433 Teams

MEDICINE

18| Peripheral Neuropathy

Part 1

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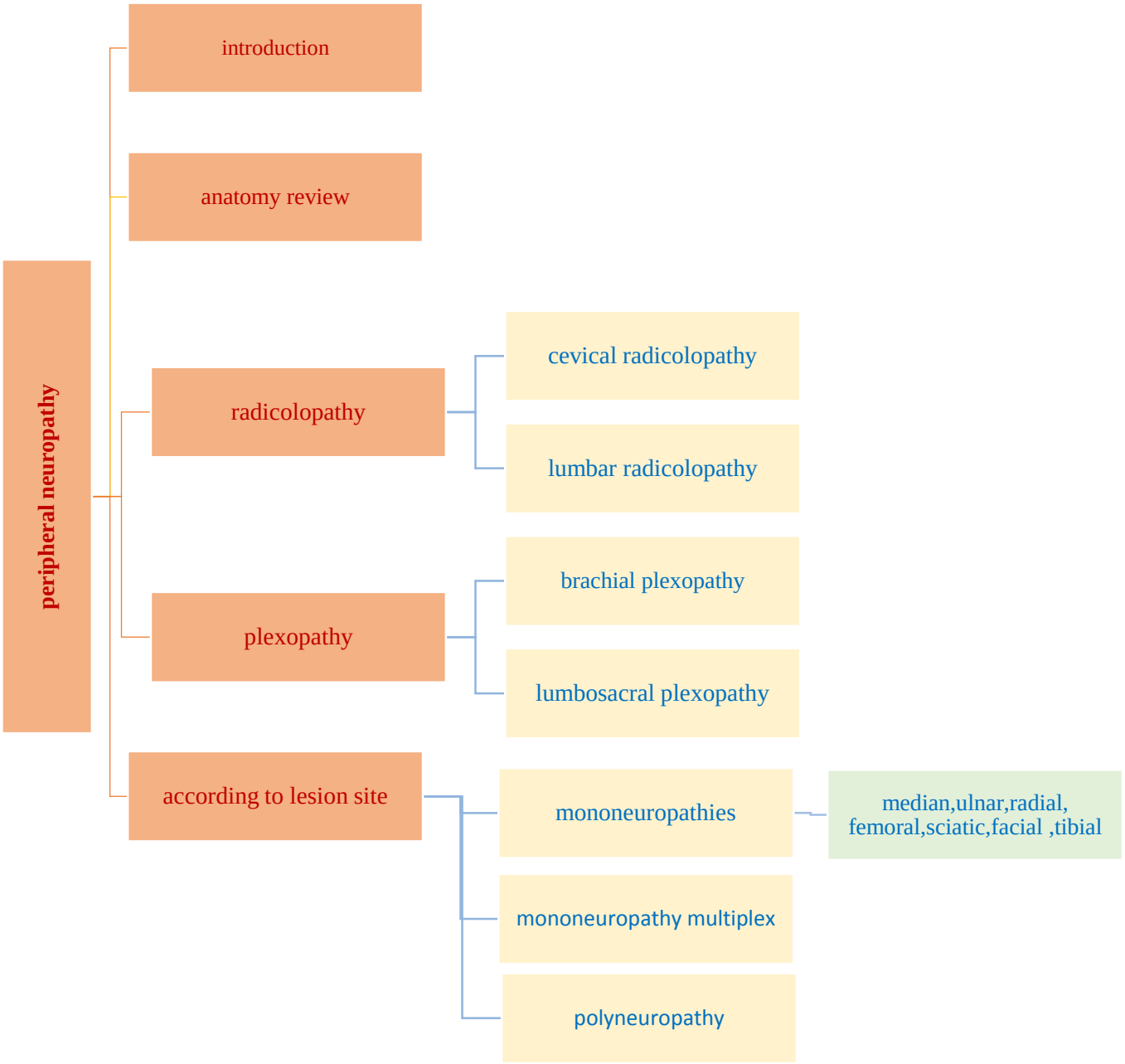
Objectives: note given



quick review of the anatomy of CNS and PNS

CNS	Brain and spinal cord
PNS	Everything else starting from the anterior horn cell, roots, cervical and lumbosacral plexi, peripheral nerves and their divisions.

