Limb Weakness: Radiculopathies and Compressive Disorders

Spot the brain cell

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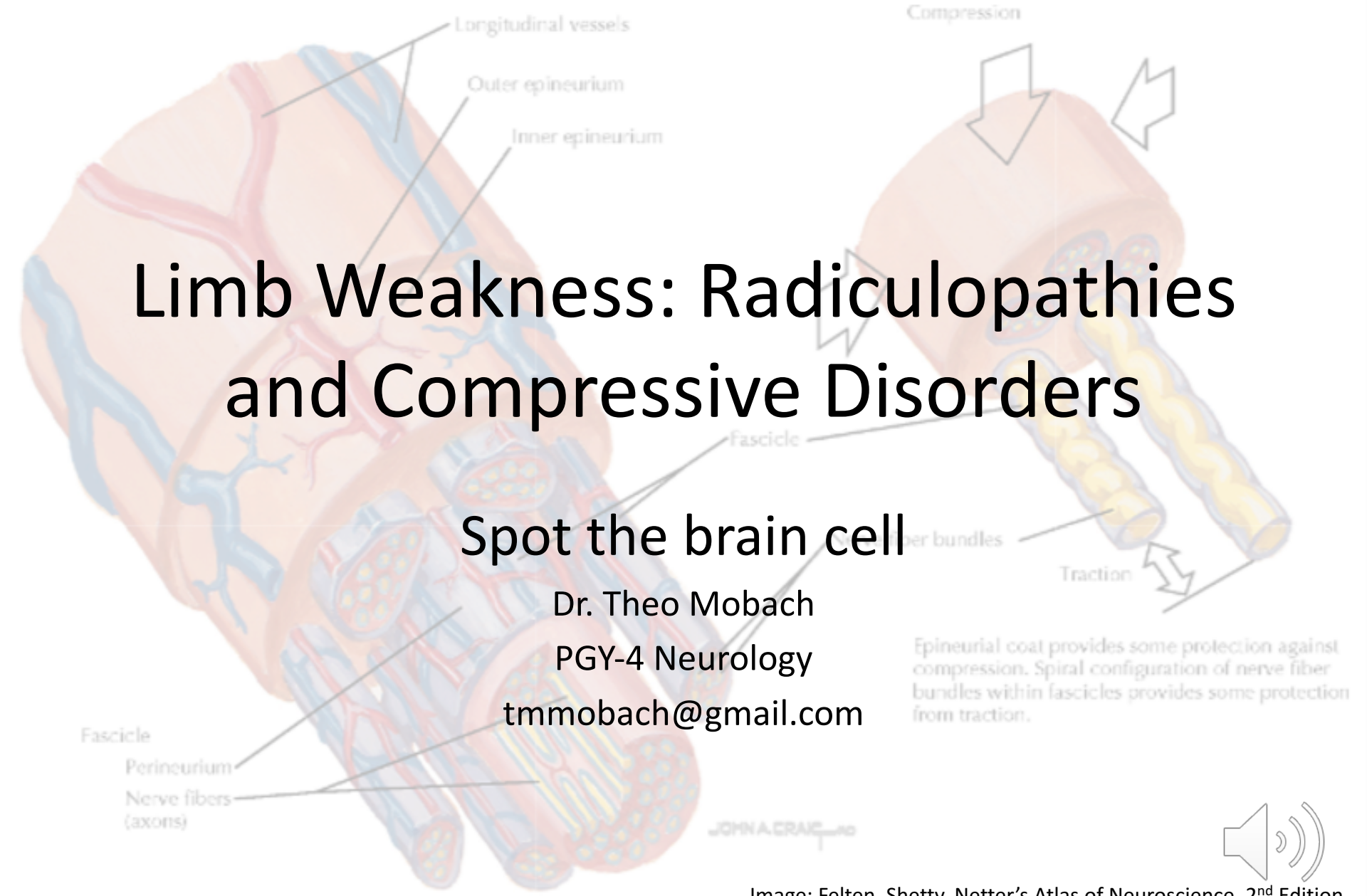


Image: Felten, Shetty. Netter's Atlas of Neuroscience. 2nd Edition.

Objectives

- Basic neuroanatomy of peripheral nervous system
- Physical exam: motor and sensory components
- Common entrapment neuropathies
  - Median Neuropathy at the Wrist
  - Ulnar Neuropathy at the Elbow
  - Fibular Neuropathy
- Radiculopathies

UMN vs LMN

Upper Motor Neuron	Lower Motor Neuron
• Spasticity • Hyperreflexia • Pyramidal pattern of weakness • Babinski sign	• Atrophy • Hypotonia • Decreased or absent reflexes • Fasciculation's

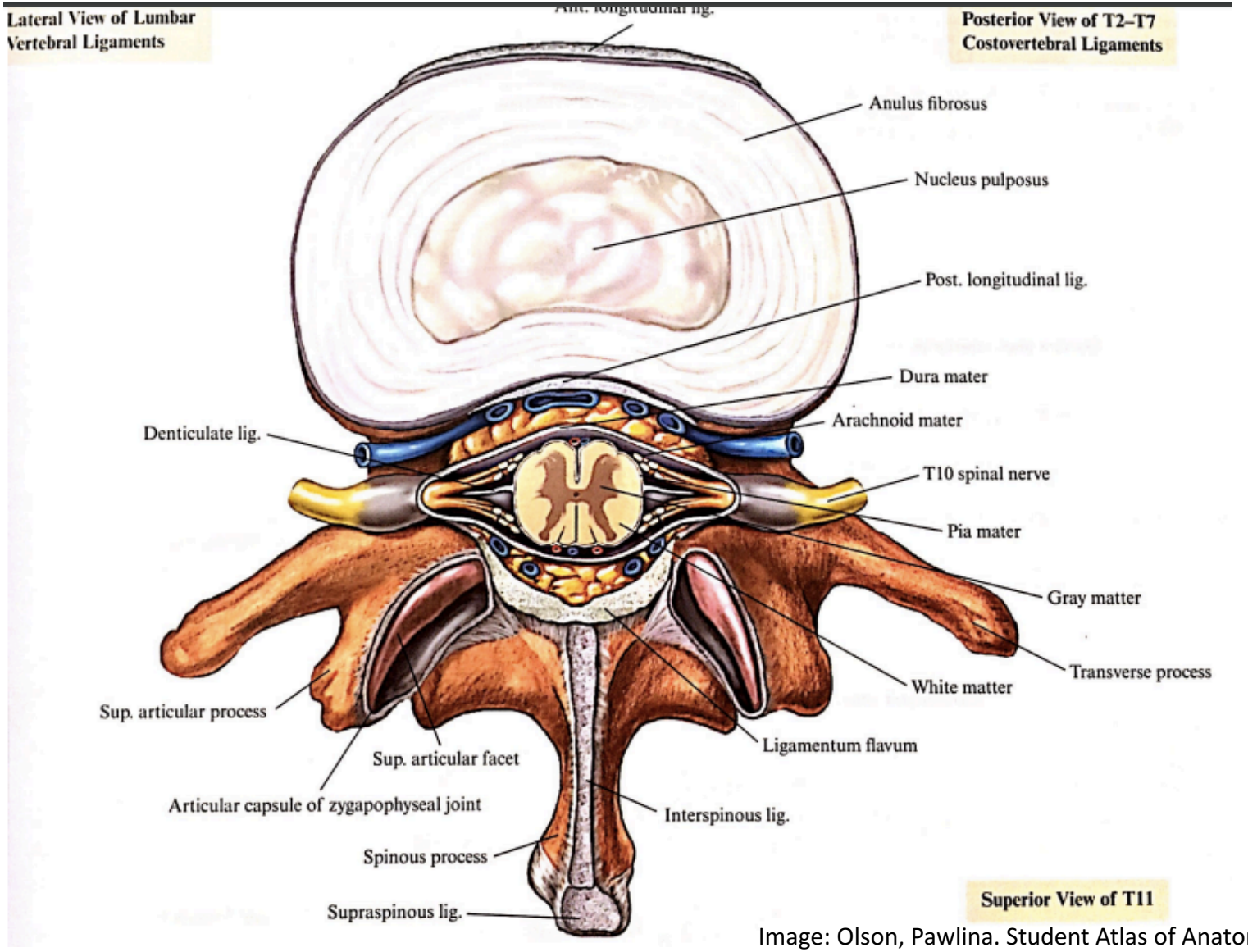
Motor Unit

Motor neuron

Skeletal
Muscle Fibers

Often several motor units work together to coordinate contraction of a single muscle

Spinal Roots



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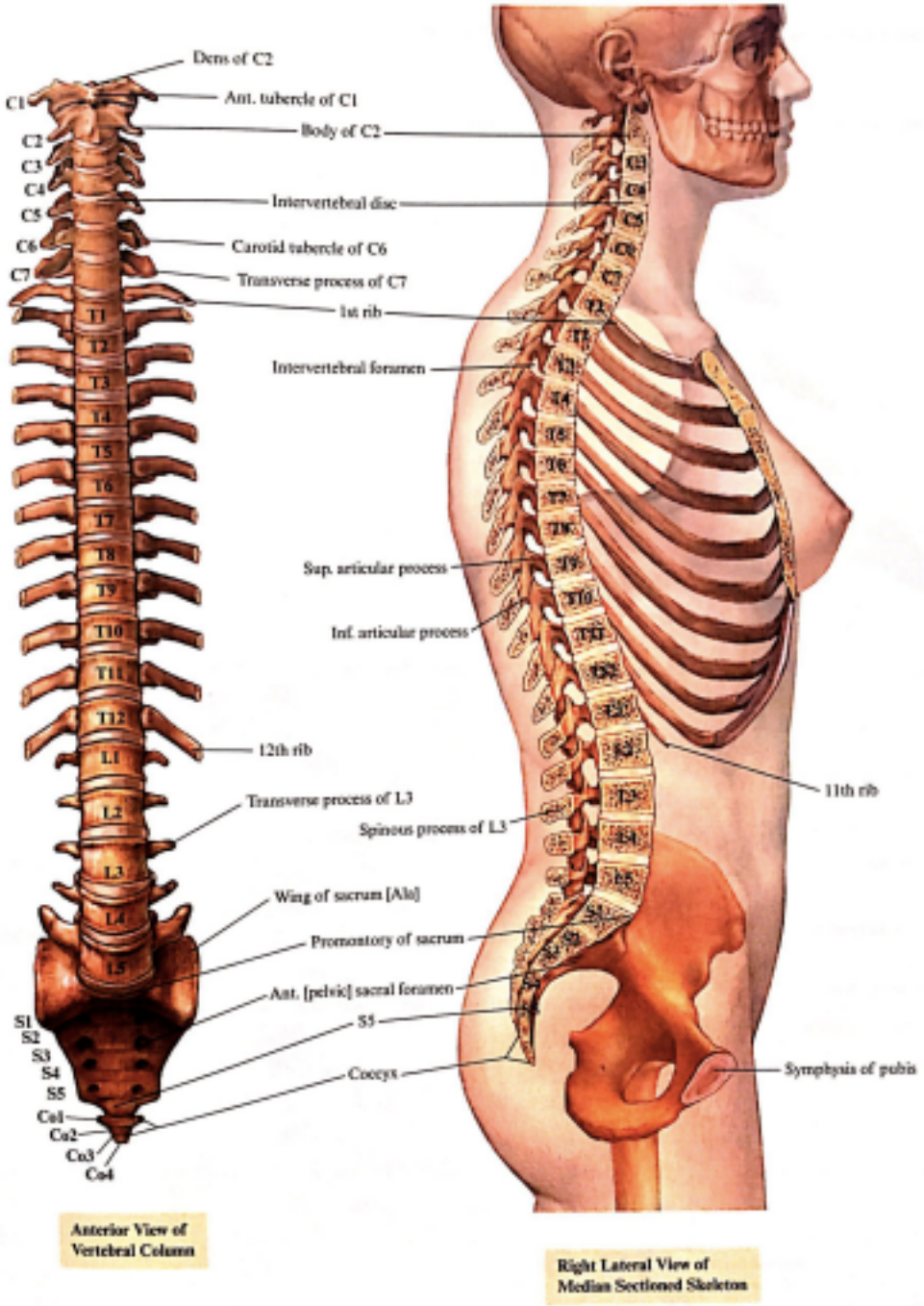

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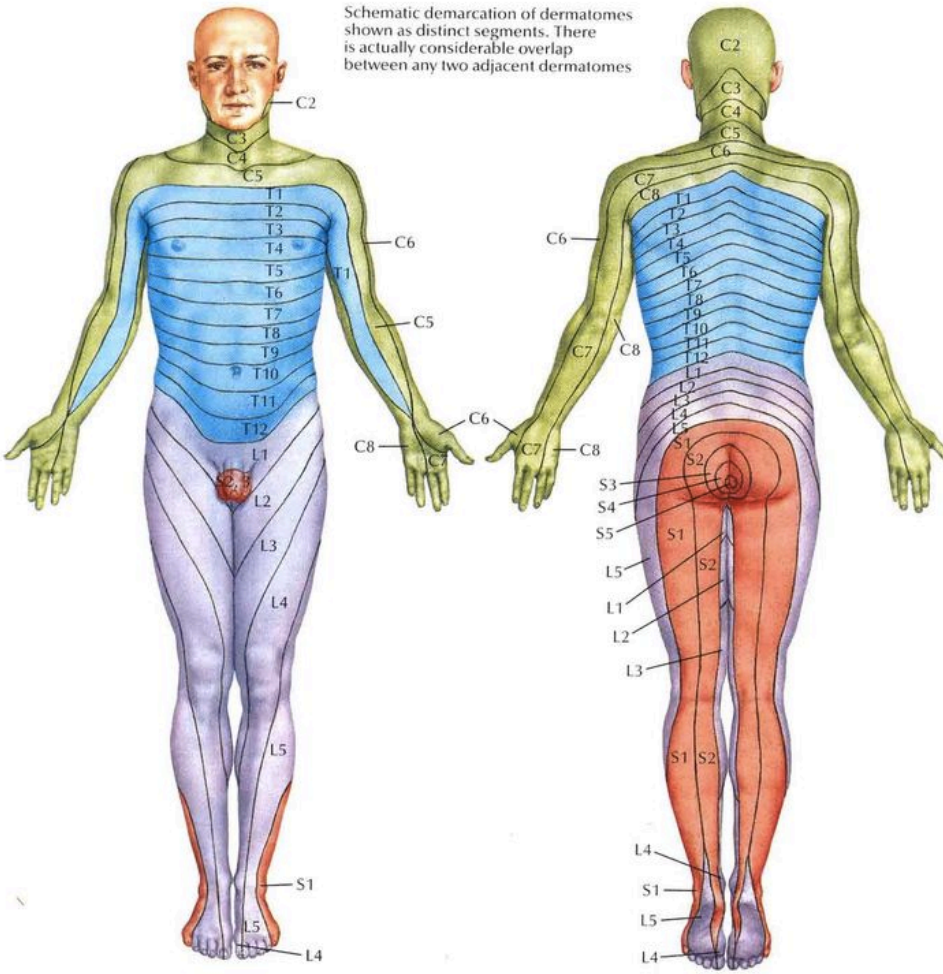
Dermatome

