

1. What type of joint is the humeroulnar joint?
- a. Ball-and-socket
 - b. Ellipsoid
 - c. Hinge
 - d. Pivot
 - e. Syndesmoses

Answer. c

2. What physical exam finding would a physician look for in order to confirm a suspected torn anterior cruciate ligament (ACL)?

- a. Anterior displacement of the tibia relative to the femur
- b. Inability to “unlock” the knee when standing
- c. Pain and stiffness localized to the medial knee
- d. Pain when applying pressure to the medial ankle and lateral knee
- e. Posterior displacement of the tibia relative to the femur

a. YES. The anterior cruciate ligament (ACL) originates from the anterior intercondylar area of the tibia. It ascends posteriorly to attach to the back of the lateral wall of the intercondylar fossa of the femur. A tear in this ligament would result in increased anterior movement of the tibia as it is no longer connected so tightly to the posterior femur attachment.

b. NO. The popliteus muscle unlocks the extended knee by initiating lateral rotation of the femur on the tibia.

c. NO. Pain and stiffness localized to the medial knee would be indicative of damage to the tibial collateral ligament (or medial collateral ligament) of the knee.

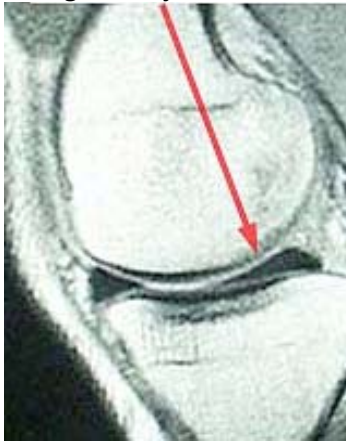
d. NO. Applying opposing (outward) pressure to the medial ankle and (inward) pressure to the lateral knee would be testing injury to the fibular collateral ligament (or lateral collateral ligament) of the knee.

e. NO. Posterior displacement of the tibia relative to the femur would indicate a tear in the ligament that

3. When an athlete tears their anterior cruciate ligament (ACL), anterior displacement of the tibia is noted. Explain why this finding occurs.

Answer: the anterior cruciate ligament (ACL) originates from the anterior intercondylar area of the tibia. It ascends posteriorly to attach to the back of the lateral wall of the intercondylar fossa of the femur. A tear in this ligament would result in increased anterior movement of the tibia as it is no longer connected so tightly to the posterior femur attachment.

4. What knee structure is designated by the red arrow in the following MRI?



- a. Mensicus
- b. Oblique popliteal ligament
- c. Patellar ligament
- d. Posterior cruciate ligament
- e. Tibial collateral ligament

- a. YES. The menisci are fibrocartilaginous c-shaped cartilages on the tibia that articulate with the femur.
- b. NO. The oblique popliteal ligament is fibrous extension of the semimembranosus tendon, coursing from the lateral to medial side of the knee
- c. NO. The patellar ligament is a continuation of the rectus femoris tendon that is inferior to the patella and attaches to the tibial tuberosity.
- d. NO. The posterior cruciate ligament courses from the posterior tibia to its attachment on the anterior intercondylar fossa of the femur.
- e. NO. The tibial collateral ligament is located on the medial side of the knee.

CONSTRUCTED RESPONSE

5. Gout is a common form of arthritis caused by high uric acid in the bloodstream or decreased uric acid excretion in the kidney. The result is uric acid crystallization within joints and capsular linings. Often times the symptoms of gout are seen as inflammation in the first metatarsalphalangeal joint (pictured below),



Beginning with the femoral artery, trace the pathway that uric acid in the bloodstream would follow in order to precipitate at the first metatarsalphalangeal joint.

Responses:

- Femoral artery – Popliteal artery – Anterior tibial artery – Dorsal pedal artery – Great toe
- Femoral artery - Popliteal artery – Posterior tibial artery – Medial/Lateral plantar arteries – Great toe

Constructive Response

6. A 22-year-old female soccer player sustains a direct kick to the lateral leg when an opponent accidentally makes contact with the player instead of the ball. Upon physical examination, the team trainer discovers that the patient has sensory loss on the dorsum of the foot and lateral leg. Recognizing that a muscle action will be affected by the injury, the trainer recommends orthotics (corrective foot supports) during and after the recovery period.

Identify what nerve has been damaged. Describe what muscle action will be affected in the patient and the desired corrective effect of the orthotics.

Response: The superficial peroneal nerve has been damaged, resulting in sensory loss on the dorsum of the foot and the lateral leg. The superficial peroneal nerve innervates the lateral compartment of the leg, the fibularis longus and brevis, the muscles of which are responsible for eversion of the foot. Nerve injury will result in a decrease in foot eversion and therefore an increase tendency in foot inversion. The corrective orthotics will strive to correct any excess foot inversion.

7. Fluoroquinolones are a class of antibiotics with increasing use due to their excellent absorption in the gastrointestinal tract and its wide spectrum of activity against infections. A noted side effect of the drug is an increased frequency of tendon ruptures. An 88-year-old man is treated with a fluoroquinolone 5 days before and after surgery for an abdominal abscess. Two weeks after the surgery he presents in the Emergency room with edema and warmth of the left leg, as well as tenderness upon palpation of the calcaneal tendon (The Journal of the American Board of Family Practice 16:458-460 (2003)).

Assuming a calcaneal tendon rupture, with what action will the patient have an increased range of motion in his left foot compared to the unaffected right foot?

- a. Foot eversion
- b. Foot inversion
- c. Dorsal flexion
- d. Plantar flexion
- e. Toe extension
- f. Toe flexion

- a. NO. The muscles in the lateral compartment of the leg and the fibularis tertius control foot eversion. This movement would not be impacted by a tendon rupture of the calcaneal (Achilles) tendon.
- b. NO. Foot inversion is controlled by the anterior and posterior tibialis muscles. This movement would not be impacted by a tendon rupture of the calcaneal (Achilles) tendon.
- c. YES. While the calcaneal tendon helps the superficial compartment of the posterior leg carry out plantar flexion, its opposed or counter movement, dorsal flexion, would have an increased range of motion as a result of the rupture.
- d. NO. While the calcaneal tendon does help the superficial compartment of the posterior leg carry out plantar flexion, this movement would no longer be possible with a ruptured calcaneal (Achilles) tendon.
- e. NO. Toe extension is carried out by the extensor hallucis longus and extensor digitorum brevis. This movement would not be impacted by a tendon rupture of the calcaneal (Achilles) tendon.
- f. NO. Toe flexion is carried out by the flexor hallucis longus and brevis. This movement would not be impacted by a tendon rupture of the calcaneal (Achilles) tendon.

