Peripheral Nerve Disorders of the Upper Extremity

BLAISE PASCALE, MD, MPH

Disclaimer:

- I have no financial disclosures
- The views, information, and conclusions expressed herein are those of the author alone.

Overview

- Basic Science
- Electrodiagnostics Refresher
- Common Disorders
- Uncommon Disorders
- Case presentation
- Surgical options

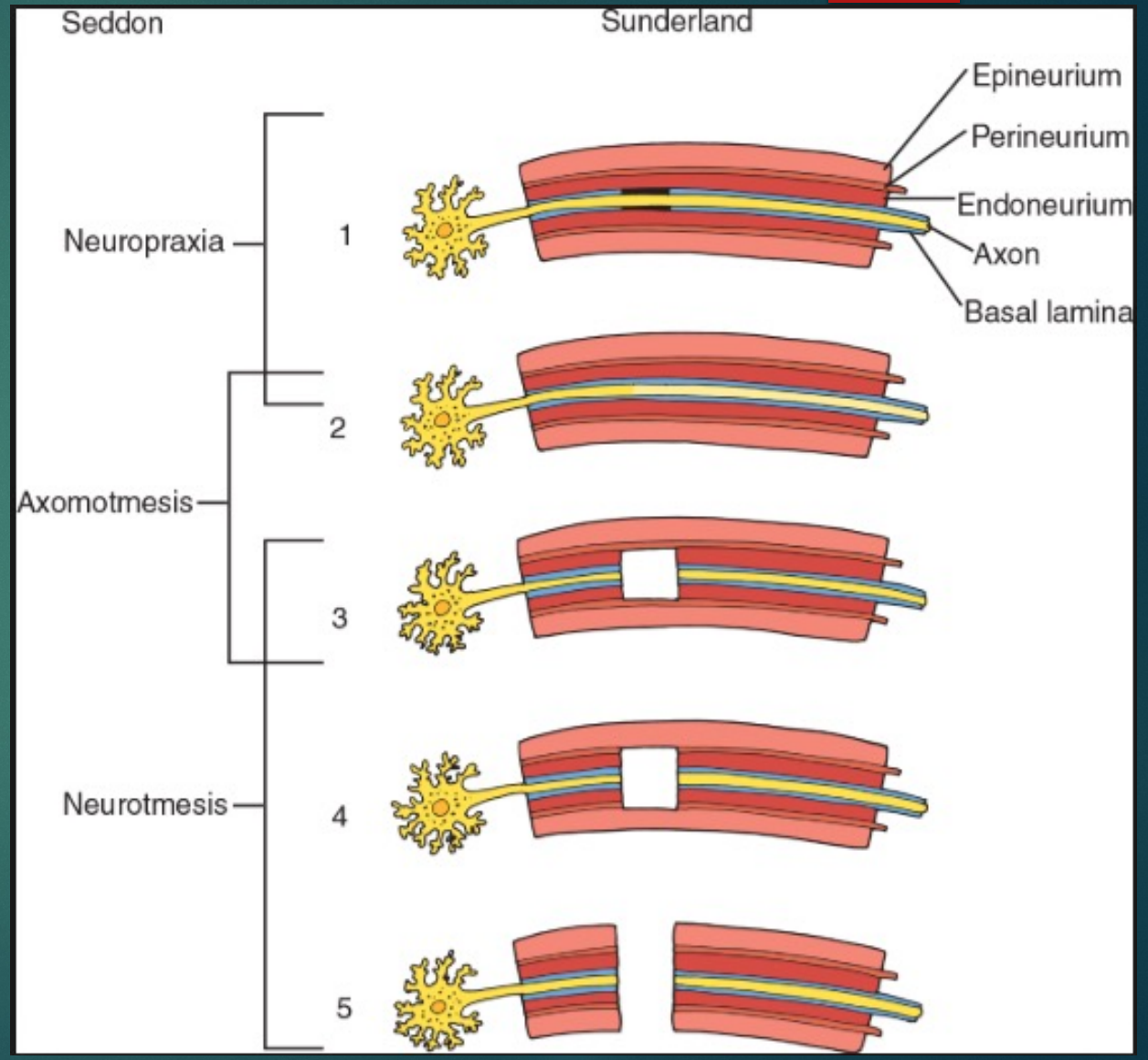
Goals:

- Identify key anatomical sites of compressive or traumatic neuropathy
- Identify common and uncommon causes of peripheral neuropathy
- Understand the role of EMG in evaluation of peripheral nerve disorders
- Comfortable with a workup for a peripheral nerve injury

Pathophysiology: Nerve Injury

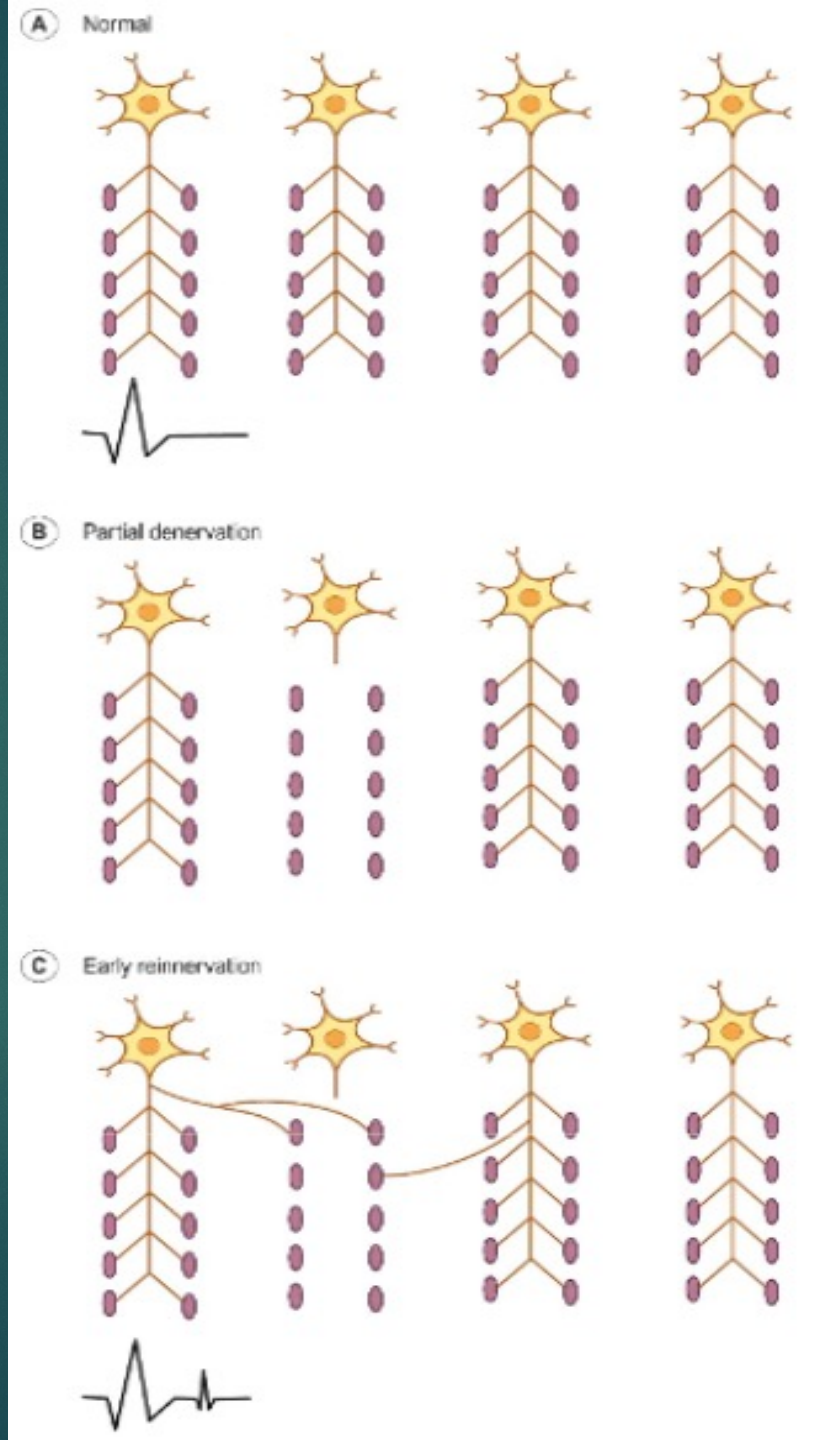
- **Seddon's Classification**
  - Neurapraxia (conduction block)
  - Axonotmesis (Connective Tissue intact)
  - Neurotmesis (transection)