Peripheral Nervous System

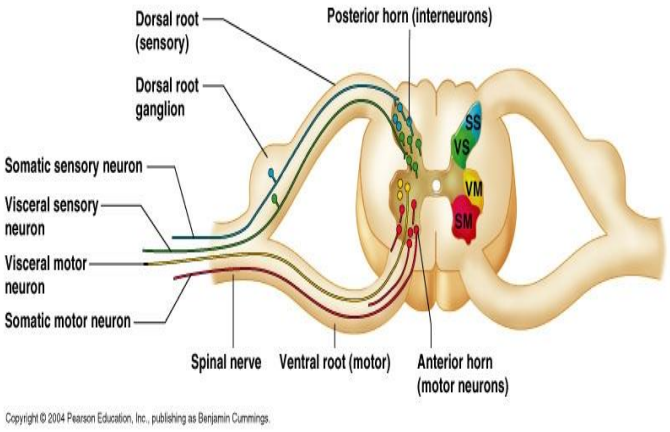
There are two types of cells in the peripheral nervous system. These cells carry information to (sensory nervous cells) and from (motor nervous cells) the central nervous system (CNS). Cells of the sensory nervous system send information to the CNS from internal organs or from external stimuli.

Motor nervous system cells carry information from the CNS to organs, muscles, and glands. The motor nervous system is divided into the **somatic** nervous system and the **autonomic** nervous system.

The **somatic nervous system** controls skeletal muscle as well as external sensory organs such as the skin. This system is said to be voluntary because the responses can be controlled consciously. Reflex reactions of skeletal muscle however are an exception. These are involuntary reactions to external stimuli.

The **autonomic nervous system** controls involuntary muscles, such as smooth and cardiac muscle. This system is also called the involuntary nervous system. The autonomic nervous system can further be divided into the parasympathetic and sympathetic divisions.

Motor pathway	Starts as the axons of anterior horn cells (in the spinal cord) come out through the ventral root. It's divided into somatic and autonomic nervous system)
Sensory pathway	Starts from periphery where sensory cells receive stimuli and send it to the CNS. It enters the spinal cord through the dorsal root (passing through dorsal root ganglia)



Sensory Tract:

1- Dorsal Column(Gracile&Cuneate fasciculi):

Carry impulses concerned with **proprioception** (movement and joint position) **and discriminative touch** from **ipsilateral side** of the body.

The axons of the 2nd order neurons decussate in the medulla

2- Spinothalamic Tracts:

- Lateral Spinothalamic Tract:
  Carries pain &Temperature to thalamus and sensory area of the cerebral cortex.

  The spinothalamic tract contains *second-order neurones*, the cell bodies of which lie in the contralateral dorsal horn.

  Fibres decussate and ascends as spinal lemniscus.

- Anterior Spinothalamic Tract:

  Carries crude touch and pressure to thalamus and sensory cortex.

3- Spinocerebellar Tracts

Only 2 Neurons.

Two tracts: Dorsal and Ventral

Carry information derived from muscle spindles, Golgi tendon organs and tectile receptors to the cerebellum.

Nerve conduction velocity :

- **There are several types of nerves.**
- **A nerve consists of many fibers (axons).**
- **The velocity of myelinated nerve(covered with myelin) fiber is higher than non-myelinated fiber.**
- **Conduction velocity is higher in thicker nerve fiber than thinner nerve fiber.**
- **Each fiber has its own velocity, different than other fibers.**
- **The higher the temperature, the higher the velocity.**

Peripheral Neuropathy

Introduction:

The terms "peripheral neuropathy," "polyneuropathy," and "neuropathy" are frequently used interchangeably, but are distinct.

Peripheral neuropathy is a less precise term that is frequently used synonymously with polyneuropathy, but can also refer to any disorder of the peripheral nervous system including radiculopathies and mononeuropathies.

Polyneuropathy is a specific term that refers to a generalized, relatively homogeneous process affecting many peripheral nerves, with the distal nerves usually affected most prominently.

Neuropathy, which again is frequently used synonymously with peripheral neuropathy and/or polyneuropathy, can refer even more generally to disorders of the central and peripheral nervous system.

(From Davidson):

Numerous inherited and acquired (most are acquired) pathological processes may affect peripheral nerves, targeting either:

A. The **nerve roots (radiculopathy**).
B. The **nerve plexuses (plexopathy).**
C. And/or the **individual nerves themselves (neuropathy).**

It's involved nerve fibers of different types (motor, sensory or autonomic) & of different sizes may be variably involved.