8. A physician uses her mallet to apply a brisk tap to the calcaneal tendon. What spinal cord levels is the physician evaluating with this tendon reflex test?

- a. L1-2
- b. L3-4
- c. L4-5
- d. S1-2

a. NO. Spinal cord levels L1-2 are primarily responsible for motor innervation of the muscles that perform flexion of the hip in the upper thigh and pelvis region (Psoas, Iliacus, sartorius).

b. NO. Spinal cord levels L3-4 primarily innervate the quadriceps femoris muscles. These muscles would not be contracting in a calcaneal tendon reflex test.

c. NO. Spinal cord levels L4-5 are primarily responsible for motor innervation of the muscles in the posterior thigh and the posterior tibialis in the deep compartment of the posterior leg. These muscles would not be contracting in a calcaneal tendon reflex test.

d. YES. The calcaneal tendon is comprised of the tendons of the soleus and gastrocnemius muscles, which are innervated by the tibial nerve (levels S1-2). Contraction of these muscles would indicate the level of motor function at spinal cord levels S1-2.

9. A 58-year-old female horseback rider presents in a chiropractic clinic with sharp right buttock pain that radiates to the anteromedial aspect of the thigh. She complains of sensory loss over the anterior part of her right knee that extends down the medial leg to the arch of her right foot. Physical exam reveals decreased strength during knee extension (JCCA J Can Chiropr Assoc. 2007 December; 51(4): 210–216). At what levels of the spinal cord will chiropractic adjustments be made in order to relieve the symptoms?

- a. T12-L1
- b. L2-4
- c. L5-S1
- d. S2-3

- a. NO. Spinal cord levels T12-L1 might be considered for abnormalities involving the ilioinguinal nerve (L1)
- b. YES. This patient displays the symptoms of femoral nerve (L2-4) myopathy, revealed by the pattern of cutaneous nerve loss radiating from the upper knee to the arch of the foot (innervation pathway of the anterior branch of the femoral nerve from which the saphenous nerve originates), as well as weakening in the quadriceps femoris muscles and the origin of the pain.
- c. NO. Spinal cord levels L5-S1 might be considered for abnormalities involving the sciatic nerve and its branches. The patient in this situation does not display any abnormalities involving nerves that emerge from spinal cord levels L5-S1.
- d. NO. Spinal cord levels S2-3 might be considered for abnormalities in the flexor hallucis longus and flexor digitorum longus as well as some of the intrinsic muscles of the foot.

10. Complex fractures of the ankle joint involving the distal tibia are most easily and safely approached surgically in the space posterior to the medial malleolus. During this procedure, surgeons must be careful to avoid damage to the tendons, vessels and nerve that course through this region (Techniques in Foot & Ankle Surgery. 6(1):44-49, March 2007). A post-operative patient whose nerve had been damaged during this surgery would display a complete loss of what motion?

- a. Dorsiflexion
- b. Great toe (digit 1) extension
- c. Great toe (digit 1) flexion
- d. Little toe (digit 5) abduction*
- e. Little toe (digit 5) flexion
- f. Plantar flexion

CONSTRUCTED RESPONSE

11. Bones can fracture or be displaced from their normal anatomical position. When this occurs, neighboring structures are at risk of damage. Likewise, ankle sprains can damage ligaments of the joint. Write the name of a structure most likely injured in each of the following situations. Provide one clinical symptom associated with the injury.

- I. Fracture of the neck of the fibula
- II. Fracture of the head of the femur
- II. Inversion sprain of the ankle

Response:

- I. Neck of the fibula fracture :: common fibular/peroneal nerve. Symptoms: weakness of dorsiflexion, reduced sensation of dorsum of foot/between great and second toe
- II. Fracture of the head of the femur :: Medial Femoral circumflex artery. Symptom: necrosis of the femoral head
- III. Inversion sprain of the ankle :: anterior talofibular ligament. Anterior displacement of the talus relative to the tibia.

12. A 25-year-old male presents in the Emergency Room complaining of a deep, dull pain in the lateral side of his right wrist. The patient explains that he tripped while playing basketball and tried to brace his fall with a fully extended arm and fell on his outstretched hand with the palm facing down. Upon physical exam you note tenderness upon palpation of the anatomical snuffbox (American Academy of Family Physicians, Vol. 70 No. 5 Sept 1 2004). What is the most likely diagnosis?

- a. Compression of the recurrent median nerve
- b. Compression of the ulnar nerve
- c. Fracture of the lunate
- d. Fracture of the scaphoid

a. NO. The recurrent branch of the median nerve is not palpable through the anatomic snuffbox and would not explain a deep, dull pain radiating in the lateral wrist. It enters the hand deep to the flexor retinaculum before innervating the thenar muscles of the hand

b. NO. The ulnar nerve runs on the medial side of the wrist as it enters the hand. It passes superficially to the flexor retinaculum and is not responsible for tenderness on the lateral side of the wrist.

c. NO. The lunate bone is not palpable through the anatomic snuffbox and is located more centrally in the wrist. A fracture of this bone would not support all of the clinical findings above.

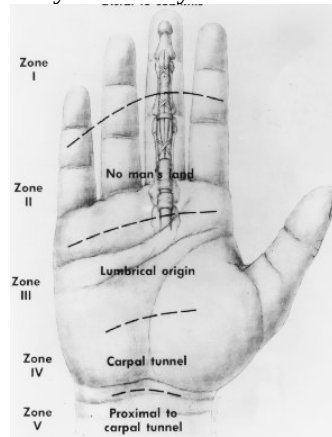
d. YES. The scaphoid bone, which is the most common type of fracture in wrist injuries, creates the floor of the anatomical snuffbox along with the trapezium. Fractures are commonly confirmed by palpitation here as well as a radiograph. The position of the arm and fully extended during the fall also indicate contact of the scaphoid and the ground, resulting in a fracture.

