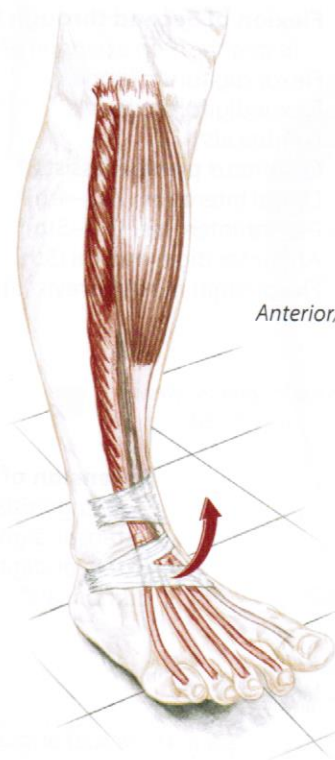
Posterior view



### Dorsiflexion

(antagonists on plantar flexion)

- Tibialis anterior
- Extensor digitorum longus
- Extensor hallucis longus



Anterior/lateral view

# Foot and Toes

(talotarsal, midtarsal, tarsometatarsal, metatarsophalangeal, proximal and distal interphalangeal joints)



## Inversion

(antagonists on eversion)

- Tibialis anterior
- Tibialis posterior
- Flexor digitorum longus
- Flexor hallucis longus
- Extensor hallucis longus

Posterior view



Anterior view



## Eversion

(antagonists on inversion)

- Peroneus longus
- Peroneus brevis
- Extensor digitorum longus

Anterior/lateral view

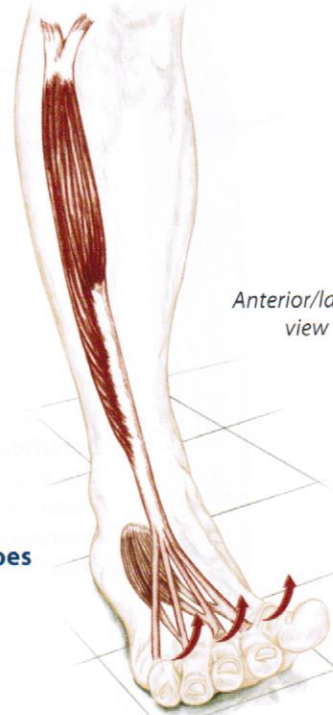


Posterior/plantar view,  
toes flexed

## Flexion of Second through Fifth Toes

(antagonists on extension of toes)

- Flexor digitorum longus
- Flexor digitorum brevis
- Lumbricals\*
- Quadratus plantae (assists)\*
- Dorsal interossei (2nd–4th)\*
- Plantar interossei (3rd–5th)\*
- Abductor digiti minimi (5th)
- Flexor digiti minimi brevis (5th)\*



Anterior/lateral  
view

## Extension of Second through Fifth Toes

(antagonists on flexion of toes)

- Extensor digitorum longus
- Extensor digitorum brevis (2nd–4th)
- Lumbricals\*

See p. 411 for a list of muscles performing flexion, extension, abduction and adduction of the toes.

# Gastrocnemius and Soleus DVD

The large muscle mass of the posterior leg is composed of the gastrocnemius and the soleus muscles. Together they form what is known as the “triceps surae” that attaches to the strong calcaneal (Achilles) tendon. Both the gastrocnemius and soleus are easily accessible.

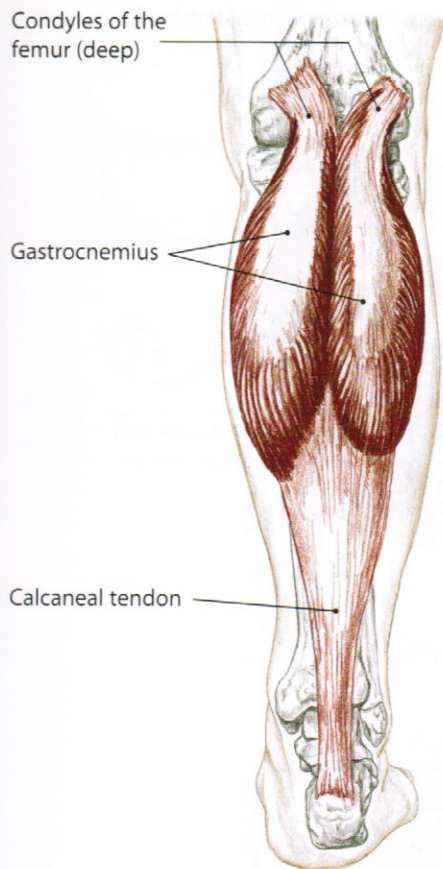
The superficial **gastrocnemius** has two heads and crosses two joints—the knee and ankle (7.60). Emerging from between the hamstring tendons, the short gastrocnemius’ heads extend halfway down

the leg before blending into the calcaneal tendon. Although its name (Greek for “belly of the leg”) suggests that the gastrocnemius is rotund, it is actually quite thin when compared to the thick soleus.

The **soleus** is deep to the gastrocnemius, yet its medial and lateral fibers bulge from the sides of the leg and extend further distal than the gastrocnemius’ heads (7.62). The soleus is sometimes called the “second heart” because of the important role its strong contractions play in returning blood from the leg to the heart.

## Gastrocnemius

- A** Flex the knee (tibiofemoral joint)
- P** **Plantar flex** the ankle (talocrural joint)
- O** Condyles of the femur, posterior surfaces
- I** Calcaneus via calcaneal tendon
- N** Tibial S1, 2



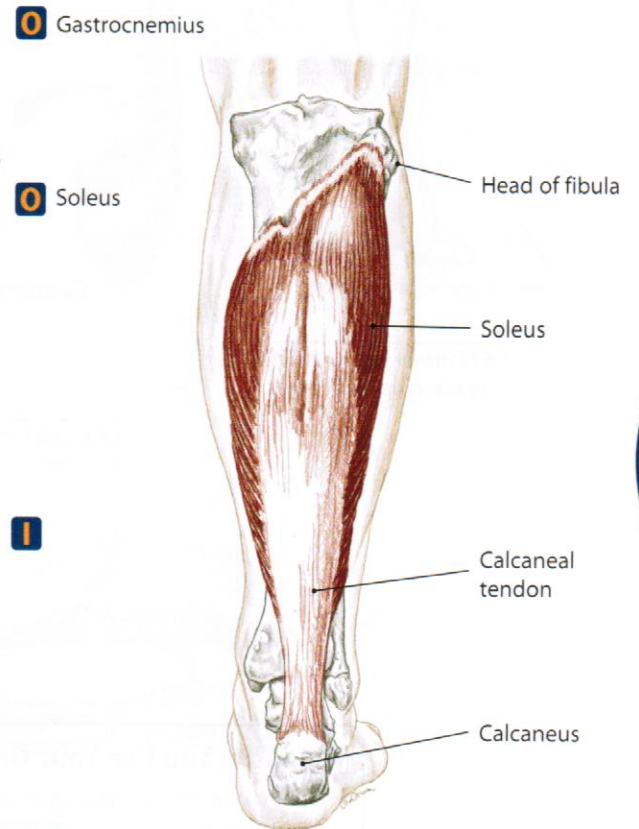
7.60 Posterior view of right leg



7.61 Posterior view of right leg with foot plantar flexed, showing origins and insertions

## Soleus

- A** **Plantar flex** the ankle (talocrural joint)
- O** Soleal line; proximal, posterior surface of tibia and posterior aspect of head of fibula
- I** Calcaneus via calcaneal tendon
- N** Tibial L5, S1, 2



7.62 Posterior view of right leg, with gastrocnemius removed

gastrocnemius  
soleus

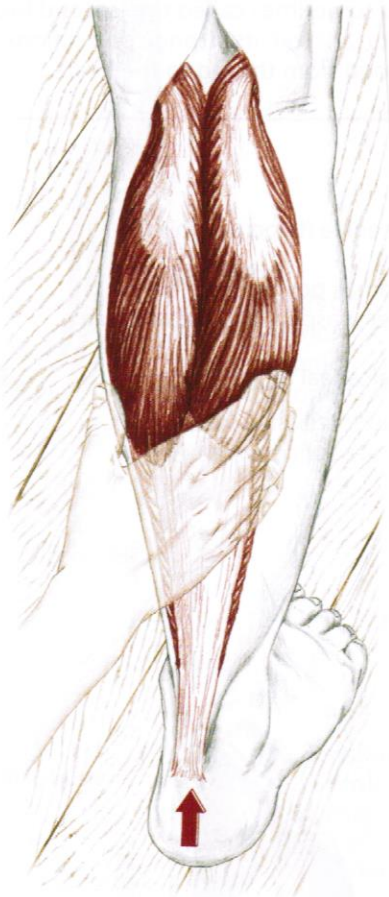
**gas**-trok-**ne**-me-us  
so-**lay**-us

Grk. *gaster*, stomach + *kneme*, leg  
L. *solea*, as in a sole fish (right)



Why was the calcaneal tendon originally called the Achilles' tendon? As a baby, the Greek mythological warrior Achilles was dipped in the River Styx by his mother to make him invulnerable. He was completely immersed except for

the ankle by which she held him. After fighting in the Trojan War, Achilles was mortally wounded when an arrow penetrated his heel. Hence, "Achilles' heel" refers to a small but fatal weakness.




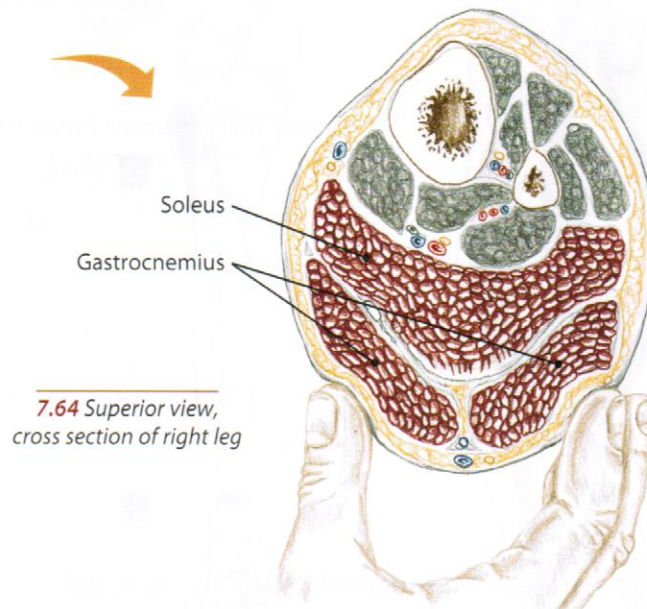
7.63 Partner raising her heel to stand up on her toes



## Gastroc and soleus—standing #1

- 1) Ask your partner, supported by a chair, to stand on her toes.
- 2) Palpate the posterior leg, sculpting out the gastrocnemius' oval heads. Follow both heads proximally to the back of the knee. Then follow them distally, noting how the medial head extends further distal than the lateral head (7.63).
- 3) Move distal to the gastrocnemius and palpate the distal portion of the soleus (7.64). Also explore the medial and lateral sides of the soleus that bulge out from the gastrocnemius.
- 4) Follow both muscles distally as they blend into the calcaneal tendon.

 Can you follow the gastrocnemius' heads proximally between the hamstring tendons? Is the medial gastrocnemius' head slightly longer than the lateral? Can you feel the difference in texture between the fleshy muscle bellies and the tough, dense calcaneal tendon?



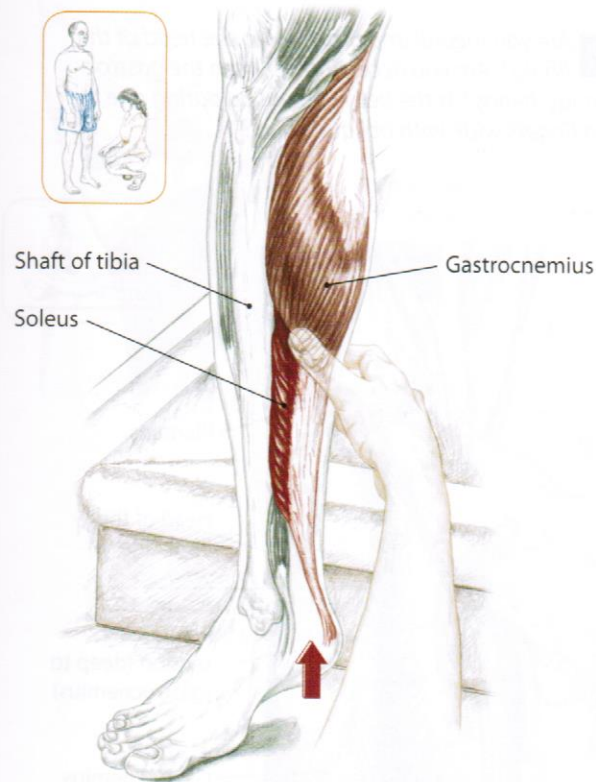
7.64 Superior view, cross section of right leg

### When Do You Use Your Gastrocnemius and Soleus?

- Peeking over a fence (standing on your toes)
- Walking, running, climbing—virtually all forms of ambulation
- Carrying a heavy backpack up a steep hill (plantar flexion with strength and balance)
- Pedaling your bike up the grueling hairpin turns of L'Alpe d'Huez in France

## ◆ Gastroc and soleus—standing #2

- 1) Although these muscles are located on the posterior leg, they are also accessible from an *anterior* direction. With your partner standing on her toes, locate the tibial shaft.
- 2) Slide medially off the shaft of the tibia and feel the wad of muscle that bulges along the medial side of the leg (7.65). This tissue is the triceps surae.
- 3) Ask your partner to lie supine and, with the tissue relaxed, note how your thumb can sink around the medial edge of the tibial shaft to specifically locate the soleus.

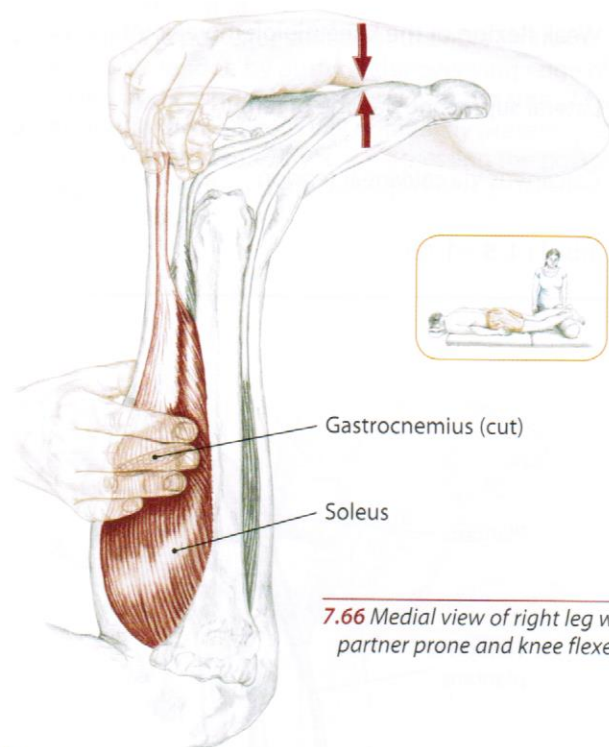


7.65 Anterior/medial view of right leg with partner raising her heel

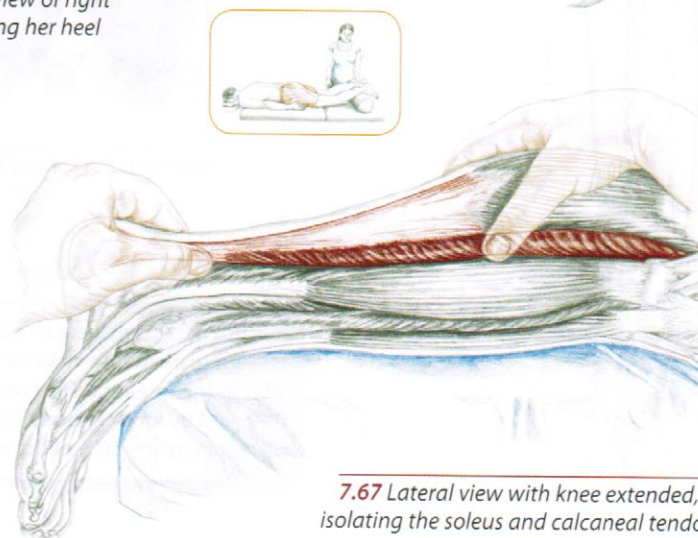
## ● Gastroc and soleus—prone

- 1) Partner prone. Bend the knee to 90° and investigate the soft, massive bellies of the gastrocnemius and soleus and the thick calcaneal tendon.
- 2) When the knee is flexed, the gastrocnemius muscle is shortened and ineffectual as a plantar flexor. Isolate the soleus by asking your partner to gently plantar flex against your resistance. Notice how the thick soleus contracts while the thin, superficial bellies of the gastrocnemius remain flaccid (7.66).

✓ Can you feel the difference in texture between the fleshy muscle bellies and the tough, dense calcaneal tendon (7.67)?



7.66 Medial view of right leg with partner prone and knee flexed



7.67 Lateral view with knee extended, isolating the soleus and calcaneal tendon

triceps surae **tri-seps sir-eye** L. three-headed muscle of the calf

# Plantaris



The plantaris has a short muscle belly but the longest tendon in the body. Its belly lies at an oblique angle along the popliteal space of the posterior knee between the gastrocnemius' heads; its tendon extends down the length of the leg and attaches to the calcaneus (7.68). Although the plantaris belly is situated in a small, cramped area, it can be readily accessed.

From the standpoint of evolution, the plantaris is thought to be what remains of a larger plantar flexor of the foot. The plantaris of reptiles, which serves as an important muscle of propulsion, still retains much of the basic character of this older, larger flexor.

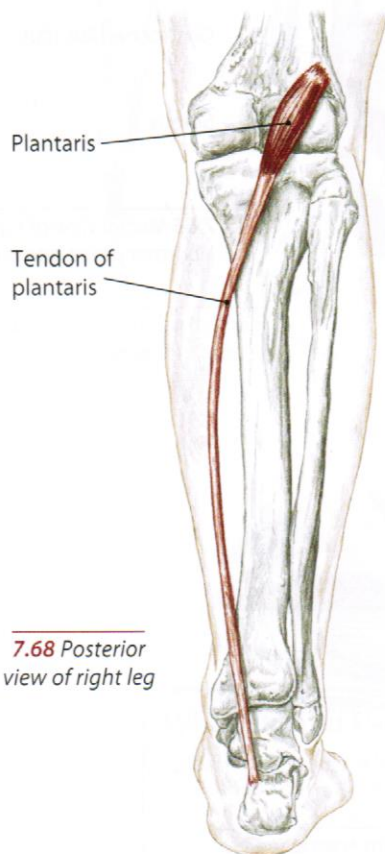
**A** Weak **plantar flexion** of the ankle (talocrural joint)

Weak **flexion** of the knee (tibiofemoral joint)

**O** Lateral supracondylar line of femur

**I** Calcaneus via calcaneal tendon

**N** Tibial L4, 5, S1, (2)

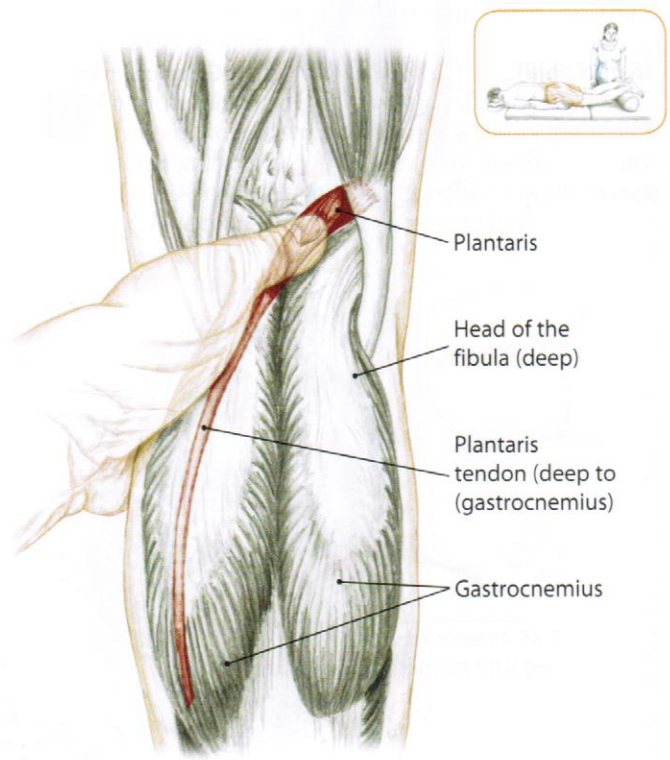


7.68 Posterior view of right leg



- 1) Partner prone with the knee flexed. Locate the head of the fibula.
- 2) Move your thumb medial into the popliteal space between the gastrocnemius' heads. (Sliding your thumb a little more proximally in the popliteal space will position it off the gastrocnemius' heads.)
- 3) With your thumb between the gastrocnemius' heads, slowly sink into the tissue of the posterior knee (7.69). Explore for an inch-wide belly that runs at an oblique angle from lateral to medial. When you believe you have located the plantaris, outline its shape by strumming your thumb across its belly.

Are you medial and proximal to the head of the fibula? Are you accessing between the gastrocnemius' heads? Is the belly you are palpating one to two fingers wide with oblique fibers?

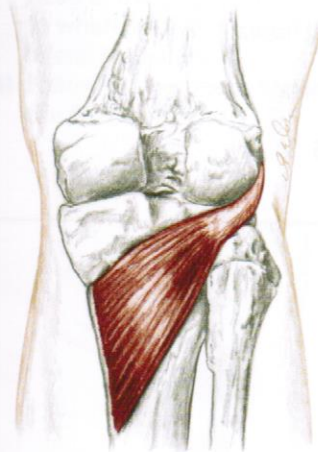


7.69 Posterior view of right knee

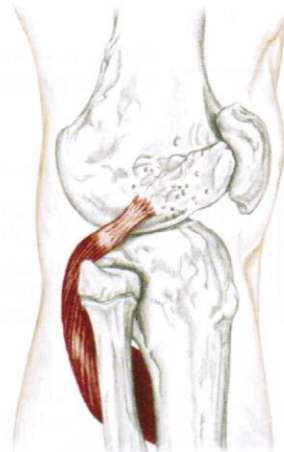
It is no mere coincidence that the plantaris of the leg bears a marked resemblance to the palmaris longus (p. 141) in the forearm: The two muscles have short bellies followed by long tendons, limited capabilities and are absent in nearly 10% of the population.

# Popliteus

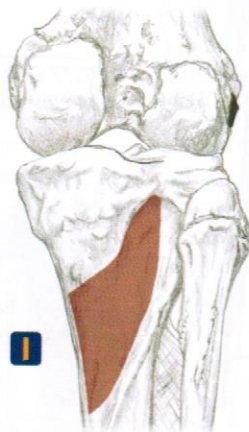
As its name suggests, the popliteus is located in the popliteal space. This muscle has a small, short belly with diagonal fibers (7.70, 7.71). Lying beneath the upper fibers of the gastrocnemius and plantaris, it is the deepest muscle of the posterior knee. Because of its depth, the popliteus is inaccessible; nevertheless, its tendinous insertion on the posterior tibia can be palpated. Although the popliteus is a weak flexor of the knee, it is vital in “unlocking” the joint from an extended position; hence its nickname, “the key which unlocks the knee.”



**7.70** Posterior view of right knee showing the popliteus



**7.71** Lateral view of right knee showing popliteus



**7.72** Origin and insertion

**A** Medially rotate the flexed knee (tibiofemoral joint)

Flex the knee (T/F joint)

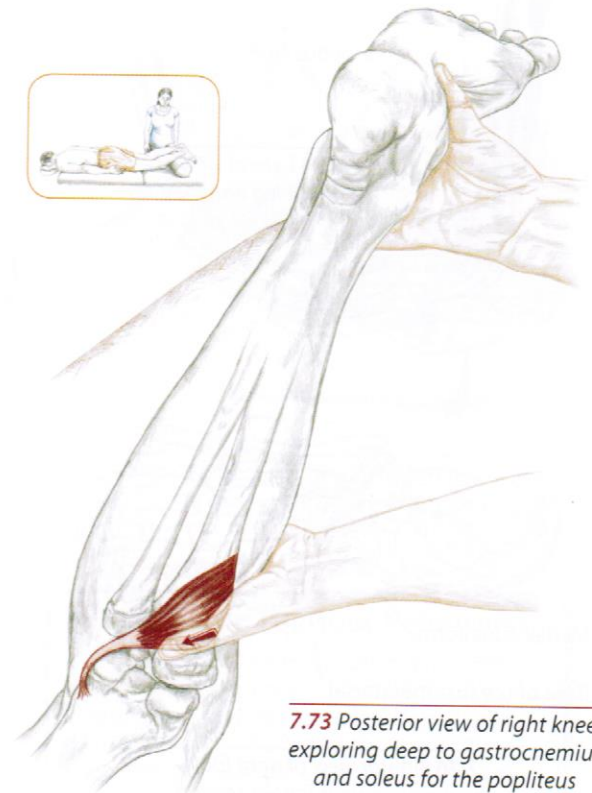
**O** Lateral condyle of the femur

**I** Proximal, posterior aspect of tibia

**N** Tibial L4, 5, S1



- 1) Prone with the knee flexed. Access a portion of the popliteus by locating the tibial tuberosity and sliding medially around the tibia to the posterior surface of its shaft.
- 2) Explore the posterior surface of the tibia for the popliteus tendon by pushing the overlying edge of the soleus and gastrocnemius muscles to the side (7.73).
- 3) Although the popliteus will not readily present itself as a palpable structure, if you are accessing the posterior region of the tibial shaft, you will be on its tendinous attachment.



