Structure Lab 5.2: Structure of the Upper Extremity I – Shoulder, Arm, and Brachial Plexus

***Insert Date and Time**

Lab Goals

By the end of this session, students will:

- participate in a case-based dissection of the proximal upper extremity
- understand the clinically relevant structure of the shoulder, arm, and brachial plexus

Session Organization:

Half of the class will begin with a case-based dissection of the proximal upper extremity for 2.25 hours. The other half will rotate through four stations of approximately 33 minutes each, covering the functional anatomy, clinical evaluation, and imaging of the proximal upper extremity. The groups will switch halfway through the lab session.

Lab Stations & Learning Objectives:

Station #1: Anatomy of the Upper Extremity; Shoulder to Elbow

1. Describe the origin, insertion, innervation, and primary actions of the following shoulder muscles: trapezius, latissimus dorsi, teres major, deltoid, pectoralis major, pectoralis minor, serratus anterior, and levator scapulae.

2. Describe the origin, insertion, innervation, and primary actions of the following muscles of the rotator cuff: teres minor, supraspinatus, infraspinatus, subscapularis.

3. Describe the origin, insertion, innervation, and primary actions of the following muscles of the arm: coracobrachialis, biceps brachii, brachialis, and triceps brachii.

4. Describe the axillary artery and its six branches.

5. Draw the structures of the brachial plexus, including its roots, trunks, divisions, cords, and five main terminal branches.

6. Explain the functional consequences of injuries involving the superior and inferior trunks, and the posterior cord.

7. Compare the inter-muscular spaces of the scapular region, posterior arm, and elbow, including the clinical implications of injuries to their contents (suprascapular notch, quadrangular space, triangular interval of the arm, and cubital fossa).

Station #2: Functional Anatomy of Joints in the Shoulder Region

1. Describe the movements permitted by the articulations between the scapula, humerus, clavicle, and sternum.

2. Describe the bony, cartilaginous, and ligamentous anatomy of the glenohumeral joint.

3. Describe the muscular reinforcement of the glenohumeral joint provided by the muscles of the rotator cuff.

4. Describe the muscular suspension of the upper limb from the thoracic cage (scapulothoracic articulation).

5. Compare and contrast the anatomy that is disrupted in (1) shoulder separation, (2) glenohumeral dislocation, and (3) labrum tear.

Station #3: Medical Imaging of the Shoulder and Arm

1. Identify normal bony anatomy of the clavicle, scapula, and humerus on plain radiographs.

2. Recognize the following structures on MR images of the shoulder: acromion, glenoid cavity, humerus, deltoid, supraspinatus, infraspinatus, teres minor, subscapularis.

3. Identify the following arteries on angiograms and describe their contributions to the scapular anastomosis: subclavian, axillary, subscapular, circumflex scapular, posterior and anterior circumflex humeral, brachial, deep brachial.

Station #4: Clinical Medicine of the Shoulder and Arm

1. Explain how the structural integrity of the shoulder is assessed using observation, palpation, and range of motion.

2. Describe how the functional anatomy of the shoulder is compromised by the following injuries: rotator cuff injury, shoulder dislocation, shoulder separation, and labrum tear.

3. Describe surgical approaches to the management of the above shoulder injuries.

4. Justify the clinical information that is essential to communicate to consultants regarding shoulder injuries.

Alternate Time: Dissection

Each group will be assigned one of two cases to frame their dissection. These cases are based on real conditions observed at least partially in real patients. Refer to your assigned case, posted on Blackboard, for more information.

How to prepare for Structure sessions:

Read the learning objectives listed for each station above. At ZSOM you are always encouraged to find and use your own resources. These may be textbooks, videos, websites, or other resources. Talk to your fellow students about which resources they prefer. The answers to the above learning objectives can be found in the suggested sources listed below. However, you are welcome and encouraged to use alternative resources.

View the Framing Session video on Blackboard (16:03)

Review relevant sections from the muscle manual and bone list posted on Blackboard

Osmosis videos:

- Bones of the upper limb | Osmosis (21:00)
- Brachial plexus | Osmosis (13:53)
- Anatomy of the arm | Osmosis (16:18)
- Anatomy of the glenohumeral joint | Osmosis (9:22)

Acland's Video Atlas of Human Anatomy [Internet]. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins. c2013. [cited 2021 Jul 31]

- Volume 1: The Upper Extremity

Moore KL, Dalley AF 2nd, Agur AMR. Clinically oriented anatomy [Internet]. 8th ed. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins; 2014 [cited 2021 Aug 3].

- Chapter 3. Upper Limb - review relevant clinical "blue boxes."

Complete the specified sections of the following online module. [cited 2021 Aug 3].

- http://www.dartmouth.edu/~anatomy/HAE/Upperextremity/ue_index.html

Complete the following sections (click “Next” at top right to advance through images):

o Shoulder > Radiology

o Arm and Elbow > Radiology

Bickley LS, Szilagyi PG. Bates' guide to physical examination and history taking [Internet]. 11th ed. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins; 2013 [cited 2021 Aug 3].

- Chapter 16: The Musculoskeletal System

  o Overview: Joint Structure and Function

  o Examination of Specific Joints: Anatomy and Physiology and Techniques of Examination - The Shoulder (stop at “Maneuvers,” be sure to see Range of Motion table)

Detton, Alan J. *Grant's dissector*. Lippincott Williams & Wilkins, 2020 [cited 2021 Aug 3].

- Chapter 2: The Upper Limb

Structure Lab
Consolidation Carnival

Case 1:

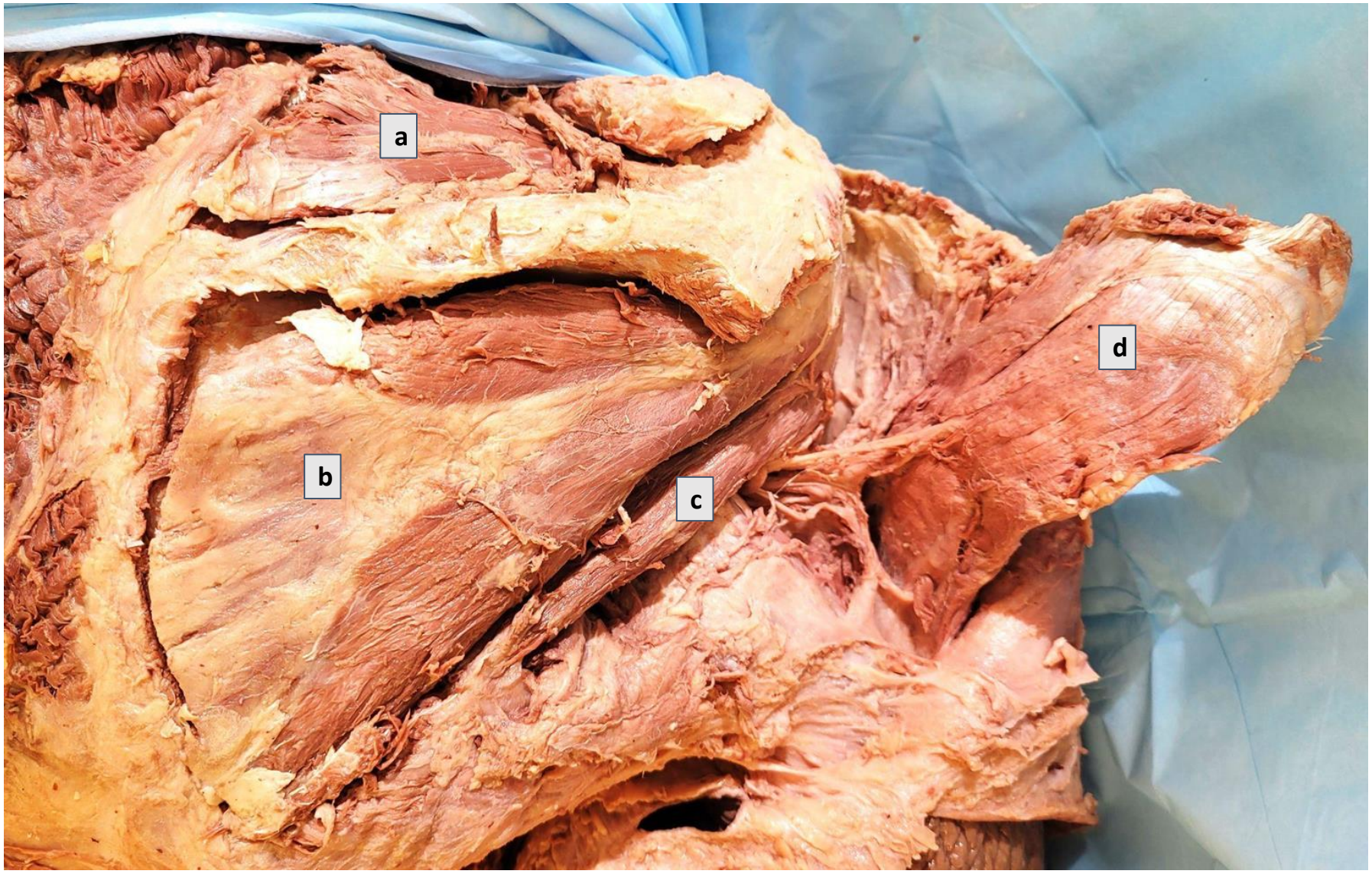
- A pitcher ignored his recurring shoulder pain after practice for two months. When the pain started to affect his pitching, an MRI revealed severe inflammation and a tear of his right rotator cuff. “I guess my pain tolerance is pretty high – I thought I was just sore,” he said, after being replaced on the team.

- On the donor body, find the muscles that belong to the rotator cuff group.
  - What actions does each muscle produce?
  - What additional muscles produce the same movements?

Insert MRI showing rotator cuff tear

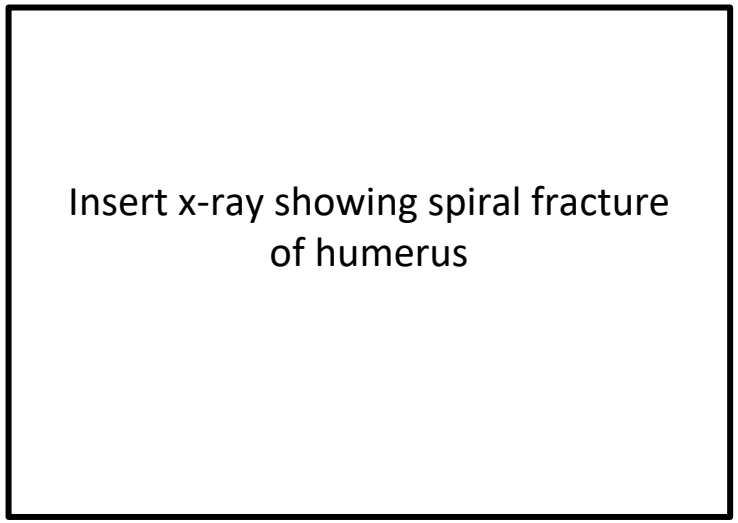
- A pitcher ignored his recurring shoulder pain after practice for two months. When the pain started to affect his pitching, an MRI revealed severe inflammation and a tear of his right rotator cuff. “I guess my pain tolerance is pretty high – I thought I was just sore,” he said, after being replaced on the team.