Disorders may be primarily directed at :

A. The **axon**.
B. The **myelin sheath (Schwann cells)**.
C. Or **the vasa nervorum (the vascular supply of the nerves).**

An acute or chronic peripheral nerve disorder may be :

A. Focal **(affecting a single nerve: mononeuropathy).**
B. Multifocal **(several nerves: mononeuropathy multiplex).**
C. Or generalized **(polyneuropathy).**

Mechanisms of damage (it can be mixed in some diseases)		*Example*
Demyelination	Schwann cell damage leads to myelin sheath disruption. This causes marked slowing of conduction.	-GBS(Guillain–Barré syndrome) (1) -HSMN (hereditary sensory and motor neuropathy)
Axonal degeneration	(Usually associated with atrophy, most of chronic or metabolic diseases affect axons. Once the axons are affected, it's irreversible)	Toxic neuropathies (Alcohol and excessive sugar)
Wallerian Degeneration	Nerve section, the axon starts to degenerate distally to the area of injury (opposing the cell body direction) and takes long time to regenerate.	Trauma, Cut
Compression	Cause **Focal demyelination**	Carpel tunnel syndrome
Infarction	Nerves have small blood vessels " vasa nervosum" , these blood vessels affected in DM , arteritis. So nerves get infarcted.	Arteritis, Polyarteritisnodosa, DM, Atherosclerosis
Infiltration	Infiltration of peripheral nerves by inflammatory cells occurs in leprosy and granulomas. (nerves get damaged directly)	Infiltration Leprosy, Sarcoidosis
(1): GBS can be both demyelination and axonal degeneration. Mainly Demyelination.		

Demyelination shouldn't cause atrophy, but if the disease is already severe, it might be associated with atrophy. Later on, axons will be affected, and you won't be able to differentiate or to tell the initial mechanism. >>like in GBS

Types of symptoms and signs:

	Loss of function "Negative"	Altered function "Positive"
Motor	Wasting Hyopotonia Weakness Hyporeflexia Orthopedic deformity	Fasciculations(1) Cramps
Sensory (Large Fibers)	↓ Vibration, ↓ proprioception, hyporeflexia sensory ataxia	Paresthesias
Sensory (Small Fibers)	↓ Pain ↓ Temperature	Dysesthesias Allodynia(2)
Autonomic Nerve	↓ Sweating Hypotension Urinary retension Impotence Vascular color changes	↑ Sweating Hypertension

Note: the term positive or negative has nothing to do with the presence or absence of the symptoms. It only describes the symptom.
(1): Tiny movement caused by activation of single motor unit.
(2): Experience of pain from non-painful stimulation.

Important Notes :

- Motor nerves , sensory nerves, or autonomic nerves may be affected. More than one type of nerves may be affected at the same time (In GBS the patient has sensory/motor loss and autonomic too). The effect could be loss of function (negative) or inappropriate gain of function (Positive).
- Weakness isn't specific for LMN only, it can happen in UMN disorders as well, but in LMN lesions there are more sensory loss, hypotonia, hyporeflexia, and muscles atrophy which you don't find in UMN lesions.

- Fasciculation are found in LMN diseases and it's classical for ALS.

Q/ What's unique about peripheral nerve motor and sensory and sometimes autonomic?
Everything will fit in single peripheral nerve distribution, it doesn't fit with myotomal or radicular distribution and it doesn't fit with central distribution.

- What's central distribution?

Suppose you get a patient with hand numbness, how can I tell this hand numbness is median nerve (peripheral nerve), C6 (nerve root) or stroke, how can I tell the difference? By assessing the distribution, so If it is 3 fingers and a half and above the wrist is spared, I will think about median nerve and carpal tunnel syndrome, while If it is affecting also the forearm, I will think about nerve root, and If it is both sides of the hand but up to the wrist, so it doesn't fit with median, doesn't fit with ulnar, it can be stroke. So stroke or central pathology doesn't really go by single dermatomal or myotomal distribution, it will affect like half of the limb. So you have to think about the distribution.

A. Radiculopathy:

The location of the injury is at the level of the **nerve root**, This can result in pain (radicular pain), weakness, numbness, or difficulty controlling specific muscles.

in a radiculopathy, the problem occurs at or near the root of the nerve, shortly after its exit from the spinal cord. However, the pain or other symptoms often radiate to the part of the body served by that nerve(the same root). For example, a nerve root impingement in the neck can produce pain and weakness in the forearm. Likewise, an impingement in the lower back or lumbar-sacral spine can be manifested with symptoms in the foot.

- Pain is a key finding.
- This affects a group of muscles supplied by a spinal root (myotome) and a sensory area supplied by a spinal root (dermatome). Therefore, the distribution of affected areas can help differentiate this from a peripheral neuropathy or a plexopathy.
- Patients may present with weakness, atrophy, and sensory deficits in a dermatomal pattern, may include fasciculations and diminished deep tendon reflexes.