**7.73** Posterior view of right knee, exploring deep to gastrocnemius and soleus for the popliteus

popliteus    pop-lit-e-us    L. *popes*, ham of the knee

# Peroneus Longus and Brevis



Known also as the *fibularis longus* and *brevis*, the slender peroneal muscles are located on the lateral side of the fibula (7.74). More specifically, they lie between the extensor digitorum longus and the soleus. A portion of

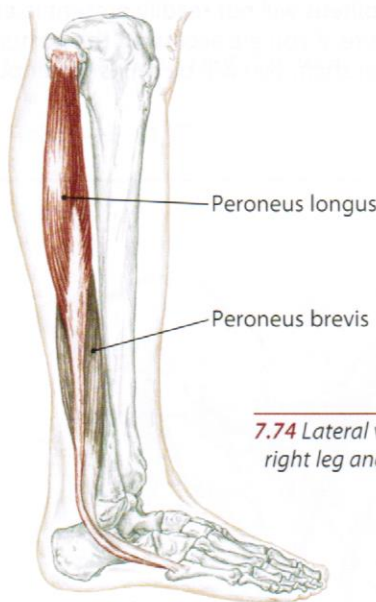
the peroneus brevis lies deep to the peroneus longus, yet both are accessible. Their distal tendons are superficial and palpable behind the lateral malleolus and along the side of the heel (7.75).

## Peroneus Longus

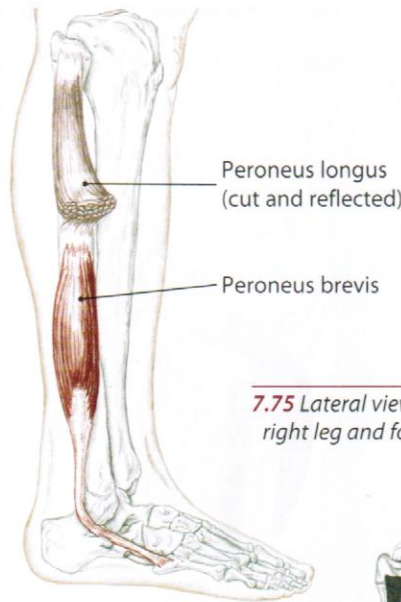
- A** Evert the foot
- Assist to **plantar flex** the ankle (talocrural joint)
- O** Head of fibula and proximal two-thirds of lateral fibula
- I** Base of the first metatarsal and medial cuneiform
- N** Superficial peroneal L4, 5, S1

## Peroneus Brevis

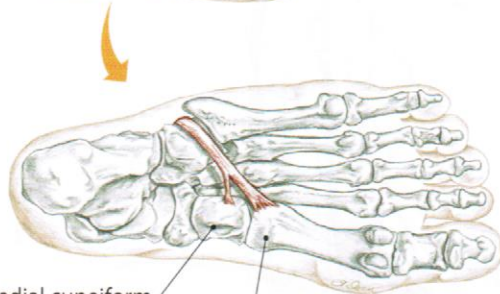
- A** Evert the foot
- Assist to **plantar flex** the ankle (talocrural joint)
- O** Distal two-thirds of lateral fibula
- I** Tuberosity of fifth metatarsal
- N** Superficial peroneal L4, 5, S1



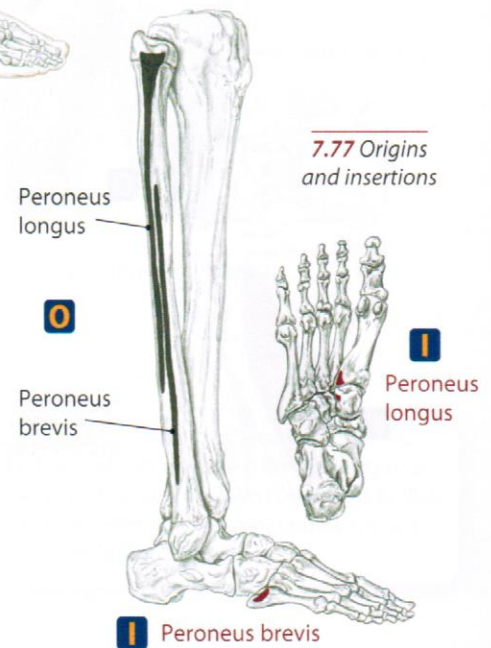
7.74 Lateral view of right leg and foot



7.75 Lateral view of right leg and foot



7.76 Plantar view of right foot showing peroneus longus tendon



7.77 Origins and insertions

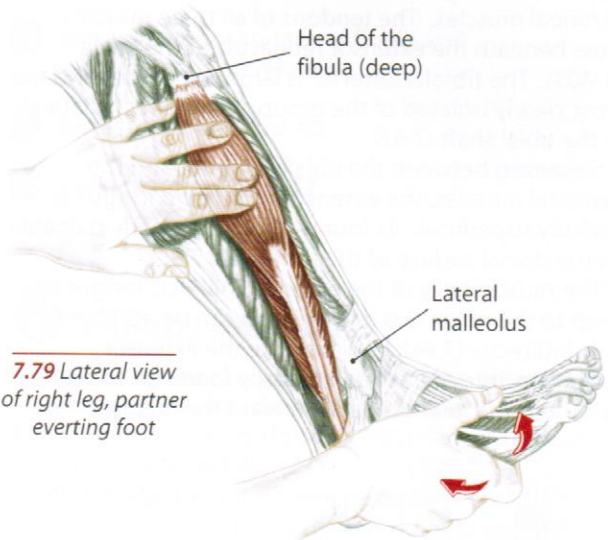
## Peroneals

- 1) Partner side lying. Place a finger at the head of the fibula and the lateral malleolus. The peroneal bellies are located between these two landmarks (7.78).
- 2) Lay your fingers between these landmarks and ask your partner to alternately evert and relax her foot. Feel the peroneals tighten upon eversion. This action will sometimes create a visible dimple or depression along the side of the leg (7.79).
- 3) As your partner continues to evert and relax her foot, follow the peroneus longus proximally toward the head of the fibula. Now follow both muscles distally to where their tendons wrap around the back of the lateral malleolus.
- 4) Follow the peroneus brevis tendon to the base of the fifth metatarsal (7.80).

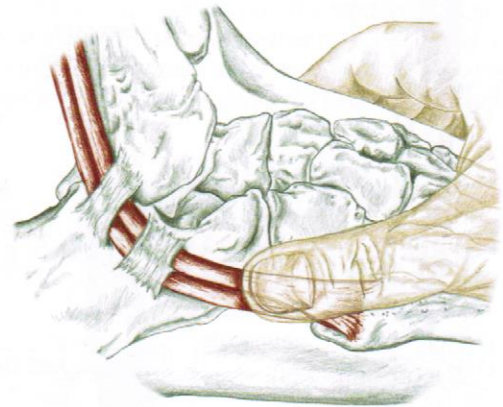


7.78 Lateral view of right leg, drawing a line between the head of the fibula and the lateral malleolus

✓ Are you on the lateral side of the leg between the head of the fibula and the lateral malleolus? Can you differentiate the slender peroneals from the lateral edge of the larger gastrocnemius and soleus? Can you feel the tendon of the peroneus brevis attach to the base of the fifth metatarsal?



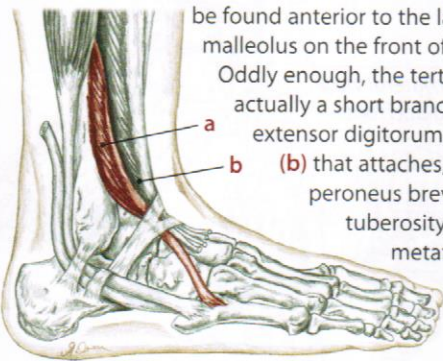
7.79 Lateral view of right leg, partner everting foot



7.80 Lateral view of right ankle, accessing the peroneus tendons

It is not uncommon for there to be a third peroneal. If present, the peroneus (or fibularis) tertius (a)

will be found anterior to the lateral malleolus on the front of the ankle. Oddly enough, the tertius is actually a short branch of the extensor digitorum longus (b) that attaches, along with peroneus brevis, at the tuberosity of the fifth metatarsal.



### When Do You Use Your Peroneals?

- Scraping mud off the inside edge of your boot (eversion of the ankle)
- Hiking on a rocky trail (small, specific stabilizing movements of the foot)
- Ice skating or skate skiing (eversion occurring at the end of a stroke)

tertius

ter-she-us

L. third

# Extensors of the Ankle and Toes

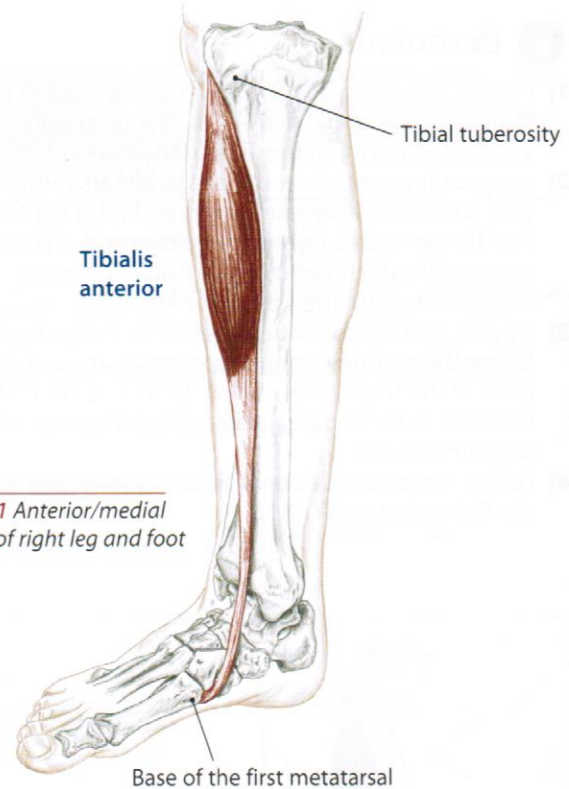


*Tibialis Anterior*  
*Extensor Digitorum Longus*  
*Extensor Hallucis Longus*

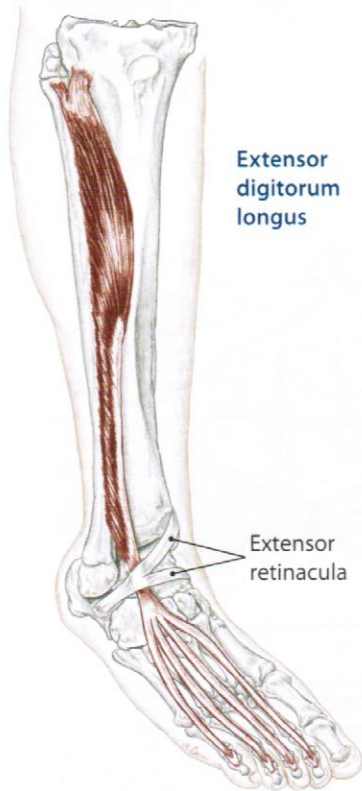
These extrinsic muscles are located on the anterior aspect of the leg between the shaft of the tibia and the peroneal muscles. The tendons of all three muscles cross beneath the extensor retinacula at the ankle (p. 403). The **tibialis anterior** is large, superficial and the most clearly isolated of the group. It lies directly lateral to the tibial shaft (7.81).

Squeezed between the tibialis anterior and the peroneal muscles, the **extensor digitorum longus** is partially superficial. Its four tendons are clearly palpable on the dorsal surface of the foot (7.82, 7.83).

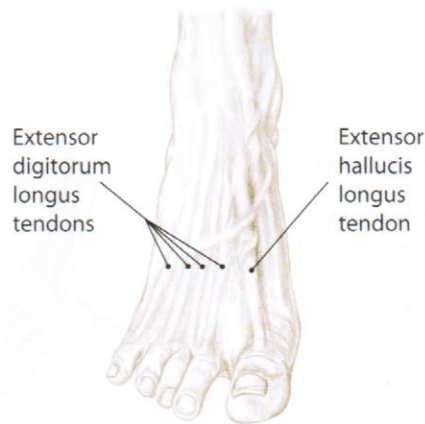
The muscle belly of the **extensor hallucis longus** lies deep to the other two muscles and can be accessed only indirectly (7.84); however, like the extensor digitorum, its distal tendon is easily found on the dorsal surface of the foot as it leads toward the first toe.



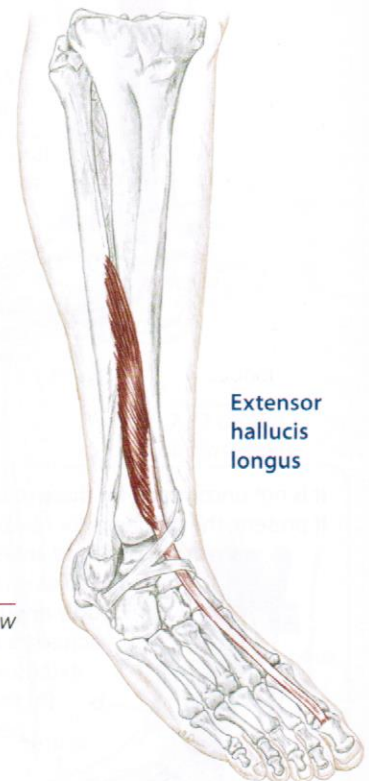
7.81 Anterior/medial view of right leg and foot



7.82 Anterior/lateral view of right leg and foot



7.83 Dorsal view of right foot



7.84 Anterior/lateral view of right leg and foot

### When Do You Use Your Extensors?

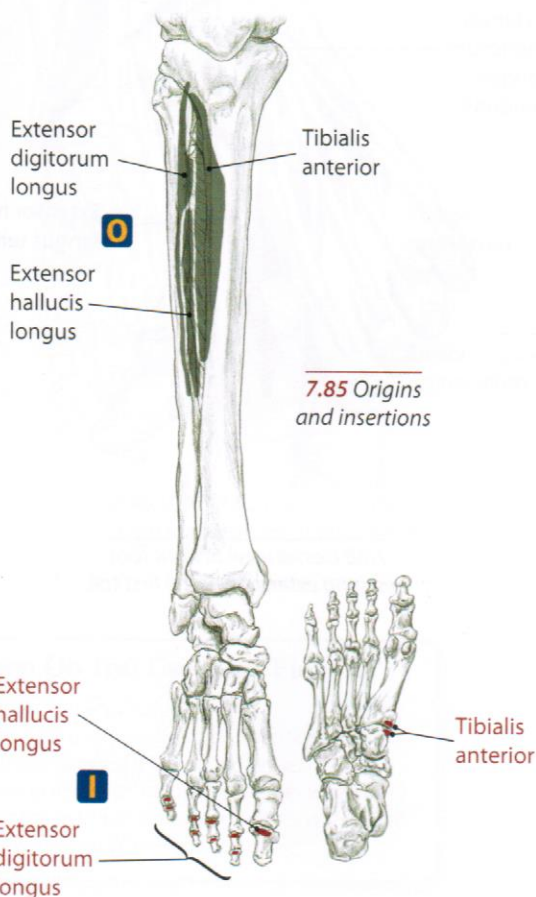
- Balancing on one foot
- Putting on and taking off your socks and shoes
- During the swing phase of your gait (lifting the foot after toe-off so that your foot clears the ground)

## Tibialis Anterior

- A** **Invert** the foot  
**Dorsiflex** the ankle (talocrural joint)
- O** Lateral condyle of tibia; proximal, lateral surface of tibia and interosseous membrane
- I** Medial cuneiform and base of the first metatarsal
- N** Deep peroneal L4, 5, S1

## Extensor Digitorum Longus

- A** **Extend** the second through fifth toes (metatarsophalangeal and interphalangeal joints)  
**Dorsiflex** the ankle (talocrural joint)  
**Evert** the foot
- O** Lateral condyle of tibia; proximal, anterior shaft of fibula and interosseous membrane
- I** Middle and distal phalanges of second through fifth toes
- N** Peroneal L4, 5, S1



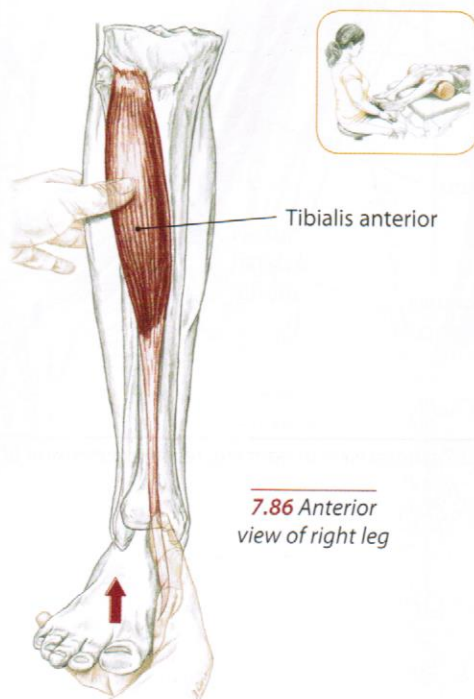
## Extensor Hallucis Longus

- A** **Extend** the first toe (metatarsophalangeal and interphalangeal joints)  
**Dorsiflex** the ankle (talocrural joint)  
**Invert** the foot
- O** Middle, anterior surface of fibula and interosseous membrane
- I** Distal phalanx of first toe
- N** Deep peroneal L4, 5, S1

## Tibialis anterior


- 1) Partner supine. Locate the shaft of the tibia and slide off it laterally onto the tibialis anterior.
- 2) Ask your partner to dorsiflex his ankle and palpate its long, inch-wide belly (7.86).
- 3) With the ankle dorsiflexed, palpate the muscle distally as it becomes a thick, tendinous cord. Follow it to the medial side of the foot as it disappears at the medial cuneiform.

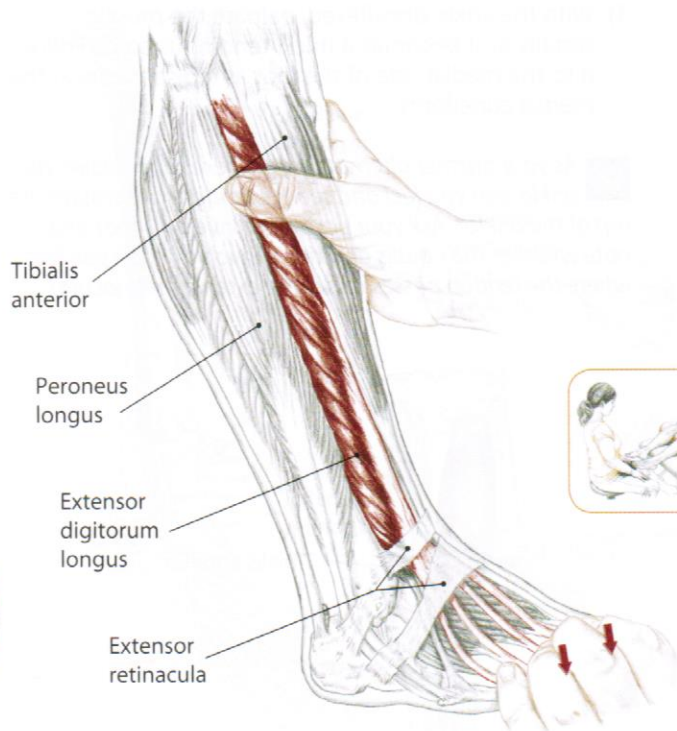
**✓** As your partner alternately dorsiflexes and relaxes his ankle, can you feel and see the tendon that crosses the top of the ankle? Ask your partner to invert his foot and note whether the tibialis anterior is involved. Can you feel where the tendon passes under the extensor retinacula?



## Extensor digitorum longus

- 1) Supine. The easiest way to begin is by palpating the digitorum's distal tendons. Ask your partner to extend his toes. Visibly identify and palpate the four tendons of the digitorum on the top of the foot.
- 2) With the toes still extended, follow the tendons toward the ankle. Notice how they converge into a single tendinous bundle that loops underneath the extensor retinacula (7.87).
- 3) Follow this tendon proximally as it merges into its muscle belly. Explore the slender belly of the digitorum as it squeezes between the tibialis anterior and the peroneal muscles.


 *Locate the digitorum and tibialis anterior tendons on the top of the ankle. With the ankle dorsiflexed, ask your partner to slowly invert and evert his foot. Do you feel the tibialis tighten upon inversion and the digitorum tighten upon eversion?*

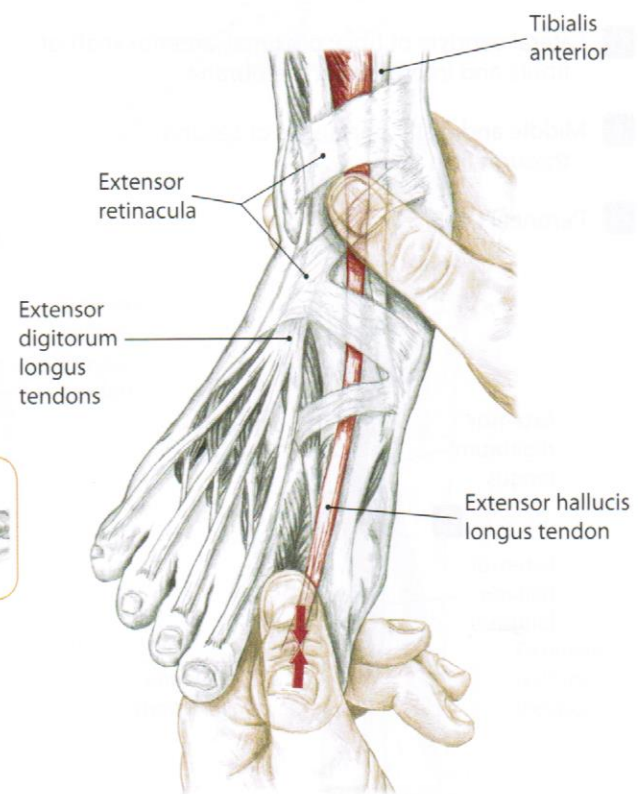


7.87 Lateral view of right leg, resisting extension of the toes

## Extensor hallucis longus

- 1) Supine. Ask your partner to extend his first toe. Visibly identify and palpate the solid tendon running along the dorsal surface of the foot to the first toe (7.88).
- 2) With the toe still extended, follow the tendon toward the ankle. Note how it snuggles between and underneath the extensor digitorum and tibialis anterior tendons.

 *Can you follow the tendon from the first toe to the dorsal surface of the ankle? Can you distinguish the three separate tendons of the extensors (hallucis, digitorum and tibialis anterior) along the dorsal surface of the ankle?*



7.88 Dorsal view of right foot, resisting extension of the first toe

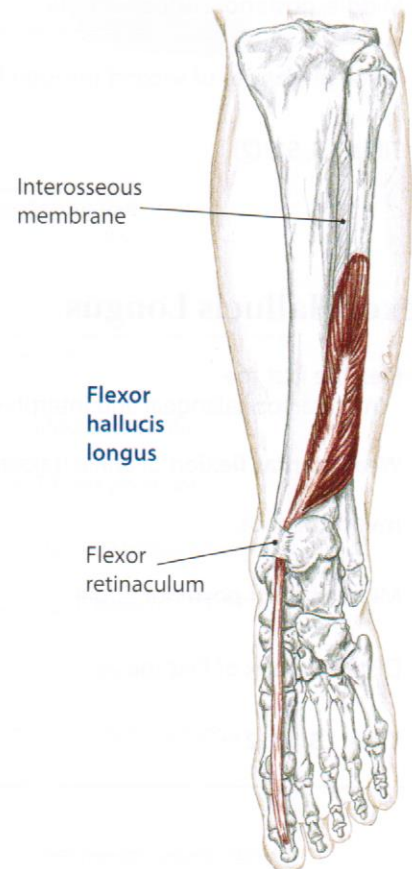
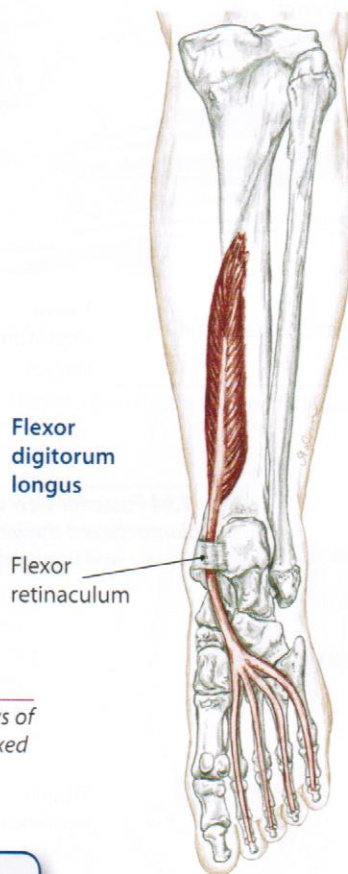
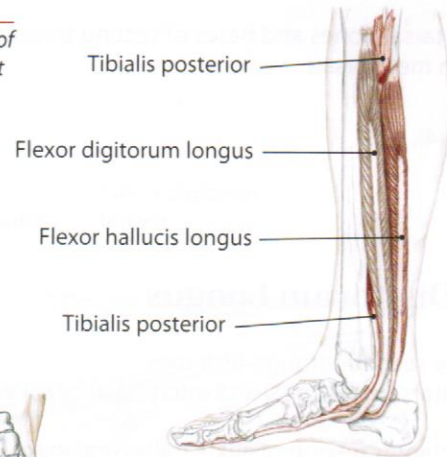
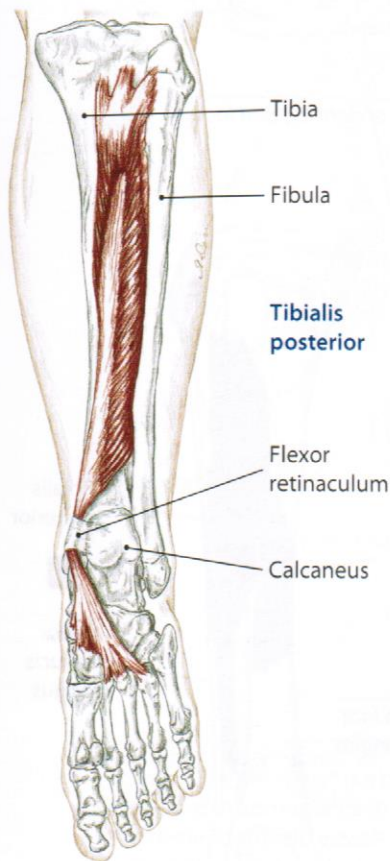
# Flexors of the Ankle and Toes

*Tibialis Posterior*      *Flexor Digitorum Longus*      *Flexor Hallucis Longus*

Buried deep to the gastrocnemius and soleus on the posterior leg are three slender muscles primarily responsible for inverting the foot and flexing the toes (7.89). All three muscles are virtually inaccessible, except at the small region on the medial side of the leg. This small gap between the tibial shaft and the edge of the

calcaneal tendon is where the most distal fibers and tendons of the flexors can be palpated directly (7.93). The tendons of these three muscles curve around the medial malleolus and pass deep to the flexor retinaculum. The tibial artery and tibial nerve (p. 404) are situated between the tendons at the medial ankle.