- **Sunderland's Classification**
  - Type 1: Neurapraxia
  - Type 2: Axonotmesis
  - Type 3: 2 + Endoneurium injury
  - Type 4: 3 + Perineurium injury
  - Type 5: 4 + Epineurium injury (Neurotmesis)



Recovery from Nerve injury

- Remyelination-- **2 to 12 Weeks**
- Collateral Sprouting-- **2 to 6 months**
  - Occurs after degeneration of injured distal axon fragments
  - Severe injury precludes sufficient sprouting
- Regeneration– **up to 18 months**
  - Proximal 6-8mm per day
  - Distal 1-2mm per day



The Case

- 19M with right shoulder pain.
- Was lifting weights and later developed significant pain in his right shoulder.
- Over the past 3 months he has taken NSAIDs, muscle relaxers, and trialed physical therapy and his pain has improved markedly.
- Referred for EMG study due to upper extremity weakness

Initial Evaluation

- History
- Neuromuscular examination
- +/- NCS/EMG
- +/- Ultrasound evaluation

The case…

RIGHT UPPER EXTREMITY:

atrophy of shoulder girdle musculature

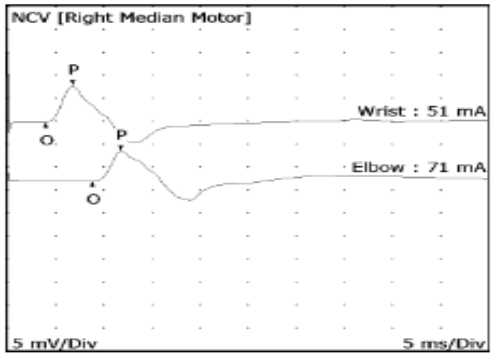
decreased sensation with allodynia in axillary distribution on RIGHT

Medial winging of the RIGHT scapula.

MUSCLE	ROOT/NERVE	LEFT	RIGHT
Deltoid	C5/6, Axillary	5	0
Supraspinatus	C5/6, Suprascap	5	4
Infraspinatus	C5/6 Suprascap	5	2
Biceps	C5/6 Musculocut	5	5
Triceps	C6/7 Radial	5	5
Wrist Flex	C6/7 Median	5	5
Wrist Ext	C6/7 Radial	5	5
Flexor Digitorum	C8 Median	5	5
Interossei	T1 Ulnar	5	5
Opponens Pollicus	C8/T1 Median	5	5

Electrodiagnostics (EDX) Overview

- Nerve Conduction Study (NCS)
  - Focal examination of a specific nerve
    - Latency
    - Amplitude
    - Conduction Velocity
- Electromyography (EMG)
  - Focal examination of individual muscles
    - Spontaneous Activity
    - Firing Rate (recruitment)



Side	Muscle	Nerve	Root	Ins Act	Fibs	Psw	Amp	Dur	Poly	Recrt	Int Pat
Right	Deltoid	Axillary	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml
Right	Biceps	Musculocut	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml
Right	Triceps	Radial	C6-7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml
Right	FlexCarRad	Median	C6-7	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml
Right	Abd Poll Brev	Median	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml
Right	Cervical Parasp Mid	Rami	C4-6	Nml	Nml	Nml					
Right	Cervical Parasp Low	Rami	C7-8	Nml	Nml	Nml					
Left	Biceps	Musculocut	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml
Left	Triceps	Radial	C6-7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml
Left	Deltoid	Axillary	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml
Left	FlexCarRad	Median	C6-7	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml
Left	Abd Poll Brev	Median	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml
Left	Cervical Parasp Mid	Rami	C4-6	Nml	Nml	Nml					
Left	Cervical Parasp Low	Rami	C7-8	Nml	Nml	Nml					

AXONAL LOSS vs DEMYELINATION

- **REDUCED amplitude**
- **Conduction Velocity normal** or slightly decreased
- **Latencies are typically normal** or slightly prolonged