Definition:

A sensory region of skin innervated by a nerve root = **dermatome**



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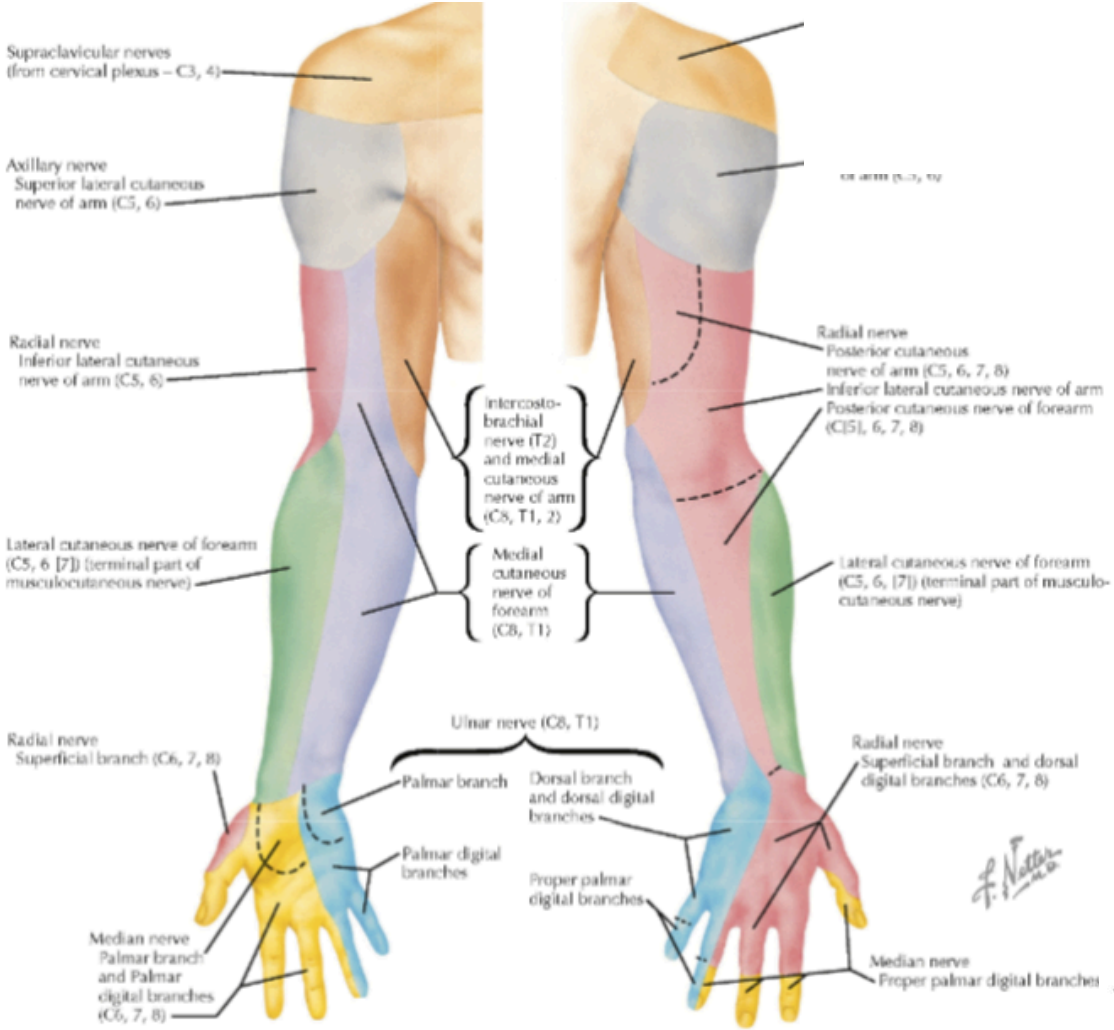
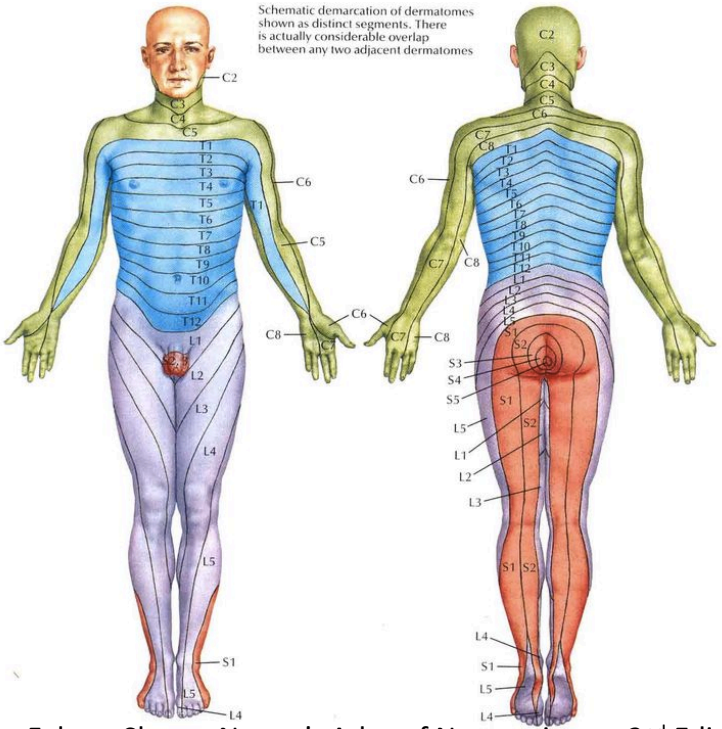
Sensory Innervation Cutaneous Nerve Branches





Images: Felten, Shetty. Netter's Atlas of Neuroscience. 2nd Edition.

Myotome

Definition:

Muscles innervated by a single nerve root = **myotome**

Nerve Root	Muscle	Peripheral Nerve
C5	Deltoids Infraspinatus Biceps	Axillary N. Suprascapular N. Musculocutaneous
C6	Biceps Wrist extensors (ECR)	Musculocutaneous Radial N.
C7	Triceps Finger extensors (EDC)	Radial N. PIN (Radial N.)
C8	Extensor indicis proprius (EIP) Median innervated intrinsic hand muscles (LOAF)	PIN (Radial N.) Median
L4	Quadriceps	Femoral
L5	Foot dorsiflexion Foot inversion Foot eversion Hip abduction	Fibular N. Fibular N. Tibial N. Gluteal N.
S1	Foot plantar flexion, Hip extension	Tibial N. Gluteal N.

Recall

- Write down 2 muscle for each of the following myotomes, the muscles MUST be from different peripheral nerves:
  - C6
  - C8
  - L5
  - S1

Answer

Nerve Root	Muscle	Peripheral Nerve
C6	Biceps Wrist extensors (ECR)	Musculocutaneous Radial N.
C8	Extensor indicis proprius (EIP) Median innervated intrinsic hand muscles (LOAF)	PIN (Radial N.) Median
L5	Foot dorsiflexion Foot inversion Foot eversion Hip abduction	Fibular N. Fibular N. Tibial N. Gluteal N.
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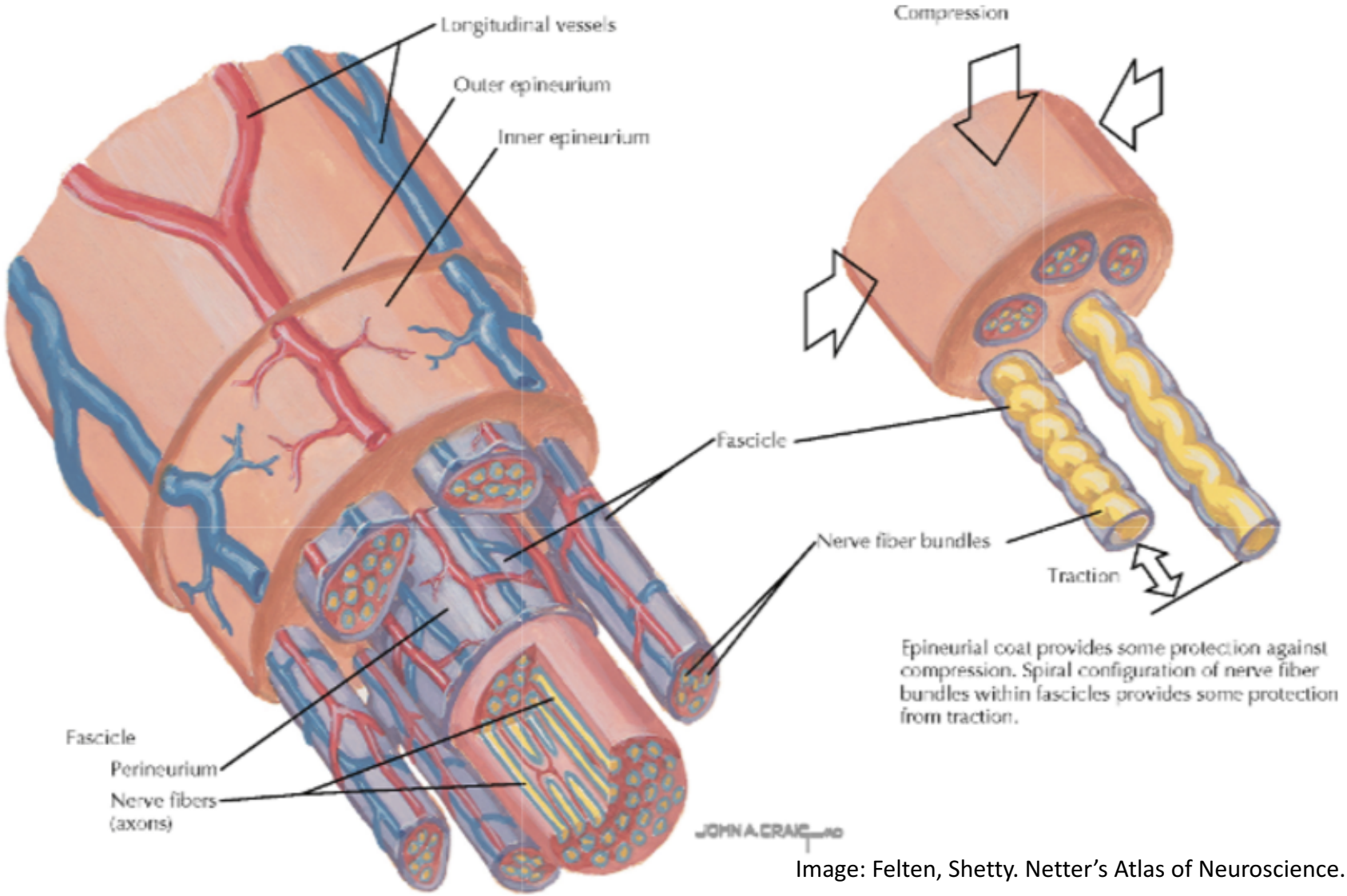
Peripheral Nerve



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Muscle Fibers

Attribute	Type 1 Fiber	Type 2 Fiber
Gross colour	Dark	Light
Oxidative enzymes	High	Low
Lipid	High	Low
Mitochondria	High	Low
Glycogen	Low	High
Function	Sustained contraction	Brief contraction
Twitch Speed	Slow	Fast
Metabolism	Aerobic	Anaerobic
Fatigue	Resistant	Sensitive

Pneumonic:
Type 1: 1 slow fat red ox
Type 2: 2 fast skinny white breasts

Motor Exam

- **Bulk**
  - Observe for fasciculation's
  - Assess for atrophy
- **Tone**
  - Determine relationship with velocity (rigidity vs spasticity)
- **Strength**
  - MRC scale
- **Reflexes**
  - Grade using a 0-4 scale
  - Babinski, clonus

MRC SCALE	
0	No movement
1	Flicker
2-	Not full ROM
2	Gravity eliminated
3-	Not full ROM
3	Against Gravity
4-	Mild resistance
4	Mod. resistance
4+	Good resistance
5-	Questionably full
5	Full Strength

Motor Exam Pearls

- Always explain before testing strength
- Adjust strength testing based on patient
- Remember neck flexion and extension
  - Useful correlate for respiratory weakness
- Screen for bulbar, facial, and eye weakness

Motor Exam Pearls

- When examining small muscles of the hand, use like against like, matching your corresponding muscle
- Muscle are most powerful when maximally shortened
- For unilateral weakness use the contralateral side as a control
- Always assess the lower extremities even when symptoms are only upper extremity. Motor or sensory changes plus UE radiculopathy could indicate myelopathy in the C-spine

Sensory Exam

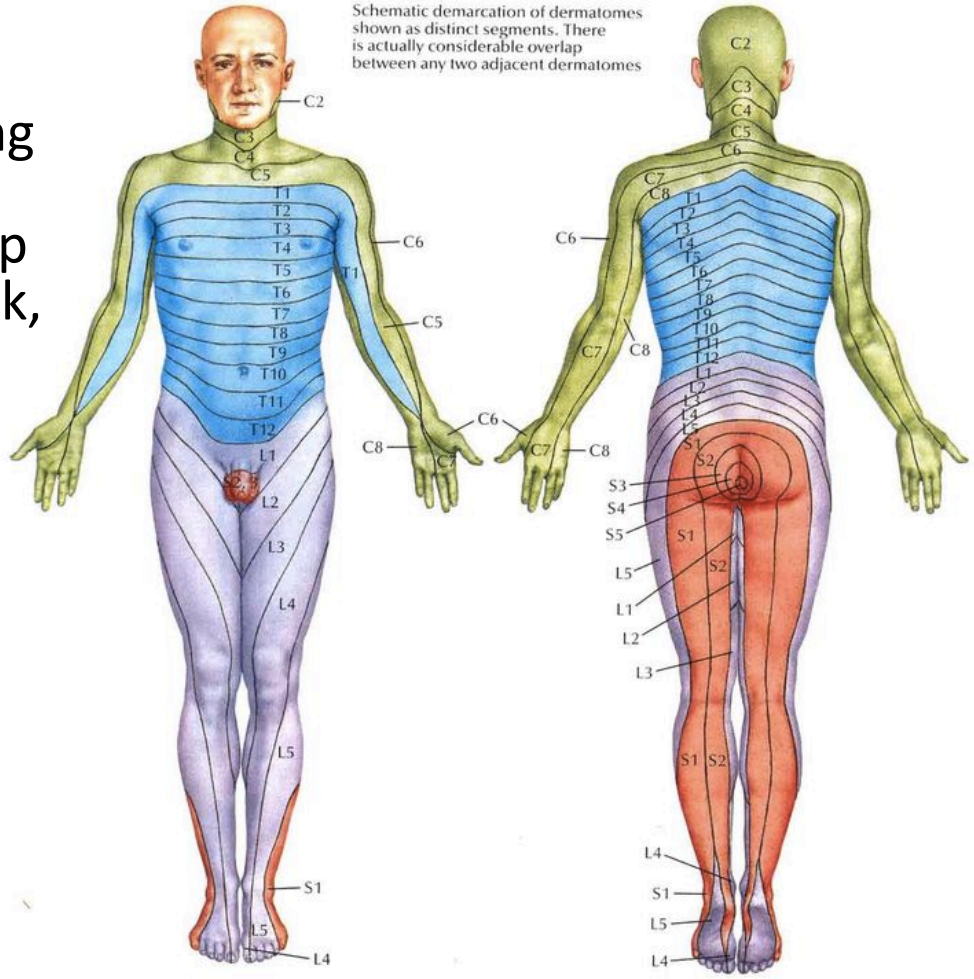
Spinothalamic

- Standardized method of starting with C2 and going down the lateral aspect of the arm and up the medial aspect with pin prick, then light touch.

