

EANS/UEMS European examination in neurosurgery

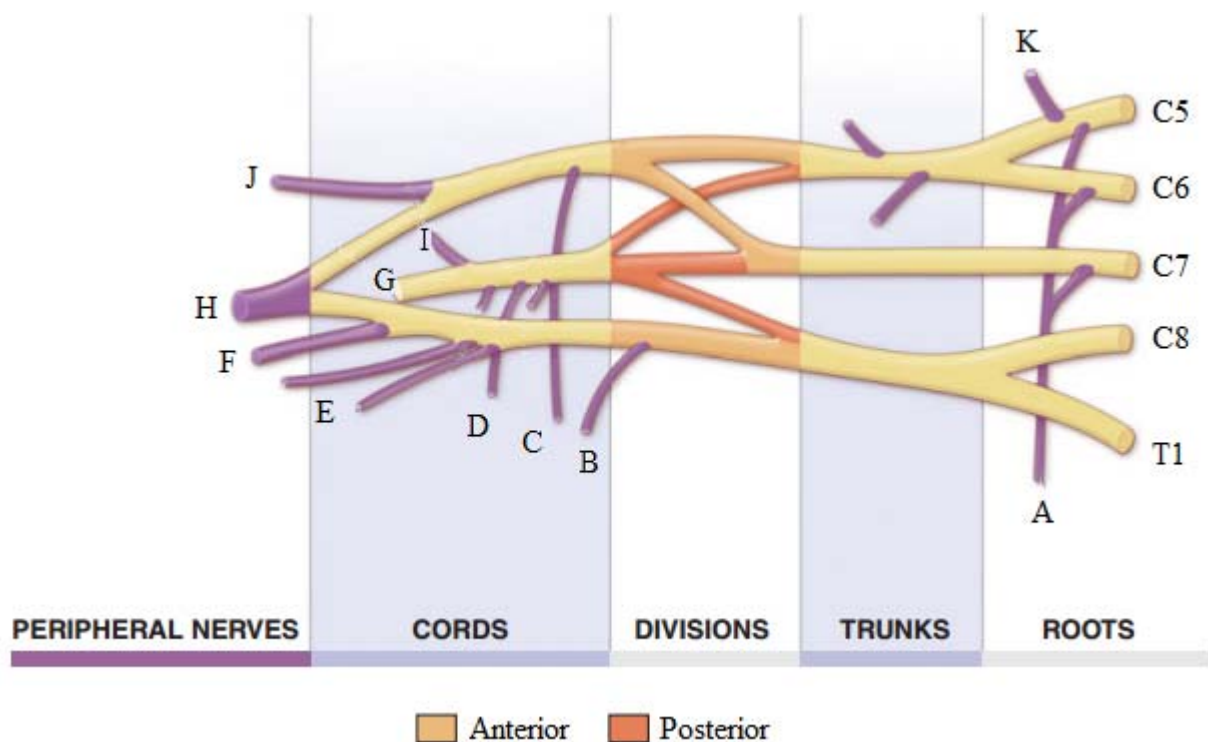
Part I (written)

Variants of questions with answers (compilation - Vyacheslav S. Botev, Department of Neurosurgery, M.Gorky Donetsk National Medical University)

Peripheral Nerves and Plexus. Questions.

Questions 1 – 12

Directions: The questions below consist of lettered headings from figure followed by a set of numbered items. For each numbered item select one heading with which it is most closely associated. Each lettered heading may be used once, more than once, or not at all.



1. Nerve supplies muscles that are antagonists to the serratus anterior.
2. Injury to this nerve may result in winged scapula.
3. Innervates teres minor muscle.
4. Injury to this nerve will result in flexion weakness, especially when the forearm is supine.
5. Innervates supinator muscle.
6. Nerve most commonly affected by entrapment neuropathy.
7. A pure lesion of a branch of this nerve can result in weakness of the long flexors of the thumb and index finger (producing a pinch sign) and pronator quadratus.
8. Injury of this nerve may occur in Guayan's canal.
9. Compression of this nerve may occur by a ligament that bridges the supracondylar process to the medial epicondyle.

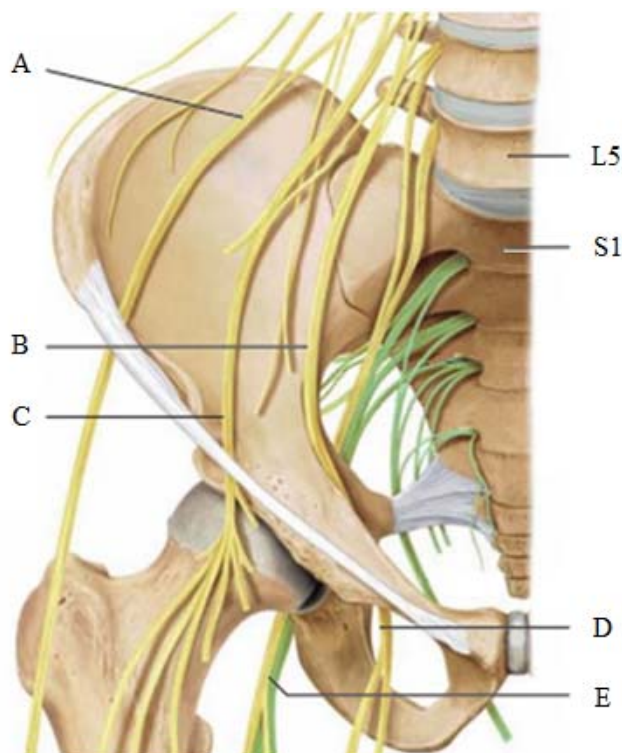
10. Innervates the interossei muscles.

11. Supplies sensation to the anteromedial and posteromedial forearm down to the wrist.

12. Entrapment in quadrilateral space.

Questions 13 – 17

Directions: The questions below consist of lettered headings from figure followed by a set of numbered items. For each numbered item select one heading with which it is most closely associated. Each lettered heading may be used once, more than once, or not at all.



13. Prone to injury during obstetric and gynecologic procedures.

14. Nerve associated with “meralgia paresthetica”.

15. Nerve likely to be damaged by hematoma in the pelvis

16. Diabetic amyotrophy is most likely to affect this site.

17. Supplies the pectineus and gracilis muscles.

18. The pectoralis minor muscle is an important landmark in identifying and describing neighboring structures in the chest and axillary regions. Which of the following relationships of the pectoralis minor is correct?

A. The lateral cord of the brachial plexus lies lateral to the muscle

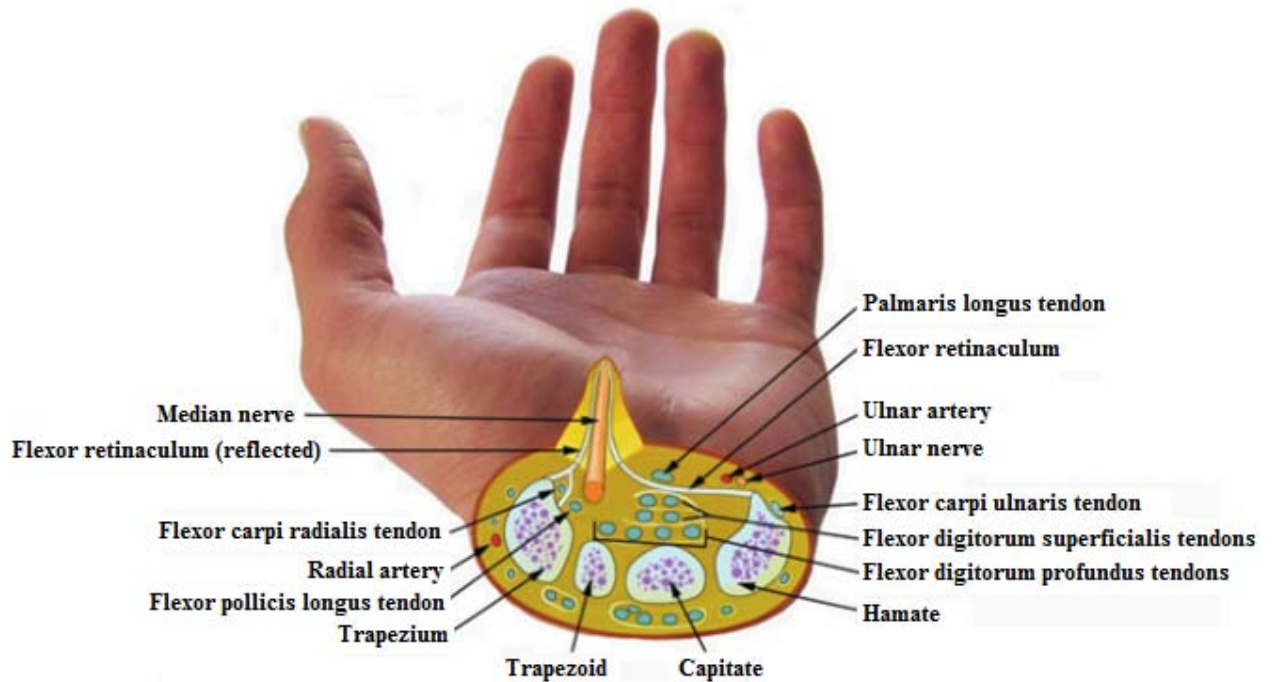
B. The clavipectoral triangle lies lateral to the muscle