- On the donor body, find the muscles that belong to the rotator cuff group.
    - Supraspinatus, infraspinatus, teres minor, subscapularis
  - What actions does each muscle produce?
    - Supraspinatus: abduction of arm
    - Infraspinatus and teres minor: lateral rotation of arm
    - Subscapularis: medial rotation of arm
  - What additional muscles produce the same movements?
    - Abduction of arm: deltoid
    - Lateral rotation of arm: deltoid
    - Medial rotation of arm: deltoid, pectoralis major, latissimus dorsi, teres major
  - Bonus questions:
    - How can the deltoid muscle be a medial rotator and lateral rotator of the arm?
    - What role does supraspinatus play in abduction of the arm?

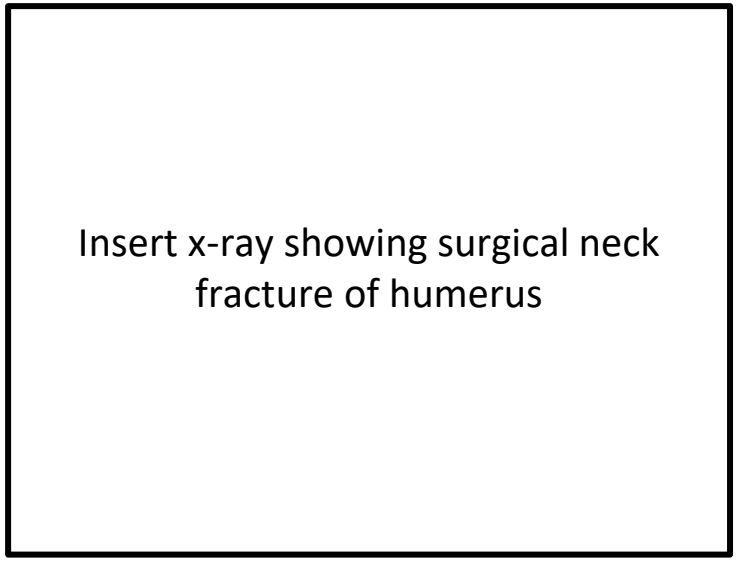


A representative prosection for case 1 showing (a) supraspinatus, (b) infraspinatus, (c) teres minor, and (d) deltoid

Spencer



Sully



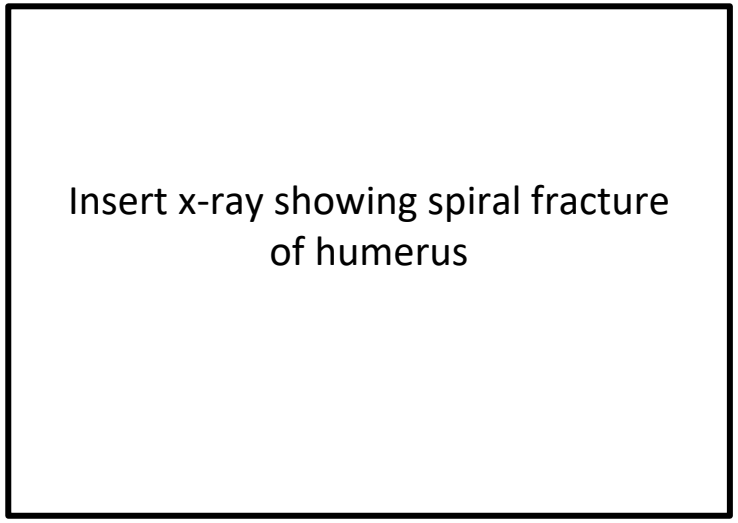
Case 2:

Spencer and Sully suffer fractures as shown in these x-rays.

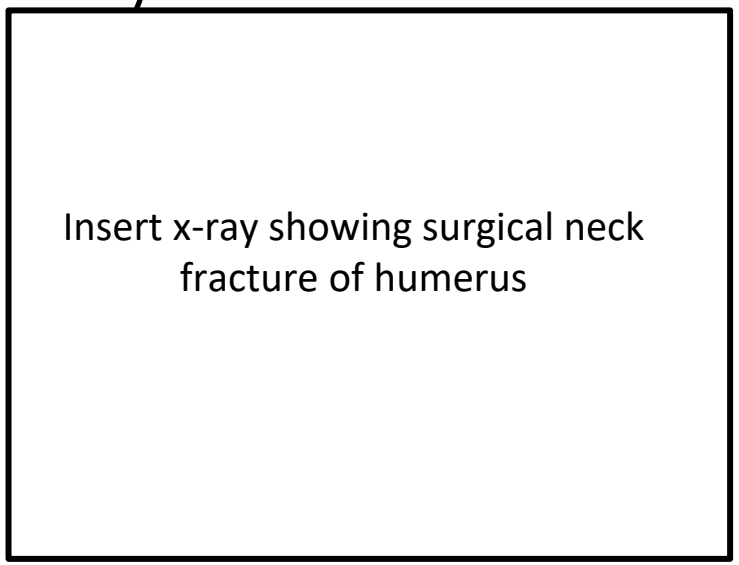
On the donor body:

- Find the nerves and vessels most at risk from each fracture
- Find the muscles most likely to be weakened or paralyzed as a result of traction on these nerves

Spencer



Sully



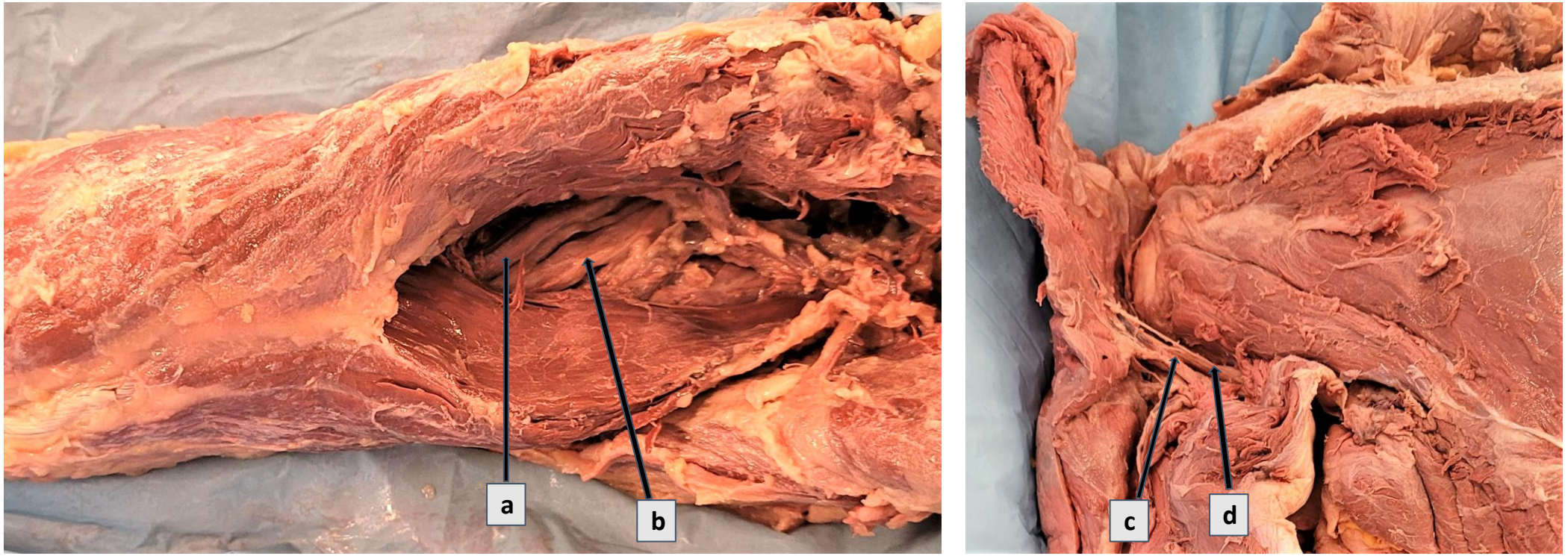
Spencer and Sully suffer fractures as shown in these x-rays.

On the donor body:

1. Find the nerves and vessels most at risk from each fracture
2. Find the muscles most likely to be weakened or paralyzed as a result of traction on these nerves.

SPencer has a SPiral fracture of the humerus. It puts at risk the radial nerve and deep brachial artery, which run in the spiral groove of the humerus. Damage to the nerve will spare triceps, but will affect wrist extensors (ECRL, ECRB), finger extensors (EDC, EDM, EI), thumb extensors (EPL, EPB) and thumb abductor (APL).

SUlly has a SUrgical neck fracture of the humerus. It puts at risk the axillary nerve and posterior circumflex humeral artery. Damage to the axillary nerve will affect deltoid (weakness in abduction above 15°) and teres minor (little effect)



A representative prosection for case 2 showing (a) deep brachial artery, (b) radial nerve, (c) posterior circumflex humeral artery, and (d) axillary nerve

Case 3:

While prospecting for a new well, the son of a wealthy oil tycoon slipped down a steep slope, catching himself at the last moment on the cliff's edge. He hung there until a neurologist, Dr. Fredericks, happened to pass by on a horse. "My boy," said the doctor, "you'll avulse part of your brachial plexus like that!"