- **NORMAL** Amplitude
- Marked slowing of CV
- Marked prolongation of distal latency

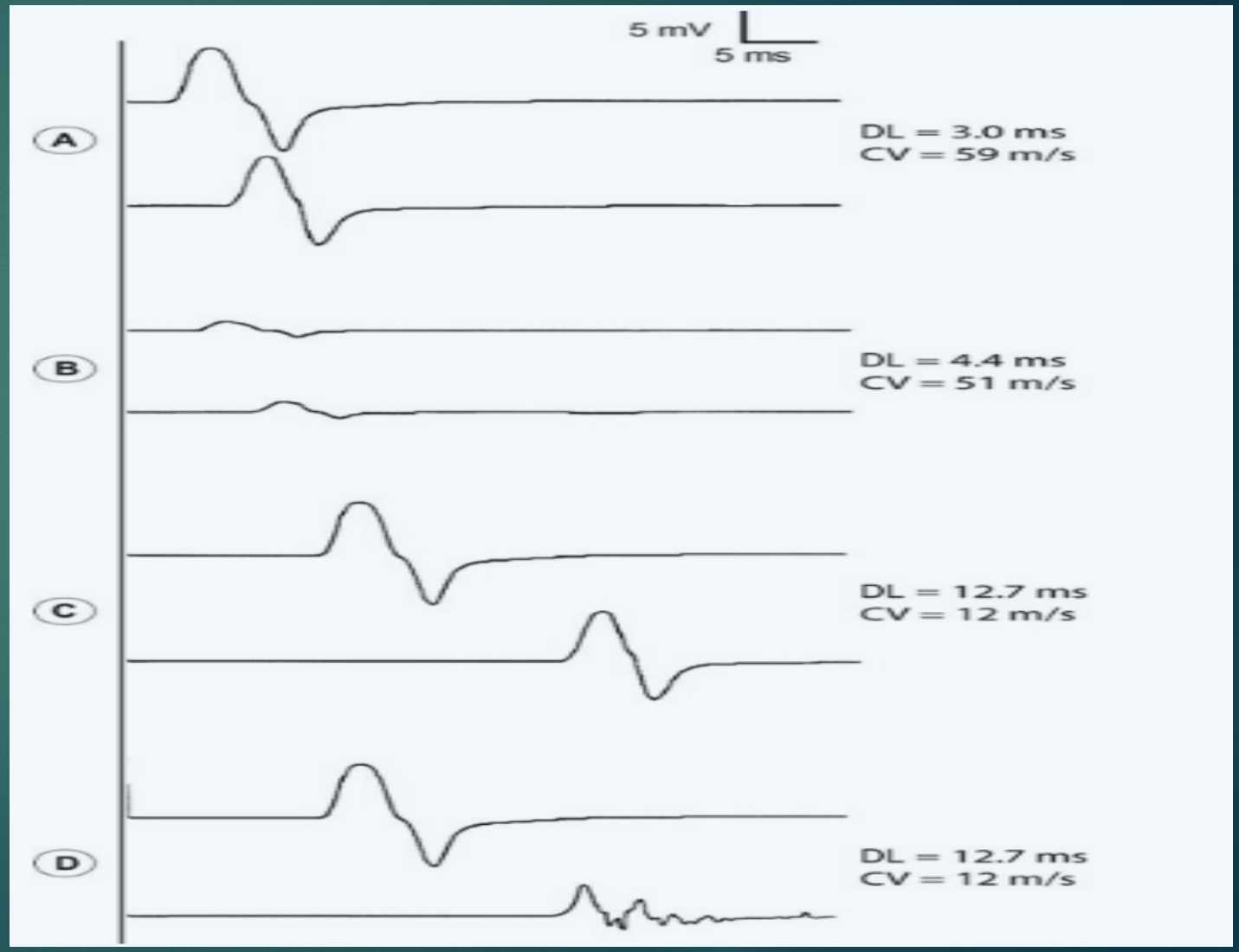
Patterns of Conduction Abnormalities

A. **Normal Study**

B. **Axonal Loss**

C. **Demyelination**
(uniform slowing)

D. **Demyelination**
(Conduction Block)