C. The anterior axillary lymph nodes lie along the medial border of the muscle

D. The lateral wall of the axillary fossa includes the muscle

E. The second part of the axillary artery lies deep to the muscle

19. Median nerve decompression in the carpal tunnel.

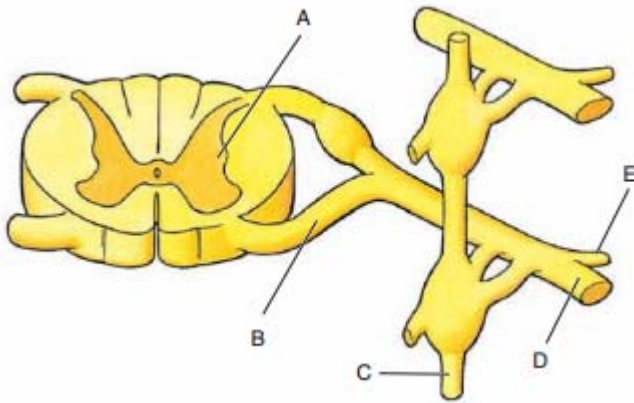


1. Which structures form the boundaries of the carpal tunnel?
2. What are the contents of the carpal tunnel?
3. What systemic conditions are associated with carpal tunnel syndrome?
4. What are the presenting symptoms of carpal tunnel syndrome?
5. Name three provocative maneuvers for the diagnosis of carpal tunnel syndrome.
6. What is Phalen's test?
7. How is carpal tunnel syndrome treated?

20. In anticipation for a medical school swimming party, a 60-year-old male professor squeezes into last year's bikini bathing suit despite gaining 25 lb over the winter. Following a day of "impressing" his students and colleagues, he notices numbness, tingling, and a burning sensation in the lateral aspect of his left upper thigh. His symptoms are exacerbated by applying pressure near the left anterior superior iliac spine. What nerve is most likely affected?

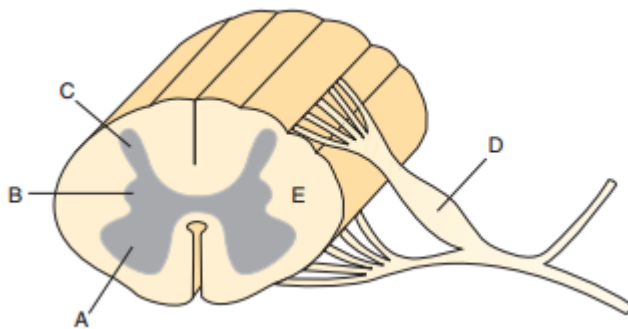
- A. Lateral femoral cutaneous nerve
- B. Femoral branch of genitofemoral nerve
- C. Anterior cutaneous branches of femoral nerve
- D. Ilioinguinal nerve
- E. Iliohypogastric nerve

21. A lesion of which of the indicated structures would cause loss of sensation in the skin overlying the trapezius muscle?



- A. Lateral gray horn of spinal cord
- B. Anterior root of spinal nerve
- C. Sympathetic trunk
- D. Anterior primary ramus
- E. Posterior (dorsal) primary ramus

22. Amyotrophic lateral sclerosis (ALS; Lou Gehrig's disease) is a progressive, fatal neurodegenerative disease caused by degeneration of the motor neurons controlling skeletal (voluntary) muscle movement. Postmortem analysis of which of the following structures would show the cell bodies of neurons affected by this disease?



- A. Anterior gray horn of the spinal cord
- B. Lateral gray horn of the spinal cord
- C. Posterior gray horn of the spinal cord
- D. Spinal ganglia
- E. Lateral column of spinal cord white matter

23. A 76-year-old man recently had coronary bypass surgery in which the small saphenous vein was harvested to establish coronary blood flow. Following the procedure, he complained of numbness and paresthesia in the limb from which the vein was removed. The given photo highlights the cutaneous area affected in the patient. No motor loss was noted. What nerve was most likely damaged during harvesting of the vein for transplantation?



- A. Sural nerve
- B. Saphenous nerve
- C. Superficial fibular nerve
- D. Deep fibular nerve
- E. Lateral plantar nerve

24. A 62-year-old man recently had coronary bypass surgery in which the great saphenous vein was harvested for reestablishing coronary blood flow. Following the procedure, he complained of loss of sensation in the cutaneous area noted in the given photo in the limb from which the vein was harvested. Which of the following nerves was most likely damaged during the surgery?



- A. Sural nerve
- B. Obturator nerve
- C. Saphenous nerve
- D. Deep fibular (peroneal) nerve
- E. Superficial fibular (peroneal) nerve

25. An anesthesiologist administers an anesthetic solution into the axillary sheath of a 19-year-old college baseball player in preparation for repair of the ulnar collateral ligament of the elbow. After 5 minutes, the patient experiences numbness and paresthesia distal to the middle aspect of the arm; however, the medial aspect of the arm and elbow remain sensitive to pain. What nerve provides sensory innervation to the sensitive area and was not blocked by the anesthetic solution?

- A. Long thoracic nerve
- B. Median nerve
- C. Medial cutaneous nerve of the arm
- D. Intercostobrachial nerve
- E. Ulnar nerve

26. A physician tests the calcaneal tendon (ankle jerk) reflex as shown. A normal response of plantar flexion of the ankle joint is noted. This myotatic (deep tendon) reflex confirms the integrity of what nerve?



- A. Tibial nerve
- B. Deep fibular nerve
- C. Superficial fibular nerve
- D. Medial plantar nerve
- E. Lateral plantar nerve

27. As part of a physical examination to evaluate lower limb function, a physician places her hands on the dorsum of the patient's foot and asks the patient to dorsiflex the ankle joint against resistance, as shown. What nerve is the doctor testing?



- A. Tibial nerve
- B. Deep fibular nerve
- C. Superficial fibular nerve
- D. Medial plantar nerve
- E. Lateral plantar nerve

28. A 17-year-old male football player suffers a shoulder injury and arrives at the ER 2 hours after the injury. The physician diagnoses a shoulder dislocation, and after administration of a local anesthetic solution, the doctor repositions the head of the humerus into the glenoid cavity of the scapula (reduction). No fractures are seen on X-rays. However, the patient displays weakness in abduction and external rotation at the shoulder. A loss of sensation is also noted at the superior and lateral aspects of the arm. What nerve was most likely damaged in this injury?

- A. Axillary nerve
- B. Median nerve
- C. Ulnar nerve
- D. Radial nerve
- E. Musculocutaneous nerve

29. A 32-year-old mixed martial arts fighter could not continue his fight after receiving a side leg kick to the neck of his left fibula. The fighter reported paresthesia and numbness on the entire dorsum of his left foot. During his physical examination, the patient often stumbled with his left toes dragging on the floor during the swing phase of his gait. Asymmetry in his normal foot position was also noted by the physician (see photo) as well as weakness in eversion of the foot at the ankle joint. What nerve was damaged?



- A. Tibial nerve
- B. Deep fibular nerve
- C. Superficial fibular nerve
- D. Common fibular nerve
- E. Sciatic nerve

30. A physician tests the myotatic biceps reflex as shown. A normal response of involuntary contraction of the biceps brachii muscle is noted. This reflex confirms the integrity of what nerve?



- A. Axillary nerve
- B. Median nerve
- C. Ulnar nerve
- D. Radial nerve
- E. Musculocutaneous nerve

31. A 36-year-old man broke a window with his fist to rescue his child from a house fire. The man sustained a laceration to the lateral aspect of his right forearm, but he only showed a sensory deficit (numbness and paresthesia) to the dorsolateral aspect of his hand (as denoted by the shaded area within the given photo). What nerve was most likely damaged?



- A. Dorsal cutaneous branch of the ulnar nerve
- B. Lateral cutaneous nerve of the forearm
- C. Posterior cutaneous nerve of the forearm
- D. Deep branch of the radial nerve
- E. Superficial branch of the radial nerve

32. As part of a physical examination to evaluate lower limb function, a physician asks her patient to stand on his tiptoes, as shown. What nerve is the doctor testing?



- A. Tibial nerve
- B. Deep fibular nerve
- C. Superficial fibular nerve
- D. Sural nerve
- E. Saphenous nerve

33. A 16-year-old boy was fishing barefoot in a muddy river when the plantar surface of his foot was cut by unseen debris. He suffers a large transverse cut, penetrating the first two layers of his plantar musculature, in the area of the first cuneiform bone. In the emergency room, his physician notes a complete inability to flex and abduct the big toe and numbness on the plantar aspect of the three medial toes. Which of the following nerves is most likely damaged?