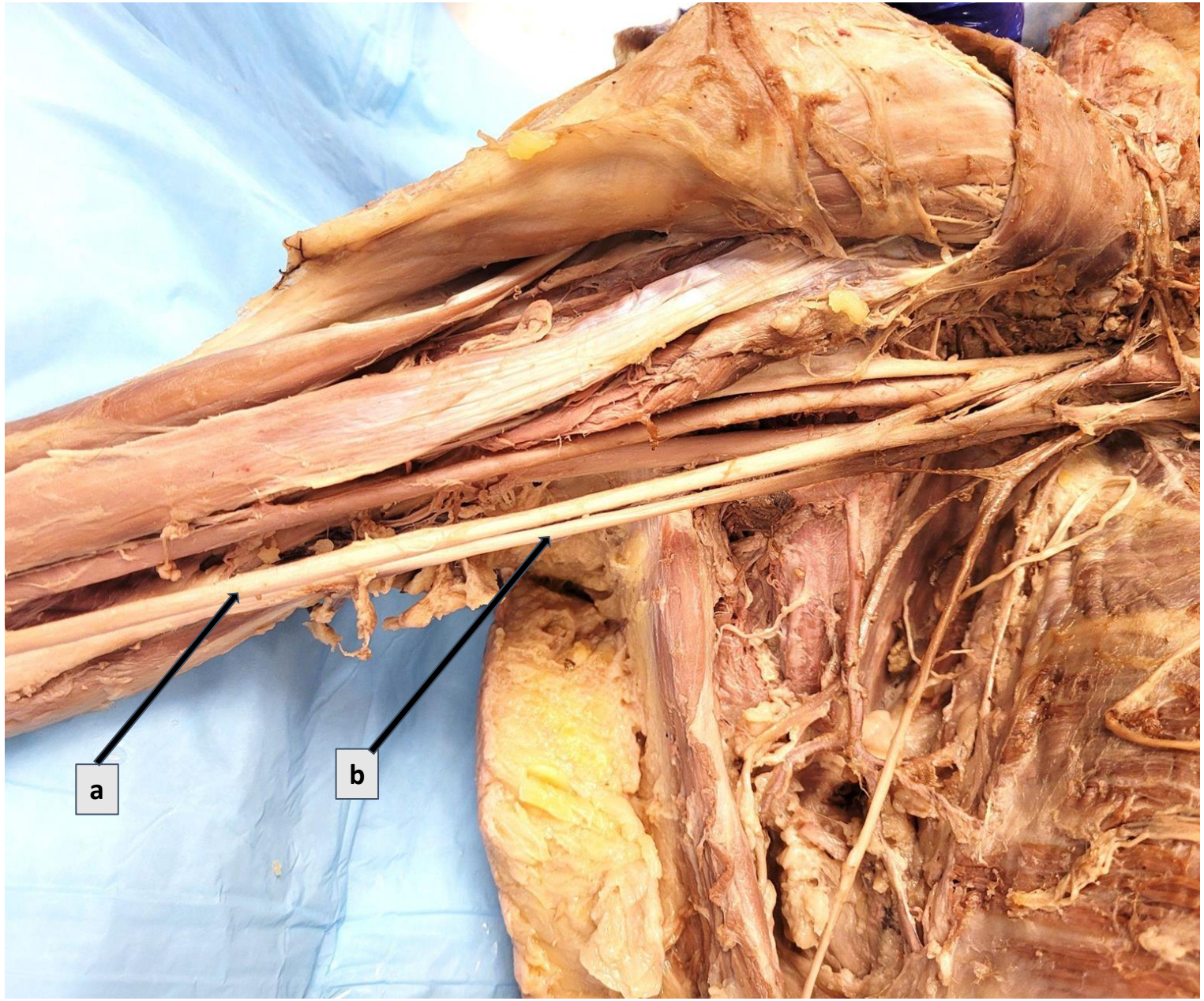
- **On the donor body, identify the part of the brachial plexus that would be affected.**
- **Identify the muscles that would be weakened and the areas of paresthesia you would expect from this injury.**

While prospecting for a new well, the son of a wealthy oil tycoon slipped down a steep slope, catching himself at the last moment on the cliff's edge. He hung there until a neurologist, Dr. Fredericks, happened to pass by on a horse. "My boy," said the doctor, "you'll avulse part of your brachial plexus like that!"

- **On the donor body, identify the part of the brachial plexus that would be affected.**
- **Identify the muscles that would be weakened and the areas of paresthesia you would expect from this injury.**

Abrupt abduction of the arm can cause avulsion of the lower roots (C8 and T1) or **inferior trunk** of the brachial plexus. This interrupts the C8 and T1 contributions to both the **ulnar** and **median** nerves. The result is Klumpke paralysis, characterized by clawing of the digits, reduced mobility of the thumb, and weakness in flexing the wrist and ulnar two digits.

- Since the **ulnar nerve** comes completely from the inferior trunk, all the muscles it innervates are affected. Clawing of the digits is due to paralysis of lumbricals and interossei. The **flexor carpi ulnaris** and the **ulnar half of flexor digitorum profundus** in the forearm are also affected. Paresthesia will be experienced on the palm and dorsum of the hand on the medial 1.5 digits.
- The **median nerve** is variably involved because it has backup through C5-C7 contributions. There may be clawing of the index and middle finger, weakness in thumb movements, weakness in pronation, and numbness of the lateral 3.5 digits.
- The medial arm and forearm skin will be affected due to involvement of the **medial brachial cutaneous nerve** and **medial antebrachial cutaneous nerve.**



A representative prosection for case 3 showing (a) median nerve, and (b) ulnar nerve

Insert photo illustrating left-sided Erb's palsy

Case 4:

- Baby MJ is one month old. Her vaginal delivery was complicated by shoulder dystocia, wherein her shoulder was caught behind her mother's pubic symphysis. She was subsequently diagnosed with a left-sided Erb's palsy, characterized by the "waiter's tip" position.

- On the donor body, find the muscles whose impairment leads to each component of Erb's palsy. Consider their innervation:
  - Adducted shoulder
  - Internally rotated shoulder
  - Extended elbow
  - Pronated forearm
  - Flexed wrist

Insert photo illustrating left-sided Erb's palsy

- Baby MJ is one month old. Her vaginal delivery was complicated by shoulder dystocia, wherein her shoulder was caught behind her mother's pubic symphysis. She was subsequently diagnosed with a left-sided Erb's palsy, characterized by the "waiter's tip" position.

- On the donor body, find the muscles whose impairment leads to each component of Erb's palsy. Consider their innervation:
  - Adducted shoulder: Deltoid (axillary nerve), Supraspinatus (suprascapular nerve)
  - Internally rotated shoulder: Infraspinatus (suprascapular nerve), teres minor (axillary nerve)
  - Extended elbow: Brachialis, Biceps brachii (musculocutaneous nerve)
  - Pronated forearm: Biceps brachii (musculocutaneous nerve), Supinator (radial nerve)
  - Flexed wrist: Wrist extensors (radial nerve)

A representative prosection for case 4 showing (a) axillary nerve and (b) radial nerve

Case 5:

Three wishes for three muscles

You are walking through an eerie New England town. A strange man stops you and says he will grant you three wishes if you can find three muscles that are innervated by the radial nerve but which do not extend a joint.

Three wishes for three muscles

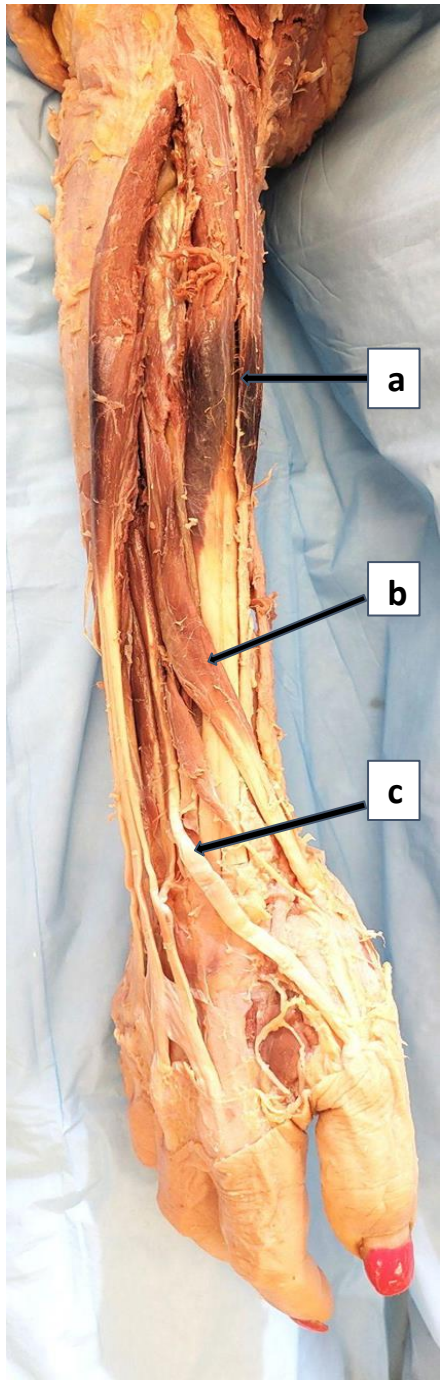
You are walking through an eerie New England town. A strange man stops you and says he will grant you three wishes if you can find three muscles that are innervated by the radial nerve but which do not extend a joint.

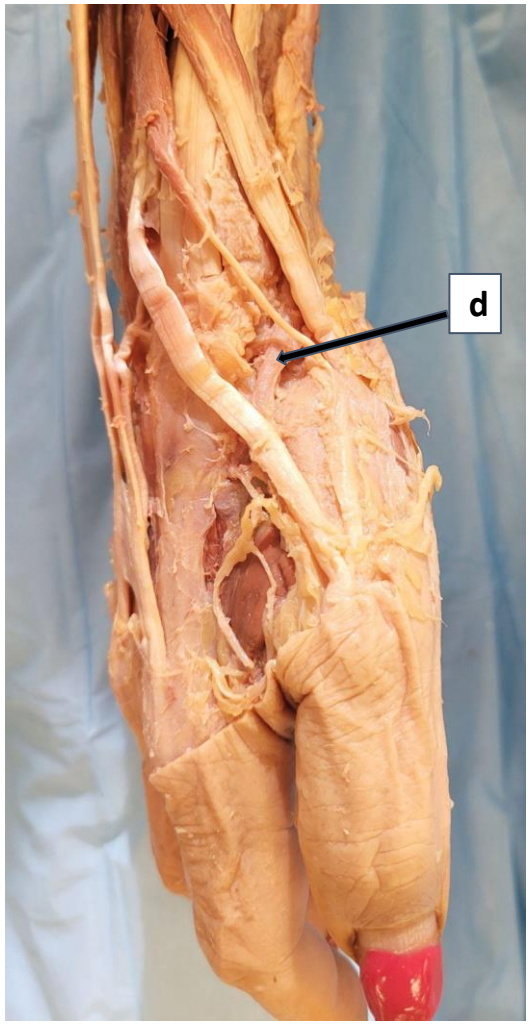
You recall that the radial nerve is the "nerve of extension" in the upper extremity. You swiftly defeat the man at his gambit, however, by identifying:

- Abductor pollicis longus – it abducts the thumb
- Brachioradialis – it flexes the forearm
- Supinator – it supinates the forearm

You ask for world peace, a 1985 Lamborghini Countach, and a chocolate lava cake.

Bonus question 1: How are these muscles related to the anatomical snuff box?
Bonus question 2: Which other muscles flex the forearm, and what are their innervations?