UE Peripheral Nerve Disorders

More Common

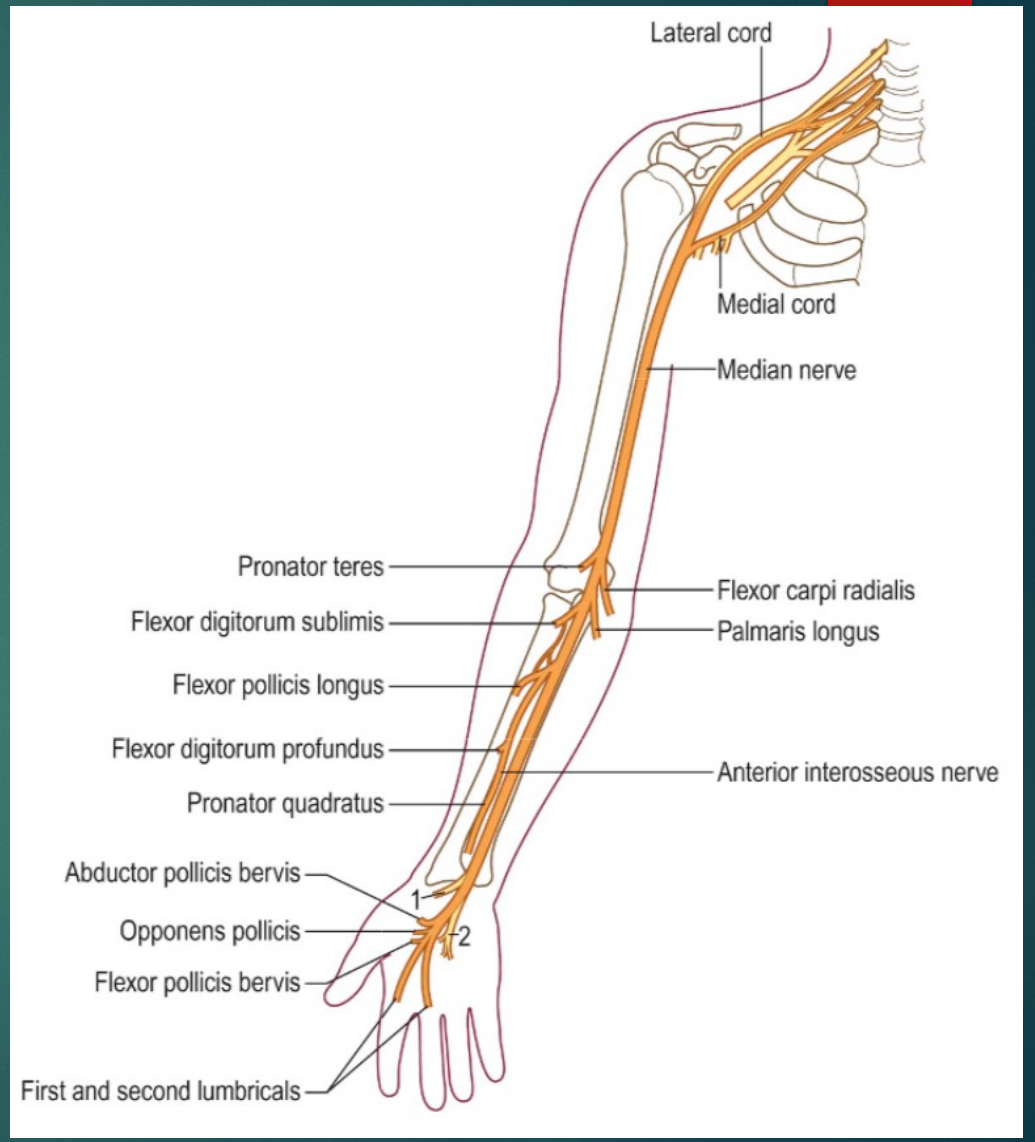
- Median Neuropathy
- Ulnar Neuropathy
- Radial Neuropathy
- Brachial Plexopathy

Less Common

- Axillary Neuropathy
- Suprascapular Neuropathy
- Neuralgic Amyotrophy
- Long Thoracic neuropathy