- common causes of Radiculopathies :

- ✓ Compressive: herniated disc, spondylosis, tumor.
- ✓ Infiltrative: tumor seeding, infection.
- ✓ Inflammatory: immune-mediated.

- To diagnose radiculopathy with through history and examination you must know :

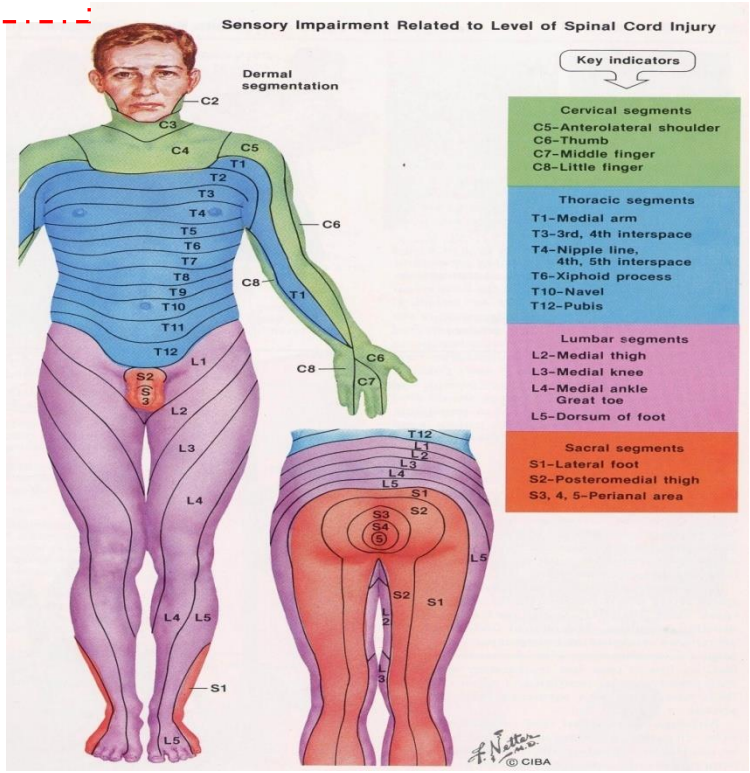
1) dermatomes, part of skin supplied by single root.

2) myotomes, the muscles supplied by it.

1) Dermatomes

Important

1. there is no C1 dermatome.
2. C4 and T2 dermatome are contiguous on trunk.
3. Thumb, middle finger, and fifth digits are innervated by C6, C7, and C8, respectively.
4. Nipple is at T4 level.
5. Umbilicus is at T10 level.
6. Lumbar and sacral dermatome are contiguous in the posterior axial line of leg.



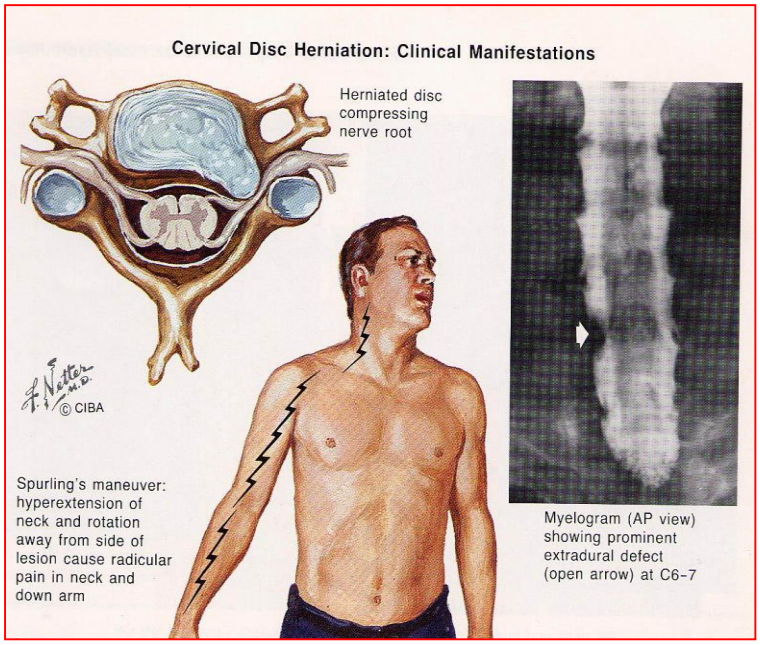
2) Myotomes :