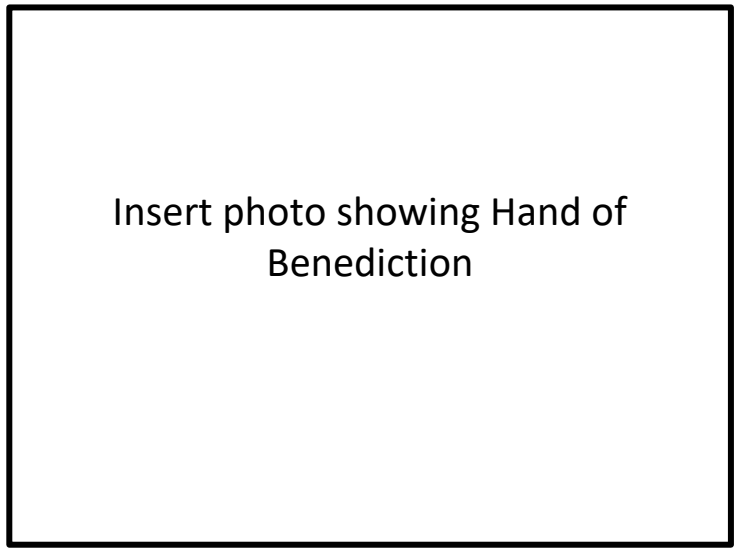




A representative prosection for case 5 showing (a) brachioradialis, (b) abductor pollicis longus, (c) extensor pollicis longus, and (d) radial artery

Ricardo

Slovik



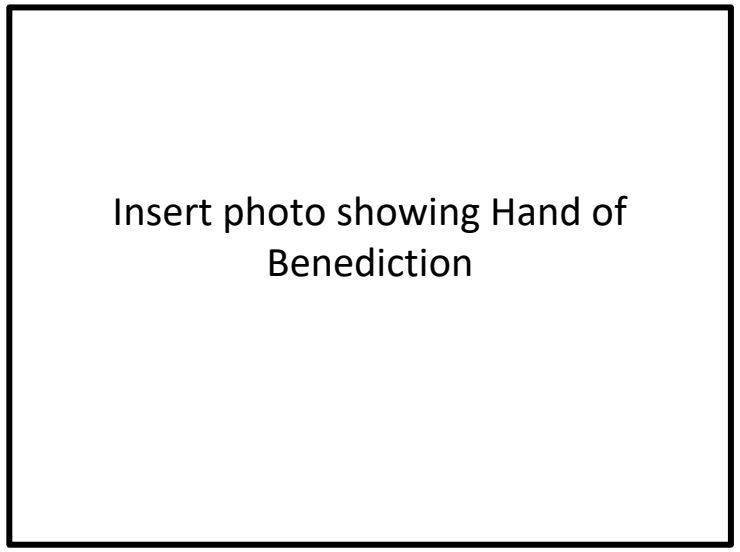
Case 6:

Ricardo and Slovik both have hand mobility problems. Ricardo is asked to hold a piece of paper and not let it be pulled away. Shawn is asked to make a tight fist. On the donor body:

- Find the likely location of nerve injury
- Find the muscles whose impairment has led to the physical findings

Ricardo

Slovik



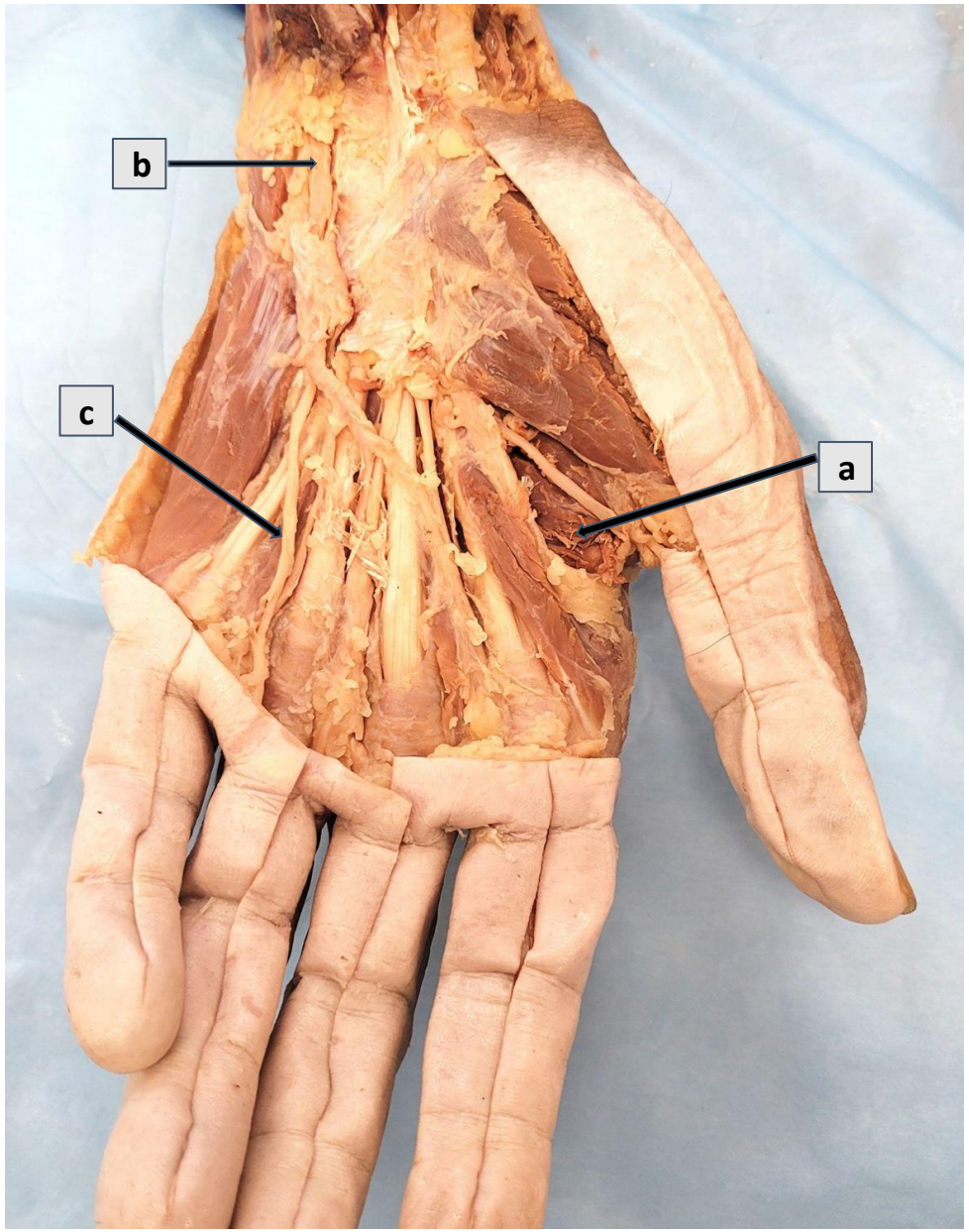
Ricardo and Slovik both have hand mobility problems. Ricardo is asked to hold a piece of paper and not let it be pulled away. Shawn is asked to make a tight fist. On the donor body:

- Find the likely location of nerve injury
- Find the muscles whose impairment has led to the physical findings

- Ricardo is showing “Froment’s sign” – he can’t pinch the paper with **adductor pollicis**, so he is using flexor pollicis longus. He also has clawing of the ulnar two digits, due to paralysis of the ulnar two **lumbricals**. This injury could be anywhere along the **ulnar nerve**.
- Slovik is showing the “Hand of Benediction” or “Pope’s blessing.” Asked to make a fist, only the ulnar two digits come down because the ulnar two digitations of FDP are still working. The radial two digitations of **Flexor Digitorum Profundus**, plus all of **Flexor Digitorum Superficialis**, are paralyzed and so the index and middle fingers are stuck in extension. Moreover, the thenar eminence muscles (**abductor pollicis brevis, flexor pollicis brevis, and opponens pollicis**) are paralyzed and the thumb is laterally rotated and largely immobile. This is a **proximal median nerve** injury, occurring before the innervation of FDS and FDP.

Bonus question 1:What additional findings would you expect if Slovik’s injury was above the elbow?

Bonus question 2:What could you ask to further narrow down the location of Ricardo’s injury?

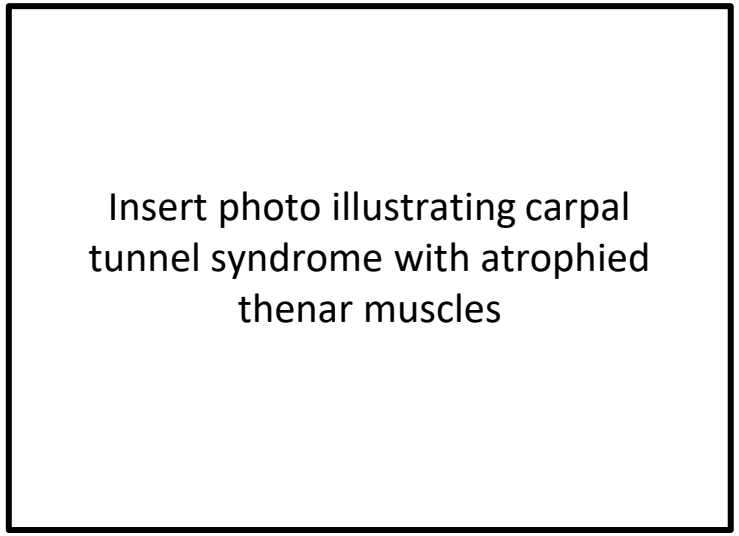


A representative prosection for case 6 showing (a) adductor pollicis, (b) ulnar nerve, and (c) 4th lumbrical

Case 7:

Gabriel is a pianist whose awful technique involves extending the wrists and sitting too far back from the keyboard. After ten years of practice, he complains of weakness and pain in both hands.

- What condition do you think Gabriel has?
- On the donor body, find the nerve that is affected in this condition. Trace its branches to muscles and skin that explain his symptoms and the physical exam findings.



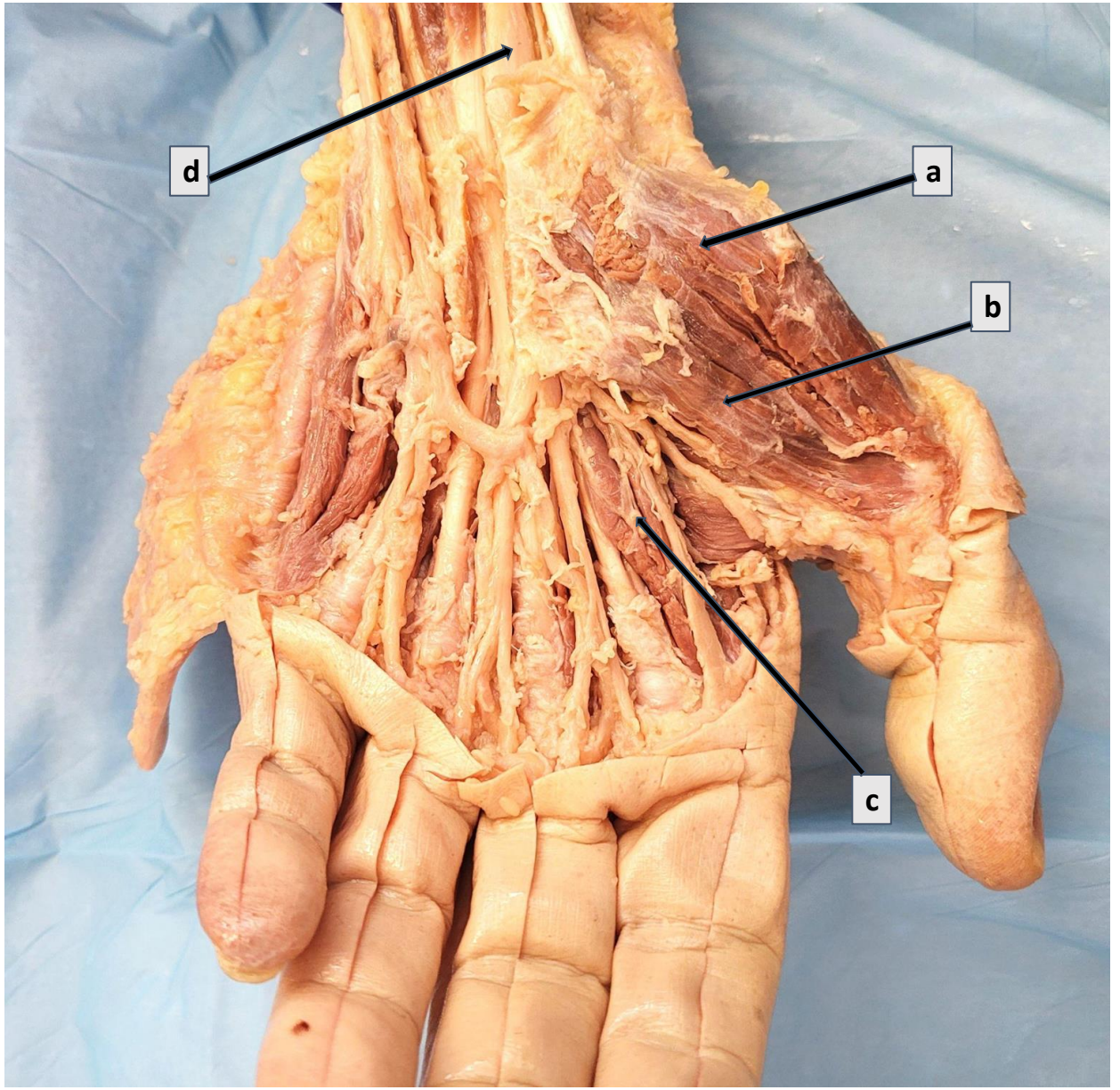
Insert photo illustrating carpal tunnel syndrome with atrophied thenar muscles

Gabriel is a pianist whose awful technique involves extending the wrists and sitting too far back from the keyboard. After ten years of practice he complains of weakness and pain in both hands.