7.89 Medial view of right leg and foot



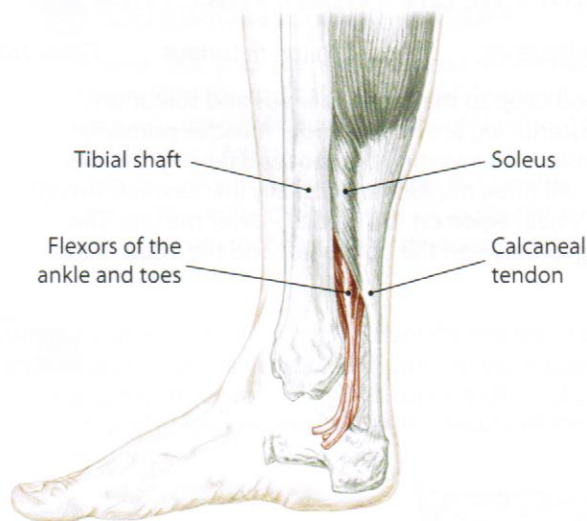
7.90, 7.91, 7.92 Posterior views of right leg with foot plantar flexed

### When Do You Use Your Flexors?

- Walking on your tiptoes
- Hiking on a rocky trail (small, specific stabilizing movements of the foot and ankle)
- Turning the water tap with your toes when lying in the bathtub (flexion of the toes with subtle movements of the foot and ankle)

## Tibialis Posterior

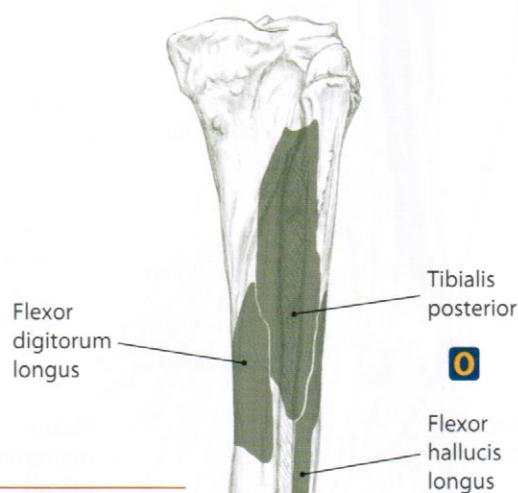
- A** **Invert** the foot
- P**lantar **flex** the ankle (talocrural joint)
- O** Proximal, posterior shafts of tibia and fibula; and interosseous membrane
- I** All five tarsal bones and bases of second through fourth metatarsals
- N** Tibial L(4), 5, S1



7.93 Medial view of right leg and foot

## Flexor Digitorum Longus

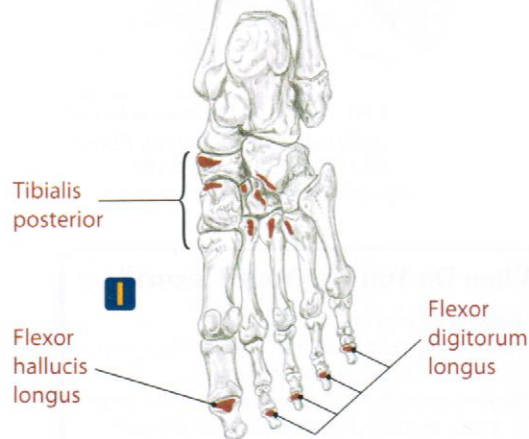
- A** **Flex** the second through fifth toes (metatarsophalangeal and interphalangeal joints)
- P**Weak **plantar flexion** of ankle (talocrural joint)
- I**nvert the foot
- O** Middle, posterior surface of tibia
- I** Distal phalanges of second through fifth toes
- N** Tibial L5, S1, (2)



7.94 Posterior view with foot plantar flexed showing origins and insertions

## Flexor Hallucis Longus


- A** **Flex** the first toe (metatarsophalangeal and interphalangeal joints)
- P**Weak **plantar flexion** of ankle (talocrural joint)
- I**nvert the foot
- O** Middle half of posterior fibula
- I** Distal phalanx of first toe
- N** Tibial L5, S1, 2

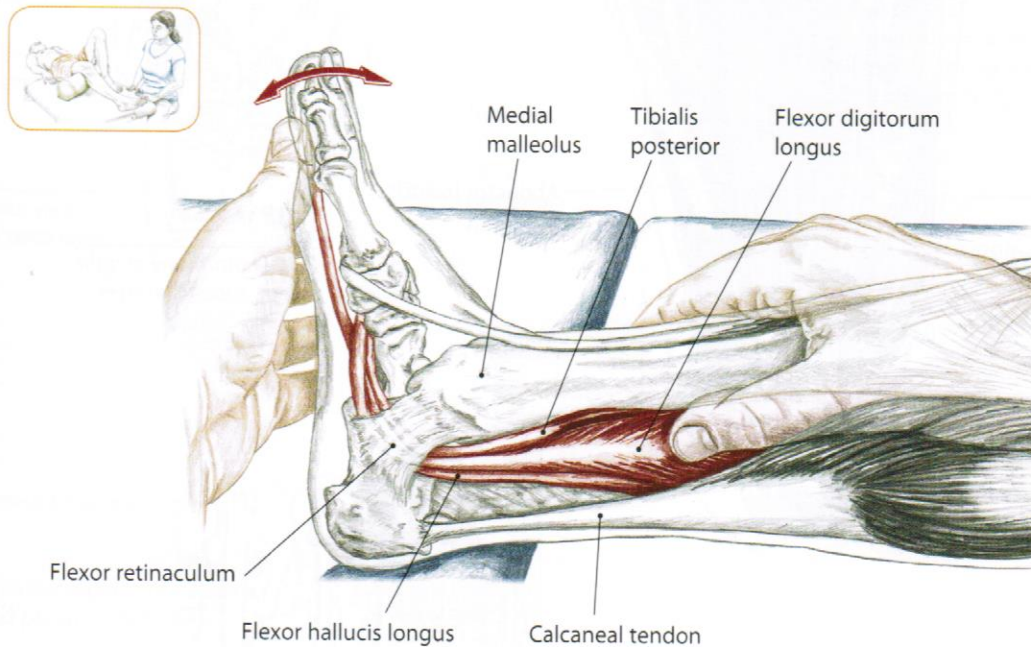


## All flexors

- 1) Partner supine, prone or side lying. Locate the medial malleolus. Slide off the malleolus posteriorly and proximally into the space between the posterior shaft of the tibia and the calcaneal tendon.
- 2) Explore this region for the distal bellies and tendons of these muscles (7.95). Follow the tendons distally around the back of the medial malleolus.

- 3) It is difficult to isolate specific tendons; however, tibialis posterior will be the most anterior. Have your partner invert his foot as you follow this tendon around the ankle to the underside of the foot.

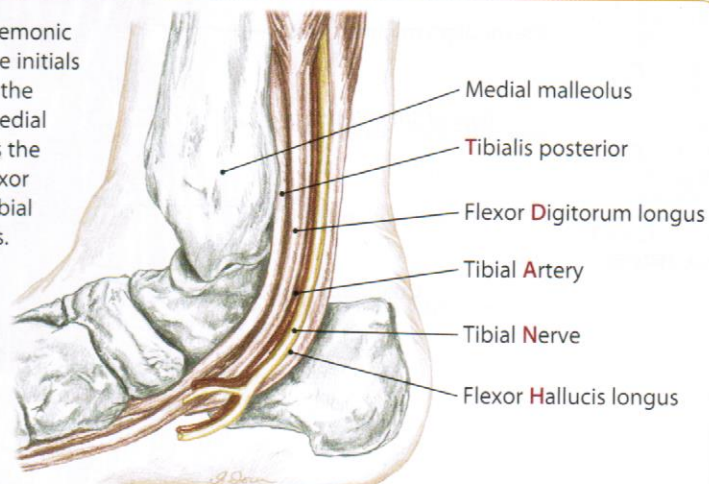
 Place your fingers on the distal bellies and ask your partner to slowly wiggle all his toes. Can you feel the muscles or tendons shift? Can you locate the medial malleolar groove (p. 357) and feel the tendons in and posterior to it? Can you locate the pulse of the tibial artery?



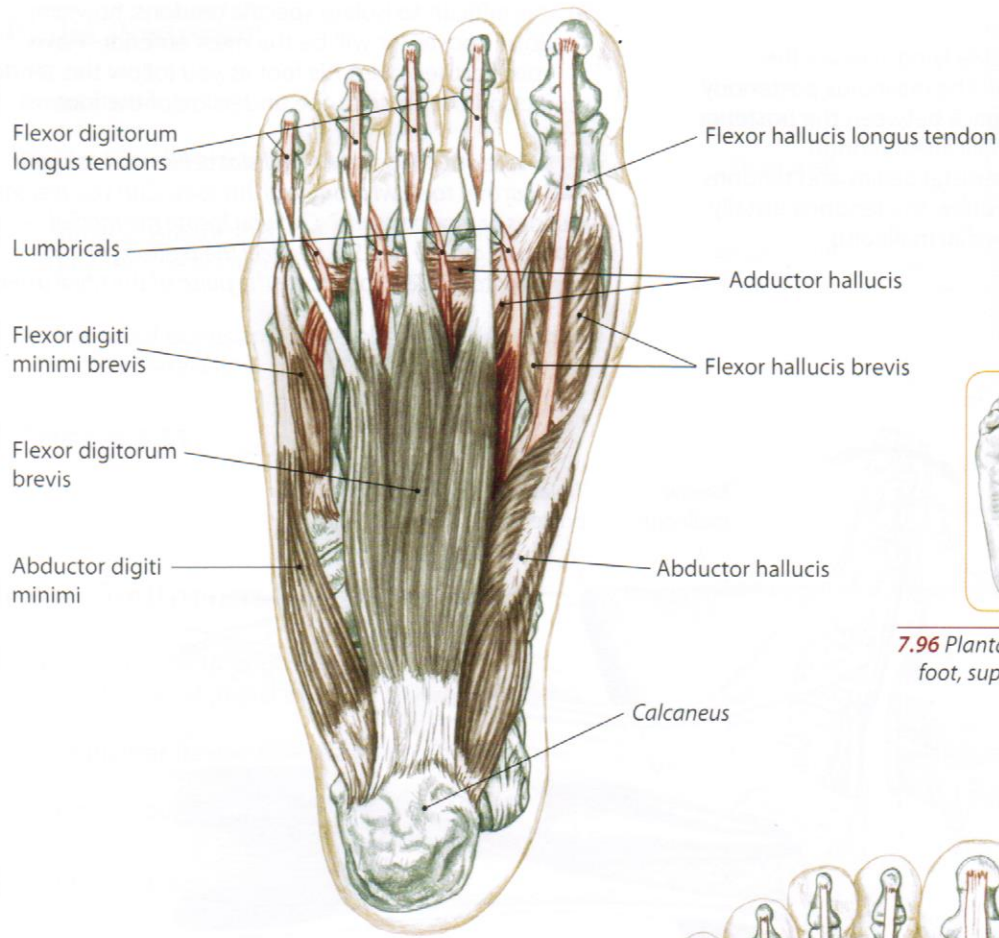
7.95 Medial view of right leg and foot, partner wiggling his toes

“Tom, Dick AN’ Harry” is a mnemonic device that corresponds to the initials of the tendons and vessels in the order that they pass by the medial malleolus. Tibialis posterior is the most anterior, followed by flexor **D**igitorum, the tibial **A**rtery, tibial **N**erve and then flexor **H**allucis.

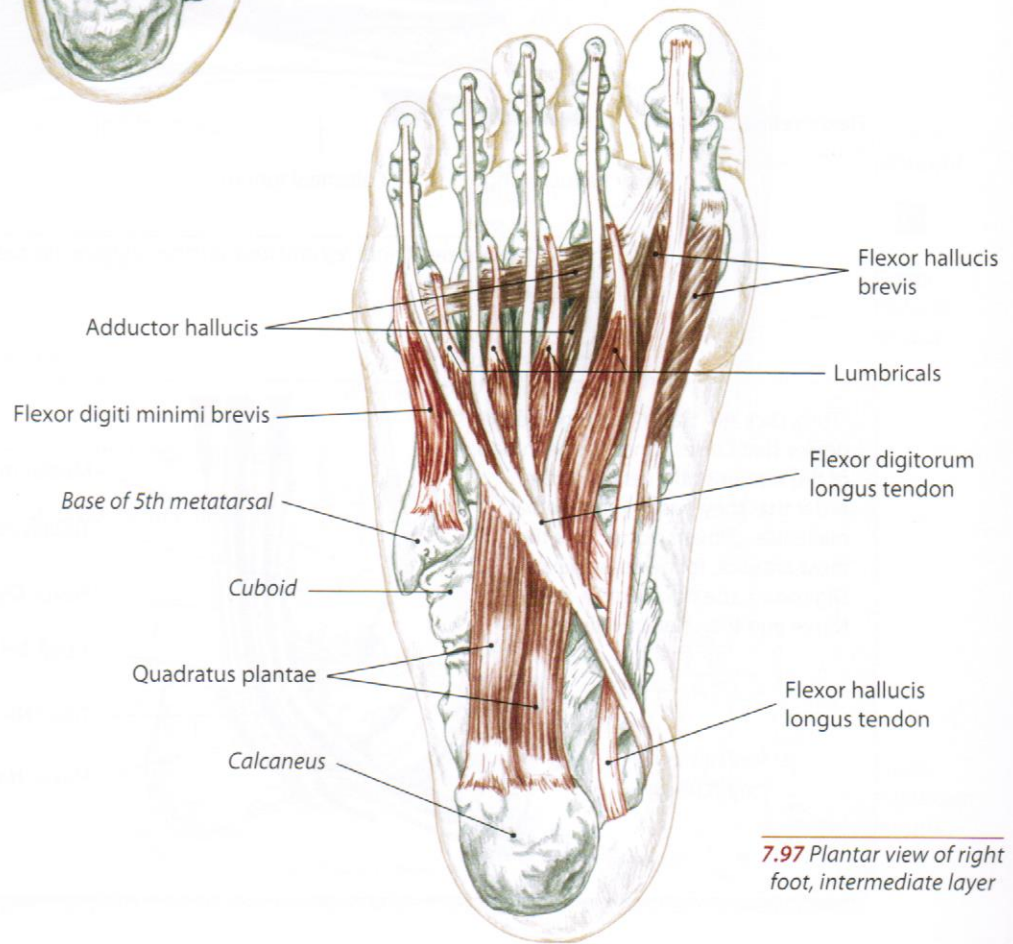
Medial view of right ankle



# Muscles of the Foot



7.96 Plantar view of right foot, superficial layer



7.97 Plantar view of right foot, intermediate layer

Leg & Foot

# Muscles of the Foot

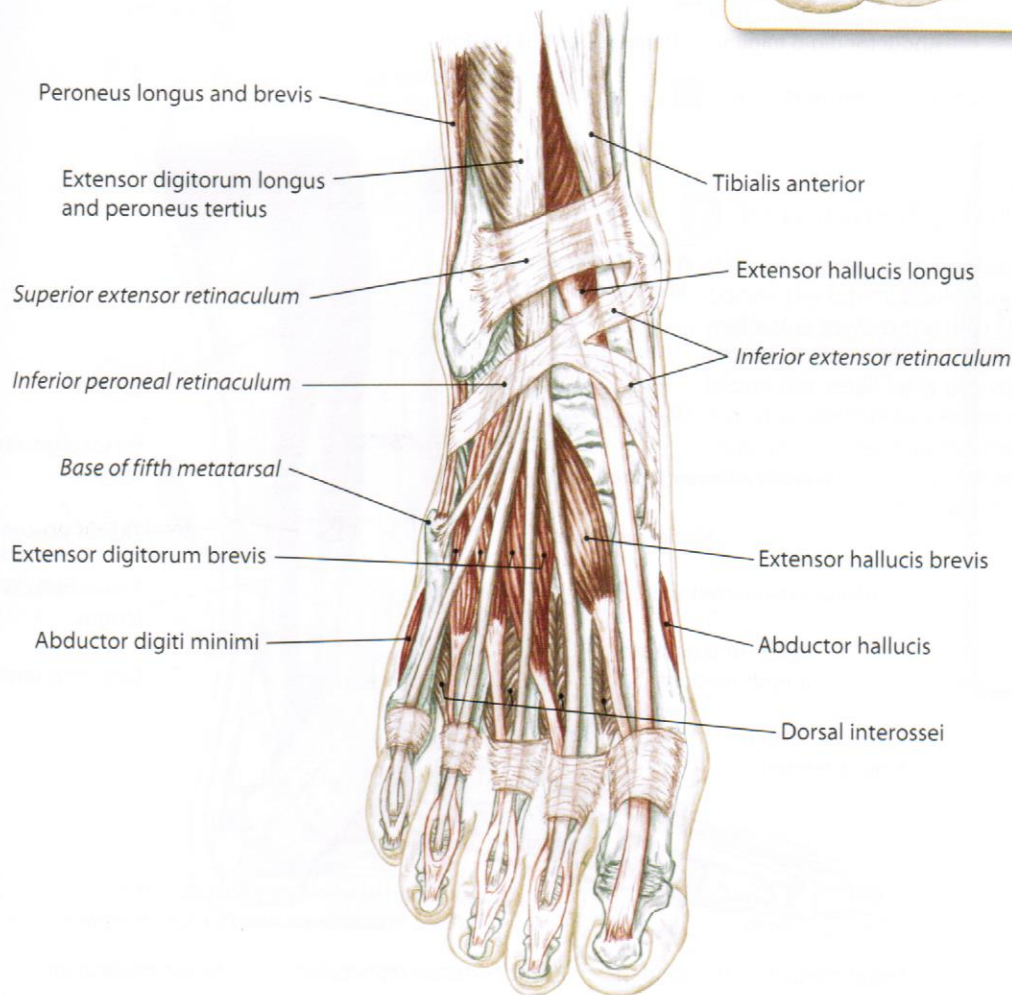


7.98 Plantar view of right foot, deep layer

Because they bear the weight of the body when standing, walking and running, the feet are sometimes known as the "little soldiers." In comparison to standing, walking increases the pressure on the feet twofold while running increases it fourfold.

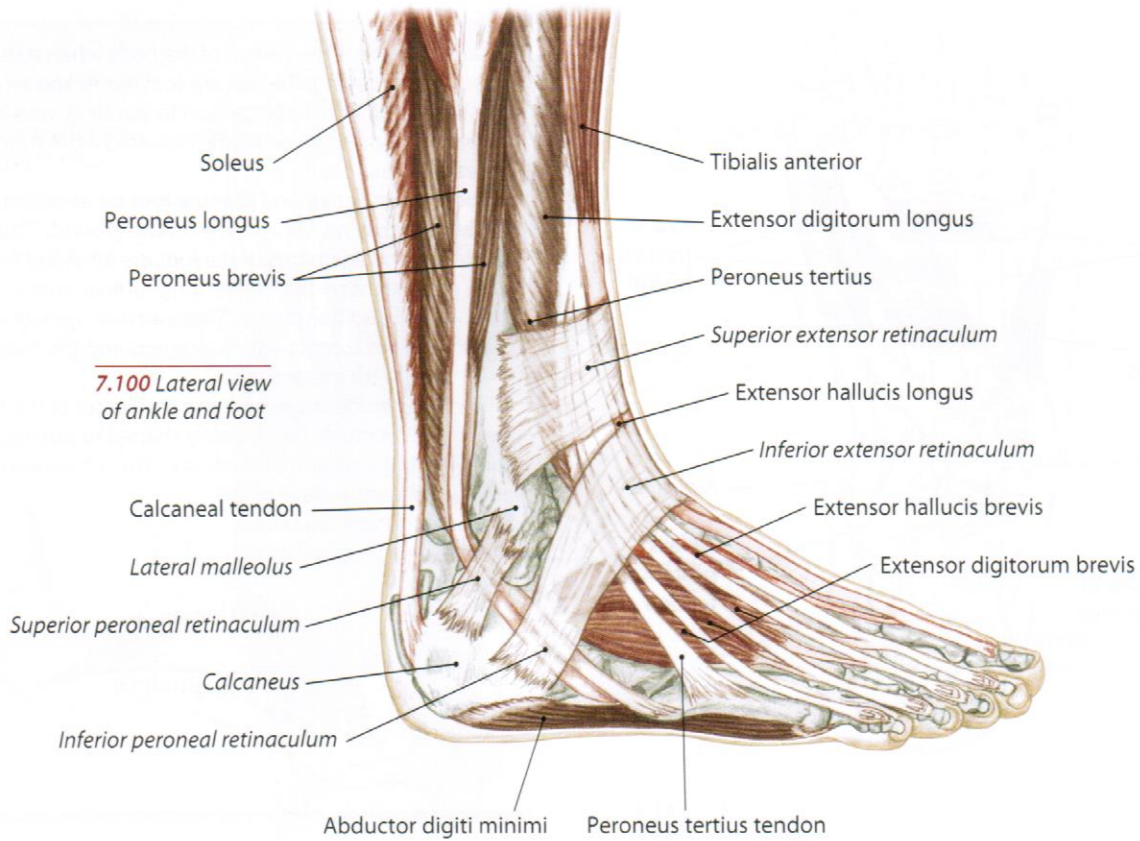
These stresses demand that the foot be designed for more than lying flat and idle on the ground. Thus the bones and ligaments of the foot are arranged to form three arches—the medial longitudinal, lateral longitudinal and transverse. These arches connect with three points of contact—the calcaneus and the heads of the first and fifth metatarsals.

The three arches together raise the center of the foot, creating a structure that is ideally shaped to distribute and absorb the weight of the body. The arches also help the plantar surface of the foot adapt to uneven terrain while hiking or climbing.

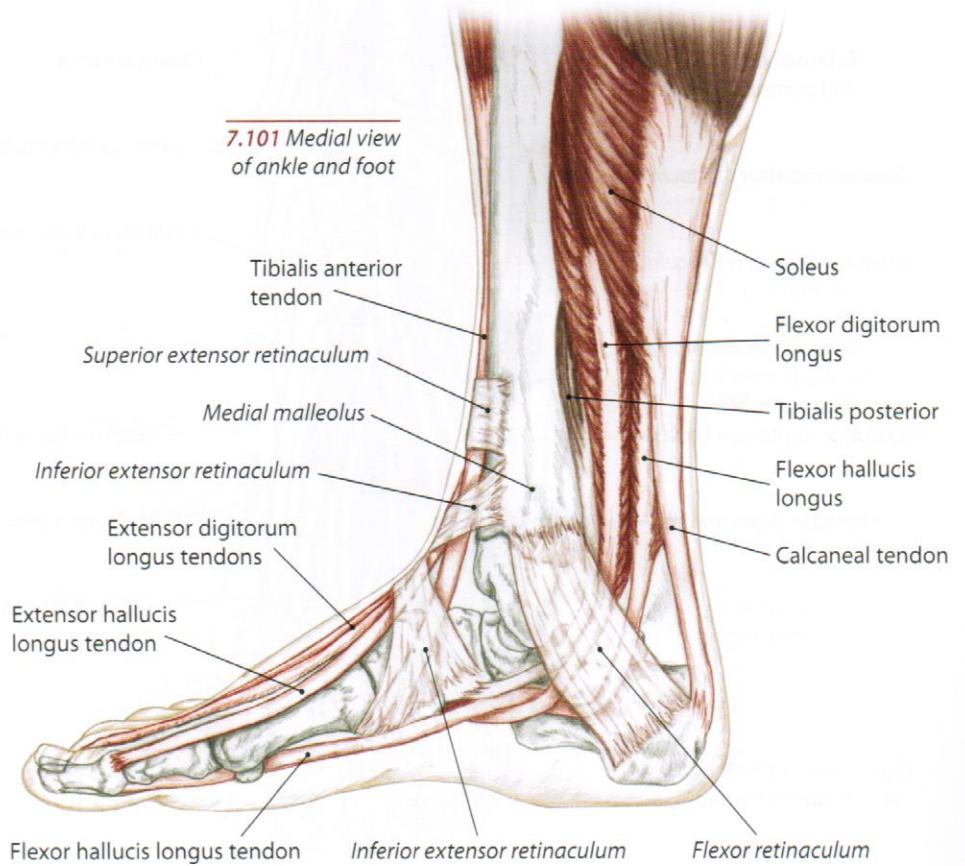


7.99 Dorsal view of right foot

# Muscles of the Foot



If the discomfort of wearing high-heeled shoes were not enough, try this on for size: The point of a spike heel worn by the average-sized woman is subjected to nearly 2,000 pounds of pressure per square inch with every step she takes. This force is shot into the heel and reverberates up the entire body. When air travel was in its infancy, women wearing high heels were actually prohibited from boarding airplanes because the heels of their shoes might pierce the thin metal floors.