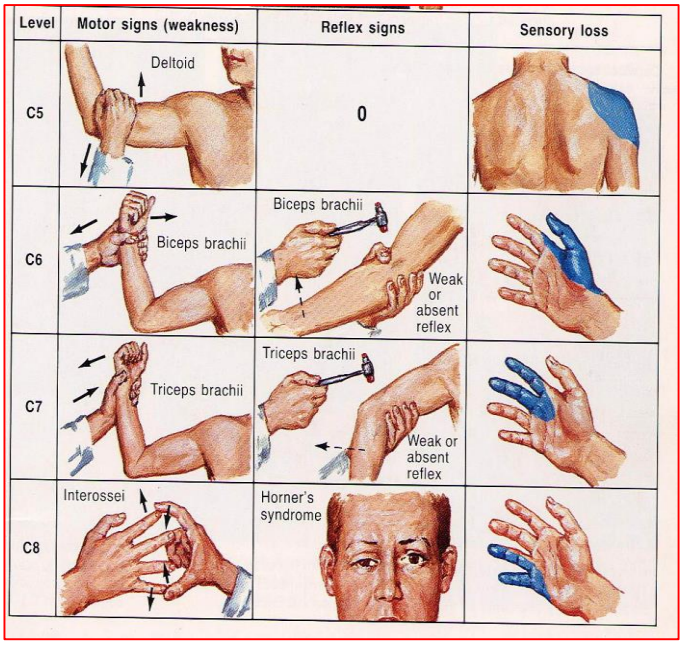
Important

- Remember each muscle is supplied by multiple roots but in this table the main ones are mentioned to help you in diagnosing or localizing the defect.
- a reflex called: supinator operator radialis reflex can be decreased if there is a lesion at C6 and C7.
- After memorizing the dermatomes and myotomes try to link things in your mind so you get the whole picture. E.g. a patient presented with abnormal sensations in his thumb and weakness while trying to flex his elbow joint→C6 is probably affected.
- Generally, you rule out UMN lesions by physical examination: absence of hypertonia and hyper-reflexia, no muscles atrophy, EMG (electromyograpgies) as well.

Root	Muscle	Primary function
C3	Diaphragm	Respiration
C4	Diaphragm	Respiration
C5	Deltoid	Arm abduction
C5	Biceps	Forearm flexion
C6	Brachioradialis	Forearm flexion
C7	Triceps	Forearm extension
L3	Quadriceps femoris	Knee extension
L4	Quadriceps femoris	Knee extension
L4	Tibialis anterior	Foot dorsiflexion
L5	Extensor hallucis longus	Great toe dorsiflexion
S1	Gastrocnemius	Plantar flexion

1- Cervical Radiculopathy:





A- Patients presented with weakness in abduction, numbness on shoulder area. Or Came with numbness on shoulder area only, you think of deltoid (C5) or it can be axillary nerve. To differentiate (by examination) check the myotome of C5 which is shoulder abduction and also it supplies the biceps (flexion) so biceps reflex weak or absent. But in axillary injury only the deltoid will be affected.

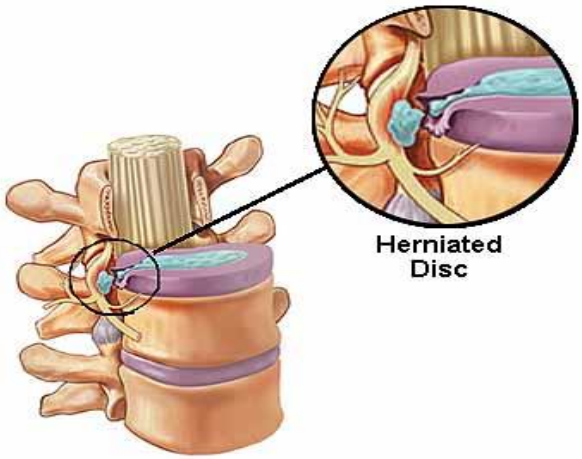
B- C7 triceps (extension) and supplies sensation to middle finger. Weak or absent reflex of the triceps.

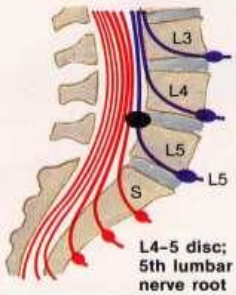
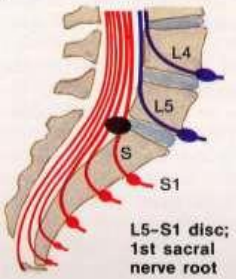
C- C6 biceps (forearm flexion) and the sensation along the forearm laterally with thumb and index fingers. What else give sensation in this area? (Median! But median gives 3.5 fingers of the radial side, also control the flexors of the forearm and the muscles of the hands causing weakness).