Dorsal Column

- Vibration rarely affected in the hands, screen with feet
- Joint position sense

Cortical sensation: consider in the appropriate setting



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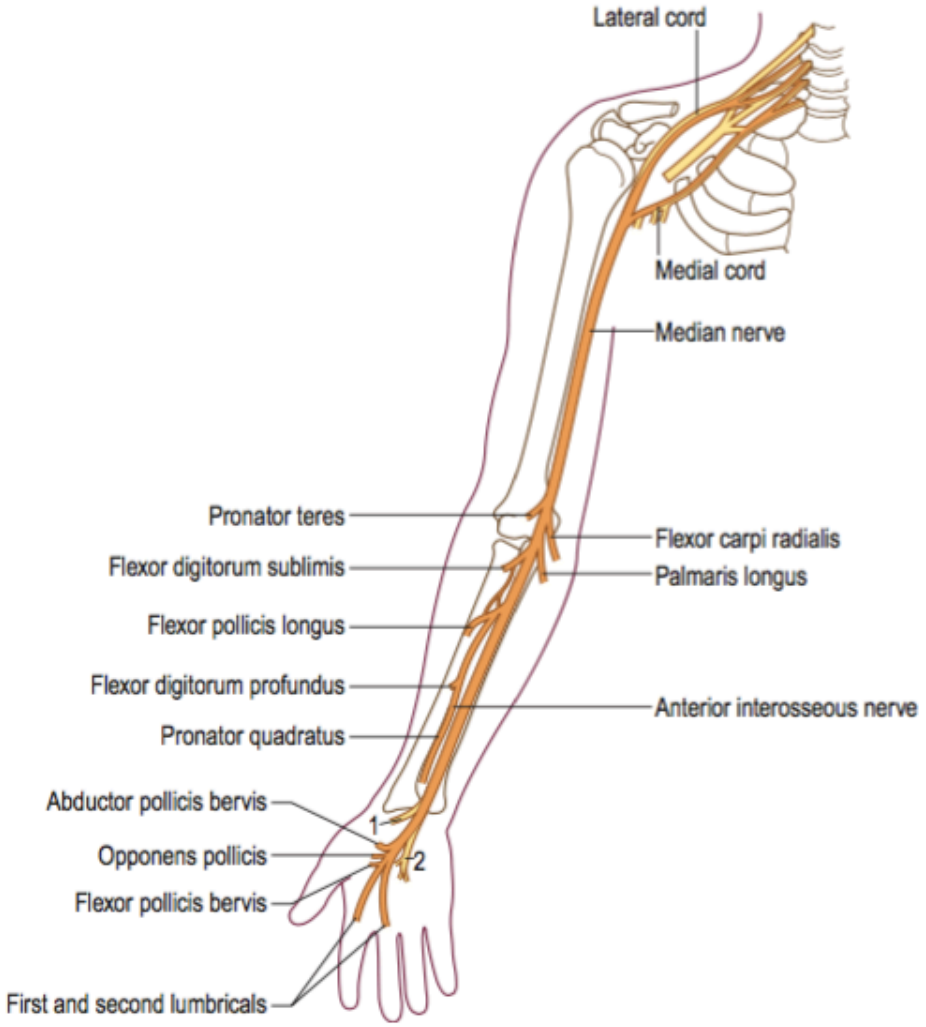
Non-neurologic examination

- Neck ROM and Spurling
- Joint exam as indicated (shoulder)
- Medial or lateral epicondylitis
- PIP/DIPs/CMPs for arthritis
- Pressure points for myofascial pain

Non-organic weakness

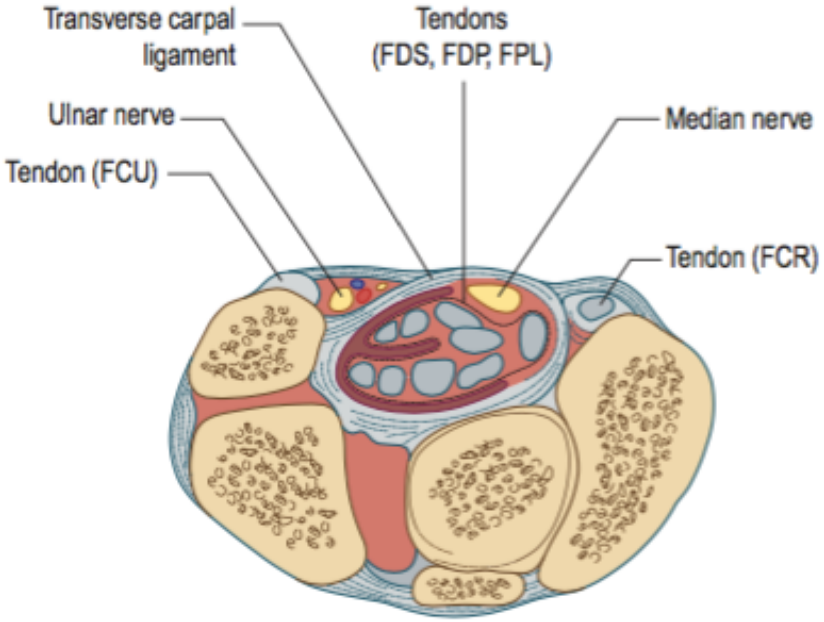
- Effort is erratic and variable
- If the examiner decreases resistance the patient with non-organic weakness stops trying
- Non-organic flaccid limb may fall slowly when dropped to avoid injury
- Patient with non-organic weakness may not be calm or indifferent towards the weakness
- Hoover’s sign

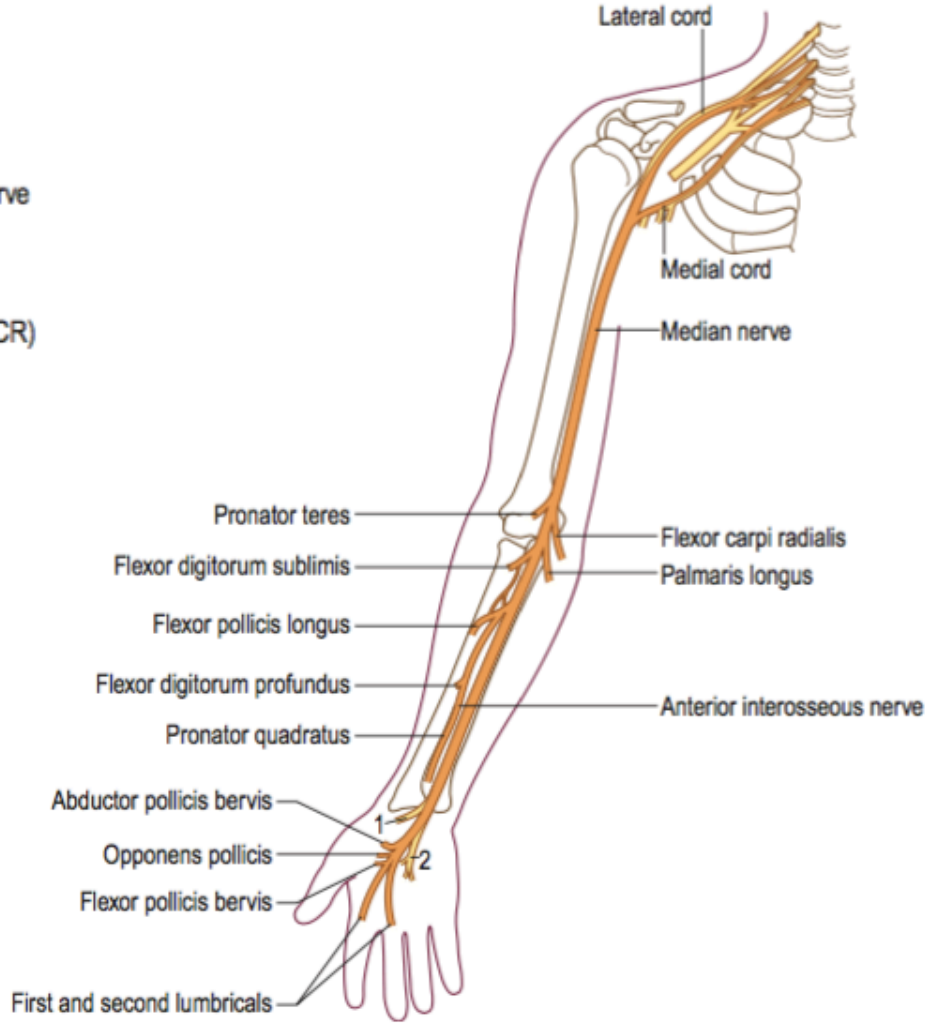
Median Nerve vs C6 Radiculopathy



Preston, Shupiro. Electromyography and Neuromuscular Disorders. 3rd Edition

Median Nerve Anatomy





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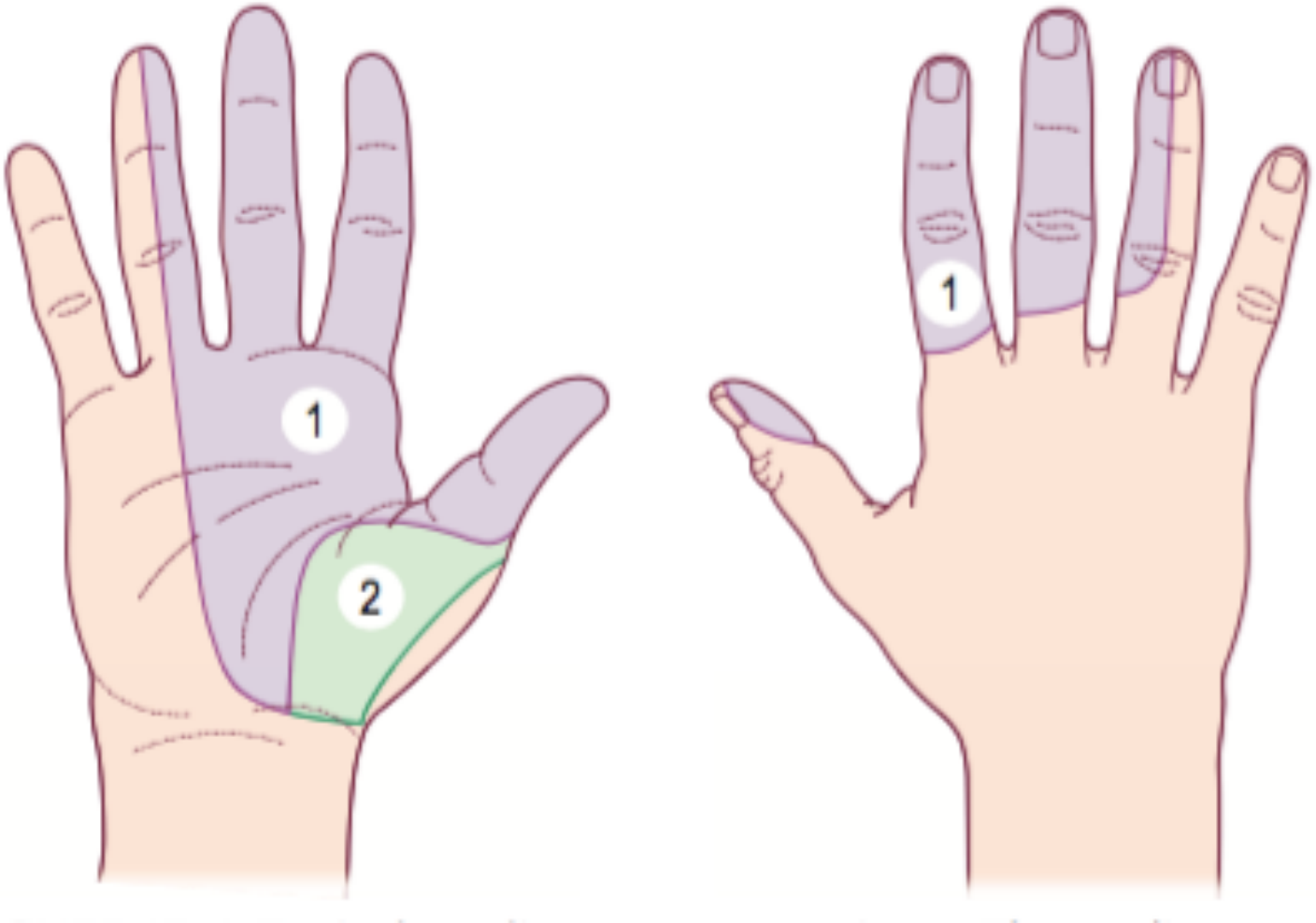
Median innervated muscles in the Hand

LOAF

- Lumbricals 1 and 2
- Opponens pollicus
- Abductor pollicus brevis
- Flexor pollicus brevis

Median Neuropathy Sensory



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Median Neuropathy at the Wrist

Clinical

- Common: 1-5% of the population
- Women > men
- Dominant hand > non-dominant

- **Sensory** paresthesia first 3.5 digits
  - Nocturnal paresthesia common
- **Pain**: wrist, may radiate into the forearm or arm, rarely shoulder

- **Provoking factors**: wrist flexion or extension, activities requiring prolonged hand grip
- **Relieving factors**: shaking their hand, wringing it out, warm water