- A. Medial plantar nerve
- B. Lateral plantar nerve
- C. Sural nerve
- D. Deep fibular nerve
- E. Superficial fibular nerve

34. A 23-year-old man was injured in a motor vehicle accident and X-rays confirmed a displaced distal radius fracture in his left forearm. Upon examination, the patient exhibits weakened pronation, weakened flexion of the index and middle fingers at the distal interphalangeal joints, and weakened flexion of the interphalangeal joint of the thumb. When asked to make the “okay” sign (make a circle with the thumb and index finger), the patient is unable to make a round circle, producing a “collapsed circle” on the affected hand (see photo). No areas of sensory loss are detected. Which nerve is most likely damaged?



- A. Deep branch of the radial nerve
- B. Superficial branch of the radial nerve
- C. Anterior interosseous nerve
- D. Median nerve, proximal to the carpal tunnel
- E. Recurrent branch of the median nerve

35. A 21-year-old male college student reports to the student health clinic on Monday morning, the day after the Super Bowl. He explains that he was intoxicated and lost consciousness with his upper limbs draped over the back of a couch. He complains of numbness and paresthesia over the dorsum of his hand on the radial side and is unable to support the weight of his left hand when the hand is placed in a pronated position (see photo). What nerve was most likely damaged in this individual?



- A. Axillary nerve
- B. Median nerve
- C. Ulnar nerve
- D. Radial nerve
- E. Musculocutaneous nerve

36. A 52-year-old retired professional cyclist, who still rides his bike 400 miles per week, comes to his physician complaining of hand problems. The physician notes hyperextension of the ring and little fingers at the metacarpophalangeal joints and flexion at the interphalangeal joints within the same fingers (see photo). During examination, the patient has no weakness in flexion or adduction of the wrist. What nerve is compressed at what location?



- A. Ulnar nerve in the elbow
- B. Ulnar nerve in the wrist
- C. Median nerve in the wrist
- D. Median nerve in the elbow
- E. Median nerve in the axilla

37. A 50-year female equestrian is thrown from a startled horse and dragged by the reins, which were wrapped around her left wrist, for some distance. At the ER, she is experiencing pain and paresthesia in the axilla and medial aspect of her upper limb. Despite being left-handed, she has marked weakness in the movements of her dominant hand, especially abduction and adduction of the fingers. What structure was most likely damaged in this woman?

- A. Upper trunk of the brachial plexus
- B. Lower trunk of the brachial plexus
- C. Posterior cord of the brachial plexus
- D. Lateral cord of the brachial plexus
- E. Long thoracic nerve

38. Physical examination of a 45-year-old man who had been stabbed in the back of the shoulder shows a deep wound penetrating into the quadrangular space of the shoulder, causing bleeding from the severed blood vessels there. Which of the following neural structures is most likely damaged as well?

- A. Musculocutaneous nerve
- B. Lateral cord of the brachial plexus
- C. Radial nerve
- D. Axillary nerve
- E. Medial cutaneous nerve of the arm

39. “Pronator teres syndrome” is a condition in which one of the following nerves is excessively compressed where it passes between the two heads of the pronator teres muscle. Which of the following nerves is entrapped?

- A. Deep branch of radial nerve
- B. Median Nerve
- C. Deep branch of ulnar nerve
- D. Superficial branch of ulnar nerve
- E. Musculocutaneous nerve

40. A 56-year-old woman was stopped at a light when her car was rear-ended by another car. She had her right arm on the steering wheel, and the impact caused forced flexion at her elbow. Several months later, she comes to her physician complaining of numbness and a “pins and needles” sensation in her right little finger when she talks on the phone, rests her head on her right hand at work, or spends most of her day typing at work. She also notices the quality of her typing and her ability to play the violin have diminished. Which nerve is compressed at what location?

- A. Ulnar nerve in the elbow
- B. Ulnar nerve in the wrist
- C. Median nerve in the wrist
- D. Median nerve in the elbow
- E. Median nerve in the axilla

41. Following a radical mastectomy procedure, a surgeon plans to conduct a breast reconstruction utilizing a latissimus dorsi muscle flap. What nerve will the surgeon need to keep intact during the surgical dissection of the chest wall to prevent atrophy of the muscle flap?

- A. Long thoracic nerve
- B. Intercostobrachial nerve
- C. Medial pectoral nerve
- D. Thoracodorsal nerve
- E. Axillary nerve

42. As part of a physical examination to evaluate intrinsic hand muscle function, a physician asks the patient to assume the Z-position (seen in photo) with his hand, which involves flexion of the metacarpophalangeal joints and extension of the interphalangeal joints of the fingers. Which of the following nerves is being tested in assuming this position?



- A. Deep branch of radial nerve
- B. Superficial branch of radial nerve
- C. Recurrent branch of median nerve
- D. Deep branch of ulnar nerve
- E. Superficial branch of ulnar nerve

43. A 10-year-old boy was running across a parking lot when he tripped and received lacerations on the base of his thumb from a broken glass bottle. On examination, his thumb was unable to oppose to his fingers, and the thumb also showed weakness when abducting and flexing. No sensory deficits were reported. What nerve was most likely severed?

- A. Deep branch of radial nerve
- B. Superficial branch of radial nerve
- C. Recurrent branch of median nerve
- D. Deep branch of ulnar nerve
- E. Superficial branch of ulnar nerve

44. What are the most common brachial plexus lesions?

45. What are the constituents of a peripheral nerve?

46. What is the lower brachial plexus paralysis (Dejerine-Klumpke palsy)?

47. What is the pinch or "O" sign?

48. What is the "benediction sign"?

49. What is Tinel's sign?

50. What is Froment's sign?

51. What is Wartenberg's sign?

52. What is the cutaneous sensory supply of the median nerve?

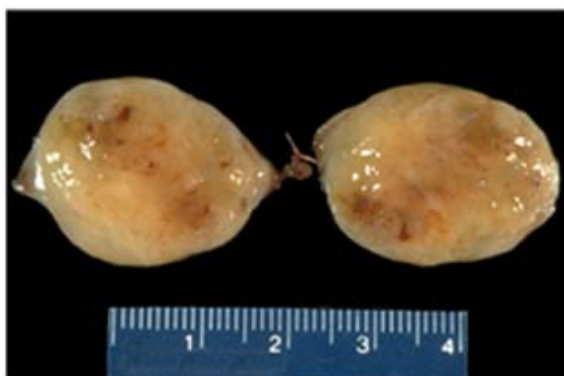
53. What is the cutaneous sensory supply of the ulnar nerve?

54. What is the cutaneous sensory supply of the radial nerve?

55. What is meralgia paresthetica?

56. Regarding schwannoma and neurofibroma:

1. What are growth patterns of schwannoma and neurofibroma within peripheral nerve?



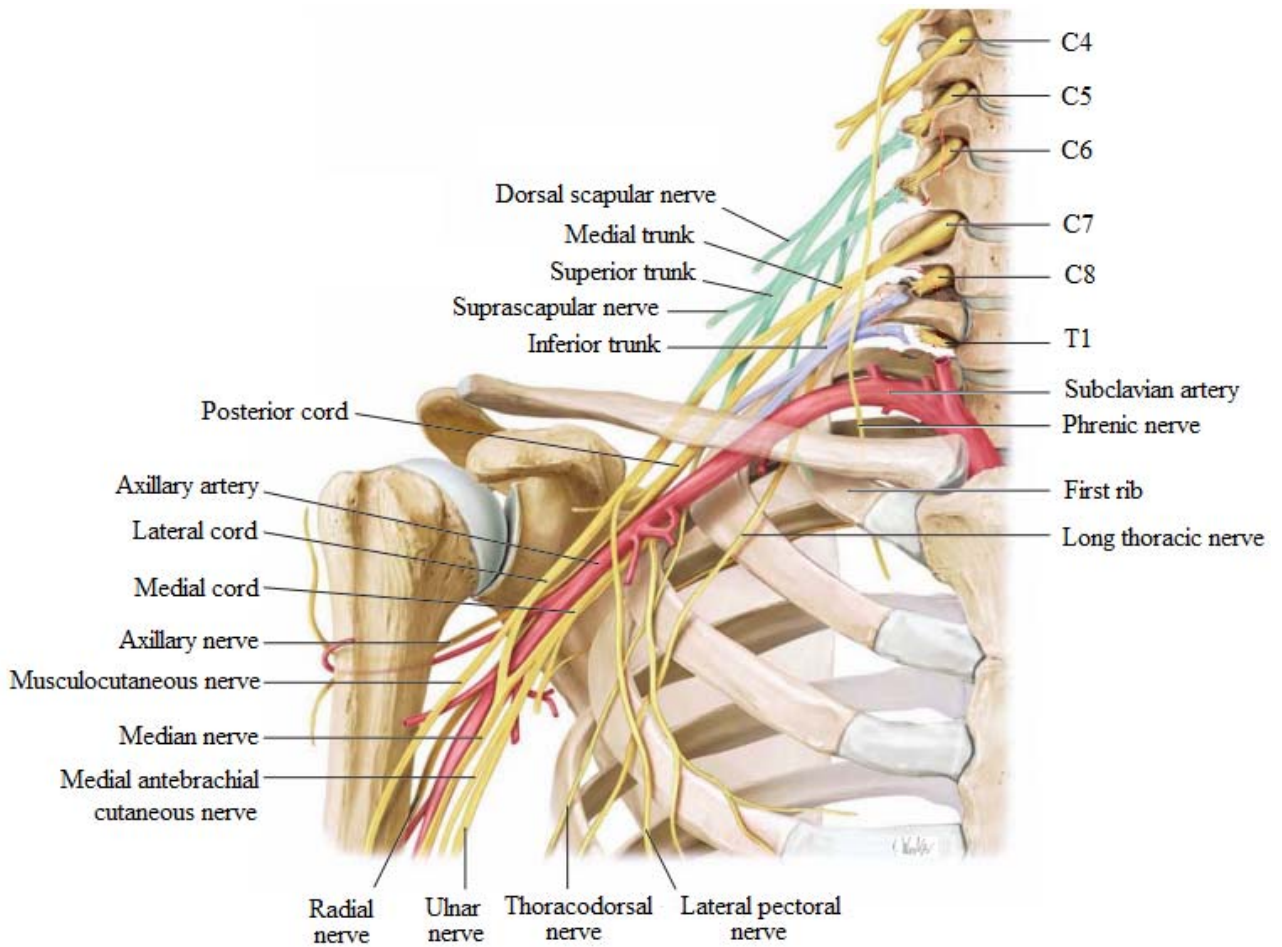
Schwannoma's "fish flesh" soft tan appearance, and median nerve neurofibroma in a patient with NF1.