13. A 24-year-old soccer goalie arrives in the Emergency Room complaining of a “dislocated wrist” that is accompanied by medial hand pain. The patient attributes his injury to blocking a shot with his hand during a practice, which resulted in the noticeable movement of a bone at the base of his hand. Physical examination indicates a loss of sensation over the little finger and medial side of the ring finger (Injury Extra, Volume 36, Issue 4, April 2005, Pages 79-81). The physician is concerned about the extent of nerve damage and asks the patient to perform what movement to test his suspicion?

- a. Adduct the wrist toward the body
- b. Cross the middle finger over the index finger
- c. Flex the ring finger at the distal interphalangeal joint
- d. Oppose the thumb to the index finger

- a. NO. Adduction of the wrist is accomplished by the flexor carpi ulnaris, which is innervated by the ulnar nerve. The innervation for this muscle would be supplied to the muscle above the level of the hand injury in this case
- b. YES. Crossing the fingers would test the function of the interossei muscles, all of which are innervated by the deep branch of the ulnar nerve.
- c. NO. Flexion of the ring finger at the DIP would be accomplished by the flexor digitorum profundus, which is innervated by the median nerve.
- d. Opposing the thumb is accomplished by the opponens pollicis m., which is innervated by the recurrent branch of the median nerve.

14. The level at which tendon injury occurs is an important consideration in tendon laceration repair. Traditionally hand surgeons have referred to specific areas as “no man’s land,” indicating a less successful level at which to repair tendon laceration due to local anatomy. Zones II and IV, pictured below, are both considered “No man’s land”. Why? (University of Pennsylvania Orthopedic Journal Volume 10 Spring 1997 Pages 5-11)



- a. Blood supply is very poor to these zones and will prolong recovery time
- b. Innervation by different nerves across these zones is too segmented for coordinated recovery
- c. Tendon adhesions can form due to multiple tendons overlapping in tightly confined spaces
- d. The lack of the synovial tendon sheaths will prolong recovery time.

- a. NO. The hand is richly vascularized by the ulnar and radial arteries, which form interconnected vascular arches in both the superficial and deep regions of the hand. Common palmar digital arteries radiate toward the digits. The wrist also receives blood supply from the ulnar and radial arteries, as well as the palmar carpal branch.
- b. NO. Although the median and ulnar nerves share innervation of the hand, this distribution of innervation would not delay or inhibit recovery more specifically in zones II and IV.
- c. NO. Zones II and IV are very dense with synovial tendon sheaths due to the number of tendons passing into the hand and digits.
- d. YES. The carpal tunnel is a postage stamp sized passageway from the hand into the wrist. Nine tendons and the median nerve must all pass through this tunnel together. This area is very sensitive to inflammation, irritation, and tendon adhesion due to the crowded passage way. Zone II considers the MCP and PIP joints, which serve as another example of small spaces that see many tendons, pass through on en route to their distal attachments. The lumbricals and interossei, as well as the flexors digitorum profundus and superficialis and the extensors of the dorsum all pass through this small region. The close proximity of so many tendons increases the likely for adhesions after surgery.

15. The range of ulnar deviation (adduction) of the hand is up to three times greater than radial deviation (abduction). What accounts for this difference?

- a. Abduction is limited by the first carpometacarpal joint
- b. Abduction is limited by the radial styloid process
- c. Adduction is enhanced by the ulna's lack of a styloid process
- d. Adduction is enhanced by ulnar articulation with the rounded triquetrum

- a. NO. The first carpometacarpal joint is extremely mobile and accounts for the varied actions of the thumb, namely flexion, extension, abduction, adduction, rotation, and circumduction. It does not impact abduction of the wrist
- b. YES. The radial styloid process extends further distally than the ulnar styloid process, which accounts for the limited abduction seen in the hand.
- c. NO. The ulna does have a styloid process, however, it does not extend as far distally as the radial styloid process.
- d. NO. The ulna does not articulate with the triquetrum.

CONSTRUCTED RESPONSE

16. Bones can fracture or be displaced from their normal anatomical position. When this occurs, neighboring structures are at risk of damage. Match the nerve most likely to be injured by the level at which the fracture occurs and provide one clinical symptom associated with a nerve injury at the specified level

- a. Fracture of the medial epicondyle of the humerus
- b. Fracture of the surgical neck of the humerus
- c. Mid-shaft humeral fracture
- d. Anterior dislocation of the lunate

Answers:

a. Fracture of the medial epicondyle of the humerus: Ulnar nerve.

The ulnar nerve courses behind the medial epicondyle of the humerus as it enters the anterior compartment of the forearm. SYMPTOM: sensory deficit over little finger and medial half of ring finger, inability to flex ring or little finger, inability to adducts the wrist, inability to abduct/adduct fingers, and numbness over medial arm

b. Fracture of the surgical neck of the humerus: Axillary nerve.

The axillary nerve passes through the quadrangular space, which serves as a passage way from the axilla and the posterior scapular region. SYMPTOM: sensory deficit over deltoid, inability to abduct arm past initial 15 degrees.

c. Mid-shaft humeral fracture: Radial nerve

The radial nerve is responsible for innervating the posterior arm and forearm. It passes through the triangular interval and courses with the profundus brachii artery lying directly in the radial groove of the humerus.