- **Motor**: functional limitation to MNW is uncommon

Box 17–1. Conditions Associated with Carpal Tunnel Syndrome

- Idiopathic disorders
  - Repetitive stress
  - Occupational
- Endocrine disorders
  - Hypothyroidism
  - Acromegaly
  - Diabetes
- Connective tissue disease
  - Rheumatoid arthritis
- Tumors
  - Ganglia
  - Lipoma
  - Schwannoma
  - Neurofibroma
  - Hemangioma
- Congenital disorders
  - Persistent median artery
  - Congenital small carpal tunnel
  - Anomalous muscles (palmaris longus, flexor digitorum sublimis)
- Infectious/inflammatory
  - Sarcoid
  - Histoplasmosis
  - Septic arthritis
  - Lyme
  - Tuberculosis
- Trauma
  - Fractures (especially Colles' fracture)
  - Hemorrhage (including anticoagulation)
- Other
  - Spasticity (persistent wrist flexion)
  - Hemodialysis
  - Amyloidosis (familial and acquired)
  - Pregnancy
  - Any condition that increases edema or total body fluid

Table: Preston, Shupiro. Electromyography and Neuromuscular Disorders. 3rd Edition

Median Neuropathy at the Wrist

Provocative Testing

- **Tinel's Test** (50%/ 77%)
- **Phalen's Test** (68%/ 73%)
- **Manual carpal compression** (64%/ 83%)
- Hand elevation test (similar sensitivity and specificity to tinel and phalen)

Image: Preston, Shupiro. Electromyography and Neuromuscular Disorders. 3rd Edition

MNW Ddx

Peripheral Nervous System

- Proximal median neuropathy
- Medial cord or lower trunk lesion
- C6 radiculopathy

Central Nervous System

- Stroke: lacunar, cortical hand
- Myelopathy
- Demyelinating lesion

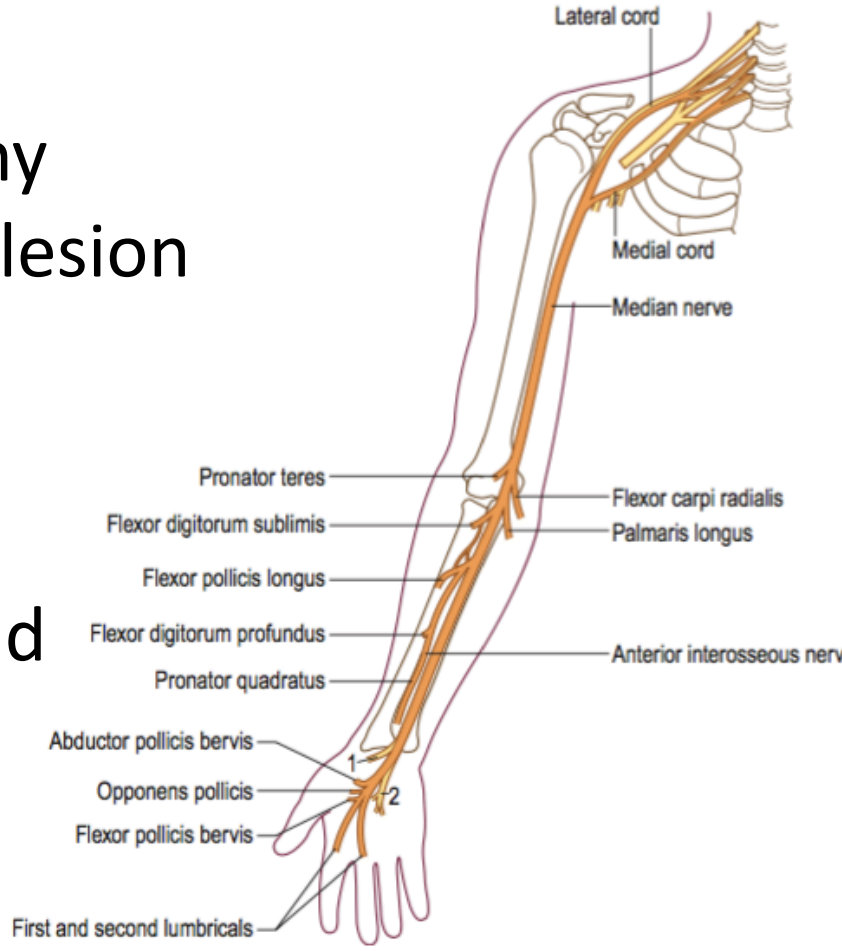


Image: Preston, Shupiro. Electromyography and Neuromuscular Disorders. 3rd Edition

MNW Treatment

- Conservative
  - Nocturnal Carpel Tunnel Splints
  - Avoid aggravating activities
  - Screen for DM and Hypothyroidism
- Carpel Tunnel Surgical Release
- Other therapies
  - Hydrodissection (mild-moderate severity CTS)
  - Steroid injection

Image:https://commons.wikimedia.org/wiki/File:Carpal_tunnel_splint.jpg

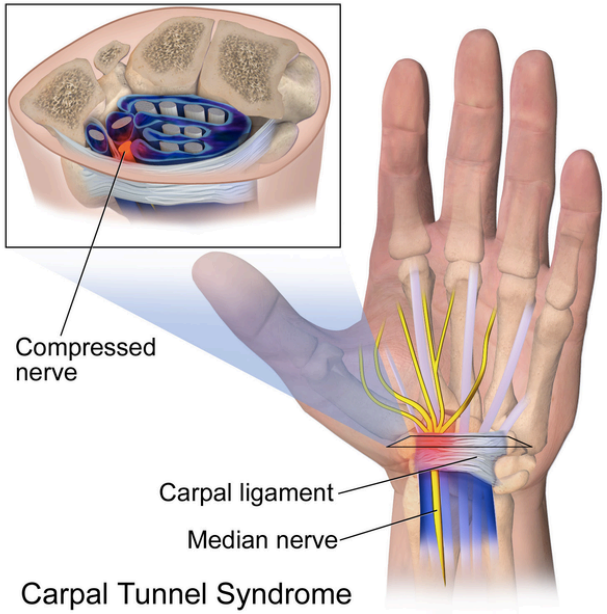


Image: https://commons.wikimedia.org/wiki/File:Carpal_Tunnel_Syndrome.p

Cervical Radiculopathy

Clinical

- Pain and paresthesia in the distribution of a nerve root
- Associated paraspinal muscle spasm typically limits movements that exacerbate symptoms

Examination

- Sensory parethesia or hypoesthesia involving a dermatome
- Weakness involving a nerve root myotome
- Reflexes may be depressed
- Spurling Test
- Horner’s syndrome

Cervical Radiculopathy

Etiology
- Discogenic
- Spondylosis
- Mass lesions such as bone mets or epidural abscess

Less common etiologies
- Leptomeningeal carcinomatosis
- Infection (HSV, VZV, CMV)
- Vasculitis
- GBS

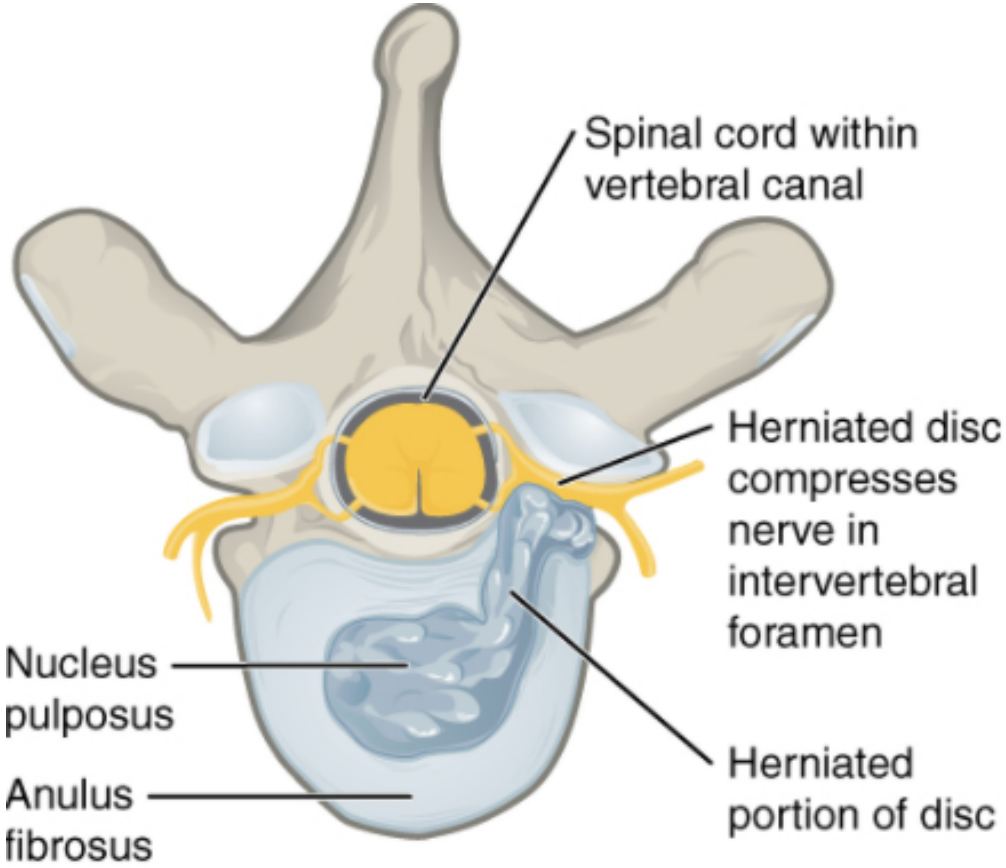


Image: https://commons.wikimedia.org/wiki/File:728_Herniated_Disk.jpg

Cervical Radiculopathy Treatment

- Conservative
  - Physical therapy
    - ROM, stretching, strengthening
  - Oral analgesia:
    - simple analgesia +/- muscle relaxant
  - Short term soft collar
  - Oral steroids
    - Short course if pain is severe
  - Avoidance of provocative activities

- Epidural steroid injections
- Surgery Indication
  - Myelopathy
  - Progressive weakness
  - Unremitting radicular pain despite 6-8 weeks of conservative therapy

MNW vs C6

	MNW	C6 radiculopathy
History	Noctornal paresthesia	Neck pain Radicular pain Sx worse with neck motion
Sensory	Palmar sparing Involves digit 3 (C7)	Sensory changes extend past the wrist
Motor	Lumbricles 1&2, FPB, APB, OP	Biceps, brachialis, brachioradialis, wrist extension
Reflexes	None	Biceps, brachioradialis
Special Tests	Carpel tunnel compression test Phalen's Tinel's	Spurling's Horner's

Ulnar Nerve vs C8 Radiculopathy

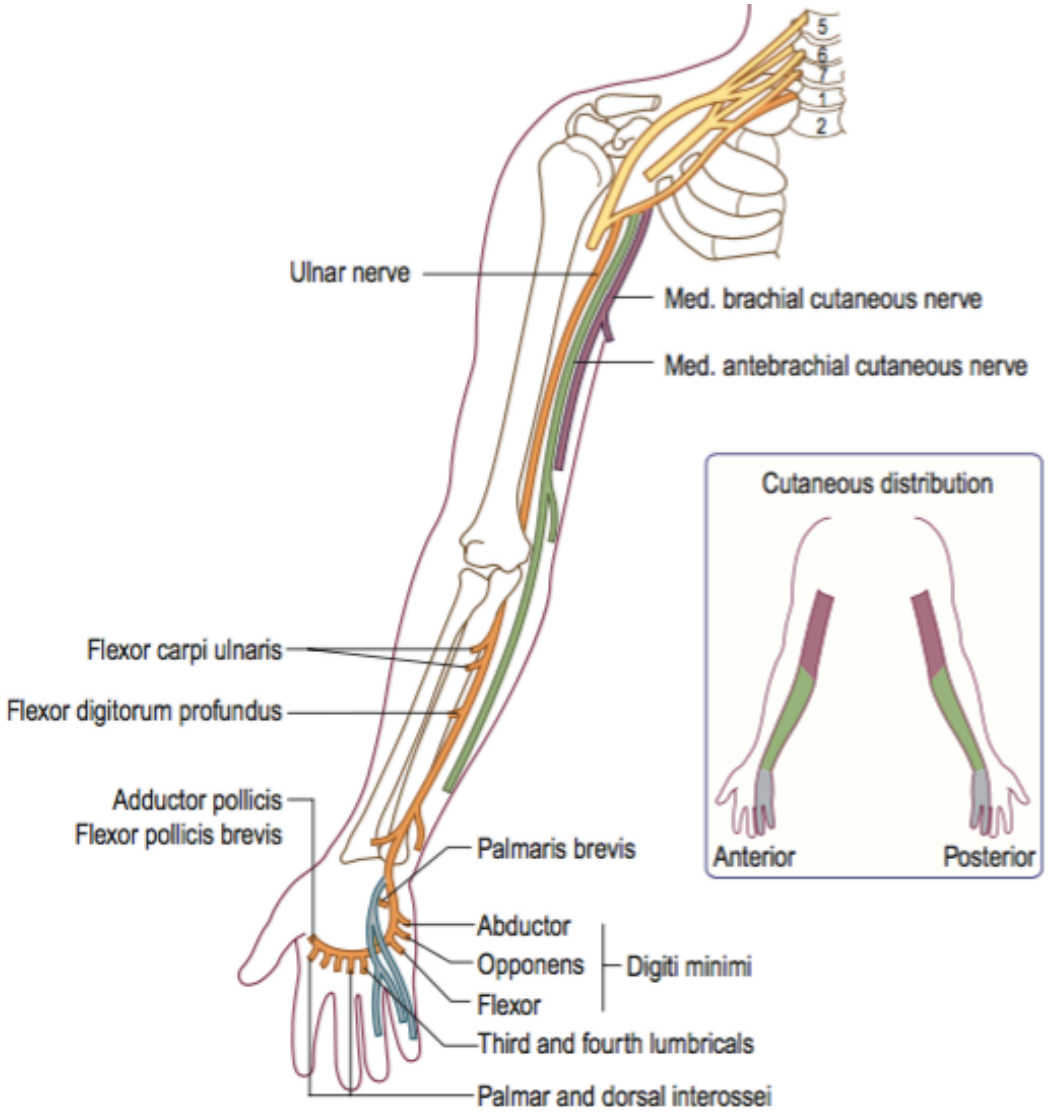
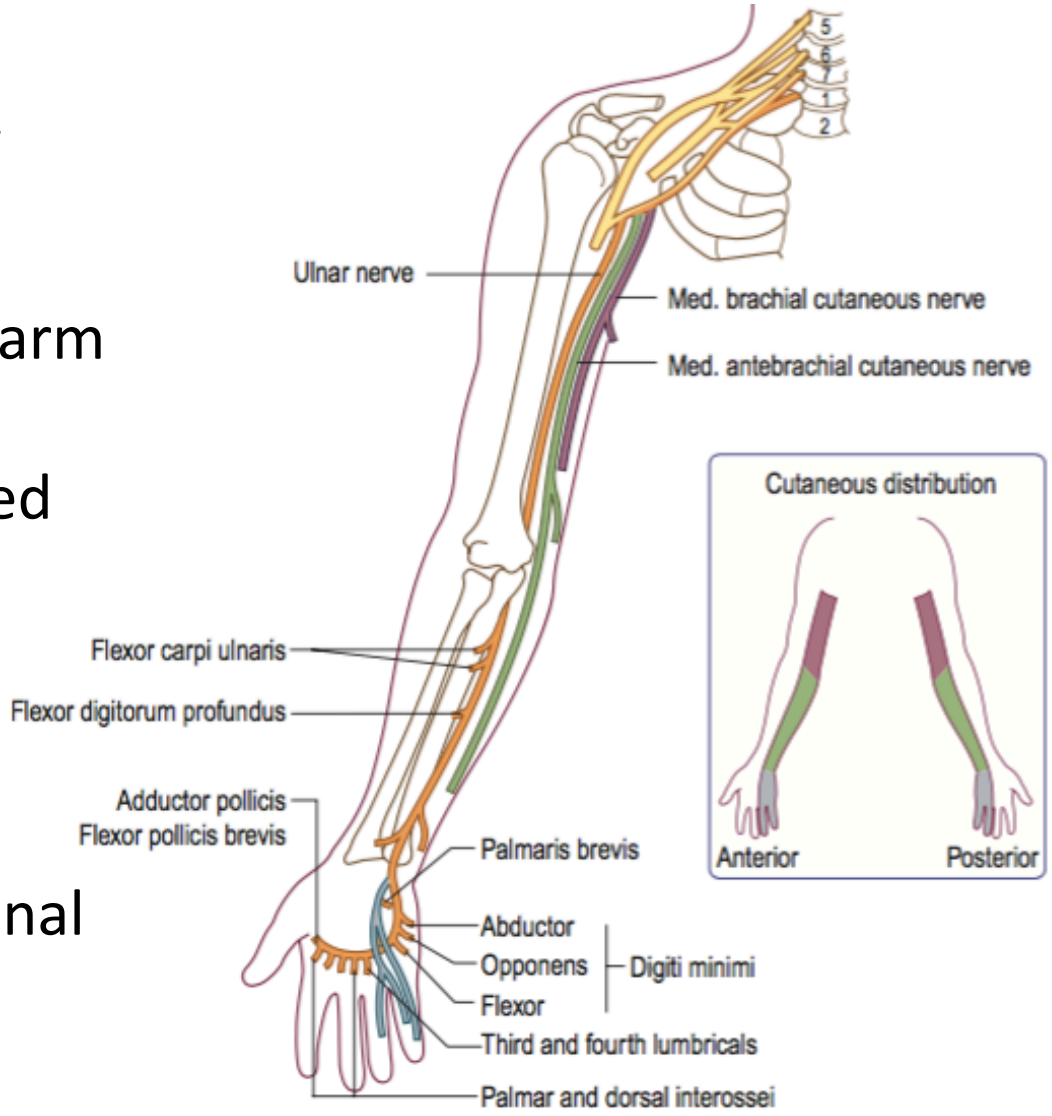