NOTE: Supinator or brachioradialis reflex supplied by C6-C7 (can be decreased) you'd think of ulnar mononeuropathy too but the myotome supply is too small to distinguish ulnar clinically so you ask for EMG. EMG is also done in cases to know if the cause of damage is demyelination or axonal.

D- C8 gives the interossei (adduction and abduction and making a fist). Sensation: pinky and ring finger.

2- Lumber Radiculopathy :



Level of herniation	Pain	Numbness	Weakness	Atrophy	Reflexes
 L4–5 disc; 5th lumbar nerve root	 Over sacro-iliac joint, hip, lateral thigh and leg	 Lateral leg, first 3 toes	 Dorsifexion of great toe and foot; difficulty walking on heels; foot drop may occur	Minor	Changes uncommon in knee and ankle jerks, but internal hamstring reflex diminished or absent
 L5–S1 disc; 1st sacral nerve root	 Over sacro-iliac joint, hip, postero-lateral thigh and leg to heel	 Back of calf, lateral heel, foot and toe	Plantar flexion of foot and great toe may be affected; difficulty walking on toes	 Gastrocne-mius and soleus	 Ankle jerk diminished or absent

- Foot drop happens due to sciatic nerve injury or it can be L5-S1 radiculopathy .
- All branches come from the sciatic nerve so all the muscles here will be affected, dorsiflextion, plantar flexion, eversion, inversion.
- What also causes foot drop in UMN lesions are strokes in MCA "middle cerebral artery" (you differentiate through physical examination, if it's UMN lesion you'll find hypertonia, hyperreflexia..etc).

  Q/ How to differentiate between sciatic nerves injuries and L5-S1 radiculopathy?
  EMG

- Sciatic nerve branches in the leg: Tibial nerve(plantar flexion and inversion),common fibular nerve(dorsiflexion and eversion).
- In lumbosacral radiculopathy L5-S1 are the most common injured ones.

B. Plexopathy:

- Deficits (motor and sensory) involve more than one nerve.
- Findings are variable depending on which part of the plexus is involved.
- Trauma is the most common cause overall, especially for the brachial plexus, while postsurgical hematoma in the pelvis is a more common cause in lumbosacral plexopathy.
- Plexuses that are commonly involved include:

A. Brachial plexus Erb–Duchenne type is the more common (upper trunk C5-6 roots) and less common lower trunk (C8-T1) .
B. Lumbosacral plexus (L5-S3).

- In plexopathy: the defect can be anywhere BUT ANYTHING PROXIMAL TO THE LESION WILL BE SPARED.
- the nerve conduction for all sensory nerves will be normal in radiculopathy (why? because the cell body is spared) But in plexopathy all sensory and motor supply are affected cause the injury is after the dorsal ganglion (where the nerve becomes mixed).
- When someone comes with mixed symptoms (sensory and motor), examine the proximal part, if intact you're probably dealing with plexopathy rather than radiculopathy .

#Case: someone presents with numbness of both hands.

Put radiculopathy at the bottom of your differential.

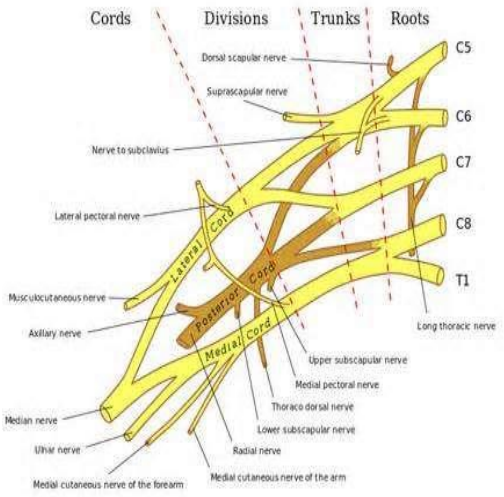
why?

1-bilateral at the same time , it won't push the nerve at the same time with all distribution it's not possible.

2- Nerves don't come out as one root, there are rootlets (it's not likely to compress all rootlets together at once)

1) Brachial plexus: "anatomy & lesions"

The anatomy part makes the diseases more understandable and easier.