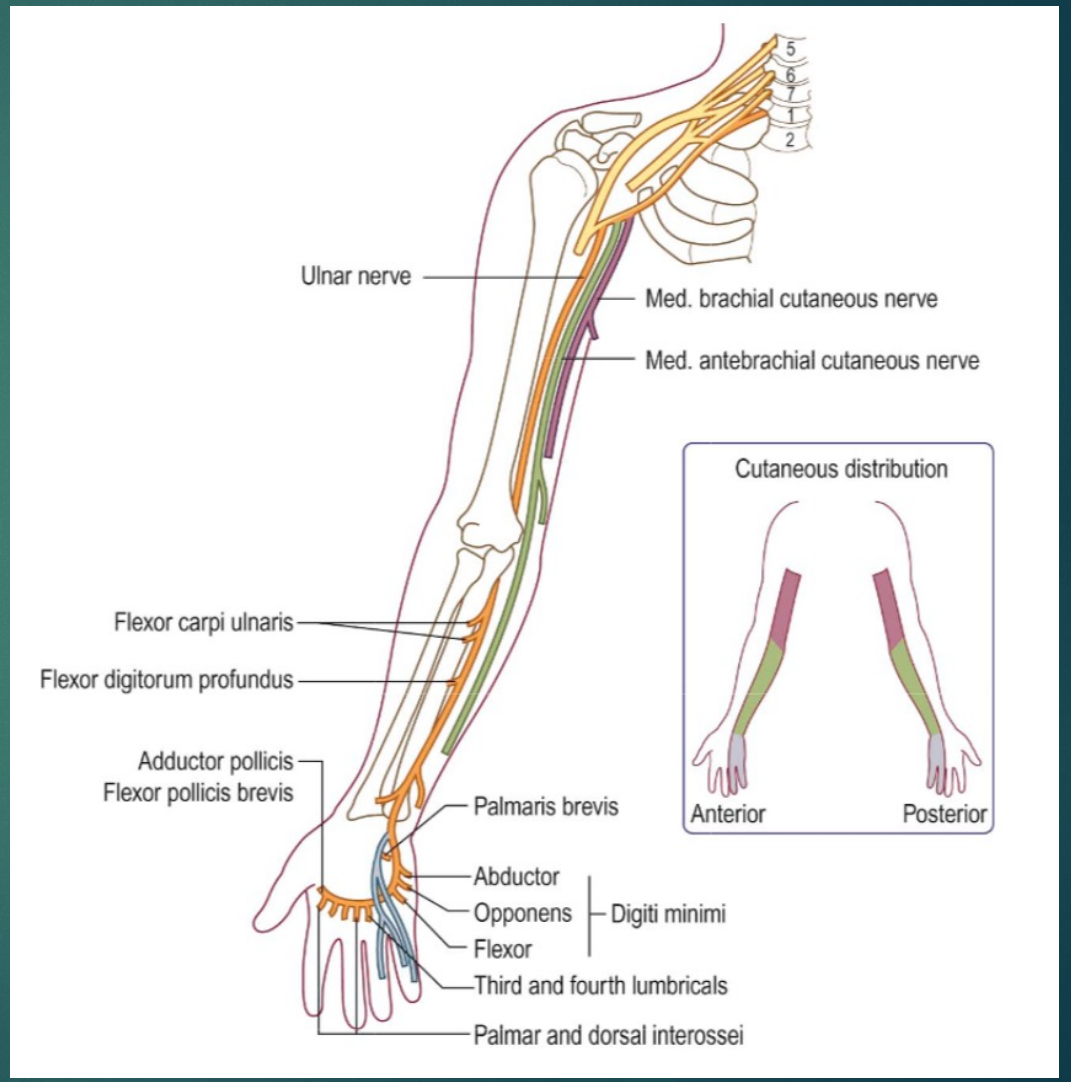
Median Neuropathy

- Etiologies:
  - Entrapment:
    - Elbow- Pronator syndrome
    - Wrist- Carpal Tunnel syndrome
  - Traumatic
- Clinical Exam:
  - Impaired sensation 1-3 digits
  - Finger flexion weakness
  - Wrist flexion weakness
  - APB