Image: Preston, Shupiro. Electromyography and Neuromuscular Disorders. 3rd Edition

Ulnar Nerve Anatomy

- Derived from C8/T1 Nerve roots
- No branches in the arm
- Ulnar groove: formed between medial epicondyle and olecrenon
- Travels through the wrist via Guyon's canal



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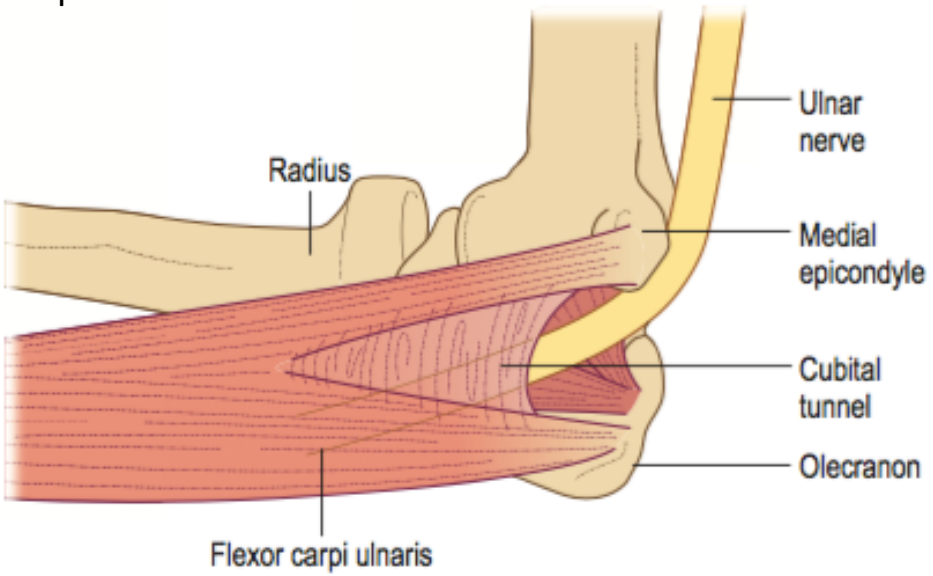
Ulnar Neuropathy at the Elbow

- Etiology:
  - Compression or Stretch
  - Trauma
- Clinical
  - Motor symptoms are common: loss of dexterity and decreased hand gr and pinch strength
  - Atrophy of thenar and hypothenar eminence
  - Sensory: paresthesia or hypoesthesia medial aspect of the hand
  - Reflexes: normal
- Differential Diagnosis
  - Medial cord, lower trunk or C8/T1 lesion
- Treatment:
  - Conservative:
    - avoid compression and stretch,
    - helbow pad
  - Surgery



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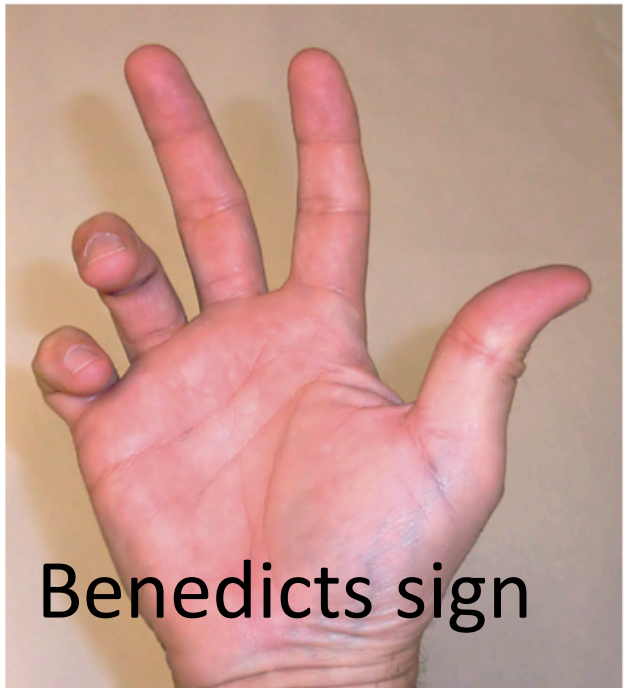
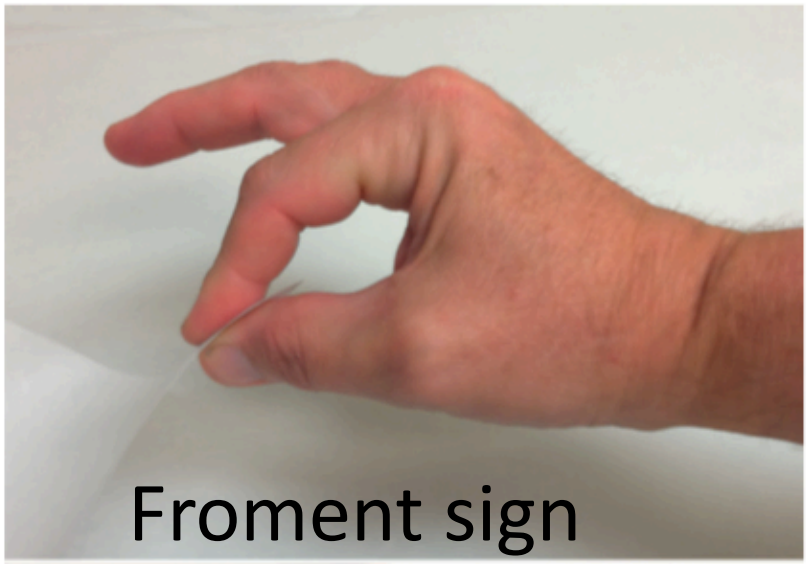
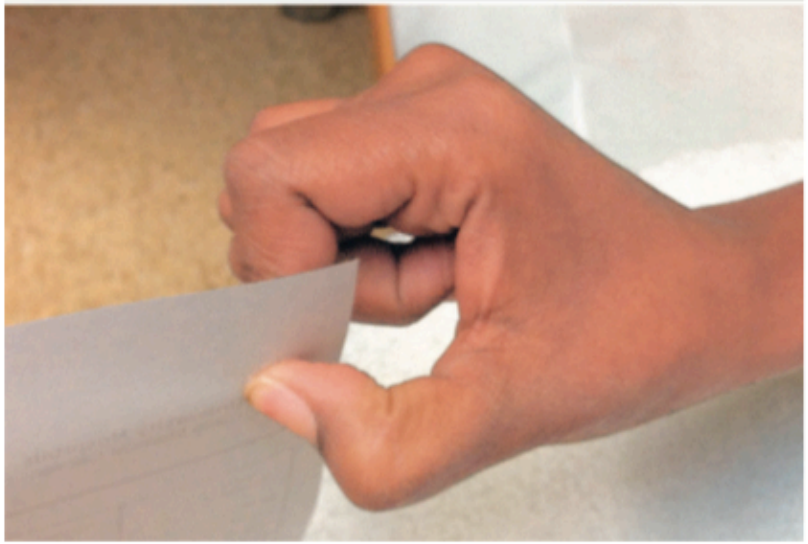
Ulnar Neuropathy Exam







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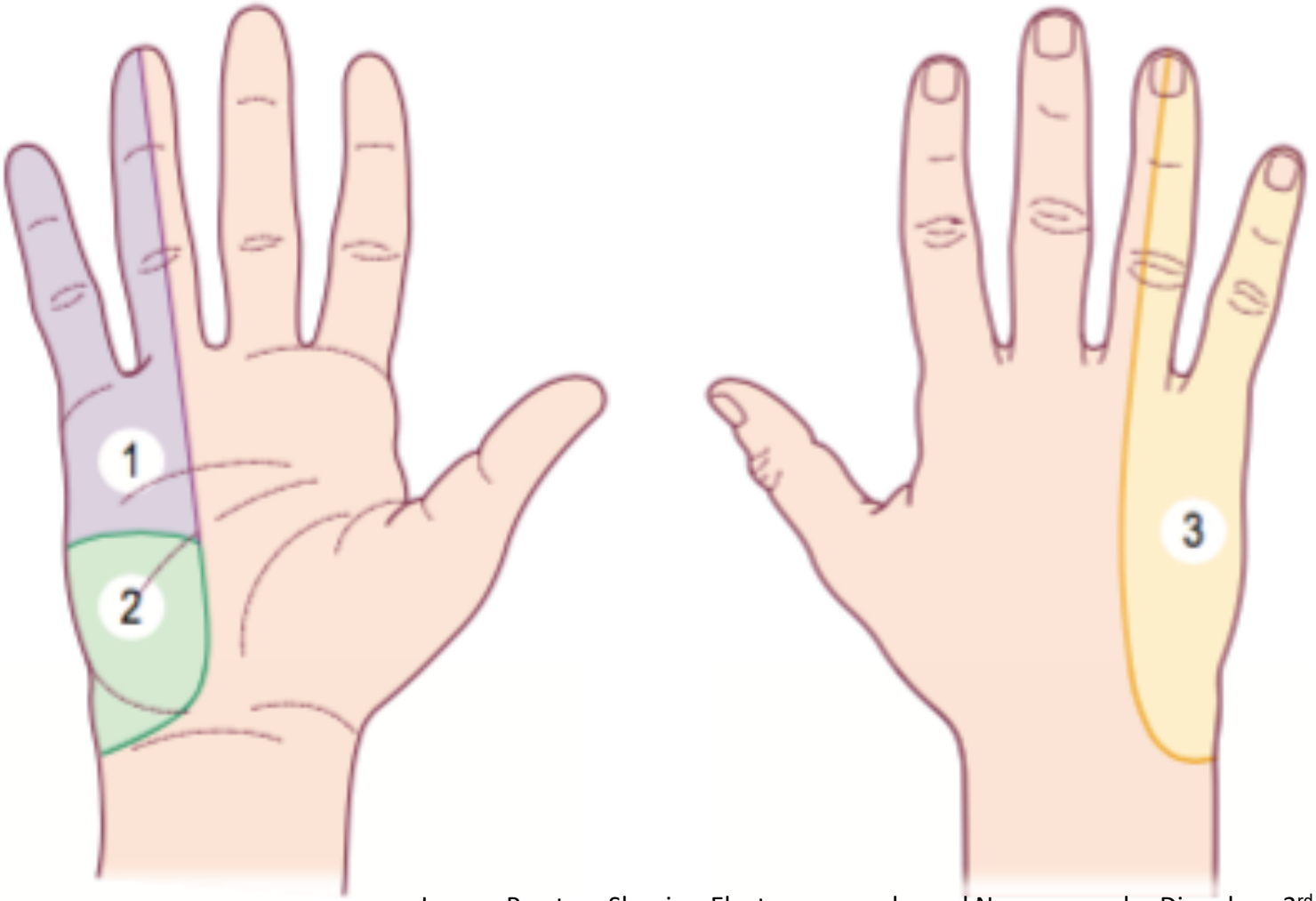
Ulnar neuropathy exam



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Ulnar vs C8/T1

	Ulnar	C8/T1 radiculopathy
History	Compression or stretch mechanism of injury	Neck pain Radicular pain Sx worse with neck motion
Sensory	Medial dorsal and volar aspect of the hand	Sensory changes extend past the wrist
Motor	ADM, dorsal and palmar interossei, lumbricles 3 &4, adductor pollicus,	Extensor indices proprius Median intrinsic hand muscles
Reflexes	None	Finger Flexor
Special Tests	Tinel's	Spurling's Horner's