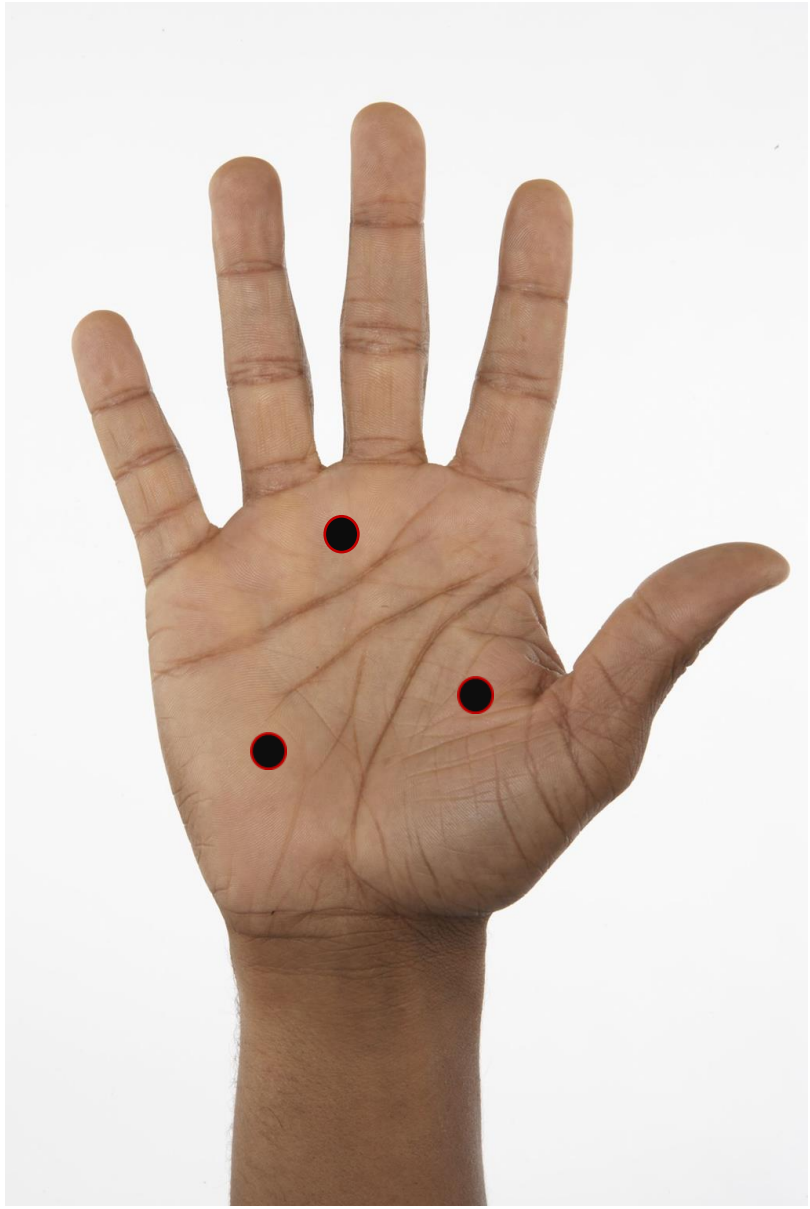
- What condition do you think Gabriel has?
- On the donor body, find the nerve that is affected in this condition. Trace its branches to muscles and skin that explain his symptoms and the physical exam findings.

This is carpal tunnel syndrome. It affects the median nerve as it passes through the carpal tunnel, and affects branches distal to the lesion. For this reason, intrinsic muscles of the hand that are innervated by the median nerve (opponens pollicis, abductor pollicis brevis, flexor pollicis brevis, and the radial two lumbricals) are weakened and may appear atrophied. The thumb is laterally rotated. The tingling will be located on the palmar surfaces of the first 3.5 digits, sparing the pinky and medial ring finger.

- Bonus question 1: Why doesn't this affect the first dorsal interosseous or adductor pollicis muscles?
- Bonus question 2: Why will there still be sensation at the base of the palm, directly over the carpal bones?
- Bonus question 3: How does carpal tunnel syndrome differ from Guyon's canal syndrome, anatomically and symptomatically?



A representative prosection for case 7 showing (a) abductor pollicis brevis, (b) flexor pollicis brevis, (c) 1st lumbrical, and (d) median nerve



Case 8:

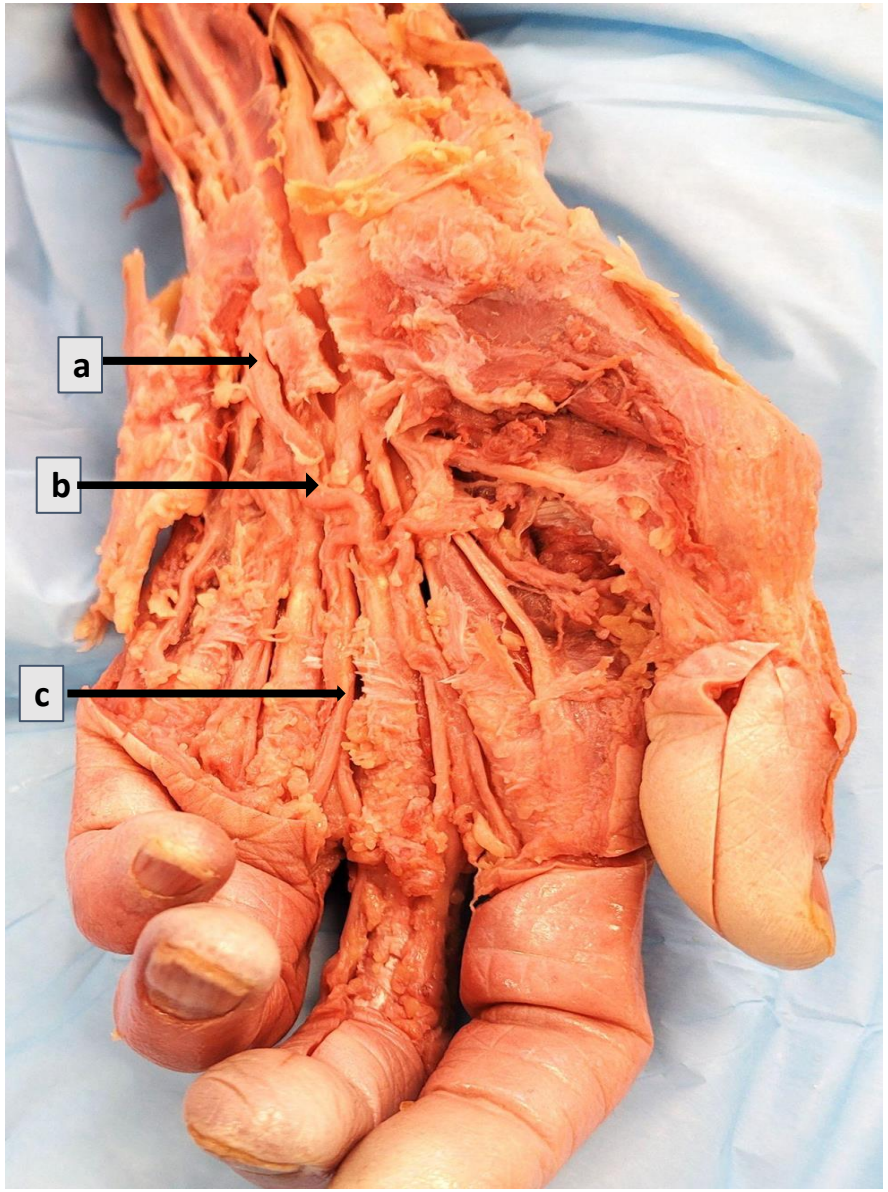
You attend the Coney Island Sideshow to witness some true anatomical wonders! After the show "The Human Pincushion" approaches you after finding out you are a group medical students to ask a *"purely hypothetical"* question. They draw three marks on their palm and ask you: "which of these locations would be the safest place to puncture a needle through for my new routine?"

Look to the donor body. Predict the musculature and neurovascular structures at risk in each location and why the performer should or should not puncture:

- between the 3rd and 4th metacarpals location
- the thenar location, or
- the hypothenar location?

Insert figure showing arterial contributions to the superficial and deep palmar arch

- In the hypothenar region, the performer risks puncturing the **ulnar artery** as it contributes to the **superficial palmar arch**. (*is there any backup for this blood supply?)* The hypothenar muscles and superficial branches of the ulnar nerve are also at risk.
- Between the 3rd and 4th metacarpals, distally, the common palmar digital artery is at risk, along with digital branches of the median nerve, interosseous muscles, and a lumbrical.
- Near the thumb, in the location shown, the actual muscles of the thenar eminence and the motor recurrent branch of the median nerve would be spared. However the digital branches of the median nerve are at risk. This puncture would pass through the **adductor pollicis** muscle and come out the back of the hand through the **first dorsal interosseous** muscle.



A representative prosection for case 8 showing (a) ulnar artery, (b) superficial palmar arch, (c) digital palmar artery

Structure Lab
Consolidation Carnival

Case 1: Gloria is a 70-year-old woman who was tango dancing at the senior center, when a particularly deep dip caused a sudden, sharp pain in her thigh. T2 MRI results are shown.

Insert CT scan showing hamstring tear

- On the body donor, find the compartment and the muscles most likely affected by her injury. Describe their innervation and action.
- What large blood vessels are visible on the axial scan? On the donor body, show how these vessels relate to the knee joint.