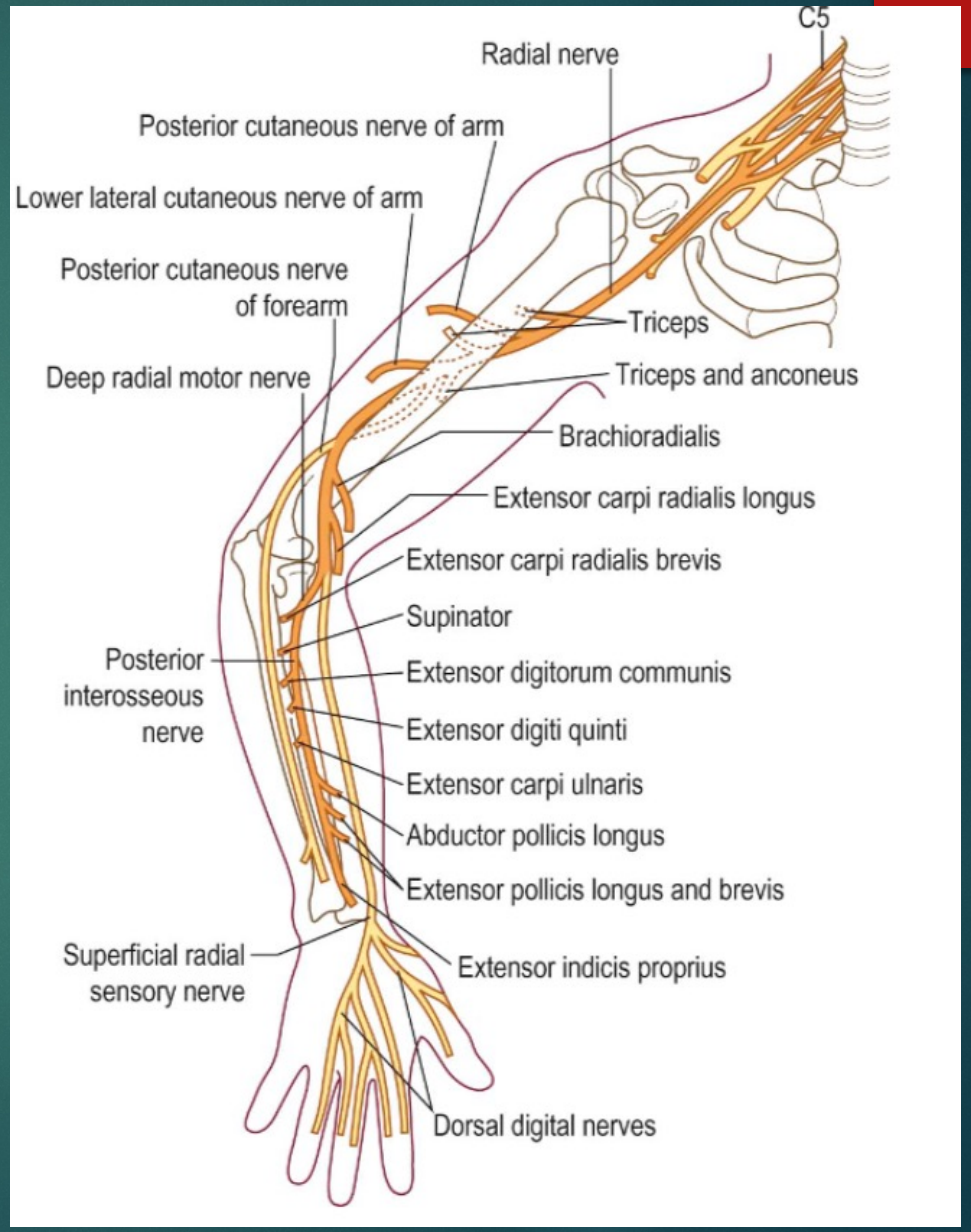
Ulnar Neuropathy

- Etiologies:
  - Entrapment:
    - Cubital Tunnel
    - Guyon's Canal
  - Traumatic
- Clinical Exam:
  - Impaired sensation 4th and 5th digit
  - Atrophy/ Weakness of ADM, FDI, intrinsics