Finger Flexor Reflex = C8/T1

Image: http://www.sciencedirect.com/topics/page/Hyperreflexia

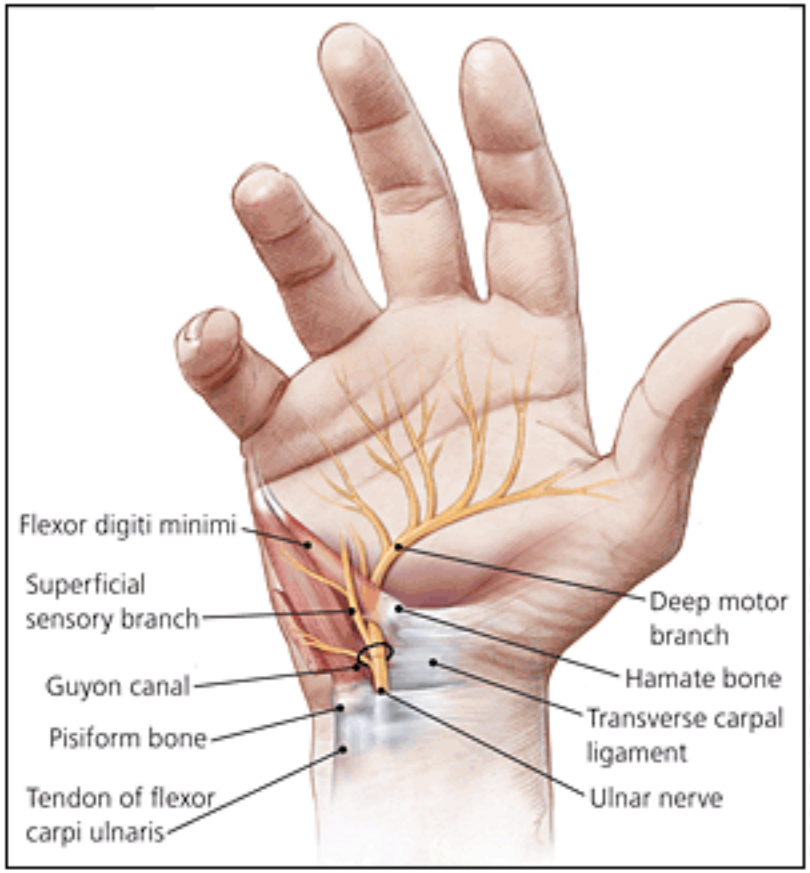


Figure 4.

Guyon canal.

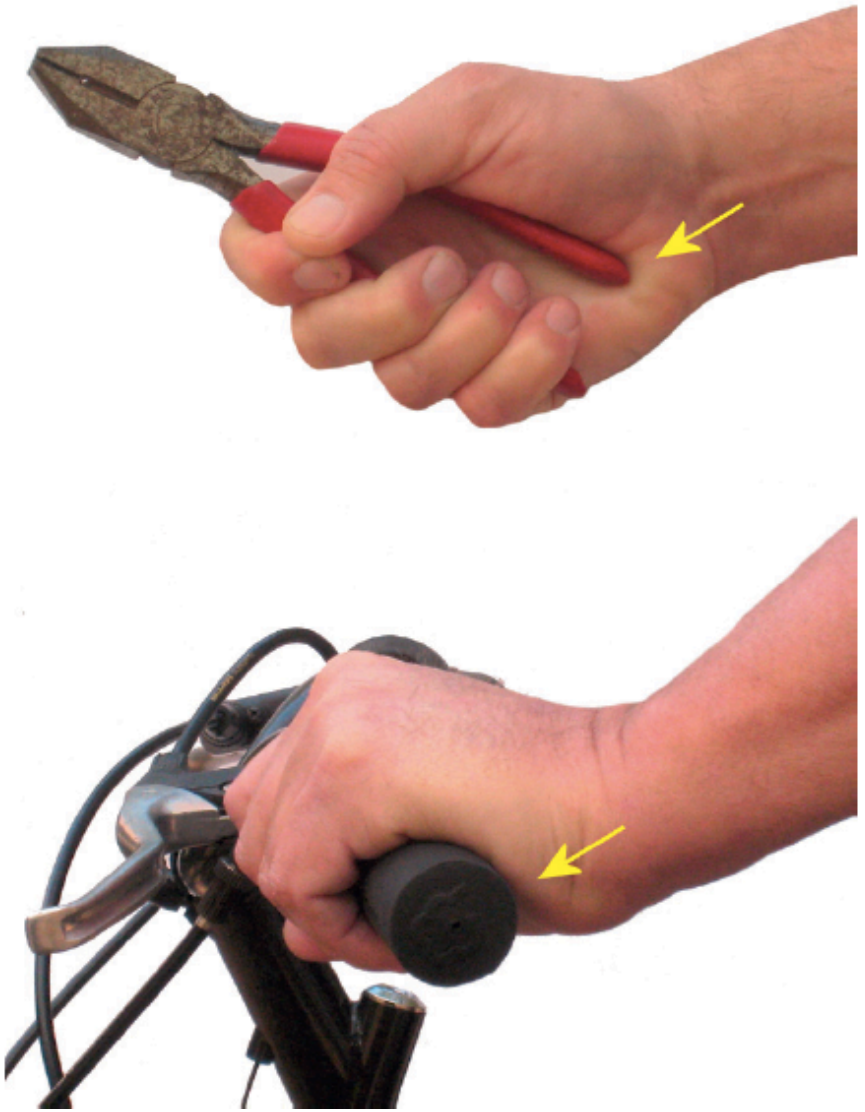
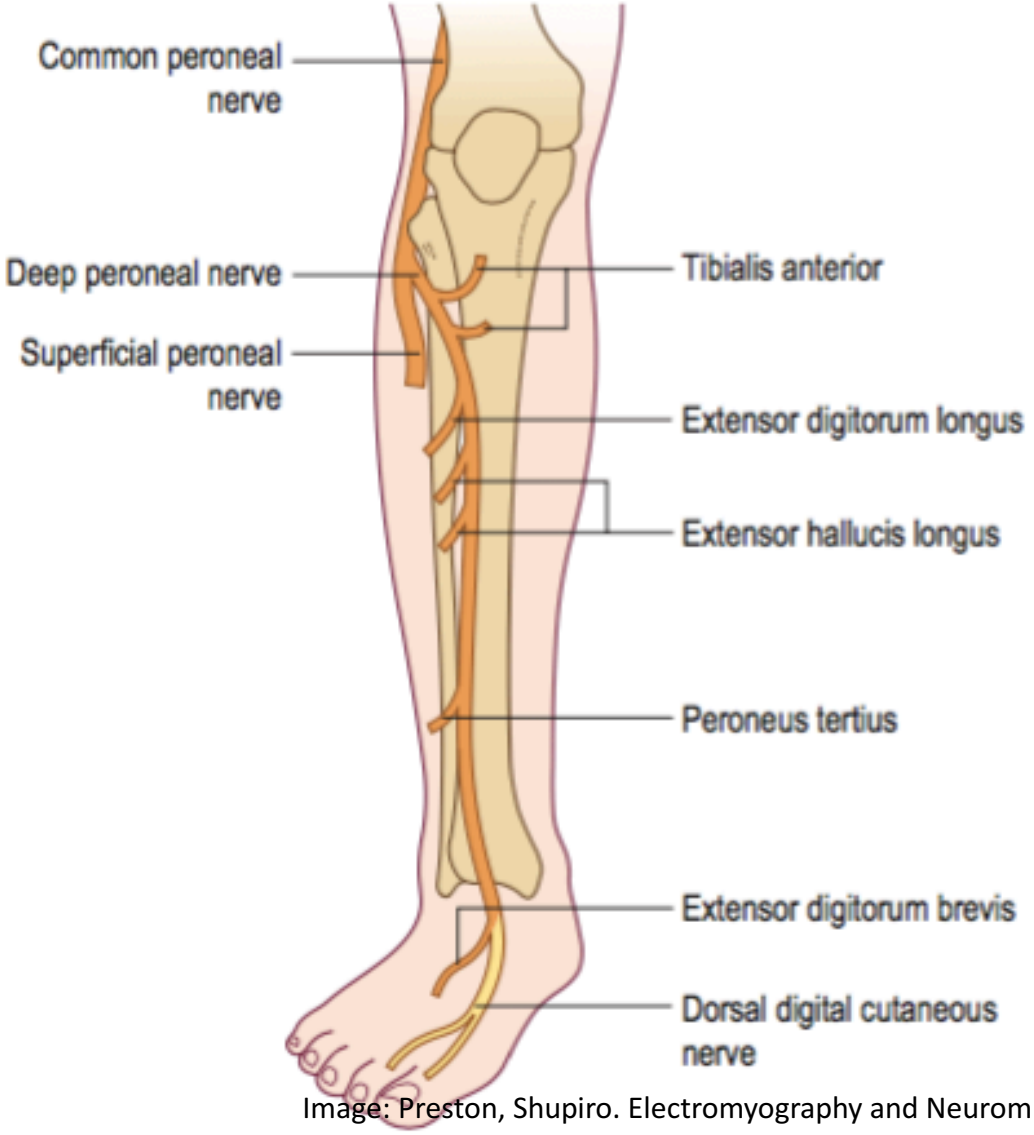


Image: http://www.aafp.org/afp/2013/0415/p568.html Image: Preston, Shupiro. Electromyography and Neuromuscular Disorders. 3rd Edition

Fibular Nerve vs L5 Radiculopathy



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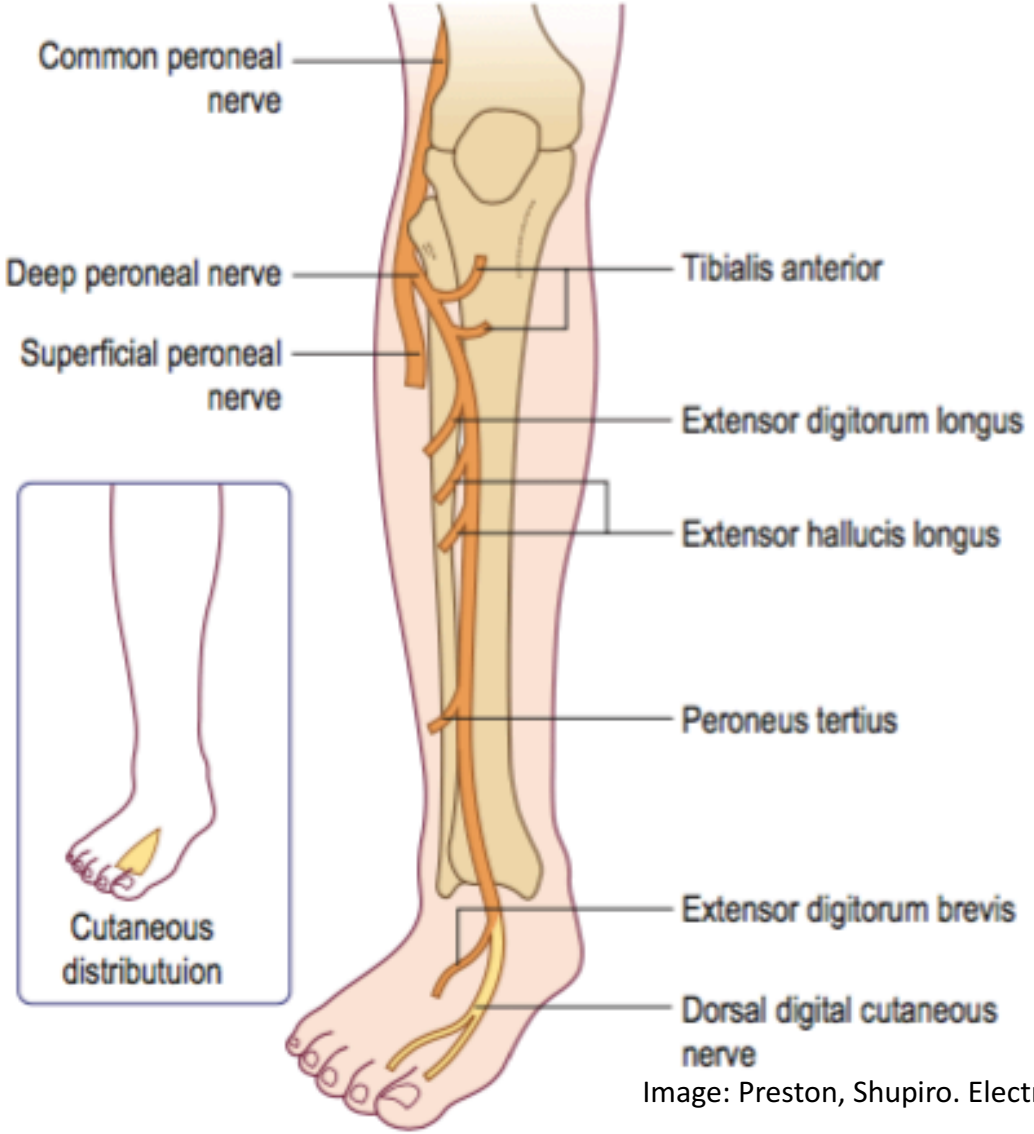
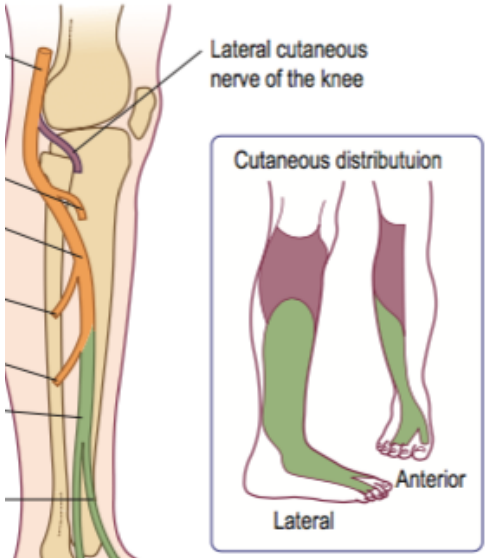
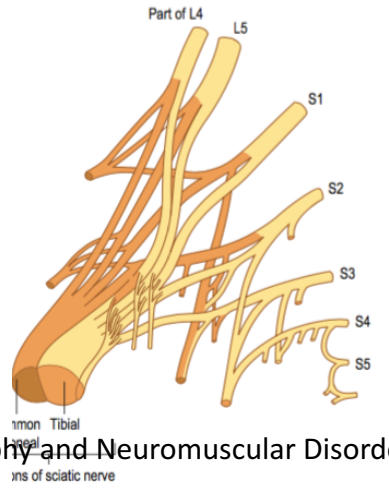
Fibular Nerve Anatomy