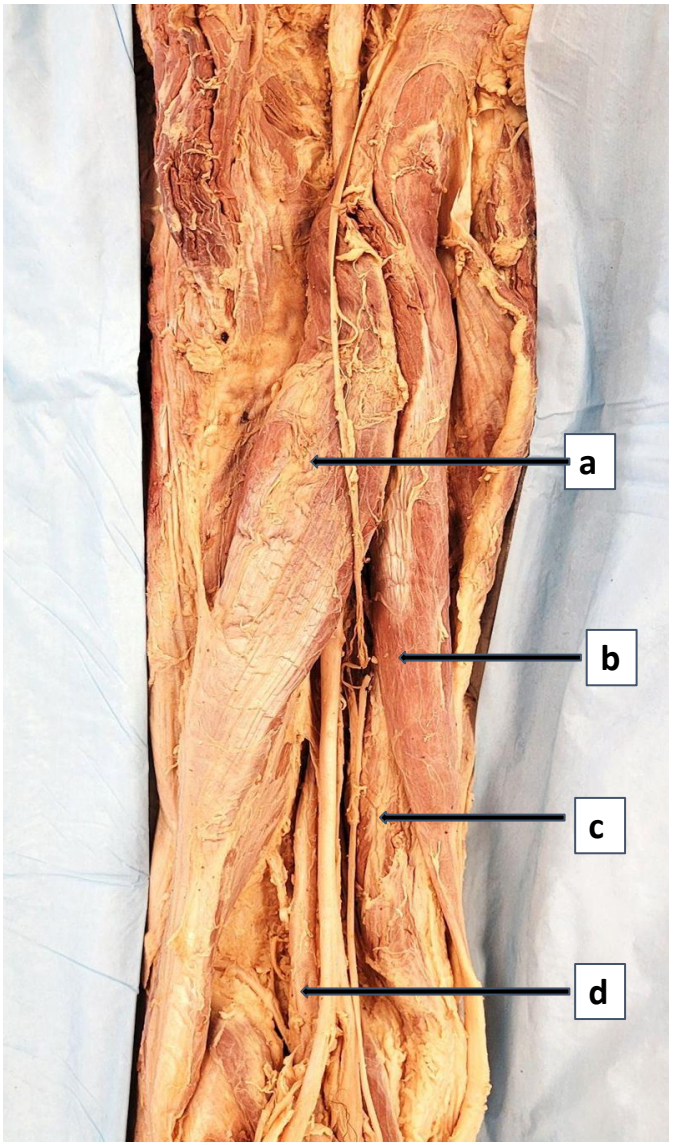
Gloria suffered a hamstring tear. Hamstrings include the **semitendinosus**, **semimembranosus**, and **long head of biceps femoris**. These three muscles are innervated by the tibial portion of the sciatic nerve and serve to **extend the hip joint** and **flex the knee joint**.

Insert image of axial scan showing femoral artery and vein in the adductor canal

The axial scan shows the **femoral artery and vein** in the adductor canal. As they pass inferiorly and posteriorly through the adductor hiatus, they become the **popliteal artery and vein**. The popliteal artery gives off four **genicular arteries** that anastomose around the knee joint.

See and scroll the real case here: https://radiopaedia.org/cases/hamstring-origin-complex-avulsion-british-athletics-classification-grade-4c

Bonus question 1: What muscle in the posterior compartment is not technically a hamstring? Why not?
Bonus question 2: What muscle in the medial compartment is more like a hamstring than an adductor?



A representative prosection for case 1 showing (a) long head of biceps femoris, (b) semitendinosus, (c) semimembranosus, and (d) popliteal artery

Case 2:

Quadratus femoris is well known for being a “Square Muscle of the Hip.”

- On the body donor, find quadratus femoris and describe its action at the hip.
- Next, find all the muscles that perform the same action.
- Paralysis of which of these muscles would have an appreciable effect on gait?

Plus…

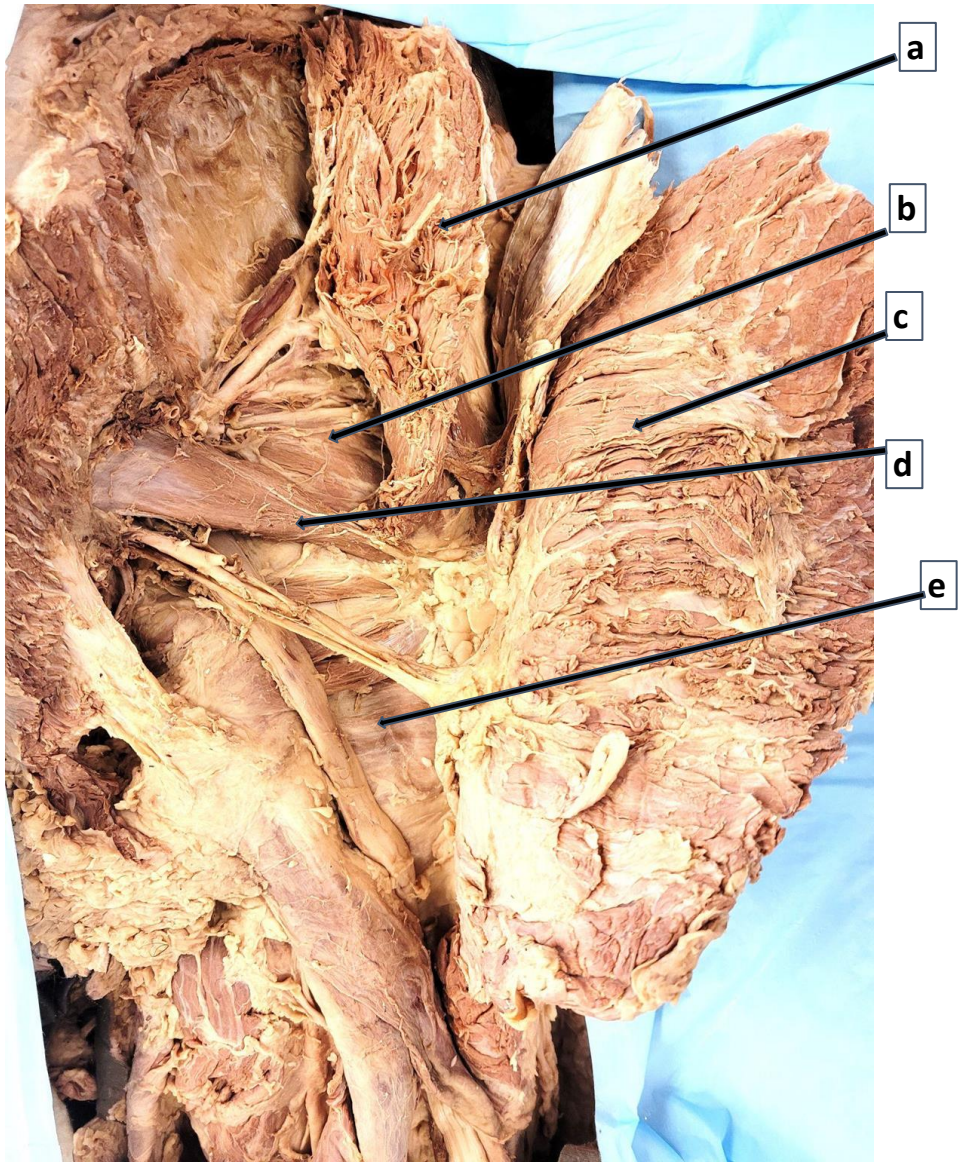
- Gluteus maximus
- Gluteus medius and minimus (posterior fibers)
- And Sartorius in the anterior compartment

Quadratus femoris is an external (lateral) rotator of the hip. There are many external rotators of the hip. Six comprise the so-called **short external rotators** (see figure at left). While they all help with rotation, paralysis of any one of these would probably not alter gait appreciably.

Gluteus maximus also aids in external rotation (though its main function is hip extension, as in climbing stairs, or rising from a squat or chair). It is not used much while walking on level terrain, so its paralysis would not appreciably affect gait.

The posterior fibers of **gluteus medius & minimus** also aid in external rotation. Their primary action, however is to abduct the hip. They are used when walking to keep the pelvis level. When paralyzed, the unsupported hip will be seen to drop (Trendelenburg gait).

Bonus question 1: What muscles internally rotate the hip?



A representative prosection for case 2 showing (a) gluteus medius, (b) gluteus minimus, (c) gluteus maximus, (d) piriformis, and (e) quadratus femoris

Insert image showing a deep wound on the anterior compartment of the thigh

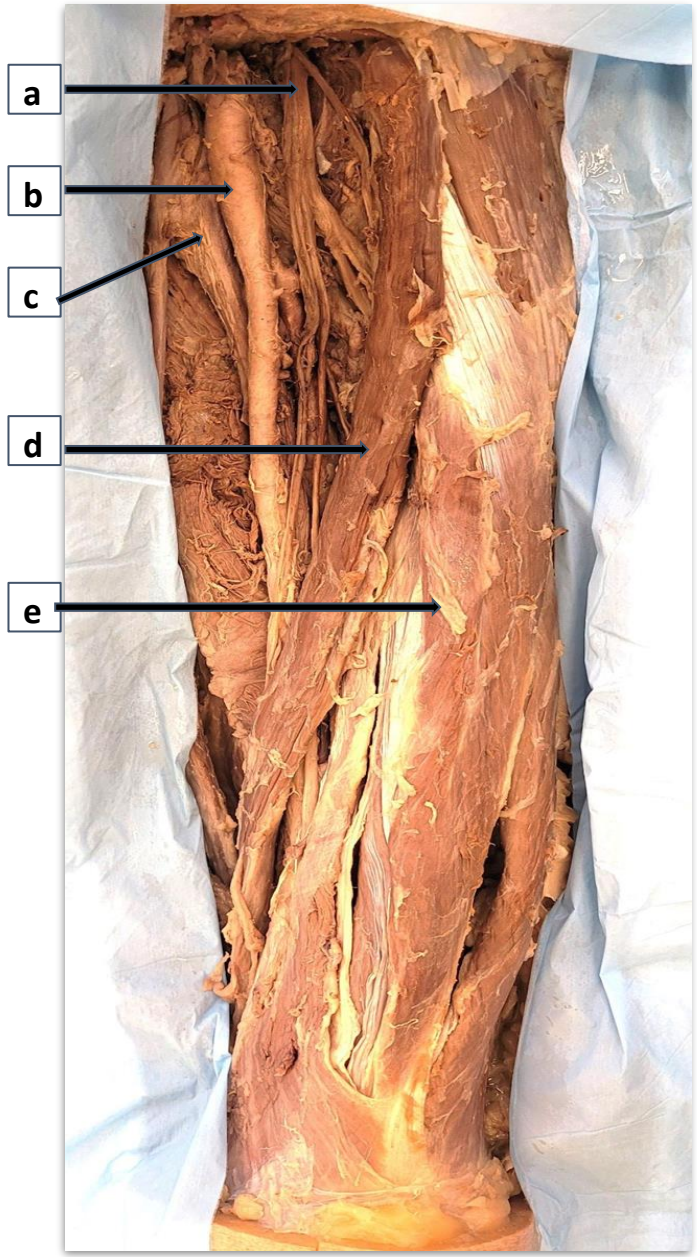
Case 3:
A propane tank explodes during a 4th of July barbeque and sends metal shrapnel into some of the dinner guests. A large piece of metal embeds itself in a student's left thigh. The student is conscious but appears to be in shock and bleeding profusely.