## Muscles of the Foot

*Extensor Digitorum Brevis*

*Flexor Digitorum Brevis*

*Abductor Hallucis*

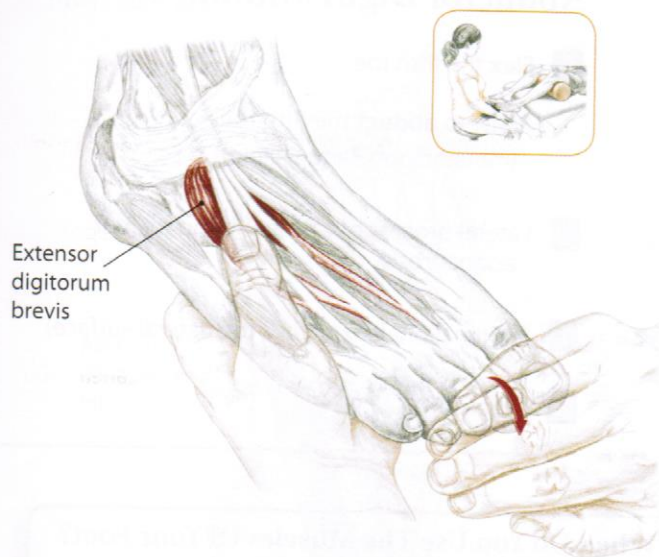
*Abductor Digiti Minimi*

The dorsal surface of the foot is home to the **extensor digitorum brevis** (7.102). Its small belly lies deep to the extensor digitorum longus tendons, but is still palpable.

Unlike the minimally muscled dorsal surface, the foot's plantar surface is made up of several layers of muscle.



7.102 Dorsal view of right foot



7.103 Dorsal/lateral view of right foot, partner extends toes against your resistance

minimi

min-i-mee

L. smallest

The first layer, located deep to the plantar aponeurosis, (p. 404), is formed by three muscles that lie side by side. The center muscle is the **flexor digitorum brevis** (7.104). It extends down the center of the foot from the calcaneus to the phalanges. Medial to the flexor digitorum brevis is the thick, superficial **abductor hallucis**; lateral to it is the superficial **abductor digiti minimi** (7.105). Both abductors are easily accessible and often visible along the sides of the foot. Although deep to the plantar aponeurosis, all three muscles are relatively superficial on the sole of the foot and are thus palpable.

## Extensor Digitorum Brevis

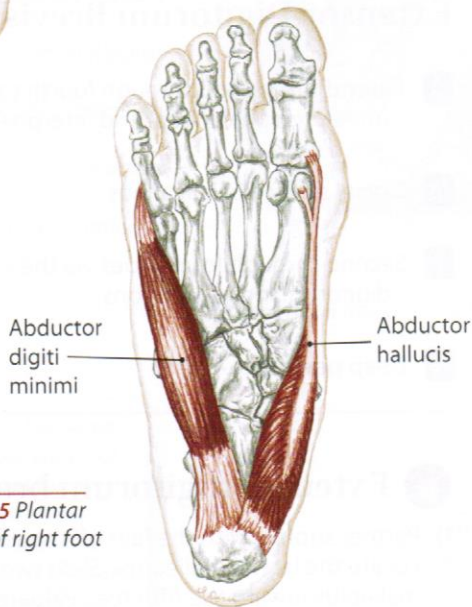
- A** Extend the second through fourth toes (metatarsophalangeal and interphalangeal joints)
- O** Dorsal surface of calcaneus
- I** Second through fourth toes via the extensor digitorum longus tendons
- N** Deep peroneal L4, 5, S1

## Extensor digitorum brevis

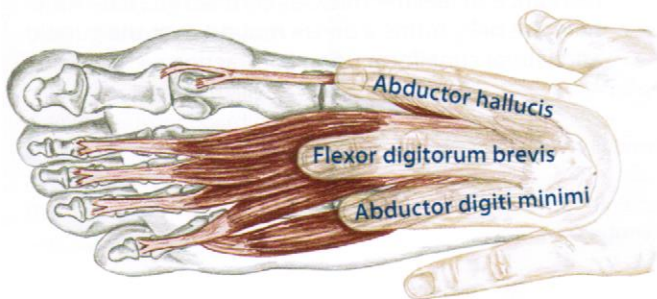
- 1) Partner supine, with the feet off the end of the table. Locate the lateral malleolus. Slide two inches off the malleolus toward the fifth toe. Palpate beneath and lateral to the extensor digitorum longus tendons to locate the small belly of extensor digitorum brevis.
- 2) Ask your partner to extend her toes against your resistance to feel the muscles contract (7.103). Note how the belly forms a dense mound over the cuboid and lateral cuneiform upon contraction.



7.104 Plantar view of right foot



7.105 Plantar view of right foot



7.106 Fingers on the plantar surface of the foot, showing order of muscles

## Flexor Digitorum Brevis

- A** Flex middle phalanges of the second through fifth toes (proximal interphalangeal joints)
- O** Medial process of calcaneus and plantar aponeurosis
- I** Middle phalanges of second through fifth toes
- N** Tibial L4, 5, S1

## Abductor Hallucis

- A** Abduct the first toe (metatarsophalangeal joint)
- Assist to flex the first toe (metatarsophalangeal joint)
- O** Medial process of calcaneus and plantar aponeurosis
- I** Proximal phalanx of first toe (medial surface) and medial sesamoid bone
- N** Tibial L4, 5, S1

## Abductor Digiti Minimi

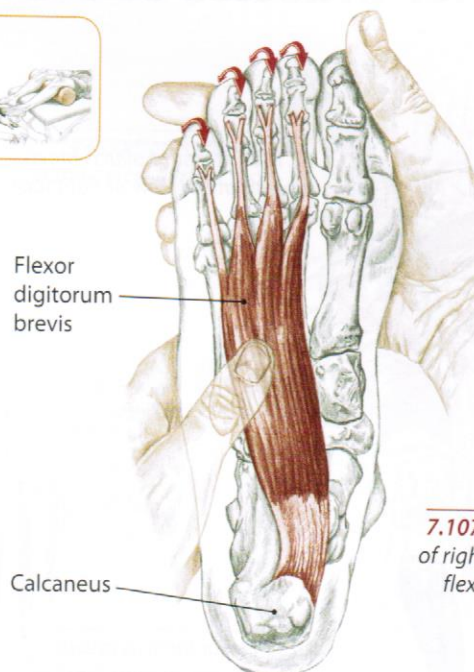
- A** Flex the fifth toe
- Assist to abduct the fifth toe (metatarsophalangeal joint)
- O** Lateral process of calcaneus and plantar aponeurosis
- I** Proximal phalanx of fifth toe (lateral surface)
- N** Tibial S1, 2

### When Do You Use The Muscles Of Your Foot?

- Stabilization when you are balancing on one foot
- Rock climbing (serious work on behalf of all of the toes)
- Walking on a patch of ice (Notice how your toes suddenly "grab.")
- Picking up a pencil off the floor with your toes

## Flexor digitorum brevis

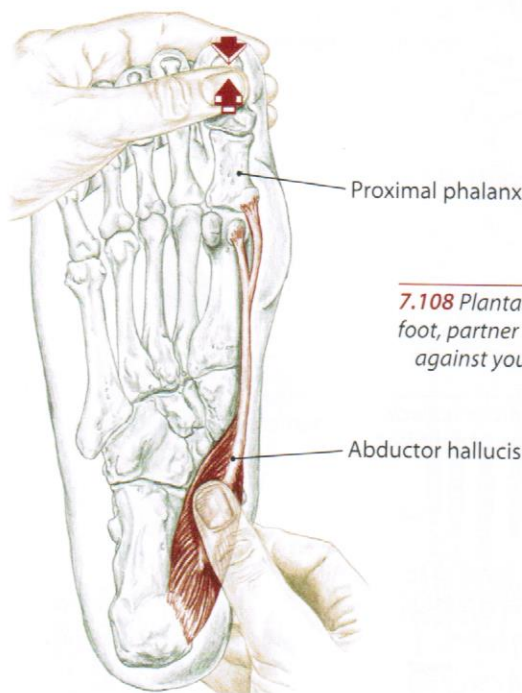
- 1) Supine, with the feet off the end of the table. Locate the plantar surface of the heel and the second through fifth toes. Visualize this muscle's location by drawing imaginary lines between these points.
- 2) Palpating along the arch of the foot, sink your thumbs along these lines and roll across the muscle fibers (7.107). Ask your partner to alternately flex and relax her toes. It may be challenging to isolate the flexor digitorum brevis belly, but have faith that you are in the correct location.



7.107 Plantar view of right foot, partner flexing her toes

## Abductor hallucis

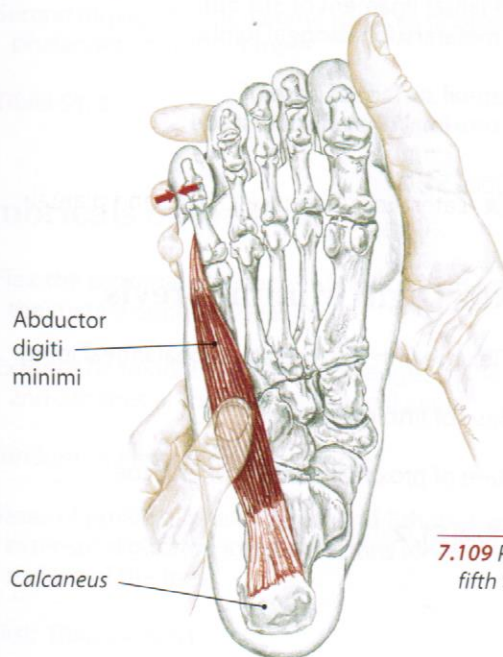
- 1) Partner supine, with the feet off the end of the table. Locate the medial surface of the heel and the medial side of the first toe.
- 2) Palpate between these points and note the thick, superficial tissue running alongside the medial/plantar surface of the foot (7.108).
- 3) Ask your partner to flex his first toe against your resistance and note the strength and density of the abductor hallucis belly.



7.108 Plantar view of right foot, partner flexes first toe against your resistance

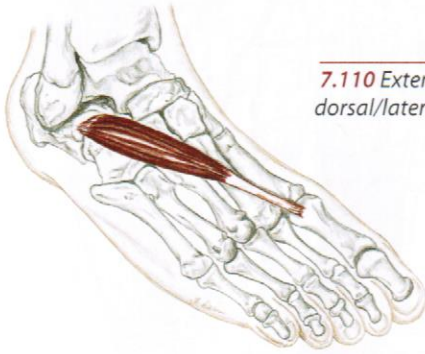
## Abductor digiti minimi

- 1) Supine, with the feet off the end of the table. Locate the plantar surface of the heel and the lateral surface of the fifth toe.
- 2) Palpate between these points for the thick, superficial tissue running alongside the lateral/plantar surface of the foot (7.109).
- 3) Ask your partner to abduct or flex his fifth toe against your resistance in order to feel the fibers contract.



7.109 Plantar view, partner abducts fifth toe against your resistance

## Other Muscles of the Foot



7.110 Extensor hallucis brevis, dorsal/lateral view of right foot



7.111 Flexor hallucis brevis, plantar view of right foot



7.112 Adductor hallucis, plantar view of right foot



7.113 Flexor digiti minimi brevis, plantar view of right foot

### Extensor Hallucis Brevis

- A** Extend the first toe (metatarsophalangeal joint)
- O** Dorsal surface of calcaneus
- I** Proximal phalanx of first toe
- N** Deep peroneal L4, 5, S1

### Flexor Hallucis Brevis

- A** Flex the first toe (metatarsophalangeal joint)
- O** Plantar surfaces of cuboid and lateral cuneiform
- I** Medial and lateral surfaces of base of proximal phalanx of first toe
- N** Tibial L4, 5, S1

### Adductor Hallucis

- A** Adduct the first toe
  - Assist to **maintain** transverse arch of foot
  - Assist to **flex** the first toe
- O** Oblique head:  
Bases of 2nd-4th metatarsals  
Transverse head:  
Plantar ligament of 3rd-5th metatarsophalangeal joints
- I** Lateral surface of base of proximal phalanx of first toe
- N** Tibial S1, 2

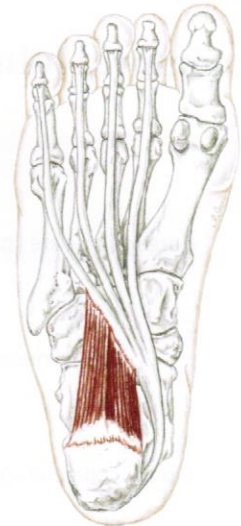
### Flexor Digiti Minimi Brevis

- A** Flex the fifth toe (metatarsophalangeal joint)
- O** Base of fifth metatarsal
- I** Base of proximal phalanx of fifth toe
- N** Tibial S1, 2

## Quadratus Plantae

- A** Assist flexor digitorum longus to **flex** 2nd-5th toes
- O** Medial and lateral sides of plantar surface of calcaneus
- I** Posterior, lateral aspect of flexor digitorum longus tendon
- N** Tibial S1, 2

7.114 *Quadratus plantae, plantar view of right foot*



## Plantar Interossei

- A** **Adduct** 3rd-5th toes (metatarsophalangeal joints)  
**Flex** 3rd-5th toes (metatarsophalangeal joints)
- O** Medial surfaces of 3rd-5th metatarsals
- I** Medial surfaces of proximal phalanges of 3rd-5th toes
- N** Tibial S1, 2



7.115 *Plantar interossei, plantar view of right foot*

## Dorsal Interossei

- A** **Abduct** 2nd-4th toes (metatarsophalangeal joints)  
**Flex** 2nd-4th toes (metatarsophalangeal joints)
- O** Adjacent surfaces of all metatarsals
- I** *First:* Medial surface of proximal phalanx of 2nd toe  
*Second through fourth:* Lateral surfaces of proximal phalanges of 2nd-4th toes
- N** Tibial S1, 2

7.116 *Dorsal interossei, dorsal view of right foot*



## Lumbricals of the Foot

- A** **Flex** the proximal phalanges of the 2nd-5th toes at the metatarsophalangeal joints  
**Extend** the middle and distal phalanges of the 2nd-5th toes at the interphalangeal joints
- O** Tendons of flexor digitorum longus
- I** Bases of proximal phalanges of 2nd-5th toes and extensor digitorum longus tendons (on dorsal surface of the toes)
- N** *First:* Tibial L4, 5, S1  
*Second through fourth:* Tibial L(4), (5), S1, 2

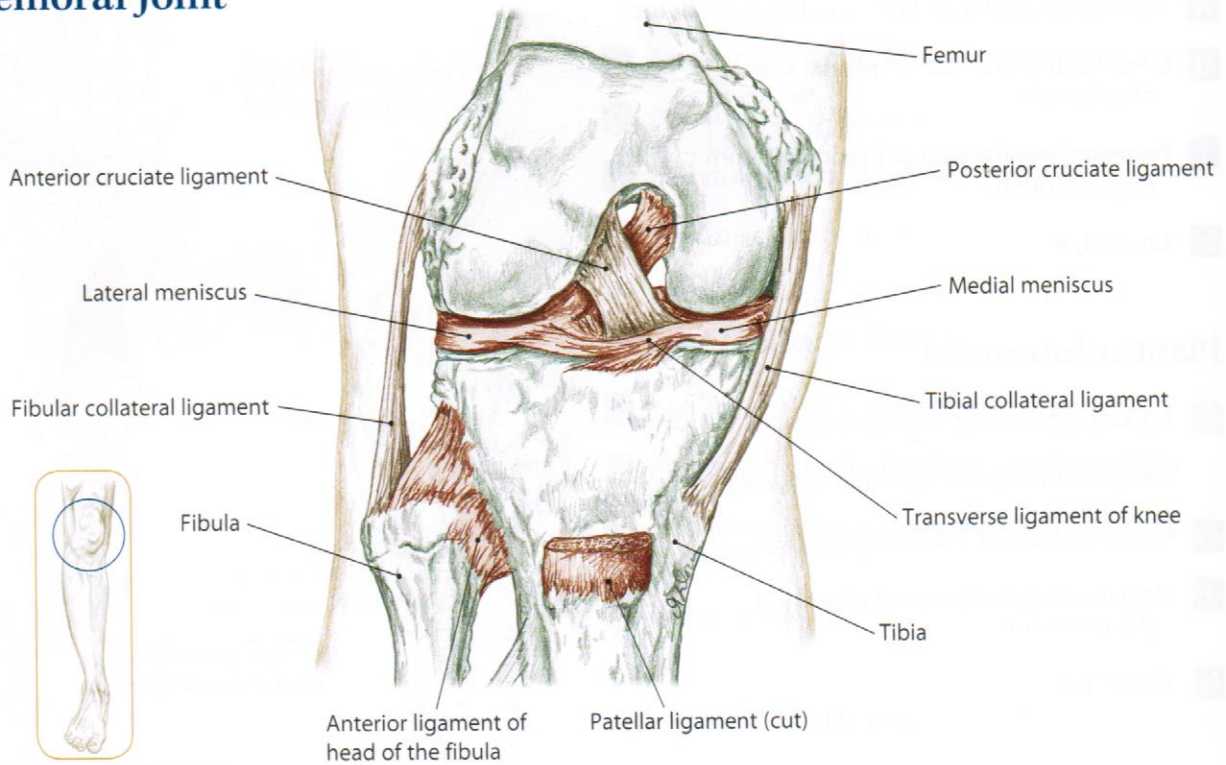


7.117 *Lumbricals, plantar view of right foot*

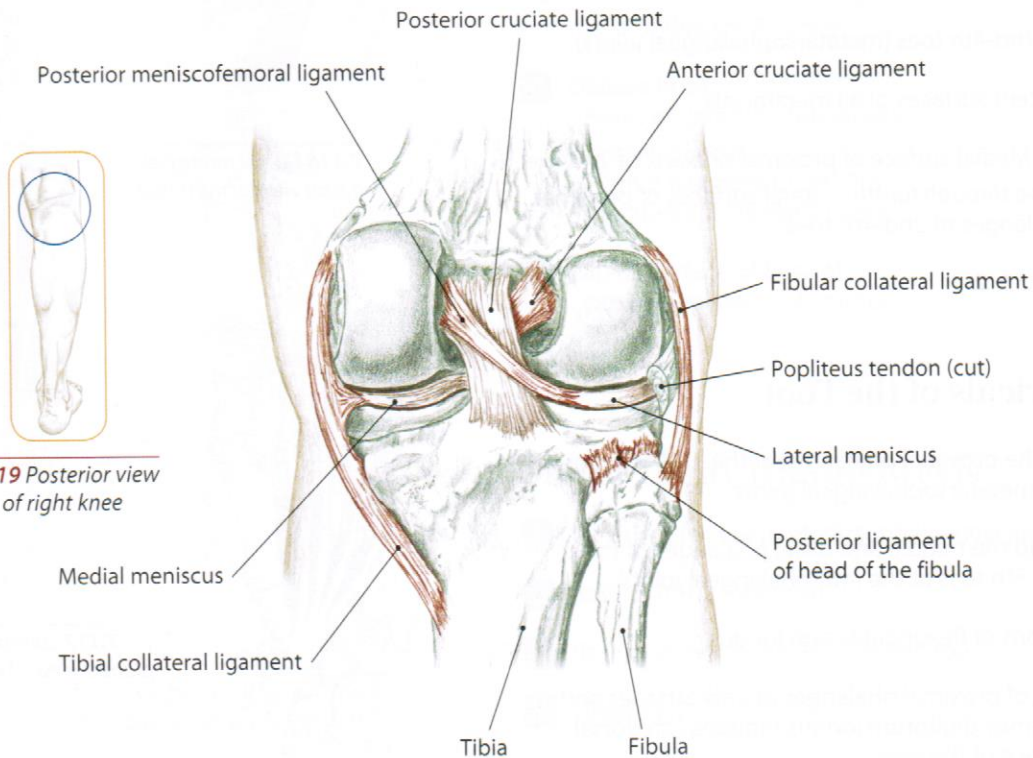


# Other Structures of the Knee and Leg

## Tibiofemoral Joint



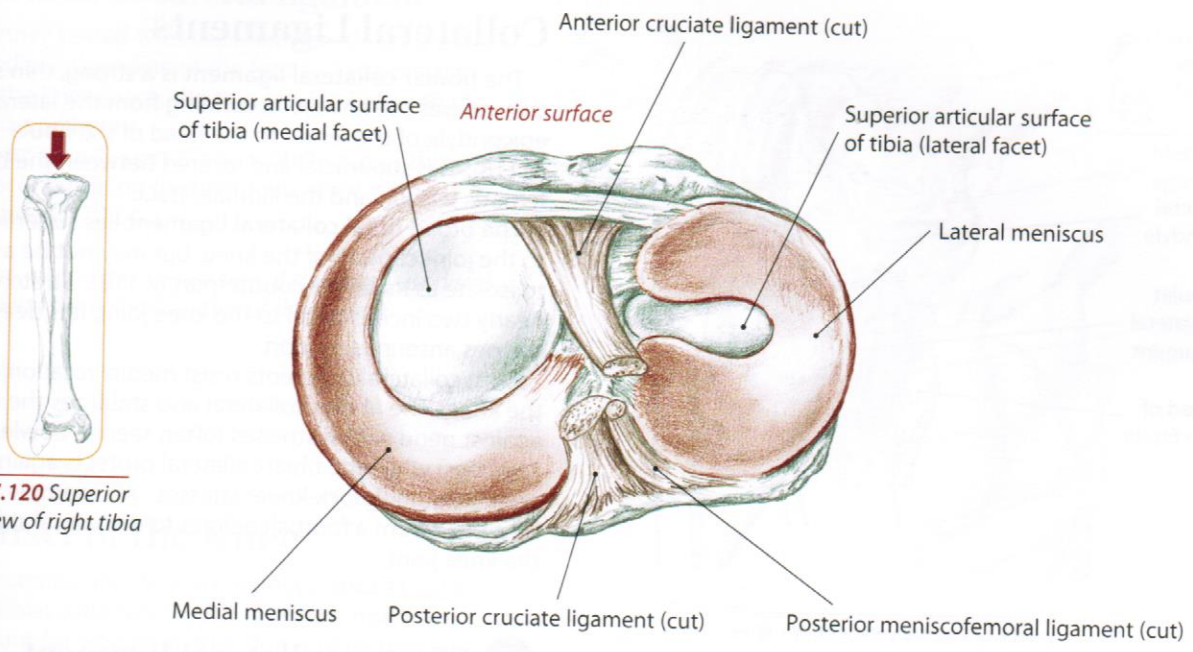
7.118 Anterior view of right knee with patella removed