2. Of what are schwannomas composed?

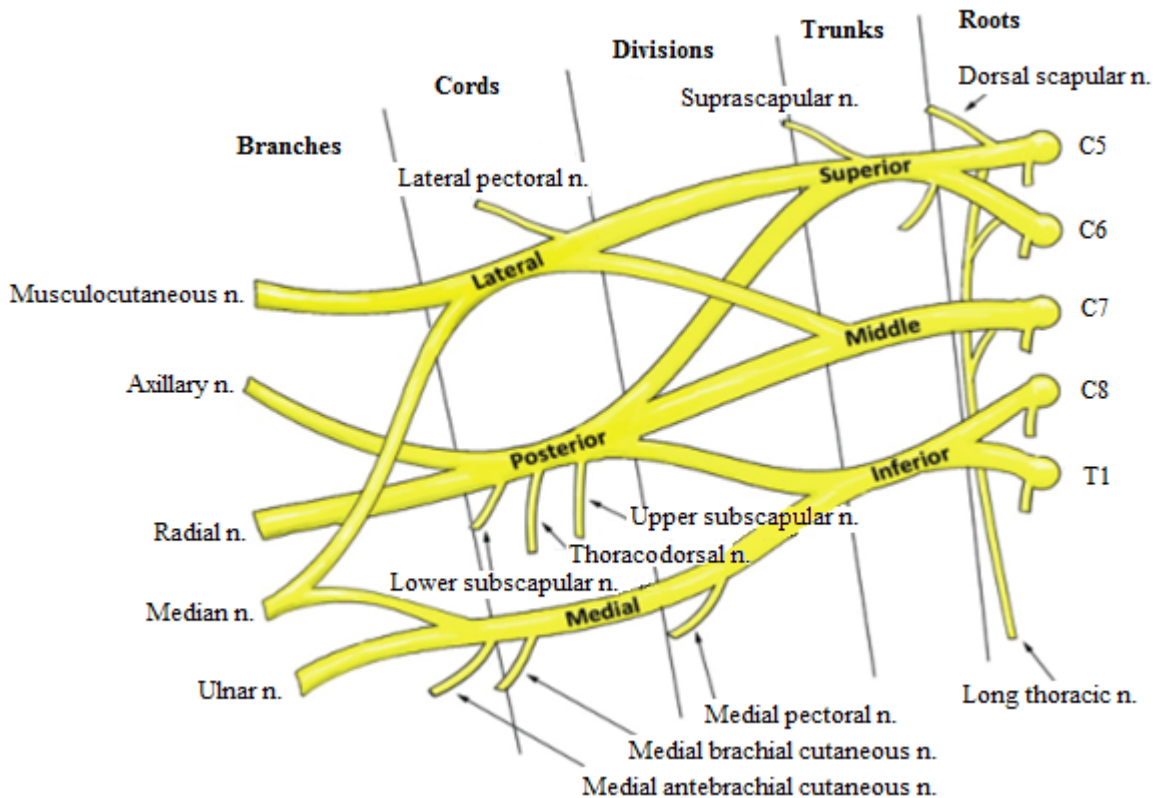
3. What are the two major patterns seen in schwannomas on histopathology?

4. With which pattern might lipid-laden cells be present?
5. What histopathology is typical of CN VIII schwannoma?
6. What are the three variants of schwannoma?
7. How can cellular schwannoma easily be mistaken for malignant peripheral nerve sheath tumors (MPNST)?

Answers Peripheral Nerves and Plexus.



Brachial plexus



1. K. The dorsal scapular nerve.

The dorsal scapular nerve (K) supplied the levator scapulae and major and minor rhomboid muscles. The rhomboids normally elevate and adduct the medial border of the scapula (antagonist to serratus anterior) and along with the levator scapulae, rotate the scapula so that the inferior angle moves medially.

2. A. The long thoracic nerve.

The long thoracic nerve (A) supplies the serratus anterior muscle, which fixes and stabilizes the scapula against the chest wall. It is tested by observing for scapular winging while the patient pushes and extends the arms against a fixed object.

3. I. The axillary (circumflex) nerve.

The axillary (circumflex) nerve descends on the subscapularis muscle and then winds around the surgical head of the humerus to supply the deltoid and teres minor muscles.

4. J. The musculocutaneous nerve.

The musculocutaneous nerve (J) is best tested by having the patient flex the supinated arm against resistance.

5. G. The radial nerve.

The radial nerve (G) innervates the extensors of the arm, forearm, and wrist.

6. H. The median nerve.

7. H. The median nerve.

In trying to pinch the tips of the index finger and thumb, the terminal phalanges extend instead of the tips and the pulps touch, producing the “pinch sign”.

8. F. The ulnar nerve.

In the wrist, the ulnar nerve may be compressed in Guyon’s canal, the roof of which is formed by the palmar fascia and palmaris brevis, the floor being the flexor retinaculum of the palm and pisohamate bone.

9. H. The median nerve.

10. F. The ulnar nerve.

The ulnar nerve (F) is the main branch of the medial cord (C8 –T1) and supplies no muscles in the arm and only two in the forearm (flexor carpi ulnaris and flexor digitorum profundus III and IV).

11. E. The medial cutaneous nerves.

The medial cutaneous nerves of the forearm are two sensory branches that supply various regions of the arm and forearm.

12. I. The axillary (circumflex) nerve.

It may be entrapped in the quadrilateral space, an anatomic compartment bounded by the teres major and minor muscles, the long head of the triceps, and neck of humerus.

13. C. Obturator nerve.

The obturator nerve lies on the medial side of the iliopsoas muscle and comes into close relationship with the uterus before reaching the obturator foramen. In the pelvis, it is particularly vulnerable to injury during obstetric and gynecologic procedures.

14. A. Lateral femoral cutaneous nerve.

Entrapment of lateral femoral cutaneous nerve as it enters the thigh can produce a numb, tingling, or burning hypersensitivity over the lateral thigh known as meralgia paresthetica. It is often encountered in obese patients of either sex who have lost a significant amount of weight, or, conversely, can be seen in late pregnancy due to a sagging anterior wall.

15. B. Femoral nerve.

In the abdomen and pelvis, a primary or secondary neoplasm, psoas abscess, or pelvic hematoma may damage the upper portion of this nerve.

16. D. Femoral nerve.

In the femoral ring, this nerve is particularly vulnerable to local compression and possibly pressure palsy from diabetes mellitus. Although diabetes can also affect the L2–L4 roots of this nerve, diabetic neuropathy of the femoral nerve is most often encountered in the femoral triangle. The patient usually presents with pain that resolves, only to be followed by rapid wasting and weakness of the quadriceps, which makes walking very difficult. Fortunately, the condition eventually improves, although it may take up to 2 years.

17. C. Obturator nerve.

The nerve supplies the adductor muscles of the thigh, which includes the pectineus; adductor longus, brevis, and magnus, and gracilis muscles. Its integrity is tested by having the patient hold the legs together against resistance.

18. The answer is E. The second part of the axillary artery lies deep to the muscle.

The pectoralis minor muscle overlies the axillary artery in such a way as to divide it into three parts: first (prepectoral; medial), second (subpectoral; deep), third (postpectoral; lateral). The first part is medial to the pectoralis minor, running from the lateral border of the first rib to the medial border of the pectoralis minor. The second part is deep to the muscle. The third part is lateral to the pectoralis minor, running from the lateral border of the muscle to the inferior border of the teres major muscle.

19.

1. Roof: thick fibrous transverse carpal ligament.

Radial: transverse carpal ligament (TCL) attaches to scaphoid tuberosity and part of trapezium.

Ulnar: TCL attaches proximally to the pisiform and distally to the hook of the hamate.