- On the donor body, find the blood vessels that would be affected from this injury.
- Find the muscles supplied by those vessels and discuss their functions.
- Which nerve is affected if the student loses sensation on the medial side of the leg?

- Based on the location of the injury, the vessels affected are the femoral artery and vein. The injury may also extend to the deep femoral artery.
- Femoral artery and vein supply muscles in the anterior compartment of the thigh. These muscles are **Sartorius** and **quadriceps muscles (rectus femoris, vastus lateralis, vastus intermedius, vastus medialis), pectineus, iliopsoas.** The pectineus muscle is responsible for flexion, adduction, and medial rotation of the hip. The **sartorius** is responsible for flexion of the knee and flexion and lateral rotation of the hip joint. The **quadriceps** are the main extensors of the knee. The **iliopsoas** is responsible for flexion of the thigh. The deep femoral artery supplies the hamstring muscles of the posterior thigh (**biceps femoris, semitendinosus, semimembranosus**) via its perforating branches and the medial circumflex humeral branch mostly supplies the neck of the femur.
- Saphenous nerve

Bonus question 1: What muscle in the anterior compartment flexes the hip but does not extend the knee?

Bonus question 2: The student complains about loss of cutaneous sensation on the anterior thigh following this incidence. What nerve is affected?



A representative prosection for case 3 showing (a) femoral nerve, (b) femoral artery, (c) femoral vein, (d) sartorius, and (e) rectus femoris

Insert image illustrating obturator hernia

Case 4: An 87-year-old woman presented to the ER with a lump in her right inguinal area, over which a bowel loop was identified by ultrasonography. An obturator hernia was suspected.

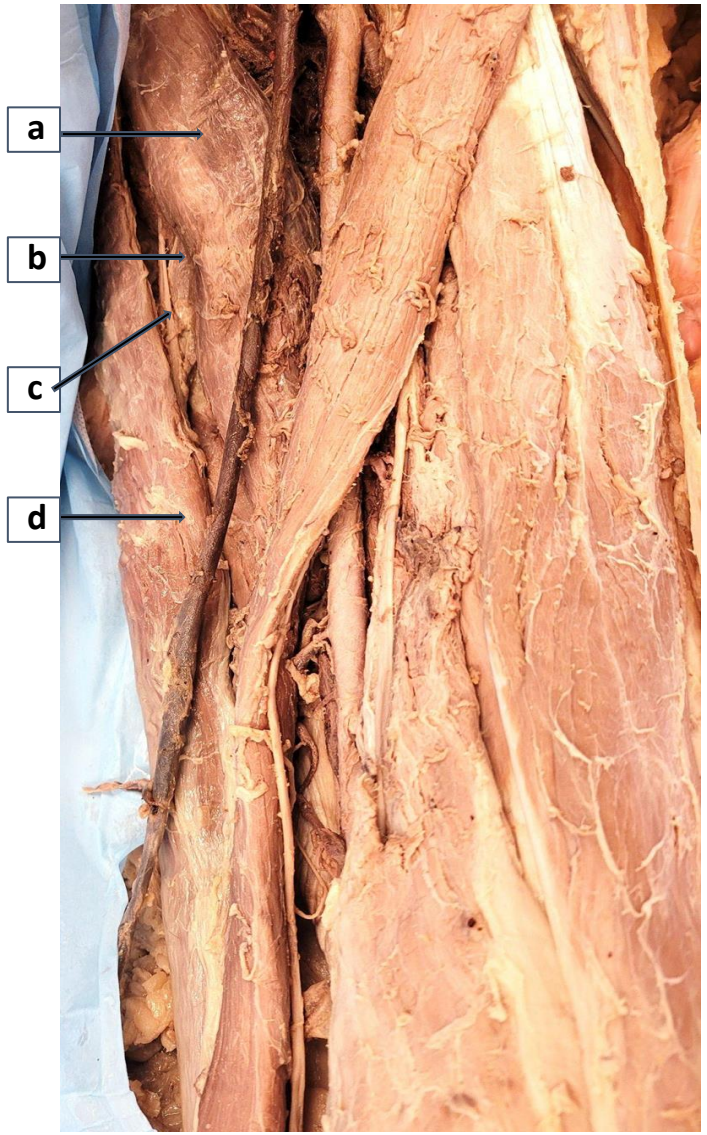
Note: Obturator hernia is a relatively rare type of abdominal hernia in which abdominal contents protrude through the obturator canal.

- Using the donor body, identify the nerve that will be compressed in this condition.
- Find the muscles innervated by that nerve and discuss their functions.

- Obturator nerve enters the medial thigh by passing through the obturator canal, and so will be compressed by a hernia in that region.
- Obturator nerve innervates most muscles of the medial compartment of the thigh - **obturator externus, *adductor longus, adductor brevis, *adductor magnus, and gracilis**. These muscles mainly function in adduction of thigh and *hip flexion.

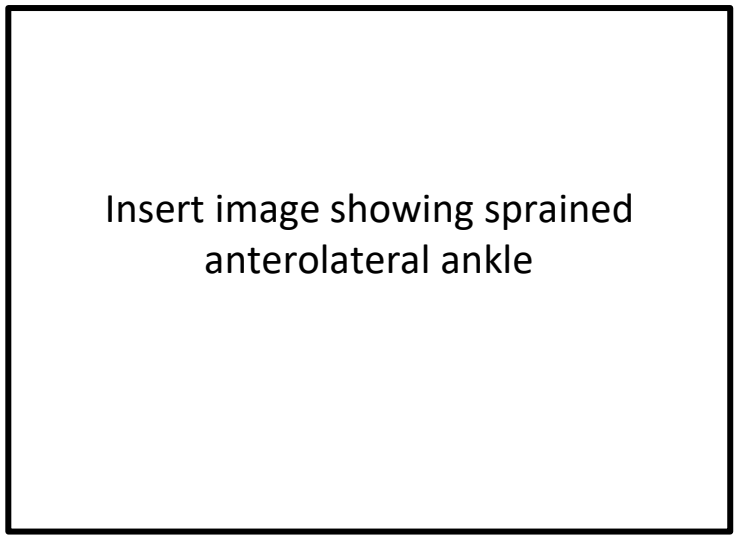
  Note:

  - *Only the adductor part of adductor magnus is innervated by obturator nerve, its hamstring part is innervated by the tibial part of the sciatic nerve.*
  - *The pectineus is usually innervated by the femoral nerve, but in about 20% of the population, it may also receive innervation via the accessory obturator nerve*
- Bonus question: If a varicosity is also observed in her medial thigh, what structure is likely affected?

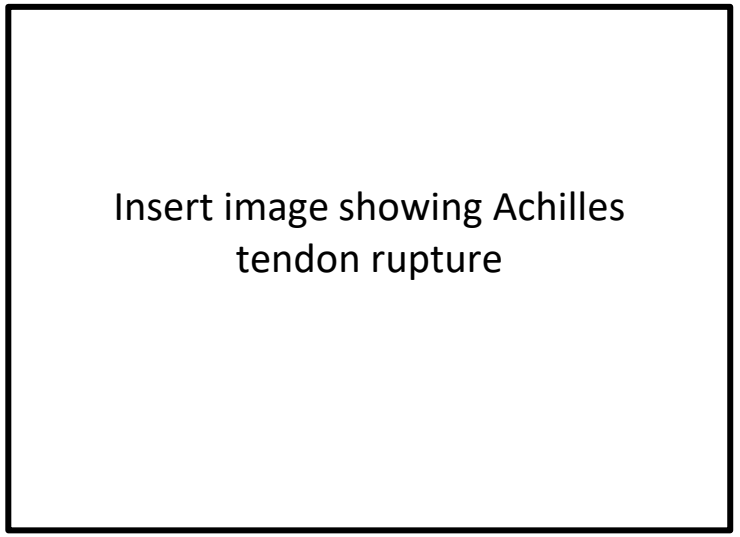


A representative prosection for case 4 showing (a) adductor longus, (b) adductor brevis, (c) obturator nerve, and (d) gracilis

Darla



Frank

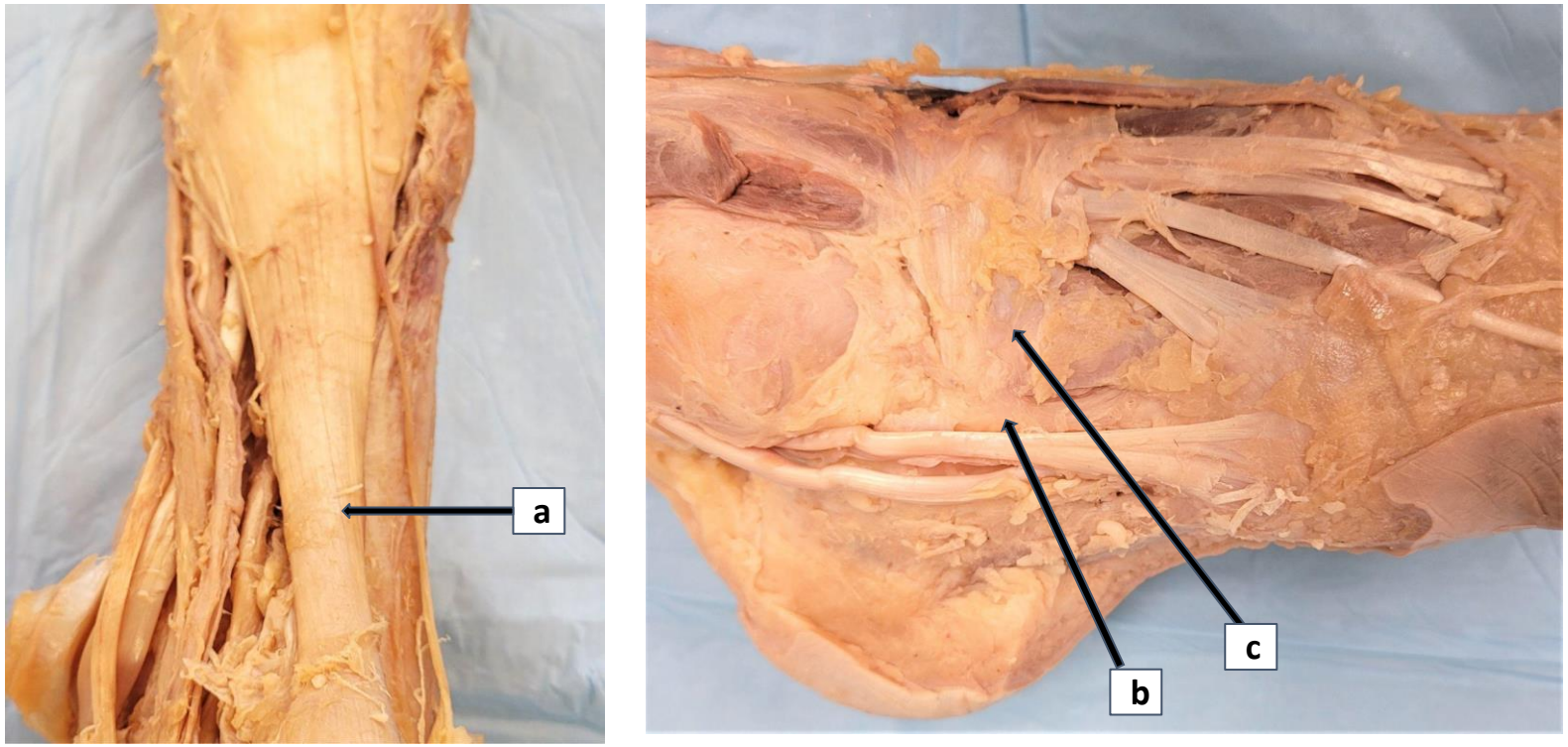


Case 5:

The Carnival is in town! Unfortunately, two of the circus performers end up in your ED after a show. The tightrope walker **Daring Darla!** and the lion tamer **Fearless Frank!**, both of which received injuries just as these photos were being taken. Darla began to fall off balance and thankfully corrected herself but says that she now feels pain and weakness of the ankle and presents to you with this bruising pattern. Frank was preparing to lunge during the show when he felt a sudden, sharp pain in his left calf and had to be helped out of the ring. He presents to your ED as shown.