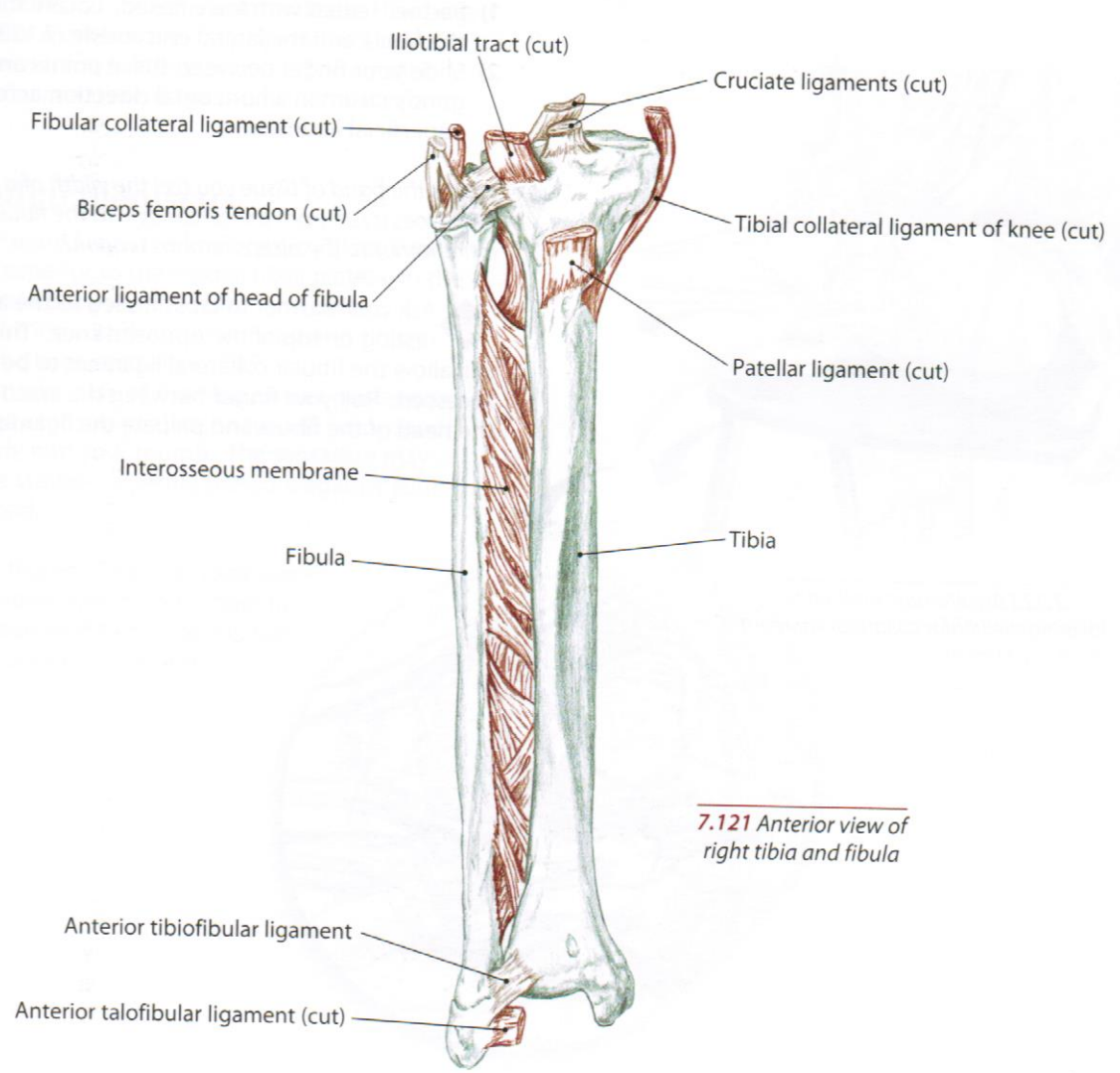
7.119 Posterior view of right knee

Leg & Foot

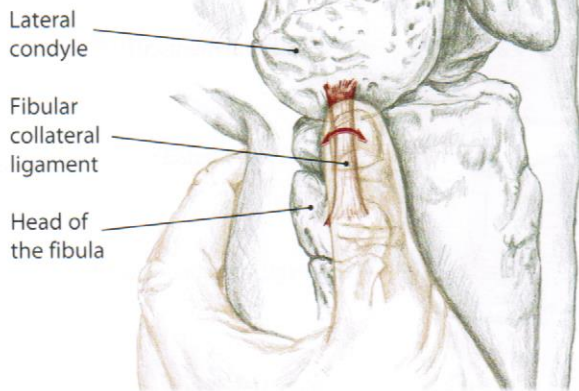
# Tibiofemoral and Tibiofibular Joints



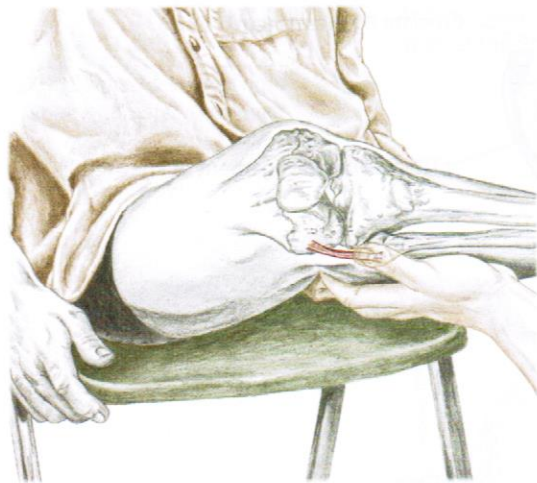
7.120 Superior view of right tibia



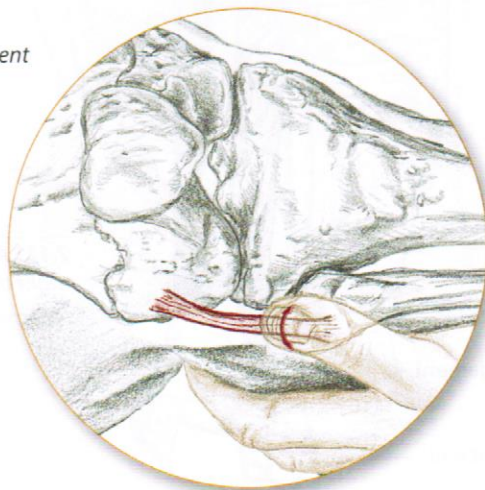
7.121 Anterior view of right tibia and fibula



7.122 Lateral view of right knee



7.123 An alternate method to locating the fibular collateral ligament



## Fibular and Tibial Collateral Ligaments

The **fibular collateral ligament** is a strong, thin strap that crosses the knee joint running from the lateral epicondyle of the femur to the head of the fibula (7.118). It is superficial and located between the biceps femoris tendon and the iliotibial tract.

The broad **tibial collateral ligament** lies superficial to the joint capsule of the knee, but may not be as easy to isolate as its lateral counterpart (7.118). Stretching nearly two inches distal to the knee joint, it is deep to the pes anserinus tendon.

Both collateral ligaments resist medial rotation of the knee. The fibular collateral also stabilizes the knee against genu varum stresses (often seen in bowlegged cowboys) while the tibial collateral protects against genu valgum (knock-knee) stresses. An example would be a blow from a football helmet to the lateral side of the knee joint.

### Fibular collateral ligament


- 1) Partner seated with knee flexed. Locate the head of the fibula and the lateral epicondyle (7.122).
- 2) Slide your finger between these points and gently strum in a horizontal direction across this superficial ligament.

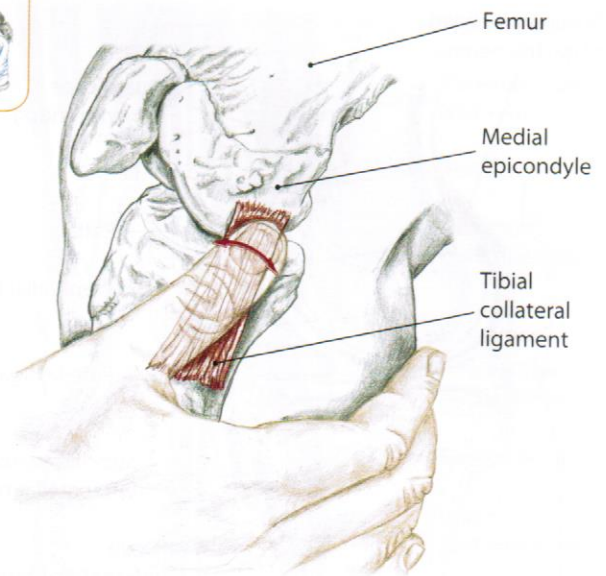
*Is the band of tissue you feel the width of a pencil?  
Does it run from the epicondyle to the fibular head?  
Is it anterior to the biceps femoris tendon?*

*Ask your partner to cross his leg so the ankle is resting on top of the opposite knee. This position will allow the fibular collateral ligament to be easily accessed. Roll your finger between the epicondyle and the head of the fibula and palpate the ligament (7.123).*

## Tibial collateral ligament

- 1) Partner seated with the knee flexed. Locate the medial epicondyle of the femur. Slide distally to the joint space, the thin crevice between the tibia and femur.
- 2) Strum your fingertip horizontally across this space, exploring for the broad fibers of the ligament (7.124).

 *Are you on the medial side of the knee, just distal to the medial epicondyle of the femur?*




7.124 Medial view of right knee

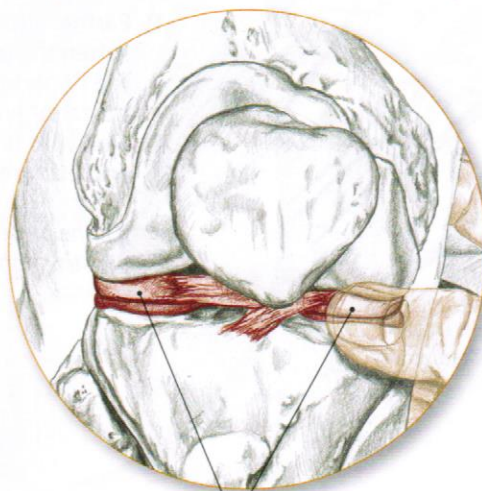
## Menisci of the Knee

The menisci are fibrocartilaginous discs attached to the tibial condyles (7.120). They are not only important for weight distribution and friction reduction, but also help the round femoral condyles sit comfortably upon the flat tibial plateaus. The edge of the medial meniscus can be palpated just above the edge of the medial tibial plateau. The smaller, more mobile lateral meniscus is difficult to access.

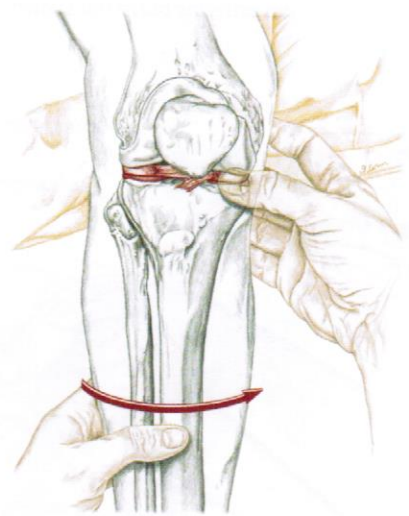
## Medial meniscus

- 1) Partner seated with the knee flexed. Place your thumb superior to the medial tibial plateau in the joint space between the femur and tibia.
- 2) Grasp the leg with your other hand and slowly rotate the knee medially (7.125).
- 3) As the medial side of the tibia rotates posteriorly, the edge of the medial meniscus will be pushed anteriorly into your thumb. The sensation may be quite subtle—a gentle pressure against your thumbpad.

 *Is your thumb in the knee joint space? If you slowly switch from lateral to medial rotation of the knee, do you feel a difference under your thumb?*



Menisci



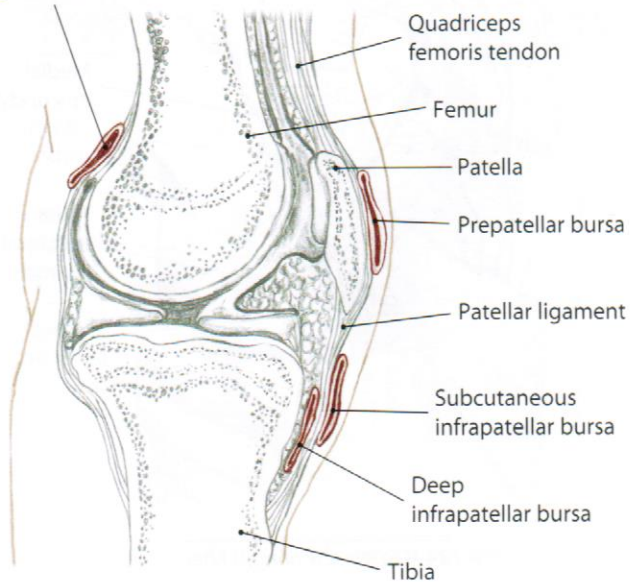
7.125 Anterior view of flexed right knee

meniscus  
menisci

men-**is**-kus  
men-**is**-ki

Grk. crescent-shaped  
plural for meniscus

Bursa under head of gastrocnemius



7.126 Lateral cross section of the knee, pes anserine bursa not shown

## Bursae of the Knee

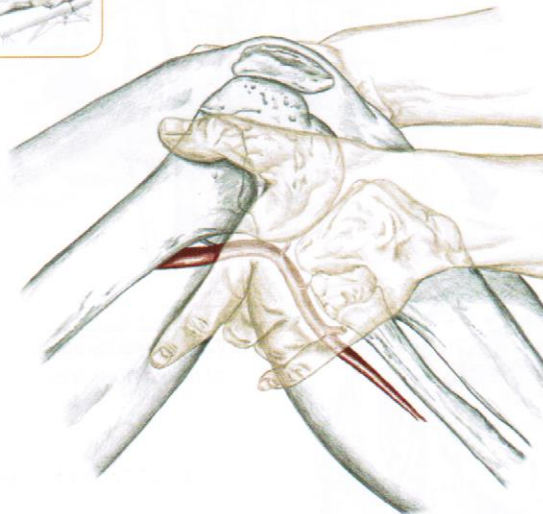
Tremendous pressures, repetitive movements and chafing tendons constantly challenge the knee joint. Nearly a dozen bursae help to protect the joint and its surrounding structures. The primary bursae are included here (7.126).

Lying superficial to the patella, the **prepatellar bursa** helps the skin to move freely over the patella, even with the knee flexed. Excessive kneeling and squatting can inflame the vulnerable bursa, a condition called "housemaid's knee" (or "carpenter's knee," depending on your vocation).

The **subcutaneous infrapatellar bursa** and the **deep infrapatellar bursa** are located on either side of the patellar ligament. The deep bursa reduces friction between the tendon and the surface of the tibia. The superficial bursa can become irritated with prolonged kneeling, sometimes called "parson's knee" (or "Buddhist's knee," depending on your faith).

The **pes anserine bursa** serves as a buffer between the pes anserinus tendons (those of the gracilis, sartorius and semitendinosus) and the tibia.

When inflamed, the superficial bursae of the knee are palpable and sometimes visible; under normal conditions, however, they are impalpable.



7.127 Lateral view of right knee, feeling the pulse of the popliteal artery

## Popliteal Artery

The popliteal artery branches from the femoral artery to pass through the popliteal fossa at the back of the knee. It is situated deep in the fossa and, for this reason, its pulse can be difficult to detect.



- 1) Partner supine. Flex your partner's knee in order to soften the overlying tissues. Hold the knee so that the fingertips of both hands are at the midline of the posterior knee.
- 2) Sink your fingertips deep into the popliteal fossa and explore for the subtle pulse (7.127).



If the pulse is undetectable, follow the same instructions with your partner prone.

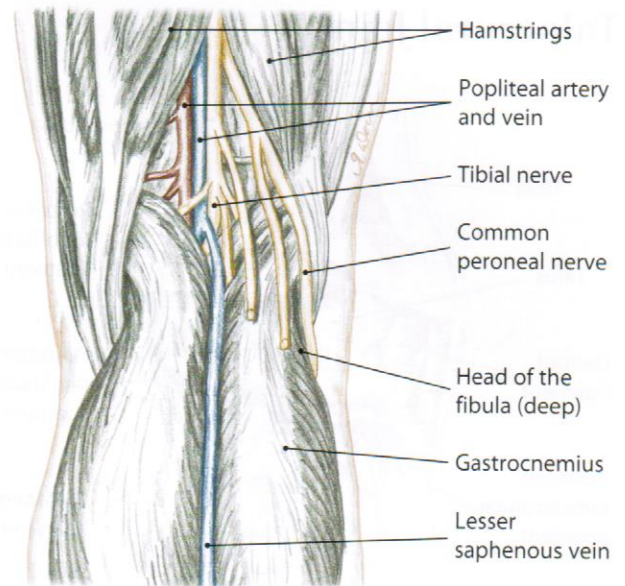
## Common Peroneal Nerve

Branching off from the sciatic nerve, the peroneal nerve courses superficially along the posterior/lateral side of the knee. Roughly the diameter of a thick piece of spaghetti, it lies medial to the biceps femoris tendon and lateral to the gastrocnemius belly. It becomes particularly accessible (and vulnerable) along the posterior surface of the head of the fibula (7.128).

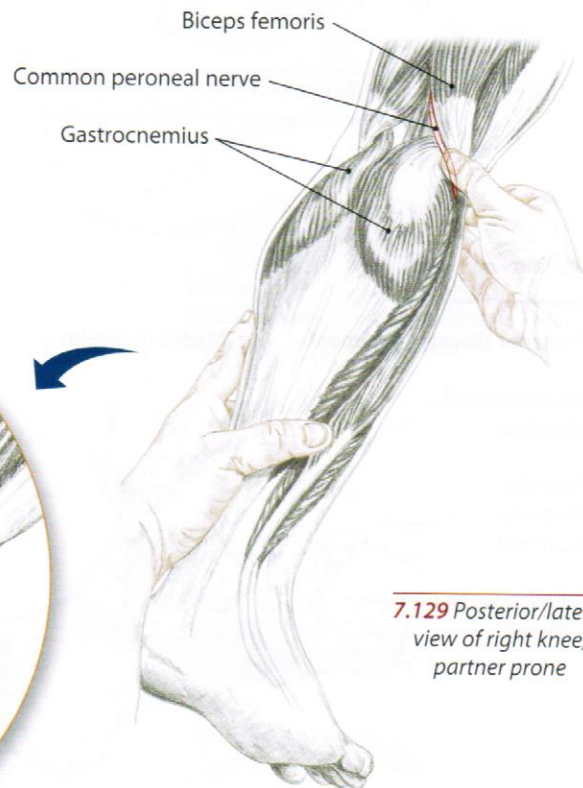


- 1) Partner prone. Passively flex the knee and locate the biceps femoris tendon and head of the fibula.
- 2) Gently roll your thumb from side to side, exploring the region just distal to the biceps tendon on the posterior surface of the fibular head.
- 3) Distinguish between the slender, slightly mobile nerve and the gastrocnemius fibers by asking your partner to gently flex her knee against your resistance. The nerve, of course, will remain soft and mobile, while the muscle fibers will become taut (7.129).

*Locate the biceps femoris tendon by asking your partner to flex her knee against your resistance. Follow the tendon to the head of the fibula, noting the nerve pathway that runs alongside it. If you follow the nerve past the head of the fibula, does it continue down the lateral side of the leg?*



7.128 Posterior view of right knee

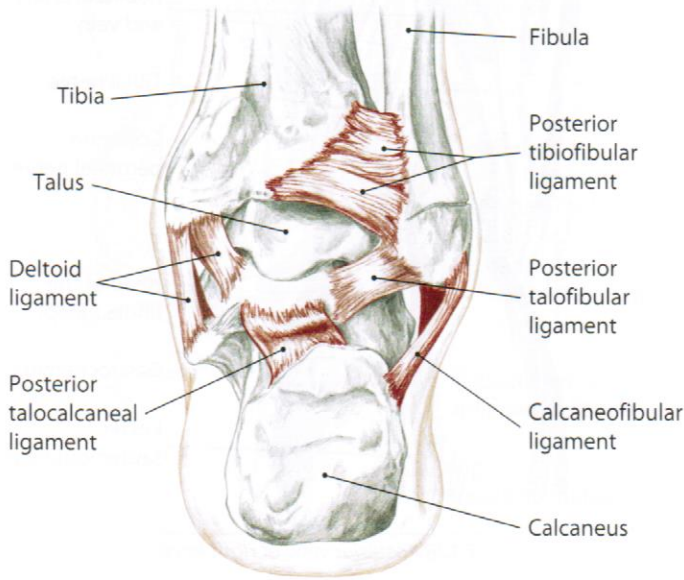


7.129 Posterior/lateral view of right knee, partner prone



# Other Structures of the Ankle and Foot

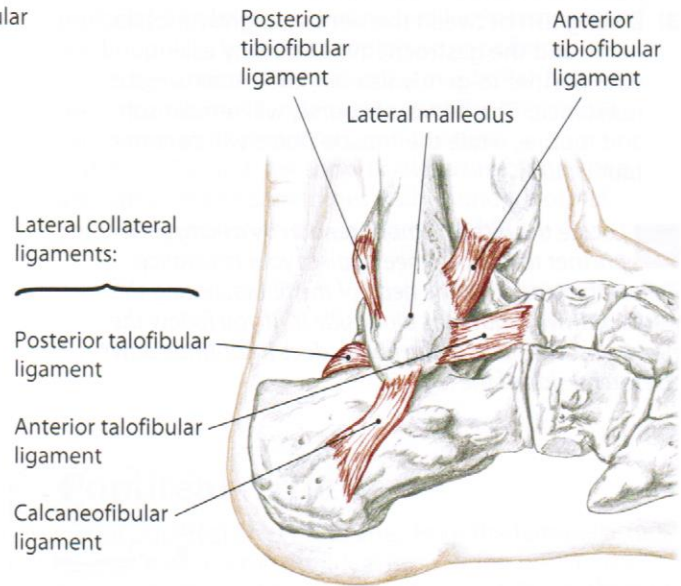
## Talocrural Joint



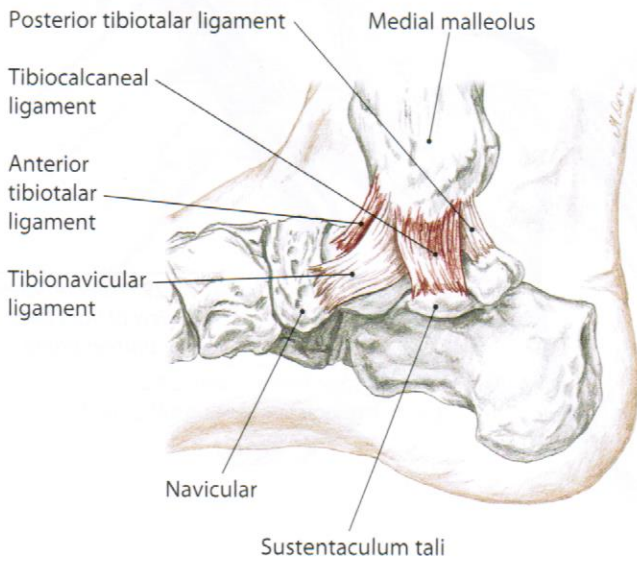
7.130 Posterior view of right ankle, showing ligaments of talocrural joint



7.131 Lateral view of right ankle, showing ligaments of talocrural joint



Deltoid ligament:

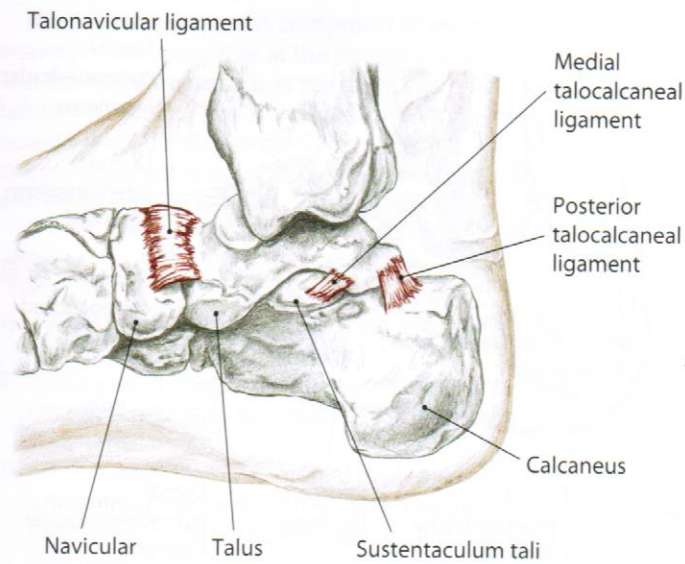


7.132 Medial view of right ankle, showing ligaments of talocrural joint

calcaneofibular  
talocalcaneal  
talofibular

kal-ka-ne-o-fib-u-lar  
ta-lo-kal-ka-ne-al  
ta-lo-fib-u-lar

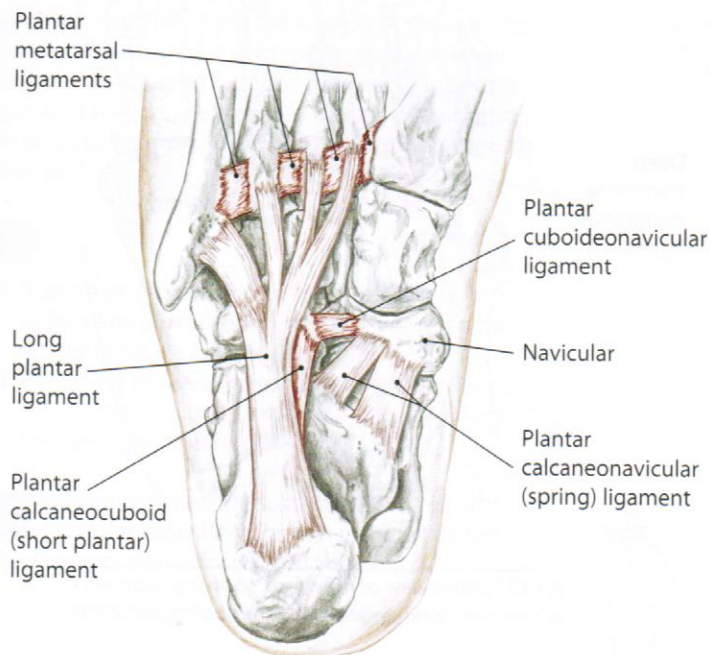
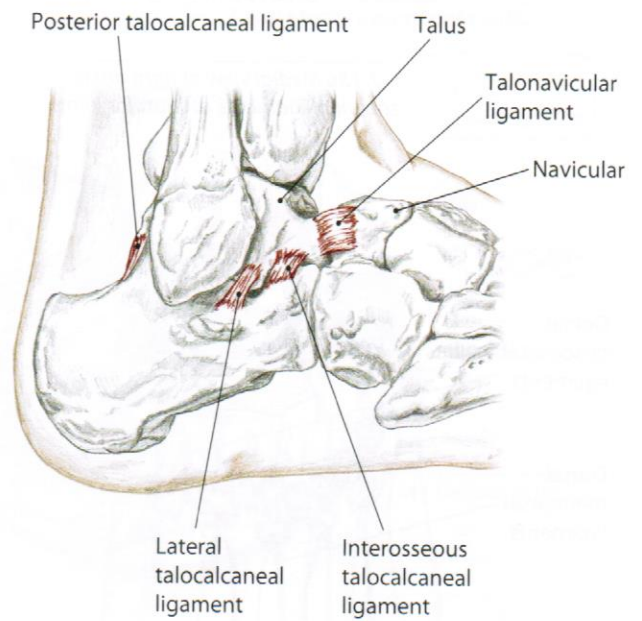
# Talotarsal Joints and Ligaments of the Foot