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Fibular neuropathy

- Fibular nerve is predominantly L5 (L4-S1)
- Clinical
  - Weakness of ankle and toe dorsifexion
  - Presents with foot drop, slap foot, tripping
  - Sensory changes over mid and lower lateral calf and dorsum of the foot
- Etiology
  - Trauma
  - Forcible stretch injury
  - Compression from prolonged immobilization
  - Positions: Leg crossing, squating
  - Tight fitting boots (ski boots)

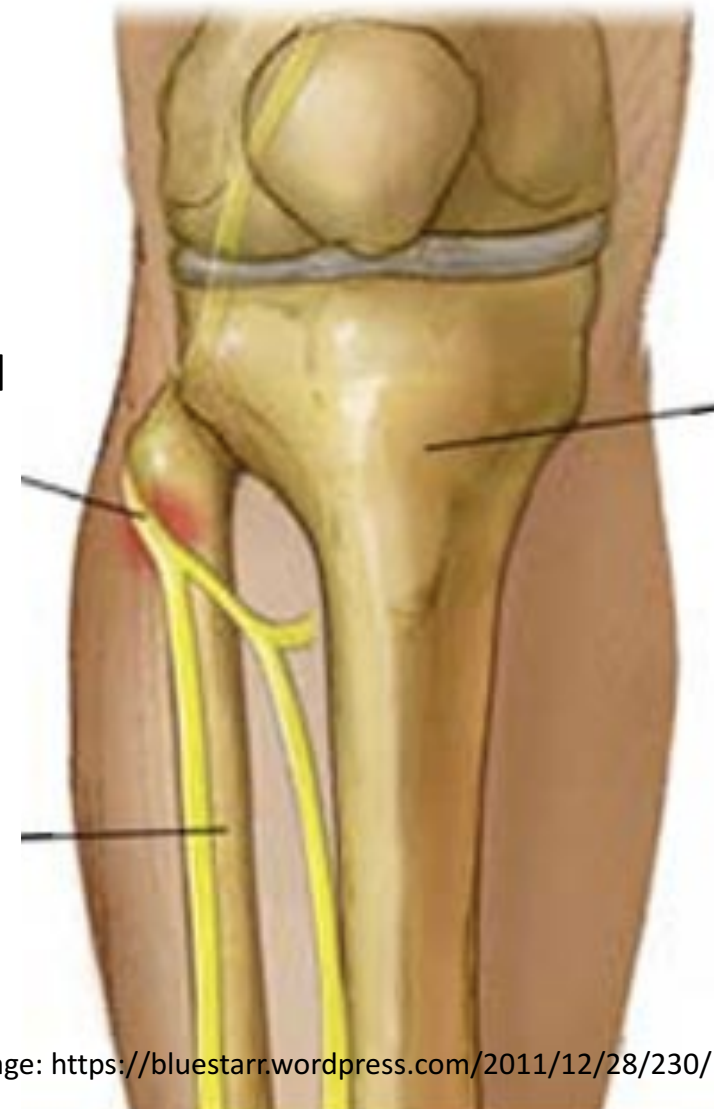


Image: https://bluestarr.wordpress.com/2011/12/28/230/

Fibular vs L5

	Fibular	L5 Radiculopathy
History	Mechanism of trauma, stretch or compression at the fibular head	Back pain Radicular pain Bladder or bowel symptoms
Sensory	Mid and lower lateral calf and dorsum of the foot	L5 dermatome and symptoms may extend above the knee
Motor	Dorsiflexion and eversion	Hip abduction Ankle inversion
Reflexes	None	None
Special Tests	Tinel's	Straight leg raise Crossed leg raise

Radiculopathies

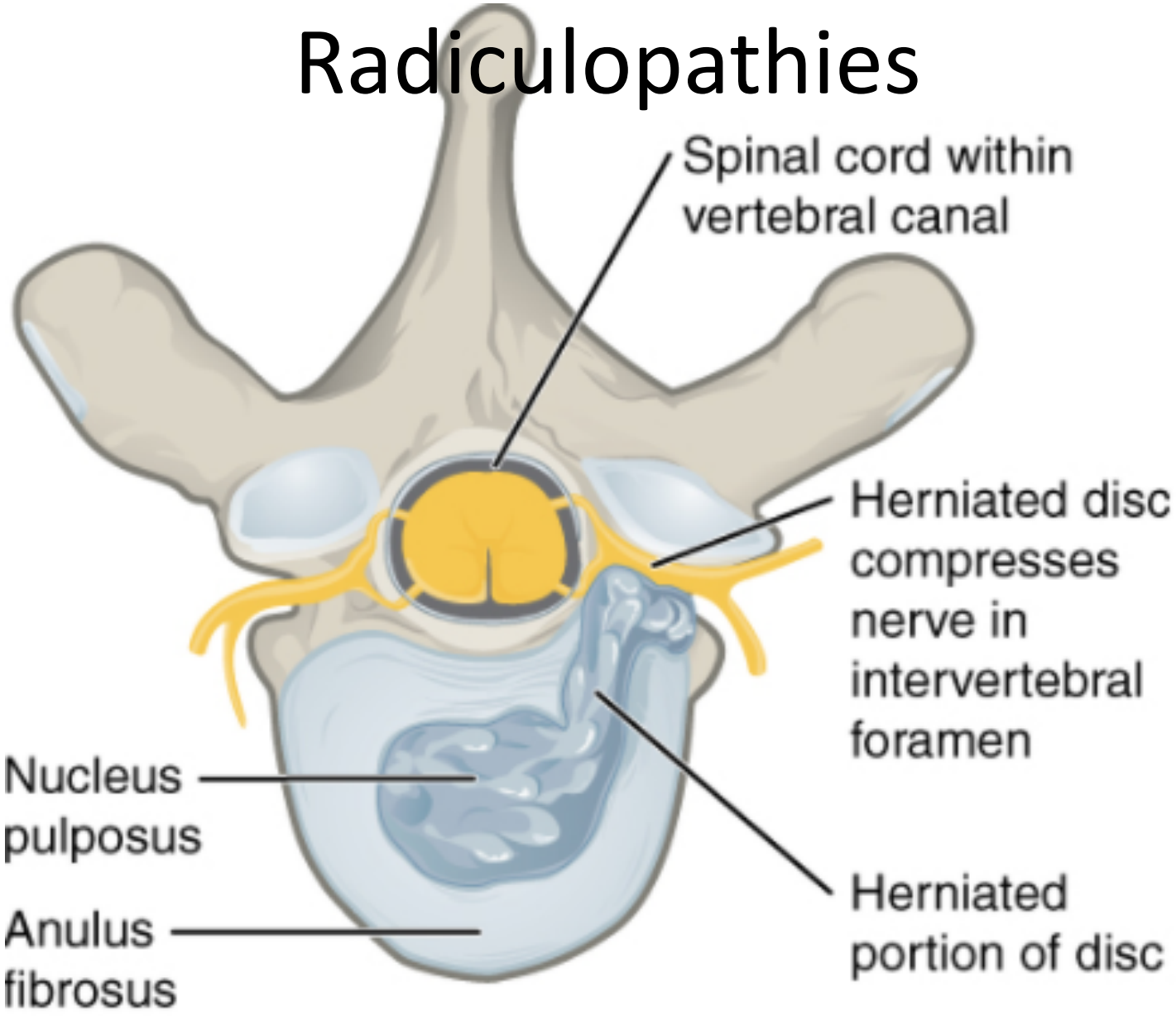


Image: https://commons.wikimedia.org/wiki/File:728_Herniated_Disk.jpg

Radiculopathies

- Sensory or motor dysfunction due to pathology of a nerve root

- Clinical
  - Pain
  - Weakness within a myotome
  - Sensory changes within a dermatome
  - Antecedent events: trauma, heavy lifting, physical exertion
- Onset
  - Acute: suggests discogenic etiology (younger age, 20%)
  - Subacute/chronic: suggests spondylosis (older age, 70%)

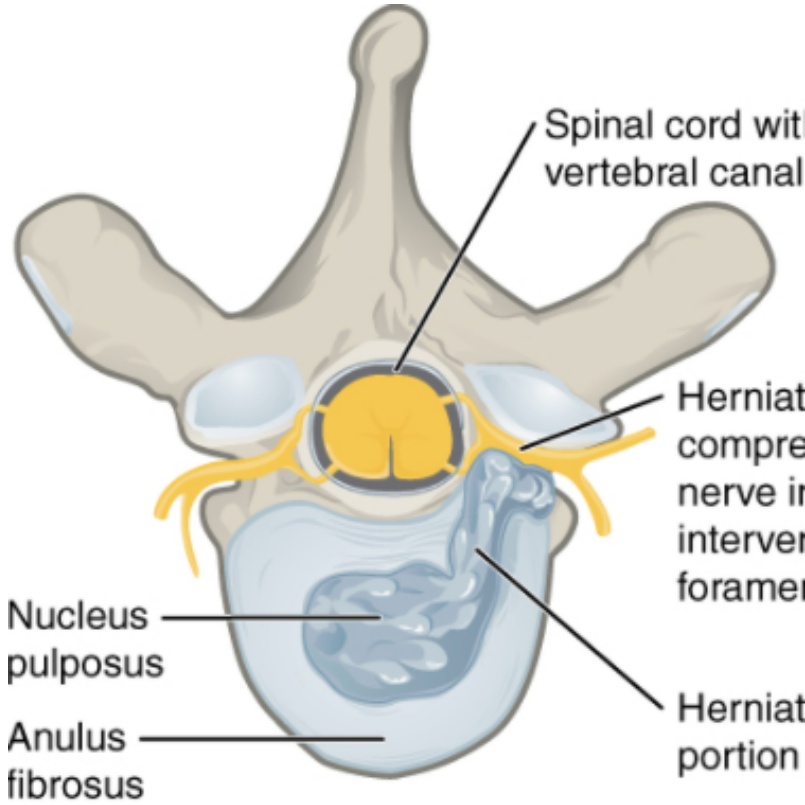


Image: https://commons.wikimedia.org/wiki/File:728_Herniated_Disk.jpg

Radiculopathies

Common Causes of Radiculopathy

- Disc herniation
- Osteophytes
- Spinal stenosis
- Trauma
- Diabetes
- Epidural Abscess
- Epidural Metastases
- Nerve Sheath Tumor
- Guillain-Barre Syndrome
- Herpes Zoster
- Lyme Disease
- Cytomegalovirus
- Idiopathic Neuritis

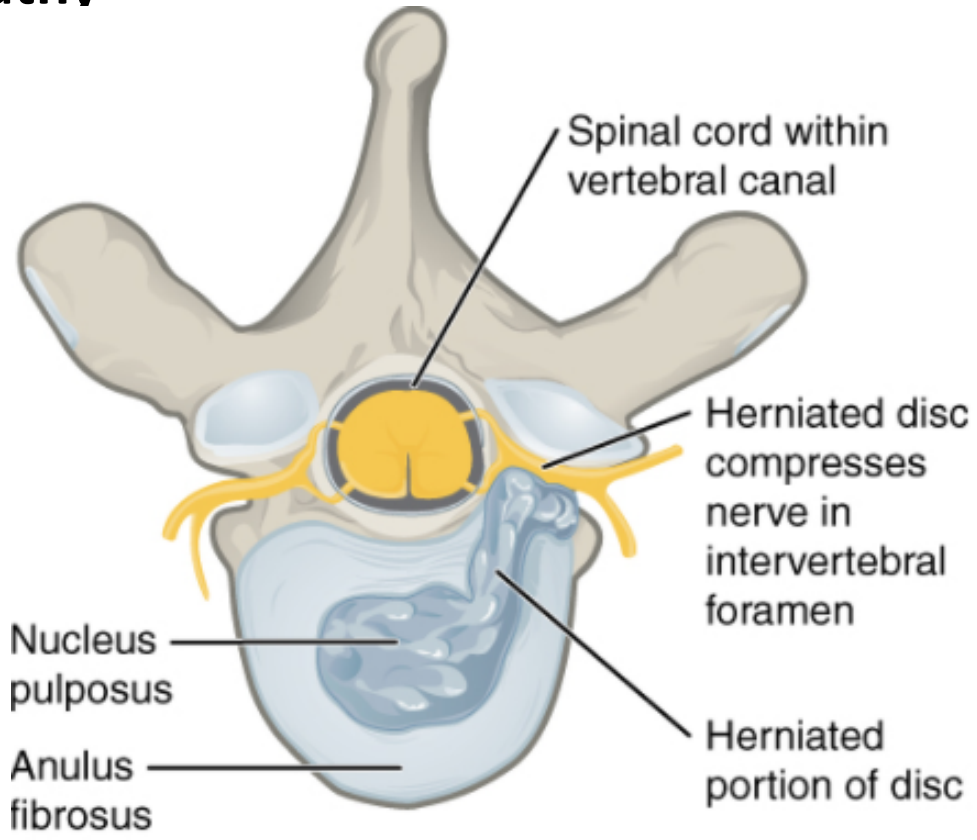


Image: https://commons.wikimedia.org/wiki/File:728_Herniated_Disk.jpg

Radiculopathies

Common Locations

- C6 and C7 most common cervical radiculopathies
- L5 and S1 most common lumbosacral radiculopathies
- 2/3 of discogenic radiculopathies occur in the lumbosacral region