- On the donor body/specimens, identify the location of each injury and the nerve supply associated
- What tests would you perform on each patient to determine the diagnosis and severity of their ankle injuries?
- What actions would your patients feel weakness or be unable to perform? Are there backups to these actions?

- What tests would you perform on each patient to determine the diagnosis and severity of their ankle injuries?
- An anterior drawer test would be performed on Darla to confirm a tear in the ATFL, she is diagnosed with a sprained ankle. She is put on bed rest with compression and ice for a few days recovery. Frank receives a positive Thompson test, confirming a full Achilles tendon rupture. He will have to receive surgery for his injury and will not be reentering the ring for some time.
- What actions would your patients feel weakness or be unable to perform? Are there backups to these actions?
- Darla's ankle would feel weak and unstable when plantarflexing or inverting so she may show signs of avoiding those movements in her gait however, she will be able to perform said movements. If the CFL was not sprained, this can be a backup stabilizer for the lateral ankle. Frank's ruptured Achilles will lead to an inability to use his major plantarflexors. He can receive backup plantar flexion from muscles of the deep posterior and lateral compartments, but they will not be as strong.
- Where are they feeling the pain and how?
- Darla's pain is being carried by the superficial fibular nerve because it travels just superficial to the ATFL so she may feel referred pain along the dorsum of the foot or up the anterio-lateral side of the leg. Frank would have felt the heavy snap of his Achilles from his sural nerve.



A representative prosection for case 5 showing (a) calcaneal tendon, calcaneofibular ligament, and (c) anterior talofibular ligament

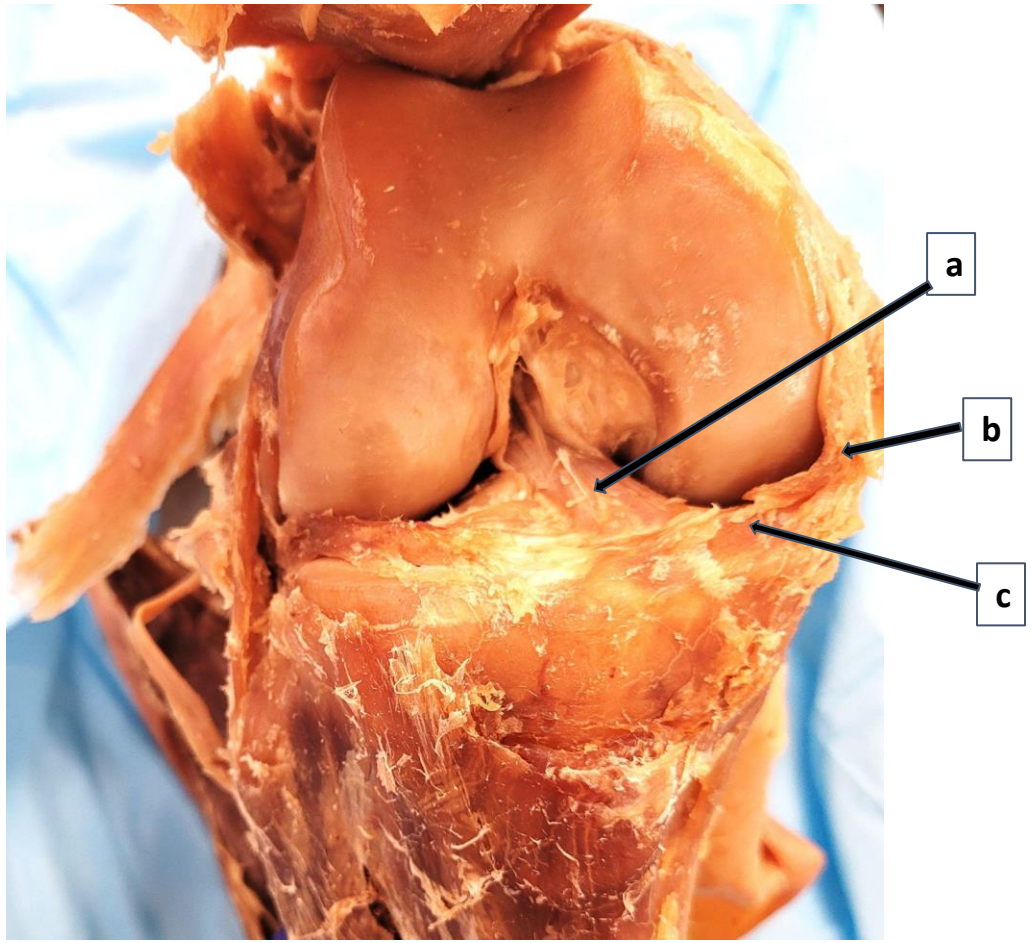
Insert MRI showing medial meniscus tear

Case 6:

The Carnival has come around! Unfortunately, you are unable to attend and are instead working a shift in the ED. Luckily for you, unlucky for others, the carnival came to you in the form of a contortionist suffering from some pain. Flora, The Flexible Femme Fatalle, is wheeled into the room. She says that for the last few weeks her knee has been feeling increasingly stiff and painful, the medial aspect the joint is now swollen and when prompted she cannot fully extend her leg without severe pain. You send her to imaging and receive this in return.

- On the donor body/specimens, find the structures shown in the image and relate them to their 3D counterparts
- How would you diagnose the contortionist?
- Find the muscle with rotational action on the knee that “unlocks” the joint to allow flexion
- What other structures may you wish to test for their integrity?

- How would you diagnose the contortionist?
- Flora is suffering from a tear of the medial meniscus, likely due to general wear-and-tear given her occupation, that would explain her pain, swelling, and inability to extend the knee fully. Most meniscus tears can heal with time and decreased wear on the joint during healing, however if it is more severe she may require surgical intervention to repair it.
- What other structures may you wish to test for their integrity?
- Medial meniscus tears are often associated with torn ACL's as well. An anterior drawer test of the knee should be performed to confirm only the meniscus is damaged along with checking the imaging for other damage in the area.



A representative prosection for case 6 showing (a) anterior cruciate ligament, (b) tibial collateral ligament, and (b) medial meniscus

Case 7:

In an attempt to overturn his reputation as “Emperor of all Wimps,” Evan attempts the “high-striker” hammer game. He misses the mark entirely, smashing his own shin instead. Later he limps into the ED and is diagnosed with an anterior compartment syndrome.

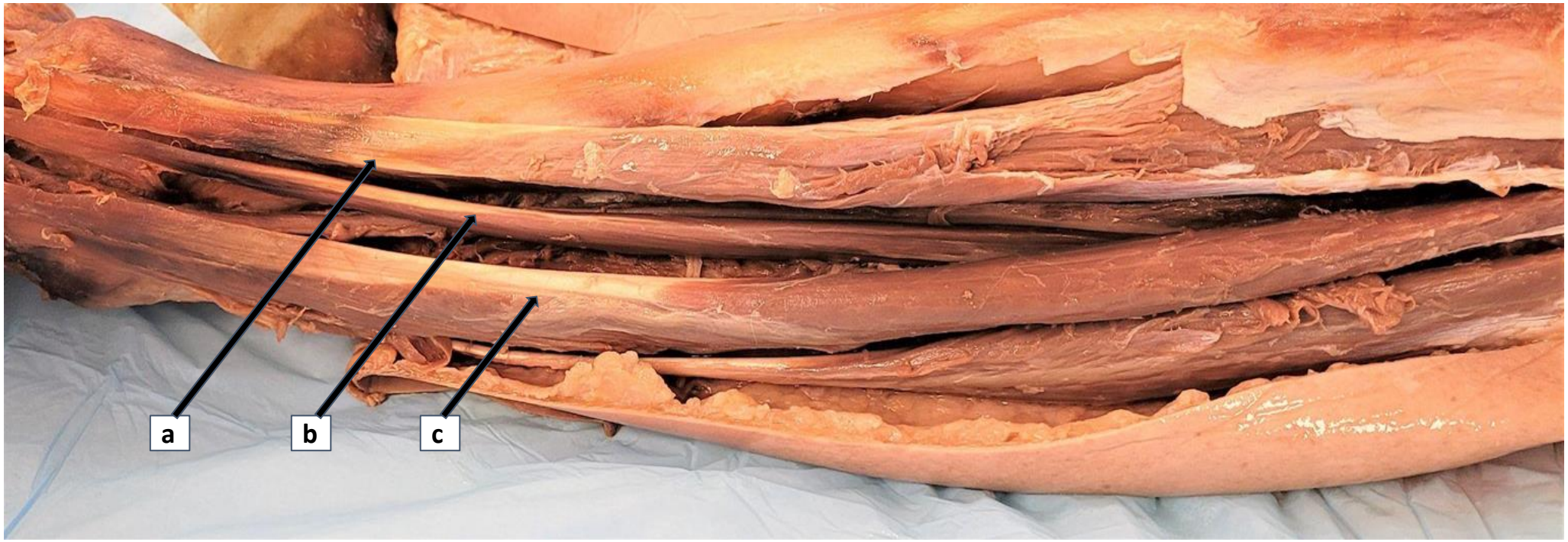
- On the donor body, identify the connective tissues that tightly enclose the anterior compartment.
- Identify the muscles in the anterior compartment and consider their primary and secondary actions.
- Identify the neurovascular structures at risk and predict neurovascular findings in the foot.

The anterior compartment is tightly enclosed between the anterior crural (leg) fascia, anterior intermuscular septum, interosseous membrane, and tibia.

Only four muscles occupy this compartment: tibialis anterior (strong dorsiflexor that also inverts the foot), extensor hallucis longus & extensor digitorum longus (extensor of the toes that also dorsiflex) and fibularis tertius (weak evertor and dorsiflexor).

Pressure in this compartment impinges upon the **anterior tibial artery** causing diminished pulse in the dorsalis pedis and attendant pallor and coolness. It also affects the **deep fibular nerve**, causing motor weakness in the muscles mentioned (leading to foot drop and a high-stepping or “steppage” gait), as well as pain and paresthesia in the area of the first web space between toes.

Bonus question: Why do some say can you diagnose this condition with eyes closed?



A representative prosection for case 7 showing (a) tibialis anterior, (b) extensor hallucis longus, and (b) extensor digitorum