7.133 Medial view of right ankle showing ligaments of talotarsal joints



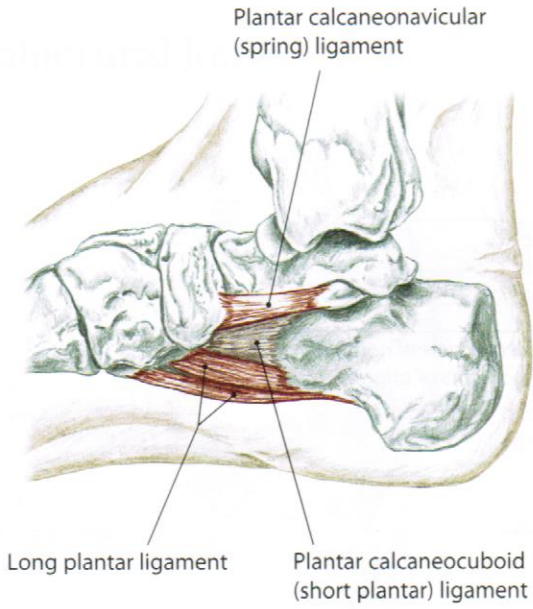
7.134 Lateral view of right ankle showing ligaments of talotarsal joints



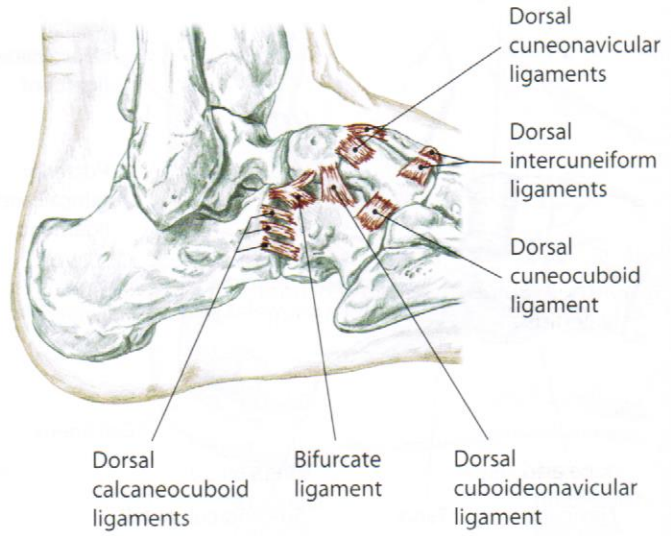
7.135 Plantar view of right foot showing ligaments of foot

calcaneocuboid kal-ka-ne-o-ku-boyd  
 cuboideonavicular ku-boyd-e-o-na-vik-u-lar  
 talonavicular ta-lo-na-vik-u-lar

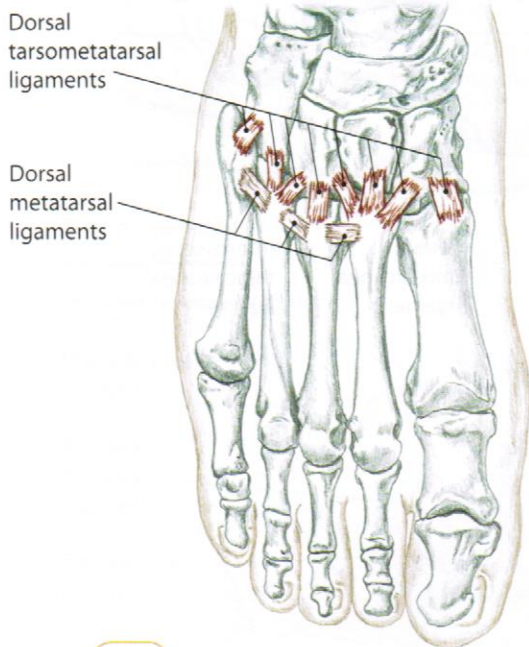
# Ligaments of the Foot



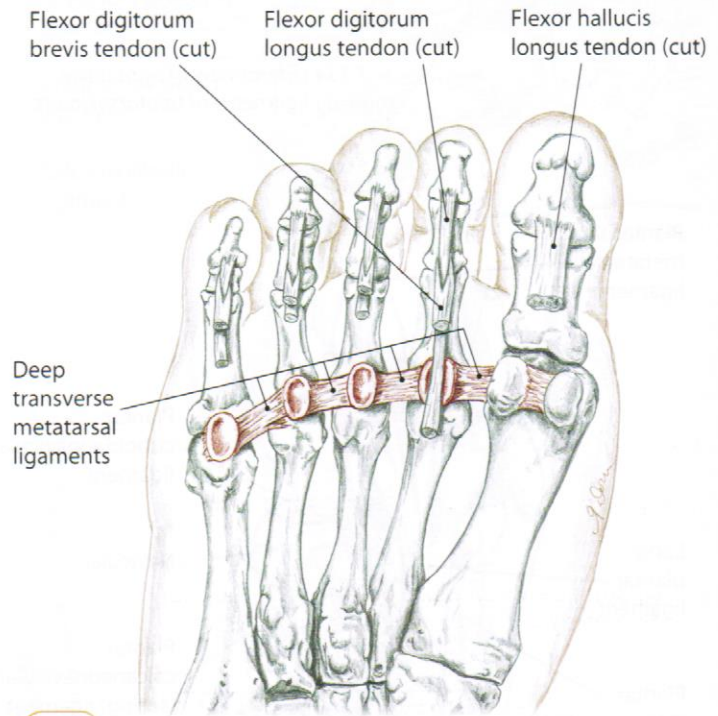
**7.136** Medial view of right ankle, showing ligaments of subtalar joints



**7.137** Lateral view of right ankle, showing ligaments of intertarsal joints



**7.138** Dorsal view of right foot, showing ligaments of tarsometatarsal and intermetatarsal joints



**7.139** Plantar view of right foot, showing ligaments of metatarsophalangeal and interphalangeal joints

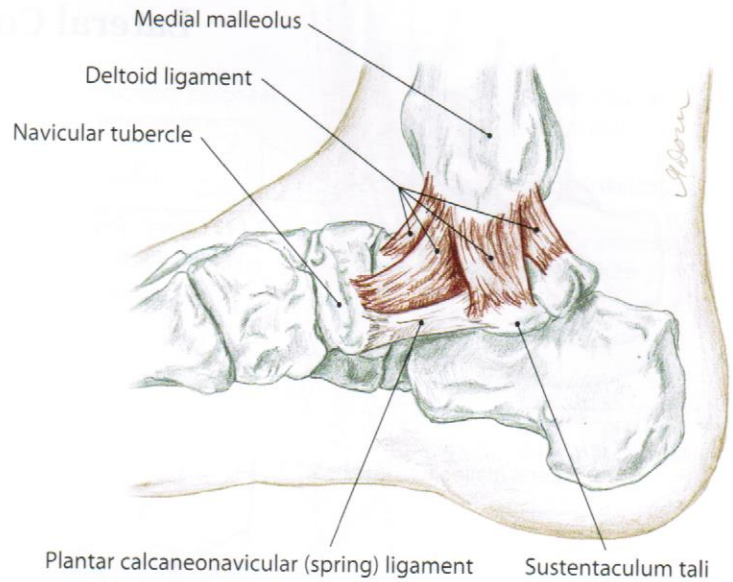
## Deltoid Ligament

The deltoid ligament is composed of several ligaments that originate at the medial malleolus and fan distally to attach at the talus, sustentaculum tali and navicular (7.140). It is designed to protect against medial stress of the talocrural joint. The deltoid ligament is deep to the flexor retinaculum and flexor tendons (p. 381), yet is palpable.

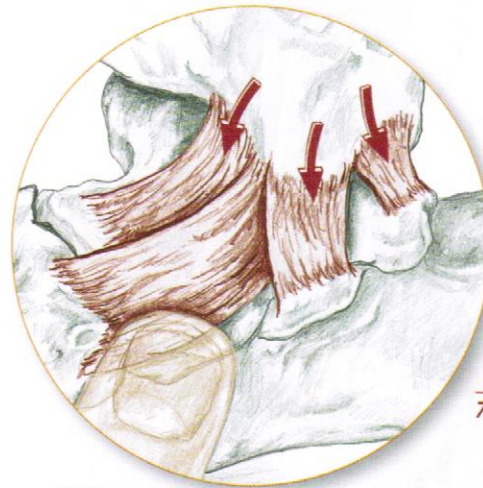


- 1) Partner supine or seated. Locate the medial malleolus and sustentaculum tali.
- 2) Place your finger between these points and strum horizontally to isolate the fibers of the ligaments.
- 3) Slide distally from the medial malleolus at a 45° angle and palpate its angled fibers to define the anterior and posterior aspects of the deltoid ligament (7.141).

Are you palpating in the space between the medial malleolus and sustentaculum tali? Do the fibers you feel fan out from the medial malleolus and have a firm, dense texture?



7.140 Medial view of right ankle



7.141 Deltoid ligament

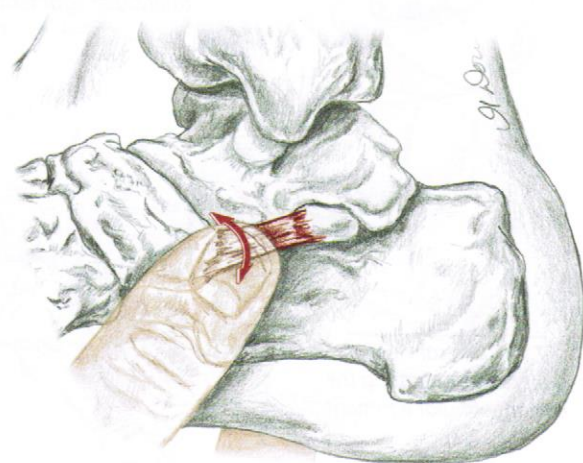
## Plantar Calcaneonavicular (Spring) Ligament

The spring ligament is a small, tough band of tissue that plays an important role in stabilizing the medial longitudinal arch of the foot (7.140). Located along the medial side of the foot, the ligament stretches from the sustentaculum tali to the navicular tubercle and might be positioned deep to the tibialis posterior tendon. The spring ligament might be extremely tender and should be accessed slowly. Be sure to communicate with your partner.



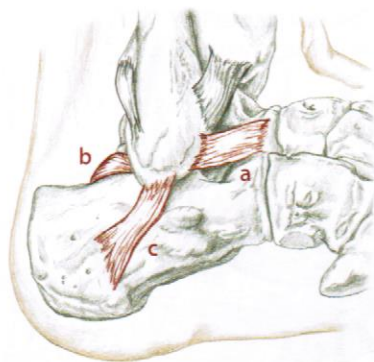
- 1) Supine or seated. Passively invert the foot to soften any surrounding tissue and locate the sustentaculum tali and navicular tubercle.
- 2) Palpating between these bony landmarks, use a fingertip to slowly explore the taut surface of the spring ligament (7.142).

Are you between the sustentaculum tali and navicular tubercle? Can you roll your fingertip slowly across the surface of the ligament?

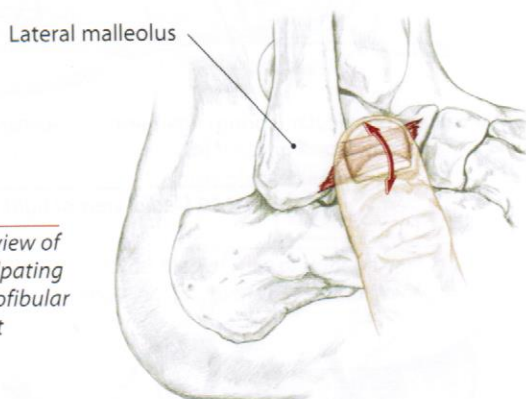


7.142 Medial view, palpating the spring ligament

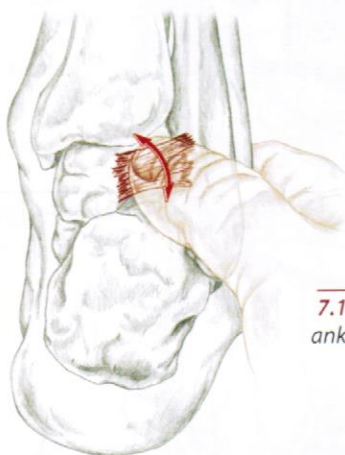
## Lateral Collateral Ligaments of the Ankle



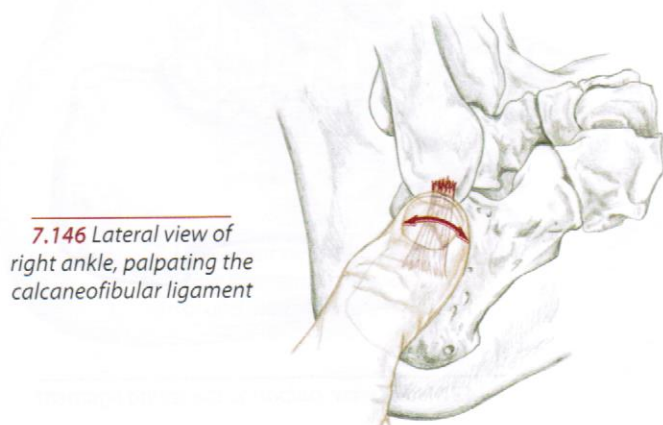
7.143 Lateral view of right ankle



7.144 Lateral view of right ankle, palpating the anterior talofibular ligament



7.145 Posterior view of right ankle, palpating the posterior talofibular ligament



7.146 Lateral view of right ankle, palpating the calcaneofibular ligament

To understand why the ankle is the most frequently injured articulation in the body, you might begin with the ankle's lateral collateral ligaments. Designed to stabilize the distal end of the fibula to the calcaneus and talus, these three bands are the most often torn ligaments during ankle sprains. They are nowhere near as strong as the deltoid ligament on the ankle's medial side and are most vulnerable when the foot is inverted and plantarflexed.

The **anterior talofibular ligament** (7.143, a) spans from the anterior surface of the lateral malleolus to the lateral side of the talus' neck. When the foot is weight-bearing and excessively inverted, this ligament is often the first to be torn.

The **posterior talofibular ligament** (b) is much stronger than its anterior counterpart and only damaged in the most severe of ankle injuries, such as dislocations. It attaches to the posterior side of the lateral malleolus and the talus' lateral tubercle.

Between these two ligaments is the **calcaneofibular ligament** (c). It spans from the lateral malleolus down to the lateral surface of the calcaneus, deep to the peroneal tendons. Only during severe ankle sprains, after the anterior talofibular has ripped, will this ligament be torn, as well.



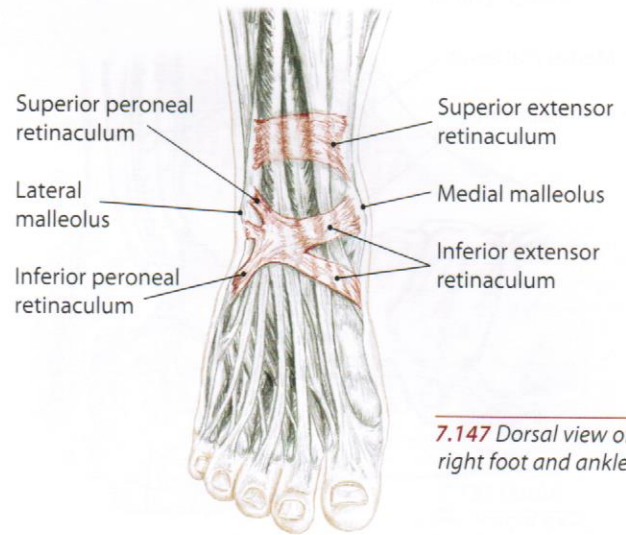
- 1) Partner supine or seated.
- 2) **Anterior talofibular** (7.144): This ligament is not very distinguishable, but its position can be isolated by first locating the anterior aspect of the lateral malleolus. Slide your thumb toward the head of the talus (p. 360), roughly an inch. The ligament passes just medial to the extensor digitorum brevis belly (p. 387).
- 3) **Posterior talofibular** (7.145): Set your finger on the posterior side of the lateral malleolus. Continue around the malleolus to the surface of the talus' lateral tubercle. (If you reach the calcaneal tendon, you have gone too far.) Between these landmarks will be the ligament. Also, use gentle pressure here since this region can often be tender.
- 4) **Calcaneofibular** (7.146): Locate the distal end of the lateral malleolus and the lateral aspect of the calcaneus. This ligament runs at a slight oblique angle and passes posterior to the peroneal tubercle.

## Retinacula of the Ankle

The tendons of the extensor muscles (p. 378) are supported by the superior and inferior extensor retinacula. The **superior extensor retinaculum** is broad and crosses the front of the ankle just proximal to the malleoli. The **inferior extensor retinaculum** is Y-shaped and begins distal to the lateral malleolus on the calcaneus. It spans the ankle and then divides, with one fork attaching at the medial malleolus and the other connecting to the navicular (7.147).

The peroneal muscles are stabilized by the superior and inferior peroneal retinacula. The **superior peroneal retinaculum** stretches from the lateral malleolus to the calcaneus, and the **inferior peroneal retinaculum** pins the peroneal tendons down at the peroneal tubercle.

The **flexor retinaculum** is a broad strap extending from the medial calcaneus to the medial malleolus. It is designed to hold in place the tendons of the flexor muscles and the tibial artery and nerve (7.150).



7.147 Dorsal view of right foot and ankle

### Extensor retinacula

- 1) Partner supine. Ask your partner to dorsiflex her ankle and extend her toes. The pressure from the bulging tendons will make the retinacula more pronounced.
- 2) Palpate an inch proximal to the medial malleolus for the broad fibers of the superior extensor retinaculum.
- 3) Locate the inferior extensor retinaculum by moving distally to the level of the malleolus (7.148). Explore either side of the large tibialis anterior tendon for easy access to this retinaculum.




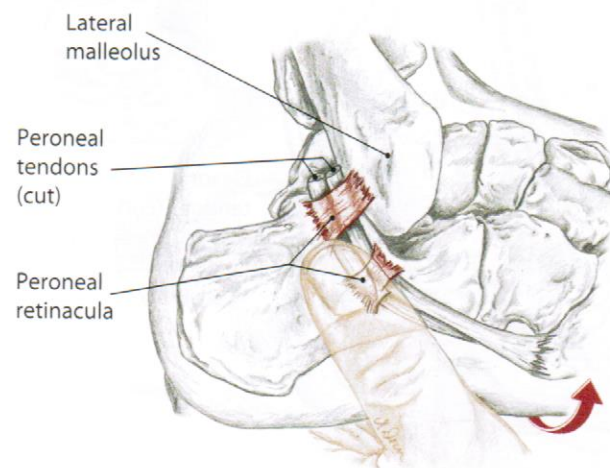
7.148 Partner extending her toes

 Are the fibers you are accessing superficial and perpendicular to the extensor tendons? Ask your partner to relax her ankle and notice how the retinacula soften.

### Peroneal retinacula

- 1) Ask your partner to evert her foot. The tension from the peroneal tendons will make the retinacula more pronounced.
- 2) Locate the peroneal tendons between the lateral malleolus and lateral calcaneus (7.149). Roll your fingers along either side of the peroneal tendons to feel the small, short fibers of the retinacula.

 For the superior retinaculum, does the tissue you feel strap across the peroneal tendons from the lateral calcaneus to the lateral malleolus? For the inferior retinaculum, do you feel a short band crossing over the peroneal tubercle?

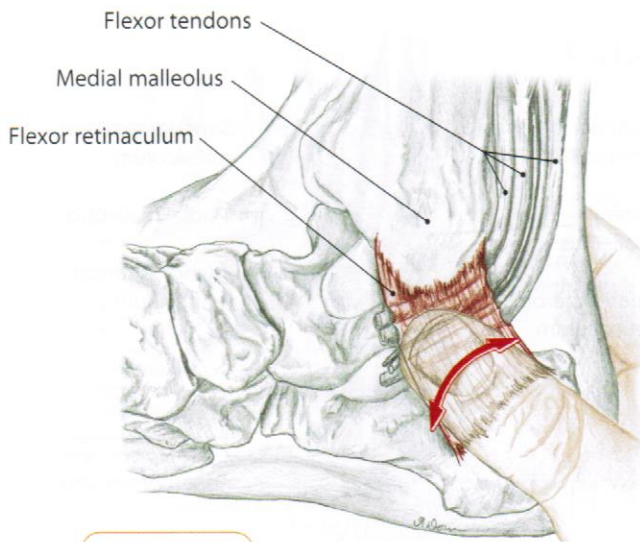


7.149 Lateral view of right ankle, partner everting foot

retinaculum  
retinacula

ret-i-nak-u-lum  
ret-i-nak-u-la

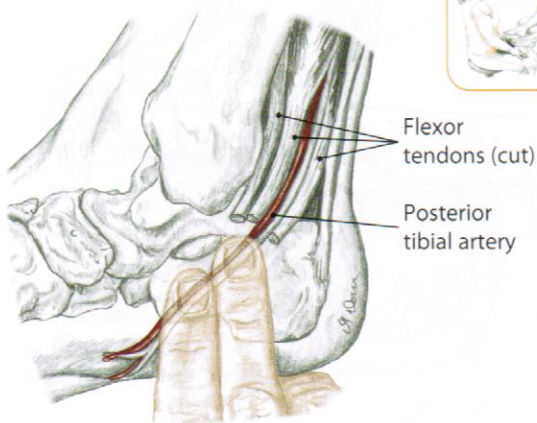
L. halter, band, rope  
plural for retinaculum



7.150 Medial view of right ankle



7.151 Plantar view of right foot



7.152 Medial view of right ankle

## Flexor retinaculum

- 1) Ask your partner to dorsiflex and invert her foot. The tension from the flexor tendons will elevate the retinaculum closer to the surface.
- 2) Locate the medial malleolus and the medial side of the calcaneus.
- 3) Palpate between these landmarks, strumming across the broad, superficial fibers of the flexor retinaculum (7.150).

Are you between the medial calcaneus and medial malleolus? Continue to explore the retinaculum with the foot relaxed.

## Plantar Aponeurosis

The plantar aponeurosis is a thick, superficial band of fascia stretching from the heel to the ball of the foot (7.151). Originating from the tuberosity of the calcaneus and expanding toward the metatarsal heads, it is important for supporting the longitudinal arch of the foot. Because the aponeurosis is located between the skin and muscles of the foot, it can be difficult to isolate from the surrounding tissues.



- 1) Partner seated or supine. Crossing the ball of the foot, draw an imaginary triangle extending down to the heel.
- 2) Within this triangle explore the superficial layers of tissue along the sole of the foot. Passively flex and extend the toes, noting how this movement affects the tension of the plantar aponeurosis.

## Posterior Tibial Artery

The posterior tibial artery extends from the popliteal artery. It is superficial and its pulse can be felt just inferior and posterior to the medial malleolus.



- 1) Partner supine. Locate the medial malleolus. Using two fingerpads, slide posterior to the malleolus and feel for the pulse of the artery (7.152).

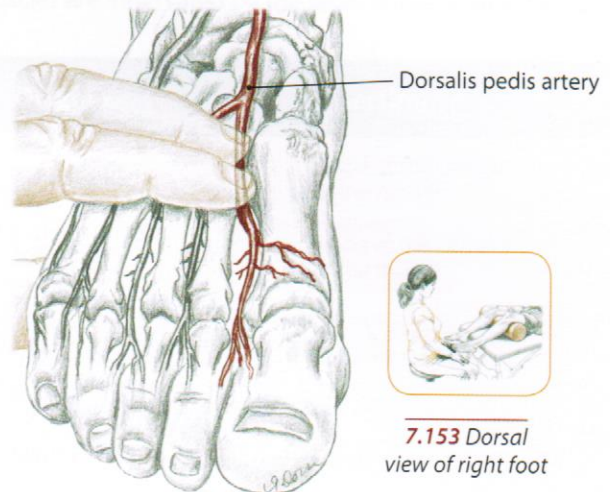
## Dorsalis Pedis Artery

Located between the first and second metatarsal bones, the dorsalis pedis artery lies superficial along the dorsal side of the foot.



- 1) Partner supine. Locate the first and second metatarsals. Place two fingerpads between the two bones and, using gentle pressure, explore for the pulse of the dorsalis pedis artery (7.153).

Are you lateral to the extensor hallucis longus tendon? If the pulse is undetectable, move slightly lateral.



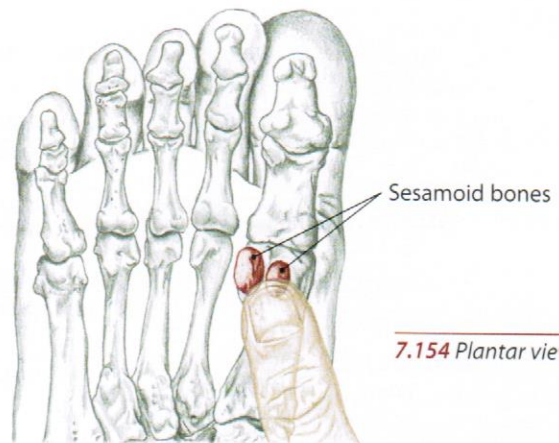
7.153 Dorsal view of right foot

## Sesamoid Bones of First Metatarsal

The sesamoid bones of the first metatarsal are located along the plantar surface of the first metatarsal head. Usually there are two of these bones, but sometimes more are present. The sesamoids are spherical and imbedded in the tendon of the flexor hallucis brevis. Often only their location and density, not their specific shapes, are palpable.



- 1) Partner seated or supine. Locate the head of the first metatarsal. Slide around to its plantar surface at the ball of the foot.
- 2) Using your thumb pad, explore this surface for the small sesamoid bones. Passively flex and extend the first toe to soften the surrounding tissues (7.154).