Floor: Carpal bones and deep volar radiocarpal and volar interosseous ligaments.

2. The median n. and the nine digital flexor tendons (FDS, FDP, and FPL).

3. Female gender, family history, diabetes, renal failure, obesity, rheumatoid arthritis, polymyalgia rheumatica, menopause, oral contraceptive use, pregnancy, acromegaly, hyper/hypothyroidism, amyloidosis, prior Colles' fracture.

4. Patients most commonly present with paresthesias and pain over the distal median n. distribution. Symptoms are particularly worse at night. If long-standing, may also have weakness and atrophy of the thenar musculature.

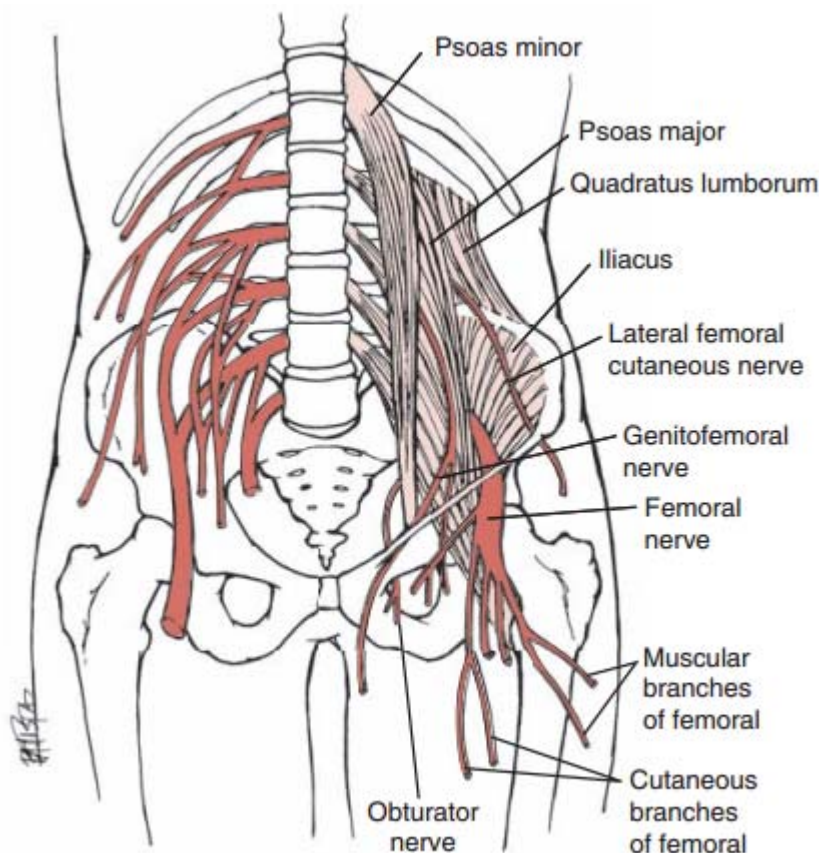
5. Phalen's test, Tinel's sign, and carpal tunnel compression test.

6. Complete and forced flexion of the wrist (typically for about 1 minute). A positive test involves recurrence of typical symptoms.

7. A trial of conservative management (wrist splinting, avoidance of exacerbating postures/activities, medications such as antiinflammatories) is warranted for mild/moderate CTS prior to considering surgery. Open or endoscopic release involves division of the transverse carpal ligament over its entire extent.

20. The answer is A. Lateral femoral cutaneous nerve.

This misguided professor presents with classic signs and symptoms of entrapment of the lateral femoral cutaneous nerve, which passes under the inguinal ligament in proximity to the anterior superior iliac spine, demonstrated in the given figure. Impingement of the lateral femoral cutaneous nerve is called meralgia paresthetica or bikini brief syndrome and results in abnormal sensations of burning, pain, and numbness in the lateral portion of the upper thigh. In the case of this progressive professor, his fashionable swimwear compressed the lateral femoral cutaneous nerve near the anterior superior iliac spine. Moreover, meralgia paresthetica is seen in individuals who have gained considerable weight (e.g., pregnancy) in a short period.



21. The answer is E. Posterior (dorsal) primary ramus.

Sensory receptors in the skin overlying the trapezius muscle project through general sensory (general somatic afferent) neurons to the spinal cord via the posterior (dorsal) primary rami of spinal nerves (marked “E” in this diagram), traverse the mixed spinal nerves, travel within posterior (dorsal) roots of spinal nerves, and reach the posterior (dorsal) gray horn of the spinal cord. Cutting the posterior rami of spinal nerves would cause degeneration of the distal axonal processes of the general sensory fibers and lead to loss of sensation in the skin of the back. Additionally, the distal axonal processes of somatic motor (general somatic efferent or GSE) neurons and visceral motor (general visceral efferent or GVE) neurons contained within the posterior

primary rami would be damaged as well, causing motor and autonomic deficits in the back, respectively. Remember that the trapezius muscle is a component of the superficial extrinsic layer of back muscles, which connect the upper limbs to the trunk. These muscles are innervated by anterior primary rami of spinal nerves, except for the trapezius, which is supplied by the accessory nerve (CN XI). However, the skin overlying the trapezius muscle is innervated by the posterior (dorsal) primary rami of spinal nerves.

22. The answer is A. Anterior gray horn of the spinal cord.

Cell bodies of somatic motor neurons (a-motor neurons) innervating skeletal muscle are located within the anterior (ventral) gray horn of the spinal cord, at all segmental levels throughout the entire length of the spinal cord. The innervation of the skeletal muscles affected by ALS is through somatic motor (general somatic efferent or GSE) neurons and branchial motor (special visceral efferent or SVE) neurons (neurons that supply the embryonic pharyngeal arches). In ALS patients, postmortem analysis of the anterior gray horn of the spinal cord would show significant degeneration. In the given diagram, the anterior gray horn of the spinal cord is labeled as “A.” The locations for all five possible choices for this question are also indicated in this figure.

23. The answer is A. Sural nerve.

The sural nerve is formed in the distal posterior aspect of the leg by the convergence of the medial sural cutaneous nerve (off the tibial nerve) and the lateral sural cutaneous nerve (off the common fibular nerve). This nerve parallels the small saphenous vein coursing in between the calcaneal tuberosity and lateral malleolus of the fibula, and it is at this location that this vein is often harvested for transplantation. Damage to the sural nerve would lead to numbness and paresthesia in the posterior leg, particularly to the dorsal aspect of the fifth toe and lateral malleolus of the fibula, as seen in this patient.

24. The answer is C. Saphenous nerve.

The cutaneous area indicated in the illustration is that of the saphenous nerve, the longest branch of the femoral nerve. The saphenous nerve becomes cutaneous at the medial aspect of the knee, and descends through the leg into the foot in company with the great saphenous vein. It innervates the skin on the medial side of the leg and foot. Because of its close relationship to the great saphenous vein, this nerve is vulnerable

to injury in surgery involving the vein (e.g., harvesting of the vein for coronary bypass or repair of varicosities).

25. The answer is D. Intercostobrachial nerve.

The intercostobrachial nerve is the lateral cutaneous branch of the second intercostal nerve. As its name implies, it leaves the thorax by exiting between the second and third ribs (between the ribs = intercosto-) to supply cutaneous innervation to the axilla and medial aspect of the arm (brachium). In some instances, it may also supply skin distal to the elbow. The anesthetic solution would block all of the distal branches of the brachial plexus residing within the axillary sheath, thus sparing the intercostobrachial nerve.

26. The answer is A. Tibial nerve.

A positive response to the calcaneal (Achilles) tendon reflex causes plantar flexion of the ankle joint via the contractions of the gastrocnemius and soleus muscles, which insert distally into the calcaneal tendon. These muscles are innervated by the tibial nerve, and the plantar flexion of the ankle joint confirms the integrity of this nerve and the S1-2 spinal segments, from which this nerve is primarily derived. The tibial nerve is a terminal branch of the sciatic nerve that supplies the posterior compartment of the leg, including the superficial compartment where the gastrocnemius and soleus muscles reside.

27. The answer is B. Deep fibular nerve.

The deep fibular (peroneal) nerve is a terminal branch of the common fibular nerve that supplies motor innervation to the four muscles of the anterior compartment of the leg: (1) tibialis anterior, (2) extensor digitorum longus, (3) extensor hallucis longus, and (4) fibularis (peroneus) tertius. These four muscles are responsible for dorsiflexion of the ankle. The deep fibular nerve also innervates the extensor digitorum brevis and extensor hallucis brevis, which are intrinsic muscles of the foot, sends articular branches to joints it crosses, and supplies cutaneous innervation to the first interdigital cleft. The deep fibular nerve is responsible for dorsiflexion of the foot at the ankle joint, and the segmental innervation of this movement is L4 and L5.

28. The answer is A. Axillary nerve.

The axillary nerve may be damaged in approximately one of seven shoulder dislocations. This nerve innervates the deltoid and teres minor muscles as well as supplying innervation to the skin overlying the deltoid in the superolateral aspect of the arm. Loss of innervation to the deltoid muscle would explain the weakness in abduction of the upper limb. The teres minor assists the infraspinatus muscle in external rotation of the shoulder.