SYMPTOM: inability to extend wrist (drop wrist), inability to extend arm at elbow lack of sensation on dorsum of hand/posterior compartment of the forearm

d. Anterior dislocation of the lunate: Median nerve

The median nerve courses through the carpal tunnel in the center of the wrist. An anterior dislocation of the lunate would come into contact with this nerve. SYMPTOM: Sensory deficit over lateral palm and fingers, inability to flex fingers/wrist, inability to pronate,

17. A 23-year-old college baseball player appears in a neurologist's office complaining of severe right forearm fatigue after practices. He mentions numbness in the lateral palm of his right hand, index finger, and thumb. During the physical exam, the patient is unable to forcefully pinch his index finger and thumb together. He also experiences pain and weakness when the neurologist provides resistance during pronation. (The Journal of Bone and Joint Surgery, Vol 63, Issue 6 885-890, Copyright © 1981). What is the most likely reason for these findings is compression of the:

- a. median nerve in the elbow as it enters the forearm*
- b. median nerve in the carpal tunnel as it enters the hand
- c. ulnar nerve in Guyon's canal as it enters the hand
- d. ulnar nerve by the medial epicondyle of the humerus

18. Physicians assess the function of somatic sensory and motor function by performing tendon reflex tests. To do so the physician briskly taps a muscle tendon with a rubber mallet triggering the contraction of that specific muscle. The contraction is then graded according to its relative quickness. A patellar tendon reflex test primarily evaluates which spinal cord levels?

- a. L1-2
- b. L3-4*
- c. L4-5
- d. S1-2

a. NO. Spinal cord levels L1-2 are primarily responsible for motor innervation of the muscles that perform flexion of the hip in the upper thigh and pelvis region (Psoas, Iliacus, sartorius).

b. YES. Spinal cord levels L3-4 innervate the quadriceps femoris, the muscle that would contract in this reflex test. L2 is not included as a level tested due to its presence in the obturator nerve that innervates the medial compartment of the thigh.

c. NO. Spinal cord levels L4-5 are primarily responsible for motor innervation of the muscles in the posterior thigh and the posterior tibialis in the deep compartment of the posterior leg. These muscles would not be contracting in a patellar tendon reflex test.

d. NO. Spinal cord levels S1-2 are primarily responsible for motor innervation of the muscles in the posterior leg and the foot. These muscles would not be contracting in a patellar tendon reflex test.

19. A study of NCAA athletes was conducted in 1995 to explore anterior cruciate ligament (ACL) tears. Researchers suggested that ACL tears result when contracting muscles transfer a significant amount of stress to the ACL when the knee is in a hyperextended position. A proposed ACL tear prevention program advocated more hip and knee flexion when athletes made a sudden change in direction (Am J Sports Med, 1995 23 (6): 694.)

What muscle would contribute to stress placed on the ACL during hyperextension?

- a. Adductor magnus
- b. Biceps Femoris
- c. Gracilis
- d. Vastus lateralis

- a. NO. The adductor magnus is part of the medial compartment of the thigh. Both the adductor part and hamstring part of the muscle is responsible for adduction of the leg and medial rotation of the thigh at the hip joint.
- b. NO. The biceps femoris is part of the posterior compartment of the thigh. It flexes the leg at the knee joint and also extends and laterally rotates the thigh at the hip joint and laterally rotates the leg at the knee joint.
- c. NO. The gracilis muscle is part of the medial compartment of the thigh. It adducts the thigh at the hip joint as well as flexes the leg at the knee joint.
- d. YES. The vastus lateralis is in the anterior compartment of the thigh. It extends the leg at the knee joint and would therefore be contracted when the knee is in a hyperextended position.

20. Inability to abduct or adduct the fingers most likely indicates injury to the:

- a. Axillary nerve
- b. Median nerve
- c. Musculocutaneous nerve
- d. Radial nerve
- e. Ulnar nerve

Answer: e, the ulnar nerve innervates the dorsal and palmar interossei muscles, which abduct and adduct the digits respectively.

21. A 23-year-old male presents in the emergency room with a laceration from a knife fight that exposed bone over the medial epicondyle of the humerus (MyPACS.net Radiology files case 3563260). Assuming damage was done to tendons that attach to the medial epicondyle, what action would be unaffected?

- a. Abduction of the wrist
- b. Adduction of the wrist
- c. Flexion of the distal interphalangeal joint
- d. Flexion of the wrist
- e. Pronation of the forearm

- a. NO. Abduction of the wrist is performed by the flexor carpi radialis, which attaches to the medial epicondyle.
- b. NO. Adduction of the wrist is performed by the flexor carpi ulnaris, which attaches to the medial epicondyle.
- c. YES. The flexor digitorum profundus is responsible for flexion at the DIP and does not attach to the medial epicondyle of the humerus.
- d. NO. Flexion of the wrist is accomplished by the flexor digitorum profundus and superficialis in addition to the the flexor carpi ulnaris and the palmaris longus. The later three muscles attach to the medial epicondyle of the humerus, thereby affected wrist flexion.
- e. NO. Pronation of the forearm is performed by the pronator quadratus as well as the pronator teres, which attaches to the medial epicondyle of the humerus.

CONSTRUCTED RESPONSE

22. A cutaneous nerve test reveals that although a patient experiences thenar muscle wasting and a loss of sensation of the anterior surface of the thumb, much of the cutaneous sensation over the thenar muscle is still present. Why?

Answer:

- Palmar branch of the median nerve is spared in carpal tunnel syndrome as it originates proximal to the flexor retinaculum. It innervates the palm of the hand.
- The superficial branch of the radial nerve is responsible for cutaneous sensation over the dorso lateral surface of the hand which is responsible for some cutaneous of the thenar muscles.

23. Trigger Finger is a sometimes-painful condition that result from the narrowing of an overlying sheath that surrounds the tendon or inflammation of the tendon of an affected finger. The tendon becomes caught in the sheath and is unable to slide through easily, often times getting locked in bent position.



Based on the position of the hand, the tendons of which muscles are directly affected in this condition?