7.154 Plantar view

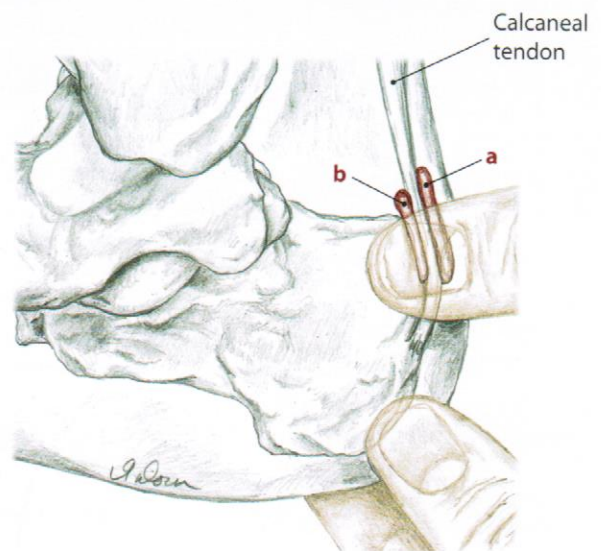
## Calcaneal Bursae

The **calcaneal bursa (a)** is located between the attachment of the calcaneal tendon and the overlying skin. The **retrocalcaneal bursa (b)** is positioned on the opposite side of the calcaneal tendon. It serves to cushion the tendon against the calcaneus.

Both bursae are impalpable; however, they can become thick or inflamed from tight shoes and, especially, from high heels.



- 1) Partner seated or supine. With the ankle in a neutral position, locate the calcaneal tendon.
- 2) Follow it distally until it merges into the calcaneus. Gently squeeze the skin posterior to the tendon. This is where the calcaneal bursa is located (7.155).
- 3) Shift your fingers between the tendon and calcaneus. If the bursae are healthy, they will not be palpable.



7.155 Medial view of right foot

... to arrive where we started  
and know the place for the first time ...





# Muscles of Facial Expression Attachment Sites

All of these muscles are innervated by the facial nerve (cranial nerve VII).

	Muscle/Nerve (facial)	Action	Origin	Insertion
Mouth	Buccinator	Compress the cheeks	Maxilla and mandible	Fascia at the corner of the mouth
	Depressor anguli oris	Draw the corner of the mouth inferiorly and laterally	Mandible	Fascia at the corner of the mouth
	Depressor labii inferioris	Depress the corner of the mouth; Depress, protrude and draw the lower lip laterally	Mandible	Fascia of the lower lip
	Levator anguli oris	Elevate corner of the mouth	Maxilla	Corner of the mouth
	Levator labii superioris	Elevate and protrude the upper lip	Maxilla	Fascia of the upper lip
	Mentalis	Elevate and protrude the lower lip; Wrinkle the skin of the chin	Mandible	Skin of the chin
	Orbicularis oris	Close the mouth; Shape and protrude the lips	Muscle fibers surrounding opening of mouth	Skin at corner of the mouth
	Platysma	Depress the mandible; Tighten the fascia of the neck	Fascia covering superior portion of pectoralis major	Lower border of the mandible
	Risorius	Retract the corner of the mouth laterally	Fascia superficial to the masseter	Fascia at corner of the mouth
	Zygomaticus major	Elevate and draw the corner of the mouth laterally	Zygomatic bone	Fascia at the corner of the mouth
Zygomaticus minor	Elevate and protrude the upper lip; Deepen the nasolabial fold	Zygomatic bone	Fascia and muscle tissue of the upper lip	
Nose	Levator labii superioris alaeque nasi	Flare the nostril; Elevate and protrude the upper lip	Maxilla	Fascia of the upper lip and nose
	Nasalis, alar portion	Flare the nostril	Maxilla	Ala of the nose
	Procerus	Draw down the medial eyebrows; Pull the skin of the nose upward	Fascia over the nasal bone	Fascia and skin between the eyes
Eye	Corrugator supercilii	Draw the eyebrow medially and inferiorly	Inferior portion of the frontal bone to the fascia	Skin deep to the medial portion of the eyebrow
	Orbicularis oculi	Depress the upper eyelid; Elevate the lower eyelid	Muscle fibers surrounding opening of eye	Skin at corner of the eye
Scalp	Frontalis	Raise the eyebrows; Wrinkle the forehead	Galea aponeurotica	Skin superior to the eyebrows
	Occipitalis	Anchor and retract the galea aponeurotica posteriorly	Galea aponeurotica	Superior nuchal line of the occiput



# Synergists—Muscles Working Together

## Shoulder (p.63-65)

(glenohumeral joint)

### Flexion

(antagonists on extension)

Deltoid (anterior fibers)  
Pectoralis major (upper fibers)  
Biceps brachii  
Coracobrachialis

### Extension

(antagonists on flexion)

Deltoid (posterior fibers)  
Latissimus dorsi  
Teres major  
Pectoralis major (lower fibers)  
Triceps brachii (long head)

### Horizontal Abduction

(antagonist on h. adduction)

Deltoid (posterior fibers)

### Horizontal Adduction

(antagonists on h. abduction)

Deltoid (anterior fibers)  
Pectoralis major (upper fibers)

### Abduction

(antagonists on adduction)

Deltoid (all fibers)  
Supraspinatus

### Adduction

(antagonists on abduction)

Latissimus dorsi  
Teres major  
Infraspinatus  
Teres minor  
Pectoralis major (all fibers)  
Triceps brachii (long head)  
Coracobrachialis

### Lateral Rotation (external rotation)

(antagonists on medial rotation)

Deltoid (posterior fibers)  
Infraspinatus  
Teres minor

### Medial Rotation (internal rotation)

(antagonists on lateral rotation)

Deltoid (anterior fibers)  
Latissimus dorsi  
Teres major  
Subscapularis  
Pectoralis major (all fibers)

## Scapula (p. 65-66)

(scapulothoracic joint)

### Elevation

(antagonists on depression)

Trapezius (upper fibers, unilaterally)  
Rhomboid major  
Rhomboid minor  
Levator scapula (unilaterally)

### Depression

(antagonists on elevation)

Trapezius (lower fibers)  
Serratus anterior (with the origin fixed)  
Pectoralis minor

### Adduction (retraction)

(antagonists on abduction)

Trapezius (middle fibers)  
Rhomboid major  
Rhomboid minor

### Abduction (protraction)

(antagonists on adduction)

Serratus anterior (with the origin fixed)  
Pectoralis minor

### Upward Rotation

(antagonists on downward rotation)

Trapezius (upper and lower fibers, unilaterally)  
Serratus anterior (with the origin fixed)

### Downward Rotation

(antagonists on upward rotation)

Rhomboid major  
Rhomboid minor  
Levator scapula (unilaterally)  
Pectoralis minor

## Elbow (p. 130)

(humeroulnar and humeroradial joints)

### Flexion

(antagonists on extension)

Biceps brachii  
Brachialis  
Brachioradialis  
Flexor carpi radialis (assists)  
Flexor carpi ulnaris (assists)  
Palmaris longus (assists)  
Pronator teres (assists)  
Extensor carpi radialis longus (assists)  
Extensor carpi radialis brevis (assists)

### Extension

(antagonists on flexion)

Triceps brachii (all heads)  
Anconeus

## Forearm (p. 130)

(proximal and distal radioulnar joints)

### Supination

(antagonists on pronation)

Biceps brachii  
Supinator  
Brachioradialis (assists)

### Pronation

(antagonists on supination)

Pronator teres  
Pronator quadratus  
Brachioradialis (assists)

## Wrist (p. 130-131)

(radiocarpal joint)

### Extension

(antagonists on flexion)

Extensor carpi radialis longus  
Extensor carpi radialis brevis  
Extensor carpi ulnaris  
Extensor digitorum (assists)  
Extensor indicis (assists)

### Flexion

(antagonists on extension)

Flexor carpi radialis  
Flexor carpi ulnaris  
Palmaris longus  
Flexor digitorum superficialis  
Flexor digitorum profundus (assists)  
Flexor pollicis longus (assists)

### Abduction (radial deviation)

(antagonists on adduction)

Extensor carpi radialis longus  
Extensor carpi radialis brevis  
Extensor pollicis longus  
Extensor pollicis brevis  
Flexor carpi radialis  
Abductor pollicis longus

### Adduction (ulnar deviation)

(antagonists on abduction)

Extensor carpi ulnaris  
Flexor carpi ulnaris

## Hand and Fingers (p. 131)

(metacarpophalangeal, proximal and distal interphalangeal joints)

### Flexion of the second through fifth fingers

(antagonists on extension of fingers)

Flexor digitorum superficialis  
Flexor digitorum profundus  
Flexor digiti minimi brevis (5th)  
Lumbricals  
Dorsal interossei (2nd-4th, assists)  
Palmar interossei (2nd, 4th, 5th, assists)

### Extension of the second through fifth fingers

(antagonists on flexion of fingers)

Extensor digitorum  
Lumbricals  
Dorsal interossei (2nd-4th, assists)  
Palmar interossei (2nd, 4th, 5th, assists)  
Extensor indicis (2nd)

### Abduction of the second through fifth fingers

(antagonists on adduction of fingers)

Dorsal interossei (2nd-4th)  
Abductor digiti minimi (5th)

### Adduction of the second through fifth fingers

(antagonists on abduction of fingers)

Palmar interossei (2nd, 4th, 5th)  
Extensor indicis (2nd)

### Opposition of the fifth finger

Opponens digiti minimi  
Abductor digiti minimi (assists)  
Flexor digiti minimi brevis (assists)

## Thumb (p. 131)

(first carpometacarpal and metacarpophalangeal joints)

### Flexion

(antagonists on extension)

Flexor pollicis longus  
Flexor pollicis brevis  
Adductor pollicis (assists)  
Palmar interossei (1st, assists)

### Extension

(antagonists on flexion)

Extensor pollicis longus  
Extensor pollicis brevis  
Abductor pollicis longus  
Palmar interossei (1st, assists)

### Abduction

(antagonists on adduction)

Abductor pollicis longus  
Abductor pollicis brevis

### Adduction

(antagonists on abduction)

Adductor pollicis  
Palmar interossei (1st)

### Opposition

Opponens pollicis  
Flexor pollicis brevis (assists)  
Abductor pollicis brevis (assists)

## Vertebral Column (194-195)

### Flexion

(antagonists on extension)

Rectus abdominis  
External oblique (bilaterally)  
Internal oblique (bilaterally)  
Psoas major (with the insertion fixed)  
Iliacus (with the insertion fixed)

### Extension

(antagonists on flexion)

Longissimus (bilaterally)  
Iliocostalis (bilaterally)  
Multifidi (bilaterally)  
Rotatores (bilaterally)  
Semispinalis capitis  
Spinalis (bilaterally)  
Quadratus lumborum (assists)  
Interspinalis  
Intertransversarii (bilaterally)  
Latissimus dorsi (assists, See box, p. 71)

### Rotation

(all unilaterally)

External oblique (to the opposite side)  
Internal oblique (to the same side)  
Multifidi (to the opposite side)  
Rotatores (to the opposite side)

### Lateral Flexion

(unilaterally to the same side)

Iliocostalis  
External oblique  
Internal oblique  
Longissimus  
Quadratus lumborum  
Psoas major (assists)  
Intertransversarii  
Spinalis  
Latissimus dorsi (See box, p. 71)

## Ribs/Thorax (p. 195)

### Elevation/Expansion (involved with inhalation)

(antagonists on depression)

Anterior scalene (bilaterally)  
Middle scalene (bilaterally)  
Posterior scalene (bilaterally)  
Sternocleidomastoid (assists)  
External intercostals (assists)  
Serratus posterior superior  
Pectoralis major (all fibers, assists with arm fixed)  
Pectoralis minor (with scapula fixed)  
Serratus anterior (with scapula fixed)  
Subclavius (first rib)

### Depression/Collapse (involved with exhalation)

(antagonists on elevation)

Internal intercostals (assists)  
Serratus posterior inferior

### Muscles of Inhalation

Diaphragm  
Anterior scalene (bilaterally)  
Middle scalene (bilaterally)  
Posterior scalene (bilaterally)  
Sternocleidomastoid (assist)  
External intercostals (assists)  
Serratus posterior superior  
Quadratus lumborum  
Pectoralis major (assists with arm fixed)  
Pectoralis minor (with scapula fixed)  
Serratus anterior (with scapula fixed)  
Subclavius (first rib)

### Muscles of Exhalation

Internal intercostals (assists)  
Serratus posterior inferior  
External oblique (by compressing abdominal contents)  
Internal oblique (by compressing abdominal contents)  
Transverse abdominis (by compressing abdominal contents)  
Quadratus lumborum

## Cervical Spine (p. 242-243)

### Flexion

(antagonists on extension)

Sternocleidomastoid (bilaterally)  
Anterior scalene (bilaterally)  
Longus capitis (bilaterally)  
Longus colli (bilaterally)

### Extension

(antagonists on flexion)

Trapezius (upper fibers, bilaterally)  
Levator scapula (bilaterally)  
Splenius capitis (bilaterally)  
Splenius cervicis (bilaterally)  
Rectus capitis posterior major  
Rectus capitis posterior minor  
Oblique capitis superior  
Semispinalis capitis  
Longissimus capitis (assists, See p. 196)  
Longissimus cervicis (assists, p. 196)  
Iliocostalis cervicis (assists, p. 196)  
Multifidi (bilaterally)  
Rotatores (bilaterally)  
Intertransversarii (bilaterally)  
Interspinalis

### Rotation

(unilaterally to the **same** side)

Levator scapula  
Splenius capitis  
Splenius cervicis  
Rectus capitis posterior major  
Oblique capitis inferior  
Longus colli  
Longus capitis  
Longissimus capitis (assists, See p. 196)  
Longissimus cervicis (assists, p. 196)  
Iliocostalis cervicis (assists, p. 196)

### Rotation

(unilaterally to the **opposite** side)

Trapezius (upper fibers)  
Sternocleidomastoid  
Anterior scalene  
Middle scalene  
Posterior scalene  
Multifidi  
Rotatores

### Lateral Flexion

(unilaterally to the **same** side)

Trapezius (upper fibers)  
Levator scapula  
Sternocleidomastoid  
Anterior scalene (with ribs fixed)  
Middle scalene (with ribs fixed)  
Posterior scalene (with ribs fixed)

Splenius capitis  
Splenius cervicis  
Longus capitis  
Longus colli  
Longissimus capitis (assists, See p. 196)  
Longissimus cervicis (assists, p. 196)  
Iliocostalis cervicis (assists, p. 196)  
Oblique capitis superior

## Mandible (p. 243)

(temporomandibular joint)

### Elevation

(antagonists on depression)

Masseter  
Temporalis  
Medial pterygoid

### Depression

(antagonists on elevation)

Geniohyoid  
Mylohyoid  
Stylohyoid  
Digastric (with hyoid bone fixed)  
Platysma (assists)

### Protraction

(antagonists on retraction)

Lateral pterygoid (bilaterally)  
Medial pterygoid (bilaterally)  
Masseter (assists)

### Retraction

(antagonists on protraction)

Temporalis  
Digastric

### Lateral Deviation

(unilaterally)

Lateral pterygoid (to the opposite side)  
Medial pterygoid (to the opposite side)

## Pelvis

### Anterior Tilt (downward rotation)

(antagonists on posterior tilt)

Psoas major  
Iliacus  
Latissimus dorsi (assists, See box, p. 71)

### Posterior Tilt (upward rotation)

(antagonists on anterior tilt)

Biceps femoris  
Semitendinosus  
Semimembranosus  
Rectus abdominis  
Psoas minor

### Lateral Tilt (elevation)

Quadratus lumborum (unilaterally)  
Latissimus dorsi (assists, See box p. 71)

## Coxal (p. 302-304)

(hip joint)

### Flexion

(antagonists on extension)

Psoas major  
Iliacus  
Tensor fasciae latae  
Sartorius  
Rectus femoris  
Gluteus medius (anterior fibers)  
Gluteus minimus  
Adductor longus (assists)  
Pectineus (assists)  
Adductor brevis (assists)  
Adductor magnus (assists)

### Extension

(antagonists on flexion)

Gluteus maximus (all fibers)  
Biceps femoris (long head)  
Semitendinosus  
Semimembranosus  
Adductor magnus (posterior fibers)  
Gluteus medius (posterior fibers)

### Medial Rotation (internal rotation)

(antagonists on lateral rotation)

Gluteus medius (anterior fibers)  
Gluteus minimus  
Tensor fasciae latae  
Adductor magnus  
Adductor longus  
Adductor brevis  
Pectineus  
Gracilis  
Semitendinosus (assists)  
Semimembranosus (assists)

### Lateral Rotation (external rotation)

(antagonists on medial rotation)

Gluteus maximus (all fibers)  
Piriformis  
Quadratus femoris  
Obturator internus  
Obturator externus  
Gemellus superior  
Gemellus inferior  
Gluteus medius (posterior fibers)  
Psoas major  
Iliacus  
Sartorius  
Biceps femoris (assists, long head)

**Abduction**

(antagonists on adduction)

Gluteus maximus (all fibers)  
Gluteus medius (all fibers)  
Gluteus minimus  
Tensor fasciae latae  
Sartorius  
Piriformis (when the hip is flexed)

**Adduction**

(antagonists on abduction)

Adductor magnus  
Adductor longus  
Adductor brevis  
Pectineus  
Gracilis  
Gluteus maximus (lower fibers)

**Knee (p. 305)**

(tibiofemoral joint)

**Flexion**

(antagonists on extension)

Biceps femoris  
Semitendinosus  
Semimembranosus  
Gracilis  
Sartorius  
Gastrocnemius  
Popliteus  
Plantaris (weak)

**Extension**

(antagonists on flexion)

Rectus femoris  
Vastus lateralis  
Vastus medialis  
Vastus intermedius

**Medial Rotation of Flexed Knee**

(antagonists on lateral rotation)

Semitendinosus  
Semimembranosus  
Gracilis  
Sartorius  
Popliteus

**Lateral Rotation of Flexed Knee**

(antagonist on medial rotation)

Biceps femoris

**Ankle (p. 369)**

(talocrural joint)

**Plantar Flexion**

(antagonists on dorsiflexion)

Gastrocnemius  
Soleus  
Tibialis posterior  
Peroneus longus (assists)  
Peroneus brevis (assists)  
Flexor digitorum longus (weak)  
Flexor hallucis longus (weak)  
Plantaris (weak)

**Dorsiflexion**

(antagonists on plantar flexion)

Tibialis anterior  
Extensor digitorum longus  
Extensor hallucis longus

**Foot and Toes (p. 370)**

(talotarsal, midtarsal, tarsometatarsal, metatarsophalangeal, proximal and distal interphalangeal joints)

**Inversion**

(antagonists on eversion)

Tibialis anterior  
Tibialis posterior  
Flexor digitorum longus  
Flexor hallucis longus  
Extensor hallucis longus

**Eversion**

(antagonists on inversion)

Peroneus longus  
Peroneus brevis  
Extensor digitorum longus

**Flexion of Second through Fifth Toes**

(antagonists on extension of toes)

Flexor digitorum longus  
Flexor digitorum brevis  
Lumbricals  
Quadratus plantae (assists)  
Dorsal interossei (2nd-4th)  
Plantar interossei (3rd-5th)  
Abductor digiti minimi (5th)  
Flexor digiti minimi brevis (5th)

**Extension of Second through Fifth Toes**

(antagonists on flexion of toes)

Extensor digitorum longus  
Extensor digitorum brevis (2nd-4th)  
Lumbricals

**Adduction of Second through Fifth Toes**

(antagonist on abduction of toes)

Plantar interossei (3rd-5th)

**Abduction of Second through Fifth Toes**

(antagonists on adduction of toes)

Dorsal interossei (2nd-4th)  
Abductor digiti minimi (5th, assists)

**Flexion of First Toe**

(antagonists on extension)

Flexor hallucis longus  
Flexor hallucis brevis  
Abductor hallucis (assists)  
Adductor hallucis (assists)

**Extension of First Toe**

(antagonists on flexion)

Extensor hallucis longus  
Extensor hallucis brevis

**Adduction of First Toe**

(antagonist on abduction)

Adductor hallucis

**Abduction of First Toe**

(antagonist on adduction)

Abductor hallucis





# Glossary of Terms

**abdomen** – the region between the diaphragm and the pelvis

**acetabulum** – the rounded cavity on the external surface of the coxal bone; the head of the femur articulates with the acetabulum to form the coxal joint

**adhesion** – abnormal adherence of collagen fibers to surrounding structures during immobilization, following trauma or as a complication of surgery, which restricts normal elasticity of the structures involved

**anatomical position** – erect posture with face forward, arms at sides, forearms supinated (so that palms of the hands face forward) and fingers and thumbs in extension

**antagonist** – a muscle that performs the opposite action of the prime mover and synergist muscles

**antecubital** – the anterior side of the elbow

**anterior** – toward the front or ventral surface

**anterior tilt of pelvis** – tilt in which the vertical plane through the anterior superior iliac spines (ASISes) are anterior to the vertical plane through the symphysis pubis

**appendage** – a structure attached to the body, such as the upper and lower extremities

**arm** – the portion of the upper limb between the shoulder and elbow joints

**arthrology** – the study of joints

**articular facet** – a small articular surface of a bone, especially a vertebra

**articular process** – a small, flat projection found on the surfaces of the arches of the vertebrae on either side, incorporating the articular surface

**articulation** – a joint or connection of bones

**atlas** – first cervical vertebra, articulating with the occipital bone and rotating around the odontoid process of the axis

**axis** – the second cervical vertebra

**bilateral** – pertaining to two sides

**bursa** – a small, fluid-filled sack that reduces friction between two structures

**cartilaginous joint** – a joint in which two bony surfaces are united by cartilage; the two types of cartilaginous joints are **synchondroses** and **symphyses**

**caudal** – downward, away from the head (toward the tail)

**cephalic** – toward the head

**collagen** – the protein of connective tissue fibers

**concentric contraction** – a shortening of the muscle during a contraction; a type of isotonic exercise

**condyle** – a rounded articular surface at the extremity of a bone

**connective tissue** – the supportive tissues of the body, made of ground substance and fibrous tissues, taking a wide variety of forms

**contraction** – an increase in muscle tension, with or without change in overall length

**coronal** – a vertical plane perpendicular to the sagittal plane dividing the body into anterior and posterior portions, also called the frontal plane

**coronal axis** – a horizontal line extending from side to side, around which the movements of flexion and extension take place

**cranial** – upward, toward the head

**crural** – pertaining to the leg or thigh, femoral

**deep** – away from the surface of the body; the opposite of superficial

**distal** – farther from the center or median line or from the thorax

**dorsal** – relating to the back; posterior

**eccentric muscle contraction** – an overall lengthening of the muscle while it is contracting or resisting a workload

**edema** – a local or generalized condition in which body tissues contain an excessive amount of fluid

**facet** – a small plane or concave surface

**fascia** – a general term for a layer or layers of loose or dense fibrous connective tissue

**fibrous joint** – a joint in which the components are connected by fibrous tissue

**flexibility** – the ability to readily adapt to changes in position or alignment; may be expressed as normal, limited, or excessive

**forearm** – the portion of the upper limb between the elbow and wrist joints

**frontal plane** – a vertical plane perpendicular to the sagittal plane, dividing the body into anterior and posterior portions, also called the coronal plane

**genu valgum** – “knock-knees,” defined as a lateral displacement of the distal end of the distal bone in the joint

**genu varum** – “bowlegs,” defined as a medial displacement of the distal end of the distal bone in the joint

**impingement** – an encroachment on the space occupied by soft tissue, such as nerve or muscle

**inferior** – away from the head

**insertion** – the more mobile attachment site of a muscle to a bone; the opposite end is the origin

**interstitial** – the space within an organ or tissue

**interstitial fluid** – the fluid that surrounds cells

**isometric** – increase in tension without change in muscle length

**isotonic** – increase in tension with change in muscle length (in the direction of shortening); concentric contraction

**isotonic contraction (dynamic)** – a concentric or eccentric contraction of a muscle; a muscle contraction performed with movement

**kinesiology** – the study of movement

**kyphosis** – a condition characterized by an abnormally increased convexity in the curvature of the thoracic spine as viewed from the side

**lateral** – away from the midline

**lateral tilt** – pelvic tilt in which the crest of the ilium is higher on one side than on the other

**leg** – the portion of the lower extremity between the knee and ankle joints

**ligament** – a fibrous connective tissue that connects bone to bone

**longitudinal axis** – a vertical line extending in a cranial/caudal direction, about which movements of rotation take place

**lordosis** – an abnormally increased concavity in the curvature of the lumbar spine as viewed from the side

**lymph node** – a small oval structure located along lymphatic vessels

**lymphatic** – pertains to the system of vessels involved with drainage of bodily fluids (lymph)

**medial** – toward the midline

**muscle** – an organ composed of one of three types of muscle tissue (skeletal, cardiac or visceral), specialized for contraction

**muscle contracture** – an increase of tension in the muscle caused by activation of the contractile mechanism of the muscle

**myofascial** – pertains to skeletal muscles ensheathed by fibrous connective tissue

**occipital condyles** – elongated oval facets on the undersurface of the occipital bone on either side of the foramen magnum, which articulate with the atlas vertebra

**odontoid process (or dens)** – a process projecting upward from the body of the axis vertebra, around which the atlas rotates

**origin** – the more stationary attachment site of a muscle to a bone; the opposite end is the insertion

**palmar** – toward the palm

**palpable** – touchable, accessible

**palpate** – to examine or explore by touching (an organ or area of the body), usually as a diagnostic aid

**paravertebrals** – alongside or near the vertebral column

**pelvic girdle** – the two hip bones

**pelvic tilt** – an anterior (forward), a posterior (backward) or a lateral (vertical) tilt of the pelvis from neutral position