- Roots:C5,C6,C7,C8,T.
- Trunk: Upper(RootsC5&C6),Middle(RootC7),Lower(RootC8&T1)
- Division: Each trunk divides into anterior and posterior divisions

Posterior cord (post division of all trunks)	Medial cord (anterior division of lower)	Lateral cord (anterior division of upper and middle)
all roots	C8,T1	C5,C6,C7
Radial nerve Axillary nerve	Median nerve Ulnar nerve	Median nerve Musculocutaneous nerve

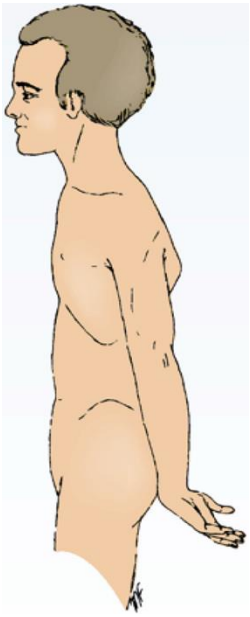
- ✓ Ulnar nerve: most common injury between medial epicondyle and olicranial process (cubital tunnel groove) causing cubital tunnel syndrome (hanging the arm on a chair and sleeping on it).
- ✓ Most of the hand muscles are supplied by the ulnar except for the thenar.

Causes of brachial plexopathy:

- Trauma
- Tumor infiltration
- Infection by viral
- Immune-mediated
- Delayed effects of radiotherapy

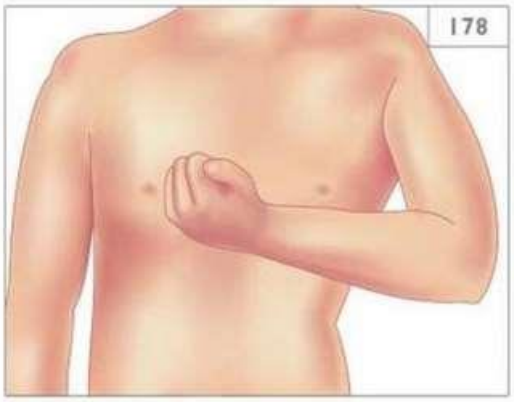
Brachial plexus lesions:

Erb's palsy	• ***Upper Lesions** of the Brachial Plexus **Upper Trunk** C5,6 (Erb-Duchenne Palsy* **"waiter's tip position".** • **Resulting from excessive displacement of the head to the opposite side and depression of the shoulder on the same side (a blow or fall on shoulder).**
Klumpke's paralysis	• ***Lower Lesions** of the Brachial Plexus, (Klumpke Palsy)/**LowerTrunk** (C8,T1)Lesion* • **The nerve fibers from this segment run in the ulnar and median nerves to supply all the small muscles of the hand. The hand has a clawed appearance due to ulnar nerve injury.**