29. The answer is D. Common fibular nerve.

The common fibular (peroneal) nerve, a terminal branch of the sciatic nerve, courses around the neck of the fibula. It is at this site that this nerve is particularly prone to injury via trauma, such as a kick to the side of the leg. Distal to this location, the common fibular nerve divides into the deep and superficial fibular nerves, which supply the motor innervation to the anterior and lateral compartments of the leg, respectively. Damage to the common fibular nerve would lead to all of the symptoms seen in this patient, such as weakness in eversion and dorsiflexion of the foot at the ankle joint, foot drop, and loss of sensation to the dorsum of the foot.

30. The answer is E. Musculocutaneous nerve.

A positive response to the myotatic biceps reflex confirms the integrity of the musculocutaneous nerve and the C5 and C6 spinal segments, from which this nerve arises. The musculocutaneous nerve supplies motor innervation and proprioception to the muscles in the anterior compartment of the arm, including the coracobrachialis, biceps brachii (tested here), and brachialis. Lesioning the musculocutaneous nerve would lead to loss of proprioception and weakness in flexing the elbow (via the biceps brachii and brachialis muscles) and supinating the forearm (via the biceps brachii), resulting in a negative myotatic biceps reflex.

31. The answer is E. Superficial branch of the radial nerve.

The superficial branch of the radial nerve is entirely cutaneous, carrying sensation from the dorsolateral part of the hand from the anatomical snuffbox to the midline of the fourth finger. This nerve is vulnerable as it runs posteriorly between the brachioradialis and extensor carpi radialis longus tendons toward the dorsum of the hand. This nerve was damaged at this location, but the area of sensory loss is less than expected due to the overlap from cutaneous branches of the ulnar and median nerves.

32. The answer is A. Tibial nerve.

The tibial nerve is a terminal branch of the sciatic nerve that supplies the posterior muscles of the knee joint and leg, including the three muscles of the superficial compartment (gastrocnemius, soleus, and plantaris) and four muscles of the deep compartment (popliteus, flexor hallucis longus, flexor digitorum longus, tibialis posterior). The tibial nerve is responsible for plantar flexion of the foot at the ankle joint, which is being tested in this patient, and the segmental innervation of this movement is S1 and S2. Distally, the tibial nerve divides into the medial and lateral plantar nerves.

33. The answer is A. Medial plantar nerve.

The medial plantar nerve, which is homologous to the median nerve in the hand, innervates four intrinsic foot muscles: first Lumbrical, Abductor hallucis, Flexor digitorum brevis, and Flexor hallucis brevis (mnemonic = “LAFF” muscles). This nerve supplies cutaneous innervation to the medial three and a half toes on the plantar surface of the foot. The given photo shows the sensory distribution of the medial plantar nerve, but please remember that the other cutaneous nerves of the plantar aspect of the foot (lateral plantar nerve on the lateral aspect, tibial nerve proximally, and saphenous nerve medially) will have some overlap with this distribution pattern. Due to the depth of the cut, the medial plantar nerve, which travels between the first and second layers of the plantar foot musculature, was most likely severed, resulting in loss of cutaneous sensation to the plantar surface of the medial three toes and loss of motor innervation to the abductor hallucis and flexor hallucis brevis. The tendon of the flexor hallucis longus muscle, which resides in the second layer of plantar foot musculature, would have also been severed by this cut. Despite being innervated by the tibial nerve, the tendon of this muscle would have been severed due to the depth of the cut, resulting in the complete inability to flex the big toe, seen in this patient.

34. The answer is C. Anterior interosseous nerve.

The anterior interosseous nerve is a branch of the median nerve in the distal part of the cubital fossa, and it courses distally on the interosseous membrane. It supplies the deep forearm flexors, including the flexor digitorum profundus of digits 2 and 3, the flexor pollicis longus, and the pronator quadratus. Loss of this nerve would cause weakness in pronation due to denervation of the pronator quadratus. This injury would also result in inability to flex the distal interphalangeal joints of the index and middle fingers and the interphalangeal joint of the thumb due to denervation of the flexor digitorum profundus and flexor pollicis longus, respectively. This deficit would lead to the collapsed “O.K. sign” indicated in the photo. Because compromising the anterior interosseous nerve would not result in any cutaneous

sensory deficits, it is this nerve that was most likely damaged by the displaced end of the left radius.

35. The answer is D. Radial nerve.

This case represents a classic presentation of “Saturday Night Palsy,” where the radial nerve is compressed against the humerus in the arm. Remember, the radial nerve supplies motor innervation to the posterior compartments of the arm and forearm, so damage to this nerve would cause weakness in extending the elbow and wrist. This patient is unable to extend the wrist when the hand is placed in a pronated position (“wrist drop”), implying damage to the radial nerve. Moreover, the superficial branch of the radial nerve is responsible for cutaneous innervation over much of the dorsum of the hand, which explains the numbness and paresthesia in his hand.

36. The answer is B: Ulnar nerve in the wrist.

The ulnar nerve can become compressed between the pisiform and hook of the hamate at the wrist in a condition termed “ulnar canal syndrome” or “Guyon tunnel syndrome.” This entrapment syndrome is especially seen in professional cyclists who spend countless hours placing pressure on the hook of the hamate bone as they grasp their handlebars. This “handlebar neuropathy” presents with hyperextension of the metacarpophalangeal joints and flexion at the interphalangeal joints of the fourth and fifth fingers. The “clawing” of these two fingers is accompanied by sensory loss in the medial side of the hand.

37. The answer is B. Lower trunk of the brachial plexus.

This woman has experienced a lower brachial plexus injury due to forced abduction of the upper limb during the accident. This injury presents with numbness and paresthesia in the C8 and T1 dermatomes, which supply the axilla and medial aspect of her upper limb. These nerve roots primarily supply the medial cord of the brachial plexus, which creates the ulnar nerve. Due to damage to the ulnar nerve, she is experiencing weakness in the movement of her left hand. The abduction and adduction of the fingers are controlled by the deep branch of the ulnar nerve by supplying the dorsal interosseous and palmar interosseous muscles, respectively.

38. The answer is D. Axillary nerve.

The quadrangular space of the shoulder is an important passageway allowing the posterior humeral circumflex vessels and their companion axillary nerve to pass from the axilla to the posterior aspect of the shoulder. The neurovascular bundle runs across the surgical neck of the humerus to enter the quadrangular space. The space itself (sometimes termed the lateral axillary hiatus) is formed by four structures: teres major, teres minor, long head of the triceps, surgical neck of the humerus. The vessels contribute to the collateral network around the shoulder. The axillary nerve supplies the teres minor and deltoid muscles and a cutaneous area on the superolateral aspect of the arm (i.e., the skin overlying the lower aspect of the deltoid muscle).

39. The answer is B. Median nerve.

Each of the five terminal branches of the brachial plexus (musculocutaneous, median, ulnar, radial, and axillary nerves) passes through a muscular or osseofascial tunnel at some point in its distribution, where it may be subject to entrapment in a tunnel syndrome. The pronator teres muscle arises via two heads, one from the medial epicondyle of the humerus and the other from the coronoid process of the ulna, with a tendinous arch connecting them. The median nerve exits the cubital fossa and enters the forearm by passing between these heads, where it may be unduly compressed in a pronator teres syndrome. This condition would influence much of the median nerve territory in the forearm plus the entire median nerve territory in the hand.

40. The answer is A. Ulnar nerve in the elbow.

Situations in which peripheral nerves are compressed or otherwise entrapped where they pass through narrow spaces (“tunnels”) in muscles and/or osseo-fascial units are generally referred to as “tunnel syndromes.” Such conditions may result in periodic or constant motor and/or sensory deficits. The ulnar nerve crosses the elbow in a narrow space between the olecranon process and the medial epicondyle of the humerus, on the posteromedial (ulnar) side of the joint. The ulnar nerve can be compressed between these bony landmarks or between the humeral and ulnar heads of the attachment of the flexor carpi ulnaris. Compression of the ulnar nerve within these areas leads to “cubital tunnel syndrome.” The symptoms are exacerbated during events where flexion of the elbow narrows these passageways and compresses the ulnar nerve at the elbow joint. The patient’s cubital tunnel syndrome would explain the paresthesia and numbness on the medial aspect of the hand and the diminished fine motor control of the intrinsic hand muscles. Her condition originated due to the forced flexion of the elbow in the motor vehicle accident, which compressed the ulnar nerve in the cubital tunnel.

41. The answer is D. Thoracodorsal nerve.

Successful transposition of muscle flaps in reconstructive surgery hinges largely on maintaining the neurovascular pedicles that supply the muscle. The latissimus dorsi muscle is innervated by the thoracodorsal (middle subscapular) nerve, a branch of the posterior cord of the brachial plexus. Lesion of this nerve during dissection of the chest wall will cause loss of the muscle flap.