- a. Extensor digitorum and fourth dorsal interosseous
- b. Extensor digitorum and third lumbrical
- c. Flexor digitorum profundus and third lumbrical
- d. Flexor digitorum profundus and fourth dorsal interosseous
- e. Flexor digitorum superficialis and third lumbrical
- f. Flexor digitorum superficialis and flexor digitorum profundus

- a. NO. The extensor digitorum is not directly affected in this condition because the finger is locked in a bent position, not a straight one. The fourth dorsal interosseous muscle is not responsible for movement at the PIP and DIP and would not be affected in this condition.
- b. NO. The extensor digitorum is not affected in this condition because the finger is locked in a bent position, not a straight one. The third lumbrical is not responsible for movements at the PIP or DIP.
- c. NO. The third lumbrical is not responsible for movements at the PIP or DIP.
- d. NO. The fourth dorsal interosseous muscle is not responsible for movement at the PIP and DIP and would not be affected in this condition.
- e. NO. The third lumbrical is not responsible for movements at the PIP or DIP.
- f. YES. The flexor digitorum superficialis and flexor digitorum profundus are responsible for movement at the DIP (profundus) and PIP (superficialis). The flexor digitorum superficialis lays directly over the flexor digitorum profundus and inflammation in the tendons would contribute to trigger finger.

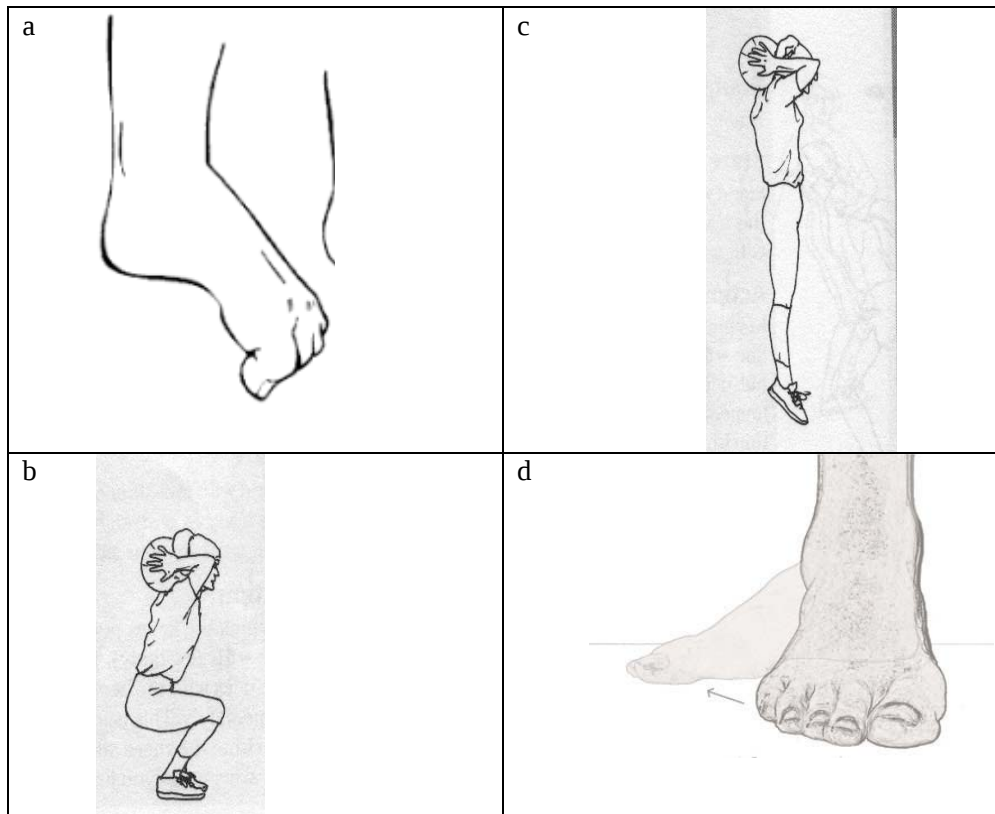
24. A 70-year-old female was walking on the beach and stepped on a piece of glass. The piece of glass penetrated an area on the plantar surface of her bare foot, cutting the lateral plantar nerve. Which one of the following muscles would be rendered non-functional?

- a. 1st lumbrical muscle
- b. Abductor hallucis muscle
- c. Dorsal interossei muscles
- d. Flexor digitorum brevis muscle
- e. Flexor hallucis brevis muscle

Answer: c. The medial plantar nerve will innervate 1 LAFF and the rest of the plantar muscles of the foot are innervated by the lateral plantar nerve.

25. A 32-year-old female mail carrier arrives in the emergency room after being bitten by a dog in the left anterolateral leg, 4 inches proximal to the ankle. The wound was cleansed and stitches were put in place. Thirteen days later, the patient returns for a follow-up visit complaining of diffuse, intense pain of the leg and inability to extend the four lateral toes. A diagnosis of compartment syndrome is considered (Resident and Staff Physician March 2007 • Vol 53 • No 3).

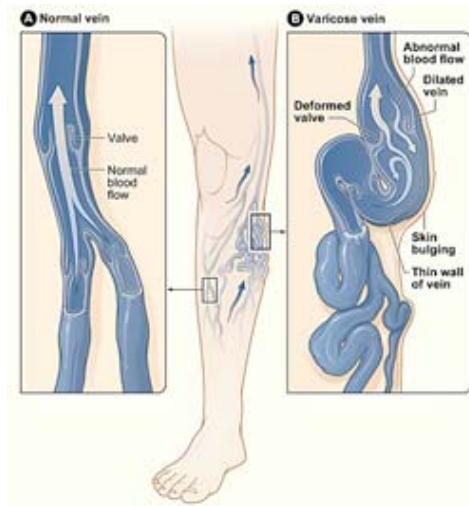
The physician can expect to see pain associated with what movement during physical exam?



- a. NO. This picture represents curling of the toes, which is accomplished through the actions of the flexor digitorum longus and brevis, both of which are innervated by the tibial nerve.
- b. YES. This picture represents dorsal flexion, an action controlled by the anterior compartment of the leg and innervated by the deep peroneal (fibular) nerve, which was damaged in this case.
- c. NO. This picture represents plantar flexion, an action controlled by the posterior compartment of the leg, which is innervated by the tibia nerve.
- d. NO. This picture represents foot/leg abduction, an action controlled by muscles in the upper thigh that externally rotate the leg (superior/inferior gemellus, obturator internus, quadratus femoris, piriformis).