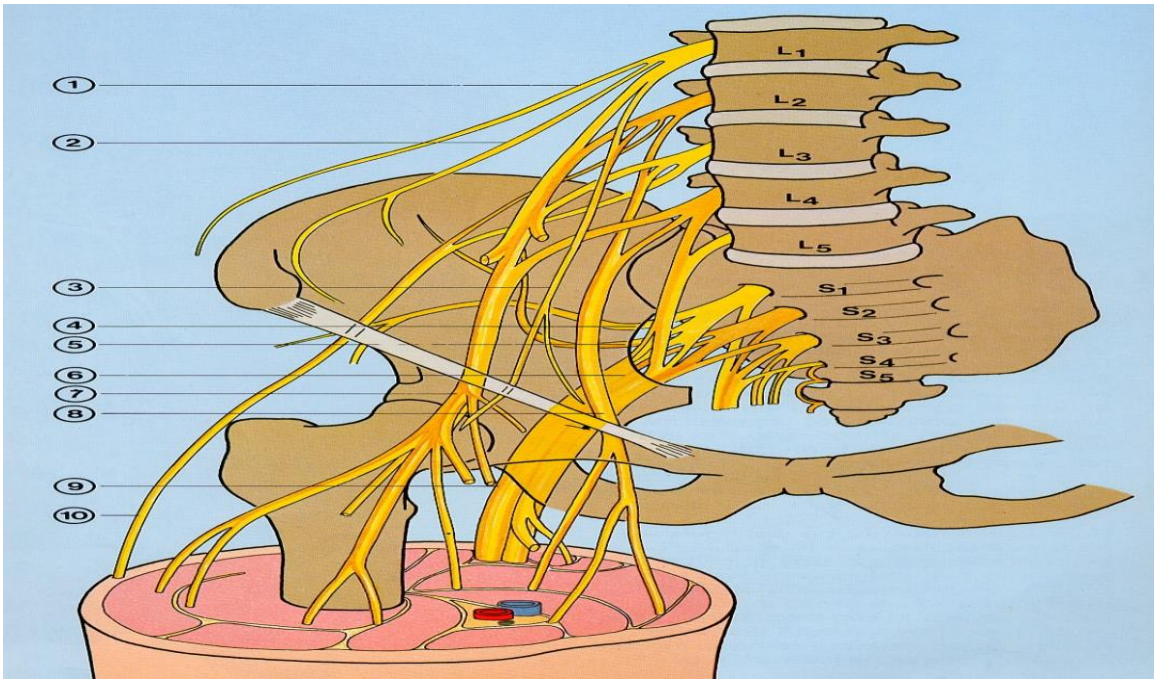
Erb's palsy

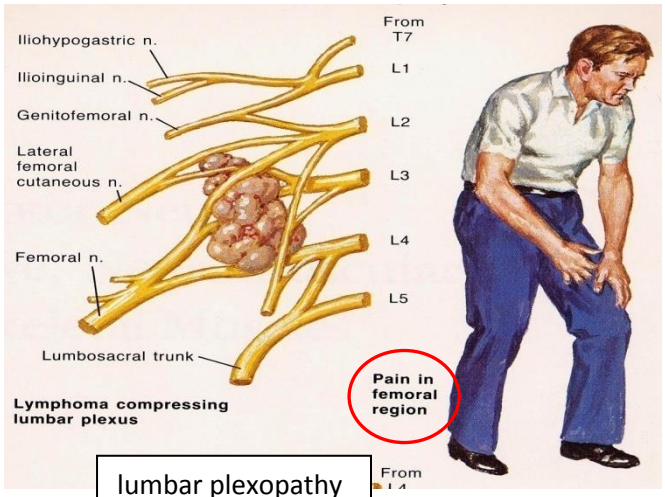
177 Erb's palsy.



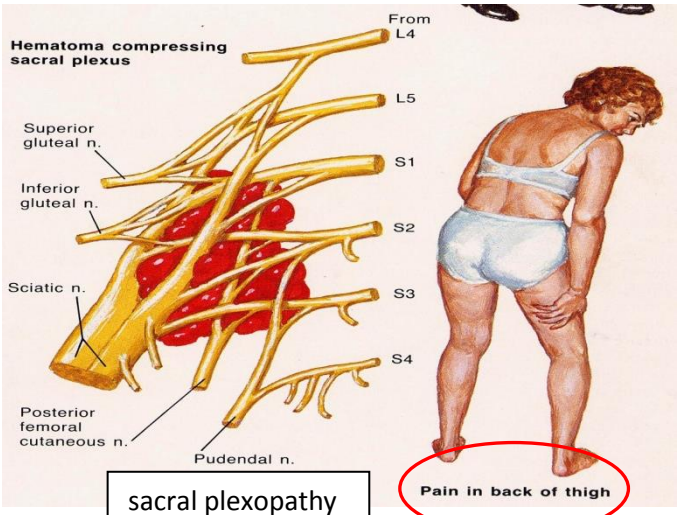
178 Klumpke palsy.

2) Lumbosacral plexus:





lumbar plexopathy



sacral plexopathy

Causes of lumbosacral plexopathy:

- Tumors : CA cervix, prostate, bladder, colorectal, kidney, breast, testis, ovary, sarcoma, lymphoma.
- Compressed by aortic aneurysm.
- Radiation plexopathy.
- Plexitis : follow herpes zostor.
- Diabetic amyotrophy.
- Trauma (rare) .

Clinical manifestations:

- Patients usually present with asymmetric, focal weakness, numbness, dysesthesia, and/or paresthesia in multiple contiguous lumbosacral nerve root distributions.
- Patterns of weakness usually help localize the "lesion" to a more specific area within the plexus.
- Lumbar plexus lesions: tend to cause weakness of hip flexion and adduction and/or knee extension.
- Lumbosacral trunk and upper sacral plexus lesions: result in foot drop or flail foot depending on the extent of involvement, and weakness of knee flexion or hip abduction.
- Patterns of sensory disturbance are less reliable given the difficult clinical delineation between dermatomal and named nerve sensory loss. However, in general:

    A. In lumbar plexus: Sensory disturbance involving the anterior and medial thigh and medial leg.
    B. In lumbosacral trunk and/or sacral plexus lesion: Sensory disturbance involving the leg, dorsum of the foot, posterior thigh, and perineum.

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