42. The answer is D. Deep branch of ulnar nerve.

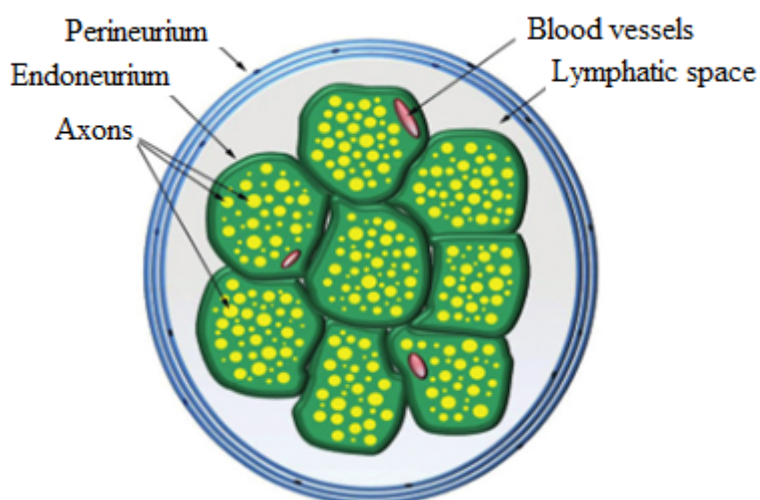
The deep branch of the ulnar nerve innervates most of the intrinsic muscles of the hand, including the hypothenar muscles, medial two lumbrical muscles, the palmar and dorsal interossei, adductor pollicis, and the deep head of the flexor pollicis brevis. Specifically, the palmar interossei, dorsal interossei, and lumbrical muscles insert into the extensor digital expansion to provide, collectively, flexion of the metacarpophalangeal joints and extension of the interphalangeal joints of the fingers. All of these muscles, with the exception of the first and second lumbrical muscles, are innervated by the deep branch of the ulnar nerve, so this nerve is being tested by placing the hand in the Z-position. If the deep branch of the ulnar nerve were severed, the hand would assume the opposite of the Z-position, which is called “claw hand.”

43. The answer is C. Recurrent branch of median nerve.

The recurrent (thenar) branch of the median nerve lies subcutaneously in the thenar eminence and can be damaged by lacerations in this area. This nerve innervates most of the thenar muscles, including the Opponens pollicis, Abductor pollicis brevis, and superficial head of the Flexor pollicis brevis (mnemonic = “OAF”). Opposition of the thumb would be lost by cutting the recurrent branch of the median nerve. Though the abductor pollicis brevis is denervated, the abductor pollicis longus, innervated by the deep branch of the radial nerve, is still intact. Also, the flexor pollicis longus, innervated by the anterior interosseous nerve, would still allow flexion at the interphalangeal joint of the thumb. Cutting the recurrent branch of the median nerve would lead to atrophy of the thenar muscular complex, a condition known as “ape hand.”

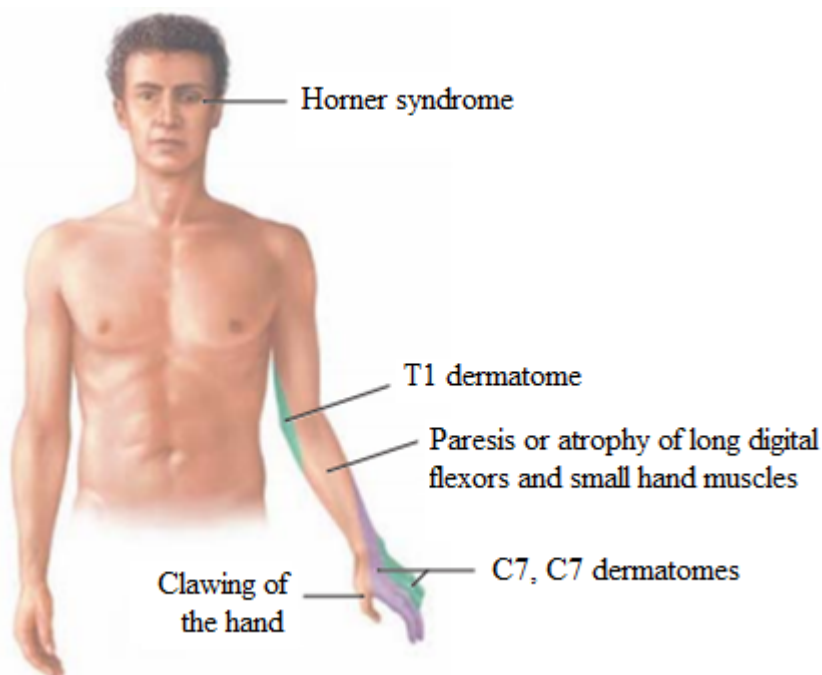
- 44.**
1. Waiter’s tip (Erb’s palsy)
 2. Claw hand (Klumpke’s palsy)
 3. Wrist drop
 4. Winged scapula
 5. Deltoid paralysis
 6. Saturday night palsy (wrist drop)
 7. Difficulty flexing elbow, variable sensory loss
 8. Decreased thumb function, Pope’s blessing
 9. Intrinsic muscles of hand, claw hand

45. Axon, Schwann cells, connective tissue matrix (endoneurium, internal and external epineurium).



Transverse section of a peripheral nerve consisting of a single nerve bundle.

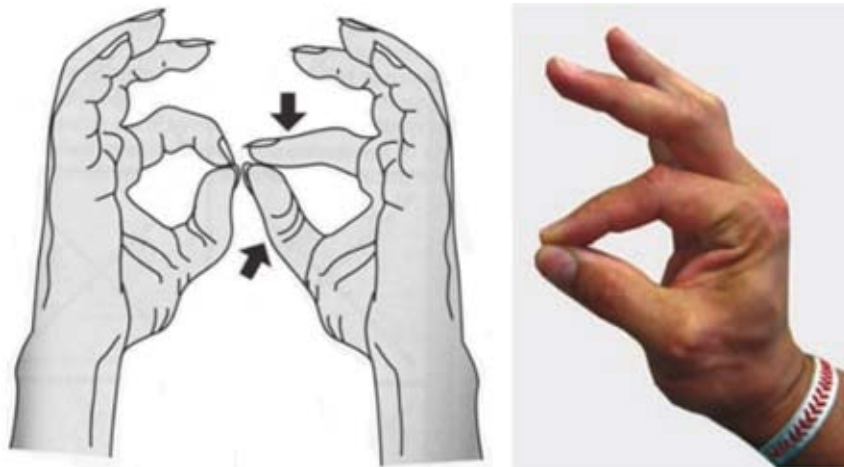
46. Lower brachial plexus paralysis (Dejerine-Klumpke palsy).



This paralysis results from a lesion of the ventral rami of the C8 and T1 spinal nerves. It affects the hand muscles, the long digital flexors, and the flexor muscles in the wrist (claw hand with atrophy of the small hand muscles). Sensory disturbances affect the ulnar surface of the forearm and hand. Because the sympathetic fibers for the head leave the spinal cord at T1, the sympathetic innervations of the head is also lost. This is manifested by a unilateral Horner syndrome, characterized by miosis (contracted pupil due to paralysis of the dilator pupillae) and narrowing of the palpebral fissure (not ptosis) due to a loss of sympathetic innervations to the superior

and inferior tarsal muscles. The narrowed palpebral fissure mimics enophthalmos (sinking of the eyeball into the orbit).

47.



To test for anterior interosseous nerve palsy, the thumb and index finger are unable to make a circle (“O”); instead, the pulps of the thumb and index finger touch each other. This is the result of weakness of flexion of the distal phalanges.

“Okay” or “circle” sign with anterior interosseous nerve weakness. A quick way to assess the flexor digitorum profundus and flexor pollicis longus innervation from the anterior interosseous nerve is to ask the patient to make an okay sign by touching the tips of the thumb and index finger together. With weakness in these muscles, the distal phalanges cannot flex, and instead of the fingertips touching, the volar surfaces of each distal phalanx make contact.

48. Absent flexion of radial three digits due to the loss of thenar muscles, FPL, and lateral half of lumbricals.



When a patient with a complete median palsy is asked to make a fist, the first digit barely flexes, the second digit partially flexes (secondary to substitution from non-

median innervated muscles), the third digit flexes but is weak, while the fourth and fifth digits flex normally, creating what is known as the Benedictine sign.

49. Tinel's test is used clinically under two clinical scenarios:

1. To assess the extent of axonal regeneration following nerve injury. The involved nerve is percussed along its entire length, starting distally and progressing proximally until paresthesias are elicited. This point represents the distal most extent of axonal regeneration.
2. To assess for compression of nerves at anatomical entrapment sites.

50. Froment's sign can be elicited by asking the patient to hold a piece of paper between the thumb and index finger. Median-innervated FPL substitutes for adductor pollicis, causing flexion of terminal phalanx while holding paper.