CONSTRUCTED RESPONSE

26. Varicose veins occur when the valves become weak and do not close properly. As a result, blood may flow backwards. Endovenous laser ablation, the use of lasers to minimize and seal off the faulty veins, has been indicated as an effective treatment for the condition that most commonly stems from a weakened saphenous/femoral junction (Society of Interventional Radiology release, April 4, 2005).

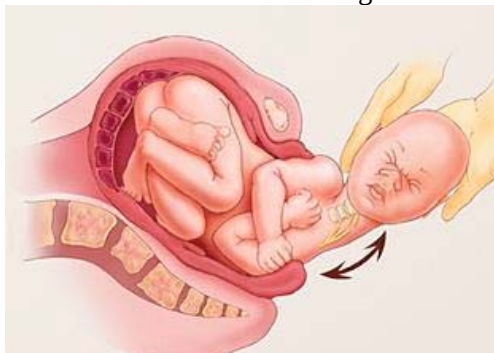


Assuming that endovenous laser ablation seals off the greater saphenous vein distal to the saphenous/femoral junction, describe an alternative route for venous return to the heart from the toes.

Response:

Digital vv. → dorsal venous arch → Small saphenous vein → popliteal v. → femoral v. → external iliac v. → common iliac v. → IVC → right atrium

27. Erb's Palsy is the paralysis of the arm due to damage of the C5 and C6 roots, often acquired from widening the angle between the head and shoulder during birth.



Fewer than 10% of brachial plexus injuries result in permanent dysfunction. Sometimes damage to the nerve roots does not resolve naturally or with the aid of physical therapy (Royal College of Obstetricians and Gynaecologists, "Shoulder Dystocia" Guideline No. 42, Dec 2005). What physical symptoms might a client with a permanent Erb's palsy display throughout adulthood in the upper limb?

a. "Sign of benediction" when trying to make a fist 	c. "Wrist drop" Inability to extend wrist 
b. "Waiters tip" Adducted and internally rotated humerus 	d. Inability to extend the elbow 

a. NO. The inability to close the hand and make a fist, the sign of benediction, occurs from damage to the median nerve (C8-T1), which innervates the thenar and lateral two lumbricals of the hand. This portion of the brachial plexus would not be affected by an Erb's palsy.

b. YES. An adducted and internally rotated humerus would be a correct manifestation of damage to C5-6 in the brachial plexus. These nerves are responsible for much of the innervation of the upper arm and shoulder region and particular loss is noted in the deltoid and supraspinatus (abduction of the humerus) as well as the infraspinatus (lateral rotation of the arm at the glenohumeral joint).

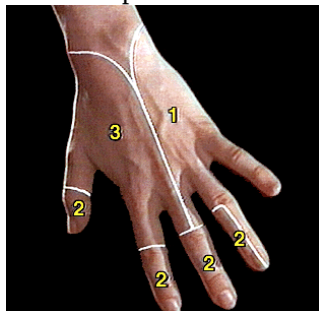
c. NO. The inability to extend the wrist, or drop wrist, is due to a lack of innervation in the extensor muscles in the posterior compartment of the forearm. These forearm muscles are innervated by the C7-8 portions of the radial nerve.

d. NO. The inability to extend the elbow would indicate a loss of function in the muscles in the posterior compartment of the arm. The main extensors of the elbow joint are the triceps, which receive innervation from the radial nerve at spinal levels C6-C8, receive the majority of innervation from C7.

28. Klumpke's Palsy commonly refers to injuries involving the nerves leading from the lower roots of the brachial plexus. As a result, C7, C8 and T1, are often strained with an increased angle of the arm, such as during the delivery of the arm of an infant.



A patient presents with a Klumpke's palsy injury that affected only the medial cord of the brachial plexus. In what areas of the hand would this patient retain cutaneous sensation after this injury?



- a. 1
- b. 2
- c. 3
- d. Patient would not retain cutaneous sensation in any area of the hand

a. NO. Area 1 receives cutaneous innervation from the ulnar nerve. The medial cord of the brachial plexus gives rise to the ulnar nerve, which would be affected in this patient's case

b. NO. Area 2 receives cutaneous innervation from the median nerve. The medial cord of the brachial plexus gives rise to the median nerve, which would be affected in this patient's case.

c. YES. Area 3 receives cutaneous innervation from the radial nerve. The radial nerve originates from the posterior cord of the brachial plexus and would not be affected in this patient's case.

d. NO. The three nerves that supply cutaneous innervation to the dorsum of the hand are the radial, median, and ulnar nerves. Think carefully about their origins from the brachial plexus cords.

29. A 15- year-old basketball player arrives in his family physician's office complaining of a painful, middle finger that got "jammed" during a game the day before. The physician wishes to assess the extent of the injury in the finger and holds the patient's uninjured fingers down while leaving the middle finger free. The physician asks the patient to flex at the proximal interphalangeal joint (PIP), which he is able to do.



When asked to flex at the distal interphalangeal joint, the patient is unable. The test is not an effective evaluation of distal interphalangeal joint function because this hand position:

- a. elicits the expected immobilization of the flexor digitorum profundus
- b. elicits the expected presentation of a functioning second lumbrical
- c. limits the counteractive movement of the extensor digitorum
- d. limits the group functioning of the flexor digitorum superficialis

- a. YES. The flexor digitorum profundus (FDP) flexes the distal and proximal interphalangeal joints of the index, middle, ring, and little finger. By restricting the movements of the three uninjured fingers in this case, the doctor has effectively immobilized the FDP at the DIP and not allowed any flexion to take place.
- b. NO. The lumbricals of the hand flex the metacarpophalangeal joint while extending the interphalangeal joints. The lumbricals have no effect on flexion at the DIP.
- c. NO. Flexion at the DIP does not require any assistance from the extensor muscles in the posterior compartment of the forearm or hand.
- d. NO. The flexor digitorum superficialis is responsible for flexion at the metacarpophalangeal joint and the proximal interphalangeal joint. It does not have an effect on the distal interphalangeal joint

Questions 30 and 31 deal with the following scenario:

In September of 2006 a 14-year-old boy underwent a transplant of his great toe after losing the phalanges of his left thumb in a firework explosion (Marlton, NJ. Sept 11, 2006.6abc.com).