**pelvis** – composed of the two hip bones, sacrum and coccyx

**periosteum** – the fibrous connective tissue which surrounds the surface of bones

**posterior** – toward the back or dorsal surface

**posterior tilt of pelvis** – tilt in which the vertical plane through the anterior superior iliac spines (ASISes) are posterior to the vertical plane through the symphysis pubis

**prime mover** – a muscle that carries out an action

**proximal** – nearer to the center or midline of the body

**range of motion** – the range, usually expressed in degrees, through which a joint can move or be moved

**range of motion, active** – the free movement across any joint of moving levers that is produced by contracting muscles

**range of motion, passive** – the free movement that is produced by external forces across any joint or moving levers

**retinaculum** – a network, usually pertaining to a band of connective tissue

**sagittal axis** – a horizontal line extending from front to back, about which movements of abduction and adduction take place

**sagittal plane** – a plane that divides the body into left and right portions

**sesamoid** – a bone or fibrocartilage in a tendon playing over a bony surface

**soft tissue** – usually referring to myofascial tissues, or any tissues which do not contain minerals (such as bone)

**superficial** – nearer to the surface of the body; the opposite of deep

**superior** – toward the head

**sural** – pertaining to calf of the leg

**surface anatomy** – the study of structures that can be identified from the outside of the body

**symphysis** – a union between two bones, formed by fibrocartilage

**synchondrosis** – a union between two bones, formed either by hyaline cartilage or fibrocartilage

**synergist** – a muscle that supports the prime mover

**synovial joint** – a joint containing a lubricating substance (synovial fluid) and lined with a synovial membrane or capsule

**tactile** – pertaining to touch

**tendon** – a fibrous tissue connecting skeletal muscle to bone

**thigh** – the portion of the lower extremity between the coxal and knee joints

**thorax** – the region between the neck and abdomen

**tightness** – shortness; denotes a slight to moderate decrease in muscle length; movement in the direction of lengthening the muscle is limited

**transverse plane** – a plane that divides the body into superior and inferior (or proximal and distal) portions

**trunk** – the part of the body to which the upper and lower extremities attach

**unilateral** – pertaining to one side

**ventral** – a synonym for anterior, usually applied to the torso



# Pronunciation and Etymology

etymology	<b>et-i-mol-o-gee</b>	the science of the origin and development of a word			
ab- (as in <i>abduct</i> )		L. away from	<b>bursa</b>	<b>bur-sah</b>	L. a purse
abdomen	<b>ab-do-men</b>	L. belly	<b>calcaneocuboid</b>	<b>kal-ka-ne-o-ku-boyd</b>	
abdominis	<b>ab-dah-min-is</b>		<b>calcaneofibular</b>	<b>kal-ka-ne-o-fib-u-lar</b>	
abduct	<b>ab-duct</b>	L. to lead away, bring apart	<b>calcaneus</b>	<b>kal-kay-nee-us</b>	L. heel
acetabulum	<b>as-e-tab-u-lum</b>	L. a little saucer for vinegar	<b>capillary</b>	<b>kap-i-lar-ee</b>	L. hairlike
acromioclavicular	<b>a-kro-me-o-kla-vik-u-lar</b>		<b>capitate</b>	<b>kap-i-tate</b>	L. head-shaped
acromion	<b>a-cro-me-on</b>	Grk. <i>akron</i> , top + <i>omos</i> , shoulder	<b>capitis</b>	<b>kap-i-tis</b>	L. of the head
ad- (as in <i>adduct</i> )		L. toward	<b>capitulum</b>	<b>ka-pit-u-lum</b>	L. small head
adduct	<b>ad-duct</b>	L. to bring together	<b>carotid</b>	<b>ka-rot-id</b>	Grk. causing deep sleep
adipose	<b>a-di-POSE</b>	L. fat, copious	<b>carpal</b>	<b>kar-pul</b>	Grk. pertaining to the wrist
alaeque	<b>a-le-kwe</b>	L. wing ( <i>ala</i> of nose)	<b>carpi</b>	<b>kar-pi</b>	L. of the wrist
alar	<b>ay-lar</b>		<b>cartilage</b>	<b>kar-ti-lij</b>	L. gristle
anconeus	<b>an-ko-nee-us</b>	Grk. elbow	<b>cephalic</b>	<b>se-fa-lic</b>	Grk. pertaining to the head
annular	<b>an-u-ler</b>	L. ringlike	<b>cervical</b>	<b>ser-vi-kal</b>	L. referring to the neck
annulus	<b>an-u-lus</b>	L. ring	<b>cervicis</b>	<b>ser-vi-sis</b>	L. neck
anococcygeal	<b>a-no-kok-si-je-al</b>	L. <i>anus</i> , anus + Grk. <i>kokkyx</i> , coccyx	<b>chest</b>		AS. box
aponeurosis	<b>ap-o-nu-ro-sis</b>	Grk. <i>apo</i> , from + <i>neuron</i> , nerve or tendon	<b>cisterna chyli</b>	<b>sis-turn-a ki-lee</b>	L. reservoir + Grk. juice
appendicular	<b>ap-en-dik-u-lar</b>	L. to hang to	<b>clavicle</b>	<b>klav-i-k'l</b>	L. little key
arrector pili	<b>a-rek-tor pee-li</b>	L. <i>arrector</i> , lifter; <i>pilus</i> , hair	<b>coccyx</b>	<b>kok-siks</b>	Grk. cuckoo
artery	<b>ar-ter-ee</b>	Grk. windpipe	<b>collateral</b>	<b>ko-lat-er-al</b>	L. of both sides
atlantoaxial	<b>at-lan-to-ak-se-al</b>		<b>condyle</b>	<b>kon-dial</b>	Grk. knuckle
atlantooccipital	<b>at-lan-to-ok-si-pi-tal</b>		<b>conoid</b>	<b>ko-noyd</b>	Grk. cone-shaped
auricularis	<b>aw-rik-u-la-ris</b>	L. little ear	<b>coracoacromial</b>	<b>kor-a-ko-a-kro-mi-ul</b>	
axial	<b>ak-see-al</b>	L. axle	<b>coracobrachialis</b>	<b>kor-a-ko-bra-kee-al-is</b>	
axilla	<b>ak-sil-a</b>	L. armpit	<b>coracoclavicular</b>	<b>kor-a-ko-cla-vic-u-lar</b>	
axillary	<b>ak-si-lar-ee</b>		<b>coracoid</b>	<b>kor-a-koyd</b>	Grk. raven's beak
basilic	<b>bah-sil-ic</b>	Arabic <i>basilik</i> , inner	<b>coronal</b>	<b>ko-ro-nal</b>	L. crownlike
biceps	<b>bi-seps</b>	L. <i>bis</i> , twice + <i>caput</i> , head	<b>coronoid</b>	<b>kor-o-noyd</b>	Grk. crown-shaped
biceps brachii	<b>bi-seps bray-key-i</b>	L. two-headed (muscle) of the arm	<b>corrugator</b>	<b>kor-u-ga-tor</b>	L. together + to wrinkle
biceps femoris	<b>bi-seps fe-mor-is</b>	Grk. the two-headed (muscle) of the thigh	<b>costal</b>	<b>kos-tal</b>	L. rib
brachial	<b>bray-key-al</b>	L. relating to the arm	<b>coxal</b>	<b>kox-sal</b>	L. hip
brachialis	<b>bray-key-al-is</b>		<b>cranio-</b>	<b>cra-nee-o</b>	Grk. skull
brachii	<b>bray-key-i</b>	L. of the arm	<b>cranium</b>	<b>cra-nium</b>	Grk. skull
brachioradialis	<b>bray-key-o-ra-de-a-lis</b>		<b>cremaster</b>	<b>kre-mas-ter</b>	L. to suspend
brevis	<b>breh-vis</b>	L. short	<b>cricoid</b>	<b>kri-koyd</b>	Grk. ring-shaped
buccinator	<b>buk-sin-aye-tor</b>	L. trumpeter, proclaimer	<b>cruciate</b>	<b>kroo-she-at</b>	L. cross-shaped
bulbospongiosus	<b>bul-bo-spon-je-o-sus</b>	L. <i>blubus</i> , bulbous root + Gr. <i>spongus</i> , sponge	<b>crural</b>	<b>kroo-ral</b>	
			<b>cuboid</b>	<b>ku-boyd</b>	Grk. cube-shaped
			<b>cuboideonavicular</b>	<b>ku-boyd-e-o-na-vik-u-lar</b>	
			<b>cuneiform</b>	<b>ku-ne-i-form</b>	L. <i>cuneus</i> , wedge-shaped
			<b>deltoid</b>	<b>del-toid</b>	Grk. <i>delta</i> , capital letter D (Δ) in the Greek alphabet
			<b>diaphragm</b>	<b>di-a-fram</b>	Grk. a partition, wall
			<b>digastric</b>	<b>di-gas-trik</b>	Grk. double-bellied

digit	di-jit	L. finger
digitigrade	di-ji-tah-grade	L. toe-walking
dorsalis pedis	dor-sal-is <b>peh-dis</b>	L. <i>dorsum</i> , back; <i>pedis</i> , foot
dorsi	dor-si	L. of the back
dura mater	dyoo-ra ma-ter	L. tough mother
epi-	eh-pee	Grk. above, upon
extrinsic		L. without
facet	fas-et	Fr. small face
facial	fa-shal	L. pertaining to the face
fascia	fash-ah	L. a band, bandage
fasciae	fash-ay	plural for fascia
fascicle	fas-i-kl	L. little bundle
femur	fee-mur	L. thigh
fibula	fib-u-la	L. pin or buckle
flavum	flay-vum	L. yellow
flex		L. to bend
foot		AS. <i>foot</i>
foramen	for-aye-men	L. a passage or opening
fossa	fos-a	L. a shallow depression
furcula	fur-ku-la	L. a little fork
gastrocnemius	gas-trok-ne-me-us	Grk. <i>gaster</i> , stomach + <i>kneme</i> , leg
gemellus	jem-el-us	L. twin
geniohyoid	je-ne-o-hi-oyd	Grk. <i>genion</i> , chin
genu valgum	je-noo val-gum	
genu varum	je-noo va-rum	
glabella	gla-bel-a	L. <i>glaber</i> , smooth
gland		L. acorn
glenoid	glen-oyd	Grk. eyeball
glossus	glah-sis	Grk. tongue
gluteus	gloo-te-us	Grk. <i>gloutos</i> , buttocks, which in turn is Anglo-Saxon for <i>buttuc</i> , meaning end
gracilis	gra-cil-is	L. slender, graceful
hallucis	hal-ah-sis	
hallux	hal-uks	L. first toe
ham		AS. haunch
hamate	ham-ate	L. hooked
hamulus	ham-u-lus	L. a small hook
humerus	hu-mer-us	L. upper arm
hyoid	hi-oyd	Grk. U-shaped
hypothenar	hi-po-thee-nar	Grk. <i>hypo</i> , under or below
iliacus	i-lee-a-cus	L. pertaining to the loin
iliococcygeus	il-ee-o-kok-si-je-us	
iliocostalis	il-ee-o-kos-ta-lis	L. from hip to rib
ilium	il-ee-um	L. groin, flank
indicis	in-di-kis	
inferior	in-fe-ree-or	L. below

infraspinatus	in-fra-spi-na-tus	
inguinal	ing-gwi-nal	L. of the groin
integumentary	in-teg-u-ment-ary	something that covers or encloses
interdigitate	in-ter-dij-i-tate	L. to interlock, as the fingers of clasped hands
interroseus	in-ter-ah-see-us	L. between bones
interspinalis	in-ter-spi-na-lis	
interstitial	in-ter-stish-al	L. placed between
intertransversarii	in-ter-trans-verse-er-i	
intertubercular	in-tur-tu-ber-ku-lar	
intrinsic		L. within
ischiocavernosus	ish-she-o-ka-ver-no-sus	
ischium	ish-ee-um	Grk. hip
joint		L. to join
jugular	jug-u-lar	L. throat
kyphosis	ki-fo-sis	Grk. bent, curved, or stooped
labii	lay-bee-eye	L. pert. to the lips
labrum	lay-brum	L. lip
lamina	lam-i-na	L. thin plate, leaf
latae	la-ta	L. broad
lateral	lat-er-al	L. to the side
latissimus dorsi	la-tis-i-mus dor-si	L. widest of the back
levator	leh-va-tor	L. lifter
levator labii superioris alaeque nasi		L. "lifter of the upper lip and of the wing of the nose"
levator scapula	leh-va-tor skap-u-la	
ligament	lig-a-ment	L. a band
linea aspera	lin-e-a as-per-a	L. rough line
longissimus	lon-jis-i-mus	L. longest
longus colli	long-us ko-li	L. long (muscle) of the neck
lordosis	lor-doh-sis	Grk. bent backward
lumbar	lum-bar	L. loin
lumborum	lum-bor-um	
lumbrical	lum-bri-kal	L. earthworm
lunate	lu-nate	L. crescent-shaped
lymph	limf	L. pure spring water
magnus	mag-nus	L. large
malleolus	mal-e-o-lus	L. little hammer
mandible	man-di-ble	L. lower jawbone
manubrium	ma-nu-bree-um	L. handle
masseter	mas-se-ter	Grk. chewer
mastoid	mas-toyd	Grk. breast-shaped
maxilla	max-il-a	L. jawbone
medial	me-dee-ul	L. middle
menisci	men-is-ki	plural for meniscus
menisconfemoral	men-is-ko-fem-or-al	
meniscus	men-is-kus	Grk. crescent-shaped

mentalis	men-tal-is	L. chin
meta-	met-a	Grk. after or beyond
metacarpal	met-a-kar-pul	
metacarpophalangeal	met-a-kar-po-fa-lan-jee-al	
metatarsal	met-a-tar-sal	
metatarsophalangeal	met-a-tar-so-fa-lan-jee-al	
mimetic	mi-me-tik	relating to, characterized by, or exhibiting mimicry
minimi	min-i-mee	L. smallest
multifidi	mul-tif-i-di	L. <i>fidi</i> , to split
muscle	mus-el	L. <i>musculus</i> , a little mouse
mylohyoid	my-lo-hi-oyd	Grk. <i>myle</i> , mill
myo-		Grk. muscle
nape		ME. the back of the neck
nasal	na-zi	L. nose
nasalis	na-sa-lis	
navicular	na-vik-u-lar	L. boat-shaped
neck		AS. nape
nerve		L. sinew
nuchae	nu-kay	L. nape of neck
nuchal	nu-kal	L. the back of the neck
oblique	o-bleek	L. diagonal, slanting
obturator	ob-tu-ra-tor	L. obstructor
occipitofrontalis	ok-sip-i-to-fron-ta-lis	
occiput	ok-si-put	L. the back of skull
odontoid	o-don-toyd	Grk. toothlike
olecranon	o-lek-ran-on	Grk. elbow
omohyoid	o-mo-hi-oyd	Grk. <i>omos</i> , shoulder
opponens	o-po-nens	L. opposing
orbicularis oris	or-bik-u-la-ris o-ris	
palpate	pal-pate	L. <i>palpare</i> , to touch
panniculus carnosus	pan-ik-u-lus car-no-sis	L. small, fleshy garment
parietal	puh-ri-e-tul	L. wall
parotid	pa-rot-id	Grk. beside the ear
patella	pa-tel-a	L. small pan
pectineus	pek-tin-e-us	L. comblike
pectoralis	pek-to-ra-lis	L. chest
pedicle	ped-i-k'l	L. a little foot
pelvis	pel-vis	L. basin
penis		L. tail
perineum	per-i-nee-um	Gr. space between anus and scrotum
peroneus	per-o-ne-us	Grk. pin, buckle
pes anserinus	pes an-ser-i-nus	L. <i>pedis</i> , foot; L. <i>anserinus</i> , goose-like
phalanges	fa-lan-jeez	Grk. closely knit row, line of battle

phalanx	fal-anks	singular for phalanges
philtrum	fil-trum	Grk. to love, to kiss
piriformis	pir-i-form-is	L. pear-shaped
pisiform	pi-si-form	L. pea-shaped
plantar	plan-tar	L. the sole of the foot
plantaris	plan-tar-is	Fr. the sole of the foot
plantigrade	plant-i-grad	L. sole-walking
platysma	pla-tiz-ma	Grk. plate
plexus	plek-sus	L. interwoven
pollex	pol-eks	L. thumb
pollicis	pol-li-sis	L. thumb
popliteus	pop-lit-e-us	L. <i>poples</i> , ham of the knee
procerus	pro-se-rus	L. slender, elongated
process	pros-es	L. going forth
profundus	pro-fun-dus	L. deep
pronate	pro-nate	L. bent forward
psoas	so-as	Grk. muscle of the loin
pterygoid	ter-i-goyd	Grk. wing-shaped
pubis	pu-bis	NL. bone of the groin
pubococcygeus	pu-bo-kok-si-je-us	
puborectalis	pu-bo-rek-tal-is	
quadratus	kwod-rai-t-us	L. squared, four-sided
quadratus lumborum	kwod-rai-t-us lum-bor-um	L. four-sided muscle of the lumbar region
quadriceps	kwod-ri-seps	L. four-headed
quadruped		Grk. four-footed
radiocapitate	ray-dee-o-kap-i-tate	
radioscapholunate	ray-dee-o-skaf-o-loo-nate	
radiotriquetrum	ray-dee-o-tri-kwe-trum	
radius	ray-dee-us	L. staff, spoke of a wheel
ramus	ray-mus	L. branch
rectus	rek-tus	L. straight
retinacula	ret-i-nak-u-la	plural for retinaculum
retinaculum	ret-i-nak-u-lum	L. halter, band, rope
rhomboid	rom-boyd	Grk. in geometry, a parallelogram with oblique angles and only the opposite sides equal
risorius	ri-so-re-us	L. to laugh
rotatores	ro-ta-tor-ays	L. plural for rotator
sacrococcygeal	sa-kro-kok-sij-e-al	
sacroteruberous	sa-kro-tu-ber-us	
sacrum	sa-krum	L. sacred or holy thing, from the use of the sacrum in Roman animal sacrifice
sagittal	saj-i-tal	L. arrowlike
saphenous	sa-fe-nus	origin unclear, perhaps Arabic <i>saphin</i> , standing; or Greek <i>saphen</i> , clearly visible
sartorius	sar-tor-ee-us	L. <i>sartor</i> , tailor

scalene	skay-leen	Grk. uneven
scaphoid	skaf-oyd	L. boat-shaped
scapula	skap-u-la	L. shoulder blade
scapulae	skap-u-lay	plural for scapula
sciatic	si-at-ik	Grk. <i>ischion</i> , hip joint
sciatica	si-at-ika	L. suffering in the hip
semimembranosus	sem-eye-mem-bra-no-sus	L. half membranous
semispinalis	sem-eye-spi-na-lis	L. half spinal
semitendinosus	sem-eye-ten-di-no-sus	L. half tendinous
septa	sep-ta	plural for septum
septum	sep-tum	L. enclosure
serratus	ser-a-tus	L. notched
sesamoid	ses-a-moyd	L. resembling a sesame seed
skeleton	skel-et-on	Grk. dried up
skull		ME. bow
soleus	so-lay-us	L. <i>solea</i> , as in a sole fish
sphenoid	sfe-noyd	Grk. wedge-shaped
spinalis capitis	spi-na-lis kap-i-tis	
spinalis cervicis	spi-na-lis ser-vi-sis	
spine		L. thorn
splenius	sple-nee-us	Grk. bandage
splenius capitis	sple-nee-us kap-i-tis	L. bandage-like (muscle) of the head
splenius cervicis	sple-nee-us ser-vi-sis	
stapedius	sta-pe-de-us	L. stirrup
sternoclavicular	ster-no-kla-vik-u-lar	
sternocleidomastoid	ster-no-kli-do-mas-toyd	
sternohyoid	ster-no-hi-oyd	
sternothyroid	ster-no-thi-royd	
sternum	ster-num	Grk. chest
stylohyoid	sti-lo-hi-oyd	
styloid	sti-loyd	Grk. a pillar
subclavius	sub-klay-vee-us	
subscapularis	sub-skap-u-lar-is	
supercilii	su-per-sil-i-i	L. above eyelid
superficialis	soo-per-fish-ee-a-lis	L. on the surface
supinate	su-pi-nate	L. bent backward
supraspinatus	soo-pra-spi-na-tus	
sural	soo-ral	
sustentaculum	sus-ten-tak-u-lum	L. support
suture	su-chur	L. a seam
symphysis	sim-fi-sis	Grk. growing together
synchondrosis	sin-con-dro-sis	
synovial	sin-o-ve-al	L. <i>synovia</i> , joint fluid
talocalcaneal	ta-lo-kal-ka-ne-al	

talocrural	ta-lo-kroo-ral	L. ankle + <i>crus</i> , leg
talofibular	ta-lo-fib-u-lar	
talonavicular	ta-lo-na-vik-u-lar	
talus	ta-lus	L. ankle
tarsal	tar-sul	Grk. wicker basket
temporalis	tem-po-ra-lis	L. time, seen by the graying of hairs in this region
tendon	ten-dun	L. to stretch
tensor	ten-sor	L. a stretcher
teres	teh-reez	L. rounded, finely shaped
tertius	ter-she-us	L. third
thenar	thee-nar	Grk. palm, flat of the hand
thoracic	tho-ras-ik	Grk. chest
thoracolumbar	tho-rak-o-lum-bar	
thorax	tho-raks	Grk. chest
thyrohyoid	thi-ro-hi-oyd	
thyroid	thi-royd	Grk. shield
tibia	tib-e-a	L. shinbone
trachea	tray-ke-a	Grk. rough
tract		L. extent, drawn out
transverse	trans-verse	L. across, turned across
transversospinalis	trans-ver-so-spi-nal-is	
trapezium	tra-pee-ze-um	Grk. little table
trapezius	tra-pee-ze-us	Grk. a little table or trapezoid shape
trapezoid	trap-e-zoyd	Grk. table-shaped
triceps brachii	tri-seps bray-key-i	L. three-headed muscle of the arm
triceps surae	tri-seps sir-eye	L. three-headed muscle of the calf
triquetrum	tri-kwe-trum	L. three-cornered
trochanter	tro-kan-ter	Grk. to run
trochlea	trok-lee-ah	Grk. pulley
tubercle	tu-ber-kl	L. a little swelling
tuberosity	tu-ber-os-i-tee	L. a swelling
ulna	ul-na	L. elbow, arm
ulnolunate	ul-no-lu-nate	
ulnotriquetrum	ul-no-tri-kwe-trum	
umbilicus	um-bil-i-kus	L. navel, center
urethral	u-ree-thral	relating to the urethra
uvula	uv-u-la	L. a little grape
vastus	vas-tus	L. vast
vein		L. vessel
vertebra	ver-ta-bra	L. joint
xiphoid	zif-oyd	Grk. sword-shaped
zona orbicularis	zo-na	or-bik-u-lar-is L. girdle + little circle
zygomatic	zy-go-mat-ik	Grk. cheekbone
zygapophyseal	zy-gah-pof-i-se-al	

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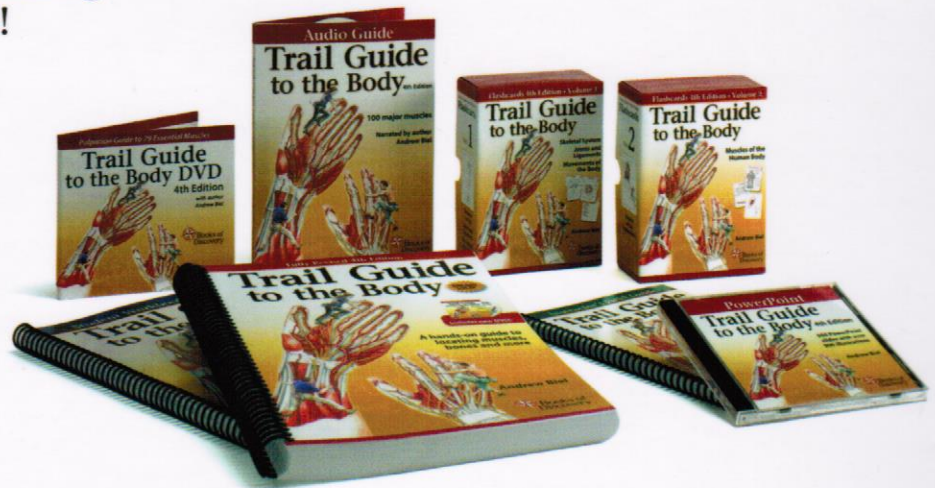
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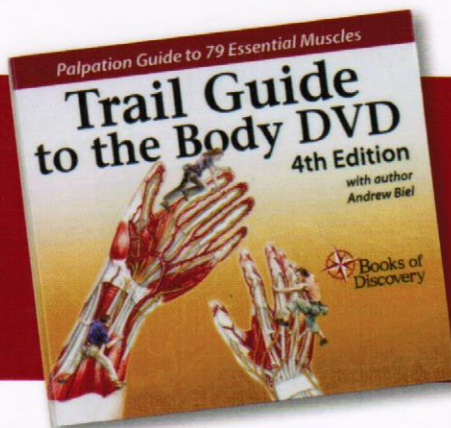
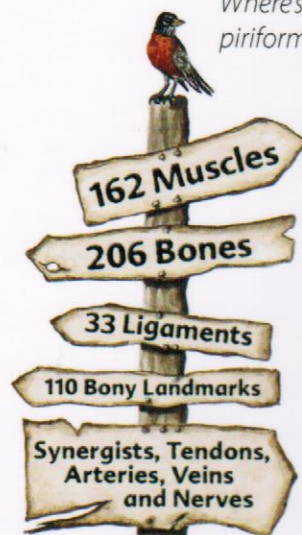
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