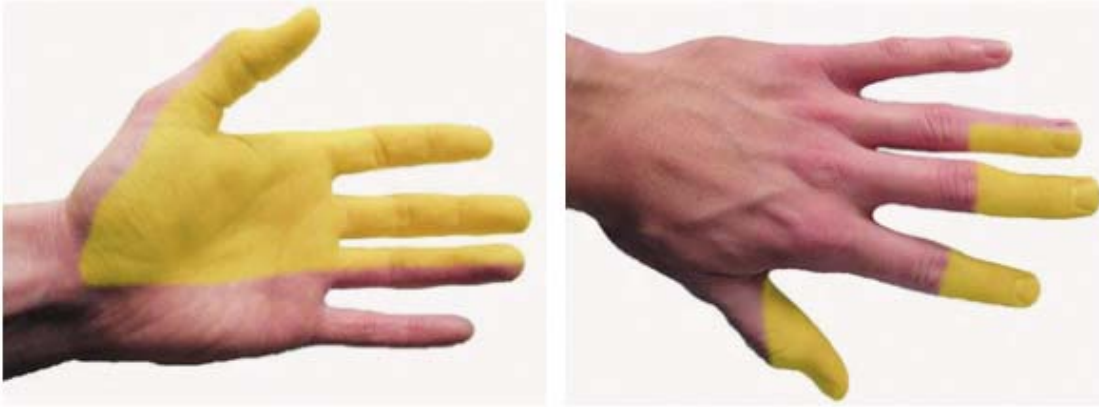


In the affected hand, the adductor pollicis is weak and thumb adduction does not occur. Instead, the interphalangeal joint of the affected thumb flexes to hold the paper through contraction of the flexor pollicis longus (median innervated).

51. Abduction of the fifth digit at the metacarpo-phalangeal (MCP) joint due to unopposed action of the extensor digiti quinti muscle and weakness of the third palmar interosseous muscle.

52.

- Palmar cutaneous branch: lateral aspect of palm
- Cutaneous branches to palmar surface and sides of thumb, index, middle, and half of ring finger, and dorsum of distal half of these fingers.



53.

- Dorsal cutaneous branch: dorsal surface of medial aspect of hand and 1½ fingers
- Palmar cutaneous branch: ulnar aspect of palm
- Superficial branch: palmar aspect of ulnar 1½ fingers



54.

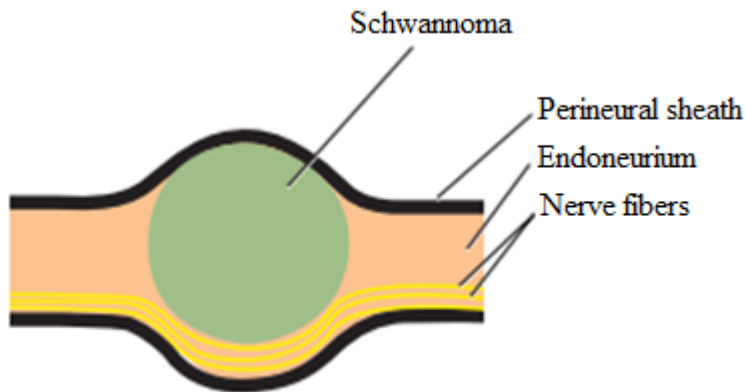
- Posterior brachial cutaneous n.
- Posterior antebrachial cutaneous and inferior lateral cutaneous n.
- Superficial terminal branch: supplies dorsoradial aspect of hand



55. Syndrome due to entrapment of the lateral femoral cutaneous nerve (purely sensory branch from L2-L3) where it enters the thigh through/below the inguinal ligament; associated with numbness, burning dysesthesias over anterolateral thigh (“trouser pocket distribution”).

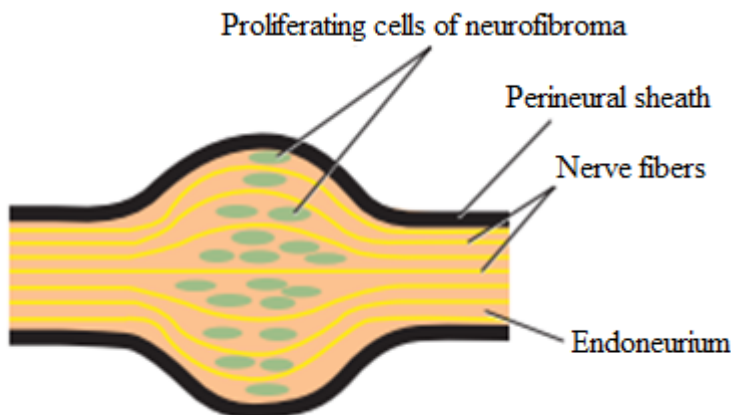
56.

1. Growth patterns of schwannoma and neurofibroma within peripheral nerve.



Schwannoma within nerve

The cellular proliferation of the schwannoma is well-circumscribed and pushes surviving nerve fibers to the periphery of the tumor.



Neurofibroma within nerve

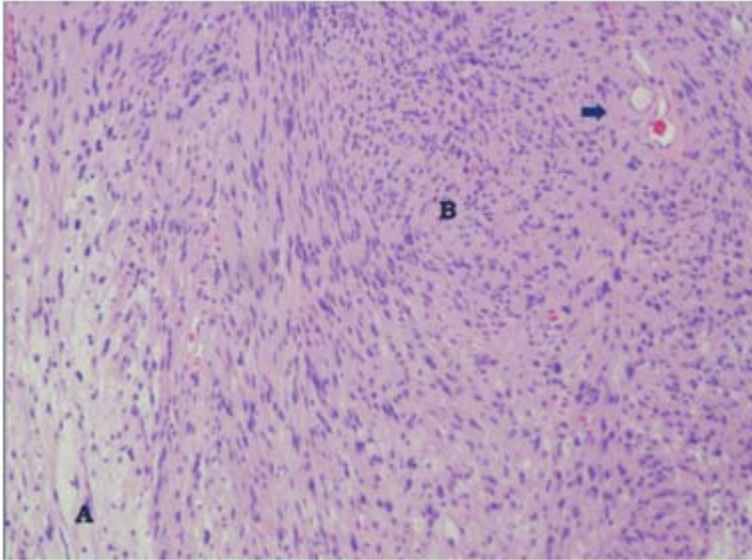
The cellular proliferation of the neurofibroma is interspersed among the surviving nerve fibers.

2. Neoplastic Schwann cells.

3. Schwannomas appear biphasic, with two patterns:

Antoni A: compact cellular areas with spindle-shaped cells, often arranged as parallel nuclear palisades (Verocay bodies).

Antoni B: less-cellular areas with loosely arranged cells that have indistinct processes.



Schwannomas are composed of cells with elongated, spindled nuclei. They are composed of Antoni A (label A) and Antoni B (label B) areas, and may show hyalinized blood vessels (arrow).

4. Trick question: both!

5.

- Mostly Antoni B tissue
- Few Verocay bodies
- Often proliferation of lipid-laden cells

6.

- Cellular
- Plexiform
- Melanotic

7. Cellular schwannoma is characterized by hypercellularity, mitotic activity ($<4/10$ HPF, a lower level than MPNST), fascicular cell growth, and sometimes nuclear hyperchromasia/atypia (these features may be seen also with MPNST).

References

1. Thomas G. Psarros, Shawn P. Moore. Intensive Neurosurgery Board Review, Lippincott Williams&Wilkins, Philadelphia, 2006.
2. Neil D. Kitchen, Hadi Manji, Guy M. McKhann II. Self-Assessment Colour Review of Clinical Neurology and Neurosurgery, Manson Publishing Ltd, London, UK, 2003.
3. Cargill H. Alleyne Jr., Jonathan Stuart Citow. Neurosurgery Board Review. Questions and Answers for Self-Assessment, Thieme Medical Publishers, New York, NY, 2005.
4. H. Wayne Lambert, Lawrence E. Wineski, Jeffery P. Hogg, Pat Abramson. Lippincott's Illustrated Q&A Review of Anatomy and Embryology, Lippincott Williams&Wilkins, Philadelphia, 2011.
5. Michael Schuenke, Erik Schulte, Udo Schumacher. Thieme Atlas of Anatomy. Head and Neuroanatomy, Thieme Medical Publishers, New York, NY, 2010.
6. Sri G. Thrumurthy, Tania S. de Silva, Zia M. Moinuddin, Stuart Enoch. SBA MCQs for the MRCS Part A, Oxford University Press, UK, 2013.
7. Mark R. Shaya, Remi Nader, Jonathan S. Citow, Hamad I. Farhat, Abdulrahman J. Sabbagh. Neurosurgery Rounds. Questions and Answers, Thieme Medical Publishers, New York, NY, 2011.
8. Jonathan Stuart Citow, David Cory Adamson. Neurosurgery Oral Board Review, Thieme Medical Publishers, New York, NY, 2011.
9. Remi Nader, Abdulrahman J. Sabbagh. Neurosurgery Case Review. Questions and Answers, Thieme Medical Publishers, New York, NY, 2010.
10. Christopher Wolfla, Daniel K. Resnick. Neurosurgical Operative Atlas. Spine and Peripheral Nerves, Thieme Medical Publishers, New York, NY, 2007.
11. Daniel H. Kim, Alan R. Hudson, David G. Kline. Atlas of Peripheral Nerve Surgery, Elsevier Saunders, Philadelphia, 2013.