30. What artery supplying the thumb would a surgeon anastomose to a toe artery involved in the transplant to maintain the original blood supply?

- a. Common palmar digital
- b. Deep palmar arch
- c. Proper palmar digital arteries
- d. Superficial palmar arch

a. NO. The common palmar digital arteries arise from the superficial palmar arch, which does not make a contribution to the thumb

b. YES. The deep palmar arch is the main blood supply to the thumb. It gives off the princeps pollicis artery.

c. NO. The proper palmar digital arteries supply the phalanges and arise from the common proper palmar digital arteries.

d. NO. The superficial palmar arch does not make any contributions to the blood supply of the hand.

31. In addition to the superficial branch of the radial nerve, what other nerve will the surgeon need to anastomose to ensure appropriate cutaneous sensation of the new thumb?

- a. Deep branch of the ulnar nerve
- b. Deep branch of the radial nerve
- c. Digital branch of the median nerve
- d. Palmar branch of the median nerve
- e. Recurrent branch of the median nerve

a. NO. The deep branch of the ulnar nerve is responsible for motor innervation for the hypothenar muscles, the interossei, the medial flexors in the FDP as well as the adductor pollicis and the two medial lumbricals.

b. NO. The only branch of the radial nerve that enters the hand is the superficial branch.

c. YES. The digital branch of the median nerve innervates the skin on the thumb, index and middle fingers in addition to the lateral side of the ring finger.

d. NO. The Palmar branch of the median nerve enters the hand superficial to the carpal tunnel. It is responsible for innervating the skin on the *palmar* surface of the lateral three and one-half digits. It does not supply cutaneous innervation to the phalanges of the thumb.

e. NO. The recurrent branch of the median nerve innervates the three thenar muscles but is not responsible for any cutaneous innervation.

32. Bones can fracture or be displaced from their normal anatomical position. When this occurs, neighboring structures are at risk of damage. Match the nerve most likely to be injured by the level at which the fracture occurs and provide one clinical symptom associated with a nerve injury at the specified level:

- a. Fracture of the medial epicondyle of the humerus
- b. Fracture of the surgical neck of the humerus
- c. Mid-shaft humeral fracture
- d. Anterior dislocation of the lunate

Answers:

a. Fracture of the medial epicondyle of the humerus: Ulnar nerve.

The ulnar nerve courses behind the medial epicondyle of the humerus as it enters the anterior compartment of the forearm. SYMPTOM: sensory deficit over little finger and medial half of ring finger, inability to flex ring or little finger, inability to adducts the wrist, inability to abduct/adduct fingers, and numbness over medial arm

b. Fracture of the surgical neck of the humerus: Axillary nerve.

The axillary nerve passes through the quadrangular space, which serves as a passageway from the axilla and the posterior scapular region. SYMPTOM: sensory deficit over deltoid, inability to abduct arm past initial 15 degrees.

c. Mid-shaft humeral fracture: Radial nerve

The radial nerve is responsible for innervating the posterior arm and forearm. It passes through the triangular interval and courses with the profundus brachii artery lying directly in the radial groove of the humerus.

SYMPTOM: inability to extend wrist (drop wrist), inability to extend arm at elbow lack of sensation on dorsum of hand/posterior compartment of the forearm

d. Anterior dislocation of the lunate: Median nerve

The median nerve courses through the carpal tunnel in the center of the wrist. An anterior dislocation of the lunate would come into contact with this nerve. SYMPTOM: Sensory deficit over lateral palm and fingers, inability to flex fingers/wrist, inability to pronate,

33. A 63-year old diabetic and obese man was admitted to the hospital after lying unconscious on the floor for 24 hours. His daughter found him dehydrated and comatose. After resuscitation it was noted that he had an obvious wrist drop (inability to extend the wrist). Flexion of the arm and forearm were unaffected. (The Internet Journal of Orthopedic Surgery, ISSN: 1531-2968) What movement of the thumb will the patient be completely unable to perform?

- a. abduction
- b. adduction
- c. extension
- d. flexion
- e. opposition

- a. NO. Abduction of the thumb is carried out by the abductor pollicis brevis (innervated by the median nerve) in addition to the abductor pollicis longus (radial nerve).
- b. NO. Adduction is performed by the adductor pollicis (ulnar nerve)
- c. YES. Extension of the thumb is made possible by the extensor pollicis longus and brevis, both innervated by the radial nerve
- d. NO. Flexion is performed by the anterior compartment of the forearm, relying on innervation from the ulnar and median nerves.
- e. NO. Opposition of the thumb is performed by the opponens pollicis (recurrent branch of the median nerve).

34. A 23-year-old male presents in the emergency room with a laceration from a knife fight that exposed bone over the medial epicondyle of the humerus (MyPACS.net Radiology files case 3563260). Assuming damage was done to tendons that attach to the medial epicondyle, what action would be unaffected?

- a. Abduction of the wrist
- b. Adduction of the wrist
- c. Flexion of the distal interphalangeal joint
- d. Flexion of the wrist
- e. Pronation of the forearm

- a. NO. The flexor carpi radialis perform abduction of the wrist, which attaches to the medial epicondyle.
- b. NO. Adduction of the wrist is performed by the flexor carpi ulnaris, which attaches to the medial epicondyle.
- c. YES. The flexor digitorum profundus is responsible for flexion at the DIP and does not attach to the medial epicondyle of the humerus.
- d. NO. Flexion of the wrist is accomplished by the flexor digitorum profundus and superficialis in addition to the flexor carpi ulnaris and the palmaris longus. The later three muscles attach to the medial epicondyle of the humerus, thereby affected wrist flexion.
- e. NO. Pronation of the forearm is performed by the pronator quadratus as well as the pronator teres, which attaches to the medial epicondyle of the humerus.

Questions 35 and 36 deal with the following scenario:

A mother brings a three-day-old infant to your office because the baby cries every time her left arm is lifted or moved. A midwife delivered the baby at home. The mother states that the baby's shoulders were stuck and that the midwife had to pull very hard for a long time to get the baby out. You order an x-ray of the shoulder, which reveals a broken bone. (Fracture is circled)



35. Which bone was fractured during the delivery?

- A) Acromion
- B) Clavicle
- C) Humerus
- D) Rib #1
- E) Scapula

A=Incorrect, acromion is part of the scapula and is not the fractured bone in the x-ray.