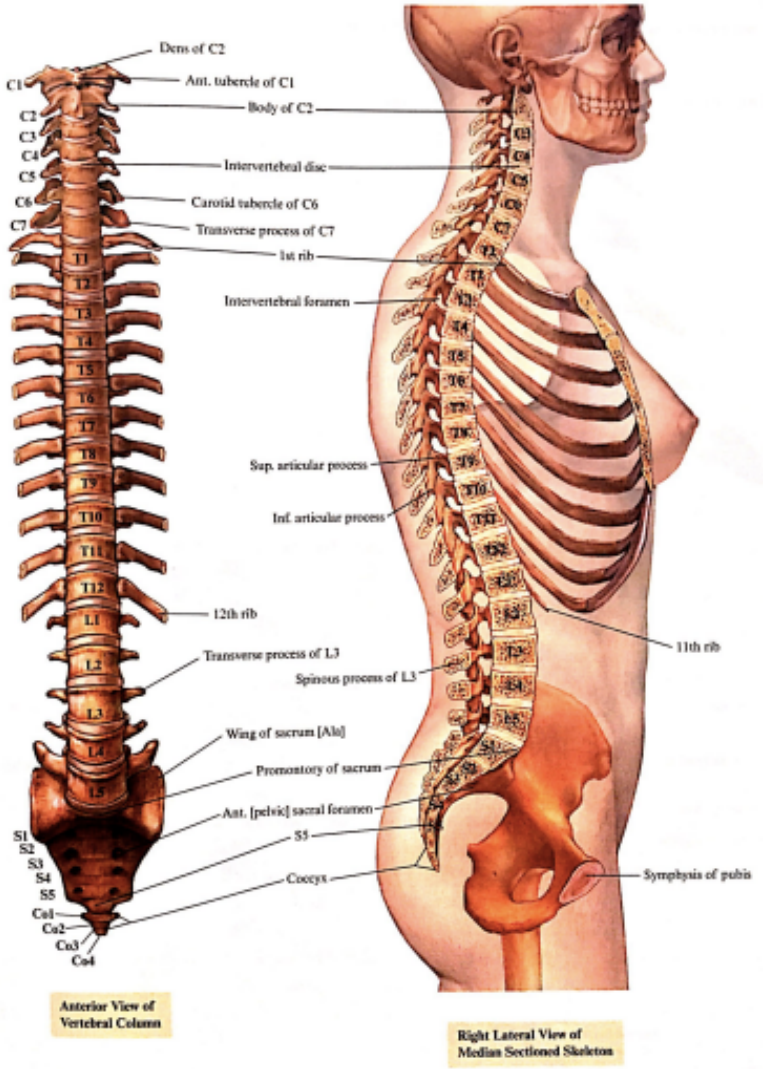


Image: Olson, Pawlina. Student Atlas of Anatomy. 2nd Edition

Radiculopathies red Flags

- Signs/symptoms to suggest inflammatory, neoplastic or infectious etiology
  - Age > 50
  - History of cancer
  - Fever
  - Unexplained weight loss
  - Immunosuppression
  - Pain that doesn’t improve in the recumbent position
  - Symptoms that don’t improve 1 month after conservative therapy

Lumbosacral Radiculopathy Treatment

- Conservative
  - Physical therapy
    - ROM, stretching, strengthening
  - Oral analgesia:
    - simple analgesia
    - Muscle relaxants
    - Opioid analgesia (short term)
  - Oral steroids
    - Short course if pain is severe (5-7 days)
  - Avoidance of provocative activities
- Epidural steroid injections
  - Moderate short term benefit
- Surgery Indication
  - Persistent or progressive neurologic deficits
  - Unremitting radicular pain despite 6-8 weeks of conservative therapy
  - Benefits of surgery seem to decrease over time compared to non-surgical groups

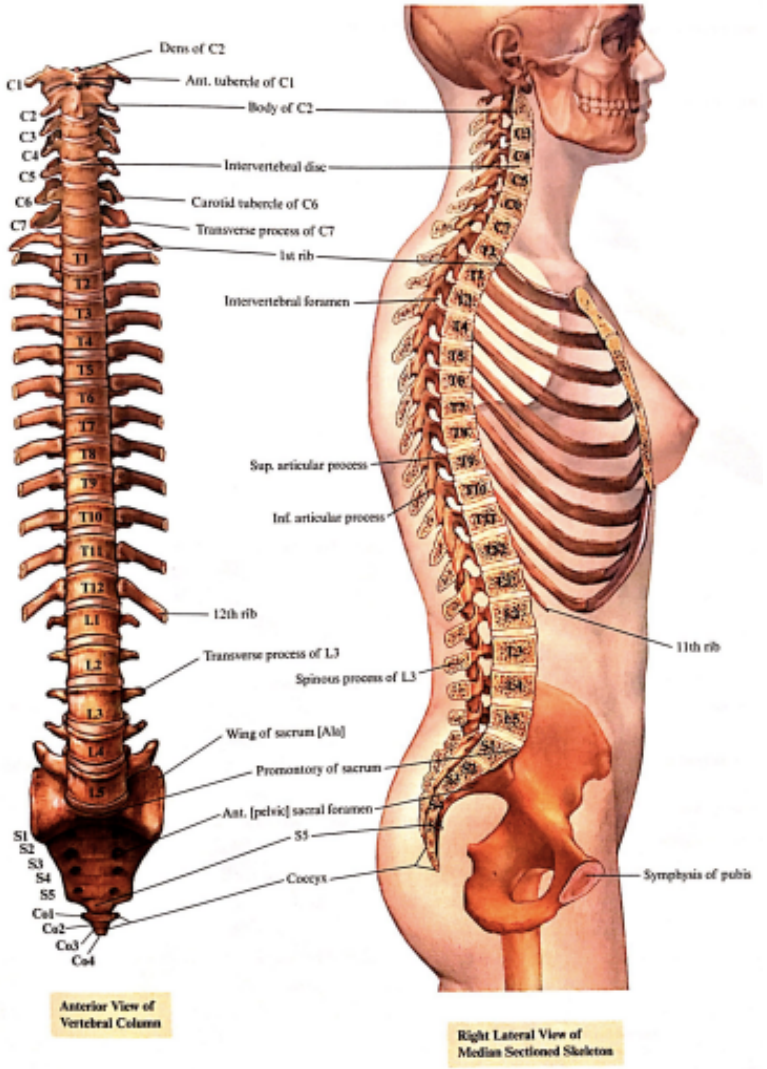


Image: Olson, Pawlina. Student Atlas of Anatomy. 2nd Edition

Alternative Etiologies

- Whiplash injury
- Rheumatoid arthritis of the spine
- Fibromyalgia/myofascial syndrome
- Polymyalgia rhuematica
- Tendonitis, bursitis, arthritis

Review

Quiz Cases

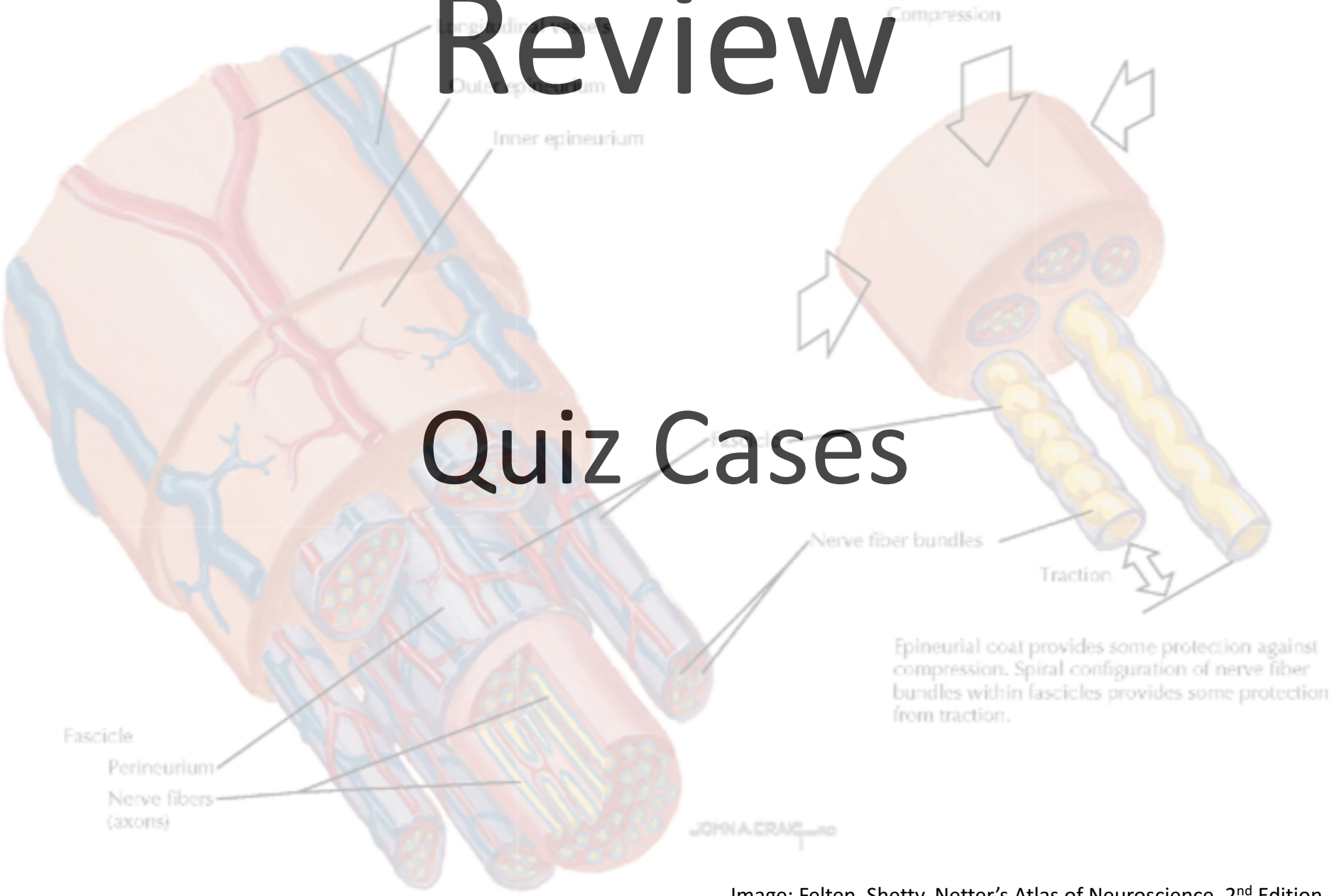


Image: Felten, Shetty. Netter's Atlas of Neuroscience. 2nd Edition.

Quiz

Image: Preston, Shupiro. Electromyography and Neuromuscular Disorders. 3rd Edition

Quiz Case 1:

48 year old married female works full time as a administrative assistant presents with 3 months of numbness in D4&5 and decreased grip strength.

1. Main Ddx: list 4 anatomical locations
2. Specific exam tests
3. Treatment

Answer to Case 1

Ddx:

- Ulnar neuropathy
- medial cord lesion
- lower trunk lesion
- C8 radiculopathy

Examination

- Sensory:
  - is there sensory loss on the dorsum of the hand (UNE)
  - does the sensory loss extend past the wrist (C8 radiculopathy)
- Motor:
  - is there weakness of ulnar innervated hand muscles (FLOAD)?
  - Is there weakness of C8 muscles by other peripheral nerves (EIP = radial, median intrinsic hand muscles)
- Special Tests:
  - Hand positions (benedicts, wartenberg,

Quiz Case

- 64 yo male with 4 month history of weakness and wasting of his right hand. No associated pain. Recently noted some left hand weakness.

- Exam shows atrophy right hand (thenar, hypothenar, and flexor compartment), fasciculations, reflexes 3+, bilateral hoffmans. Normal sensation.

Muscle	Right	Left
SA	5	5
EF	5	5
EE	5	5
WF	4+	5
WE	4+	5
FDI	4	4+
ADM	4	4+
ABP	4	4+
FDS	4	4+
FDP 2-5	4	4+

Answer Case 2

The pattern of progressive weakness and atrophy with both UMN and LMN features is concerning for a motor neuron localization.

UMN:

- Increased reflexes

LMN:

- Atrophy, fasciculations, weakness

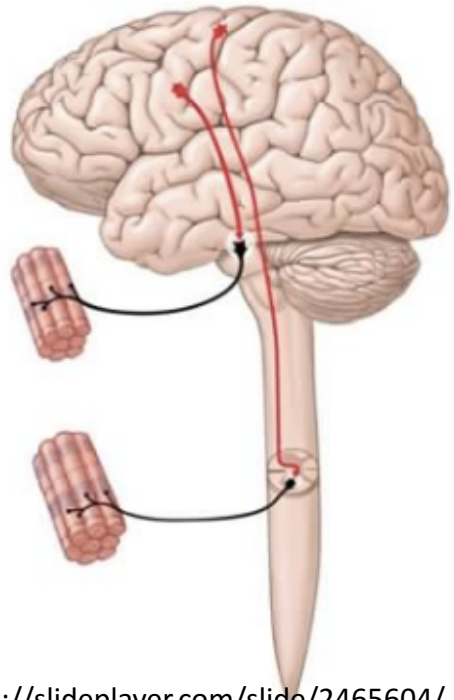


Image: http://slideplayer.com/slide/2465604/

Case Quiz 3

57 yo M with low back pain for 20 years. Tripped over a door ledge and developed sudden increase in right-sided low back pain radiating down his leg into the right big toe.

Exam:

- Motor:
  - 3/5 right extensor hallicus longus and tibialis anterior
  - 4+/5 right invertors and evertors
- Sensory
  - Decreased pinprick over right anterolateral calf and dorsum of the foot
- Positive right straight leg raise

Where is the most likely localization?

List the features on history and exam to support your localization?

How would you manage this patient?

Answer Quiz 3

Where is the most likely localization?

- Right L5 nerve root

List the features on history and exam to support your localization?

- History: traumatic inciting event, prior history of low back pain, radicular symptoms
- Exam: L5 weakness outside of the fibular nerve (namely innvertors with weakness of tibalis posterior innervated by the tibial nerve.

How would you manage this patient?

- Conservative therapy: analgesia, physical therapy, avoid provocative
- Surgical consideration if symptoms persist or progress or pain is refractory

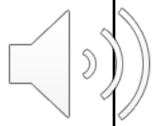
Quiz Case 4

30 yo M with 4 weeks tingling and pain in his first and second finger. Fill in the blanks below.

	MNW	C6 radiculopathy
History		
Sensory		
Motor		
Reflexes		
Special Tests		

Answer Case4

	MNW	C6 radiculopathy
History	Noctornal paresthesia	Neck pain Radicular pain Sx worse with neck motion
Sensory	Palmar sparing Involves digit 3 (C7)	Sensory changes extend past the wrist
Motor	Lumbricles 1&2, FPB, APB, OP	Biceps, brachialis, brachioradialis, wrist extension
Reflexes	None	Biceps, brachioradialis
Special Tests	Carpel tunnel compression test Phalen's Tinel's	Spurling's Horner's



References:

Blumenfeld Hal. Neuroanatomy through Clinical Cases. Second Edition. 2010.

Preston David, Shapiro Barbara. Electromyography and Neuromuscular Disorders, 3rd Edition. 2013

David Felten, Anil Shetty. Netter's Atlas of Neuroscience. 2nd Edition. 2003

Todd Olson, Wojchiech Pawlina. Student Atlas of Anatomy. 2nd Edition

Uptodate.com
http://www.uptodate.com/contents/treatment-and-prognosis-of-cervical-radiculopathy?source=search_result&search=cervical+radiculopathy&selectedTitle=2~32

http://www.uptodate.com/contents/clinical-features-and-diagnosis-of-cervical-radiculopathy?source=search_result&search=cervical+radiculopathy&selectedTitle=1~32

http://www.uptodate.com/contents/ulnar-neuropathy-at-the-elbow-and-wrist?source=search_result&search=median+neuropathy+at+the+wrist&selectedTitle=3~150

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