B=Correct, the clavicle is the most common bone broken during delivery and is the bone fractured in this x-ray.

C=Incorrect, humerus is not the fractured bone.

D=Incorrect, rib #1 is not the correct fractured bone.

E=Incorrect, the scapula is not fractured in this x-ray.

36. Three years after the original visit the mother brings her daughter into you again. The mother states that the child does not lift her left arm the same way she lifts her right arm. You have the child reach for a toy and observe that the child cannot initiate the abduction of the left arm at the glenohumeral joint for the first 15 degrees without compensating with other movements. You conclude that the child had experienced some mild damage to her brachial plexus during her birth. The damage is demonstrated in the:

- A) Axillary nerve
- B) Inferior subscapular nerve
- C) Radial nerve
- D) Suprascapular nerve

A=Incorrect, axillary nerve innervates the teres minor which laterally rotates the arm at the glenohumeral joint.

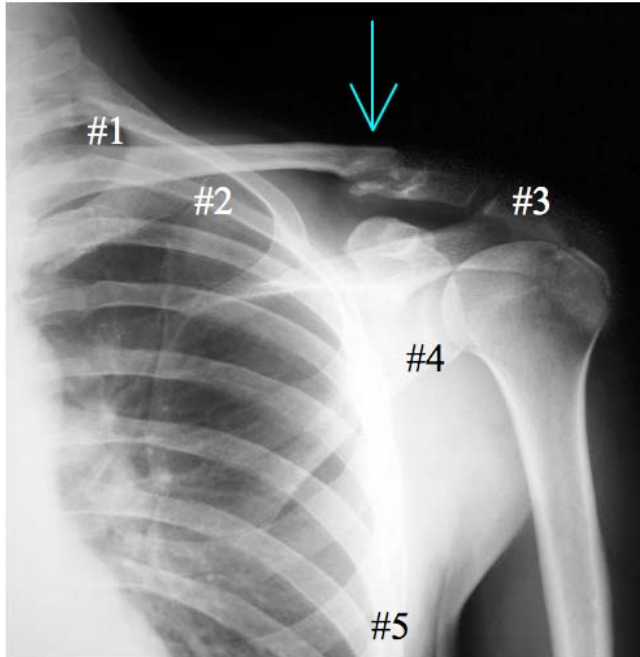
B=Incorrect, the inferior subscapular nerve innervates the teres major muscle which medially rotates and extends the arm at the glenohumeral joint.

C=Incorrect, the radial nerve innervates the long head of the triceps brachii in the shoulder which is used as an accessory adductor and extensor of the arm at the glenohumeral joint.

D=Correct, the suprascapular nerve innervates the supraspinatus muscle which initiates the abduction of the arm to 15 degrees at the glenohumeral joint.

Questions 37-39 deal with the following scenario

A 35-year-old male patient complains of a significant weakening of elbow flexion. The patient tells you that he was in a motorcycle crash 12 weeks earlier where he fractured a bone in his shoulder, and impaled his shoulder with the starter pedal of his motorcycle. You do further testing and find that the patient also has weakening of flexion at the shoulder and loss of cutaneous sensation on the anterolateral surface of the forearm. You order a shoulder x-ray, which is shown below.



37. Which bone did the patient fracture (arrow points to the fracture)?

- A) 2nd rib
- B) Acromion
- C) Clavicle
- D) Coracoid process
- E) Scapular spine

A=Incorrect, the fracture is not in the 2nd rib.

B=Incorrect, the fracture is not in the acromion.

C=Correct, the fracture is in the clavicle.

D=Incorrect, the fracture is not in the coracoid process.

E=Incorrect, the fracture is not in the scapular spine.

38) When the starter pedal impaled the patient's shoulder it damaged a main terminal branch of the brachial plexus. Which main terminal branch did it damage?

- A) Median
- B) Musculocutaneous
- C) Radial
- D) Ulnar

A=Incorrect, the median nerve does not flex the elbow it does provides sensory over the palmer surface of the lateral three and one-half digits and over the lateral side of the palm and middle of the wrist.

B=Correct, all muscles in the anterior compartment of the arm (flexing the elbow) sensory to the anterolateral side of forearm.

C=Incorrect, radial nerve innervates the posterior compartments of the arm and forearm and sensory to the posterior aspects of the arm and forearm.

D=Incorrect, the ulnar nerve does not flex the elbow.

39) In order to damage the main terminal branch of the brachial plexus, the starter pedal had to penetrate the patient in a specific spot. Which number on the x-ray is most likely to mark the spot of the penetrating wound that damaged the nerve?

A) #1

B) #2

C) #3

D) #4

E) #5

A=Incorrect, the main terminal branches of the brachial plexus are located distally to the pectoralis minor muscles in the anterior axilla. The pectoralis minor muscles go from rib #3--#5 to the coracoid process. This number is too cephalic.

B=Incorrect, again this number is not below the pectoralis minor muscles it is too cephalic.

C=Incorrect, this number is on the lateral shoulder, the main brachial plexus branches are not this lateral.

D=Correct, this number marks a spot just below the pectoralis minor muscle and in the anterior axilla where the main terminal branches of the brachial plexus are likely to be.

E=Incorrect, this number is on the lateral chest wall and is too caudal to damage the main brachial plexus branches.

40. On palpation of the anatomical snuff box, the doctor felt a pulsing artery, which artery is the doctor feeling?



- A) 1
- B) 2
- C) 3
- D) 4

*A=Incorrect, this is the radialis indicis artery it cannot be palpated in the anatomical snuffbox.
B=Correct, this is the radial artery it runs through the anatomical snuff box, and can be felt pulsing.
C=Incorrect, this is the ulnar artery; it does not pass through the anatomical snuffbox.
D=Incorrect, this is a common digital artery; it does not pass through the anatomical snuffbox.*