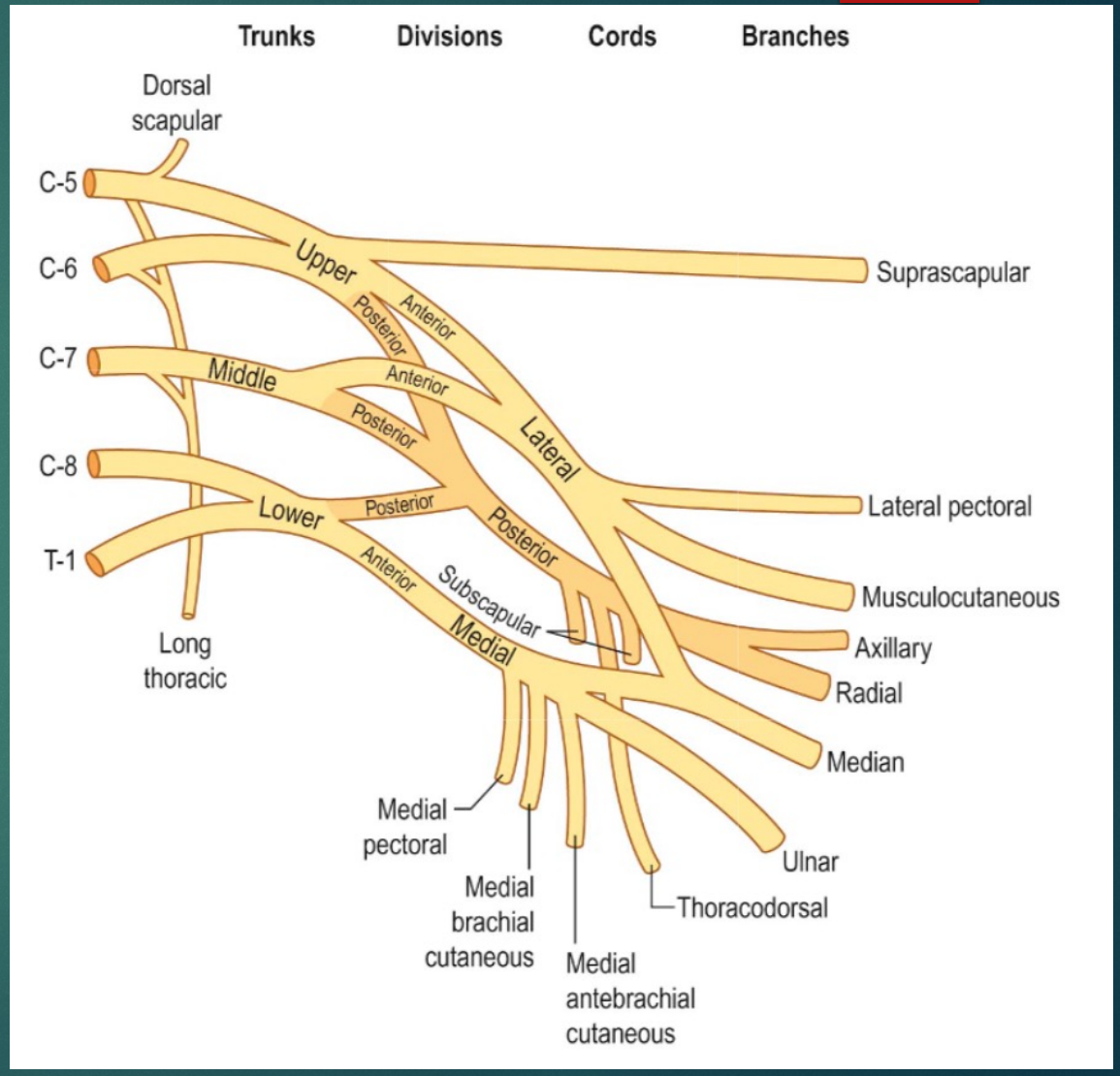
Radial Neuropathy

- Etiologies
  - Compressive:
    - Crutch use (axilla)
    - Radial Tunnel
    - Watches / wrist bands / casts
  - Traumatic
- Clinical Exam
  - Wrist drop
  - +/- Sensation changes



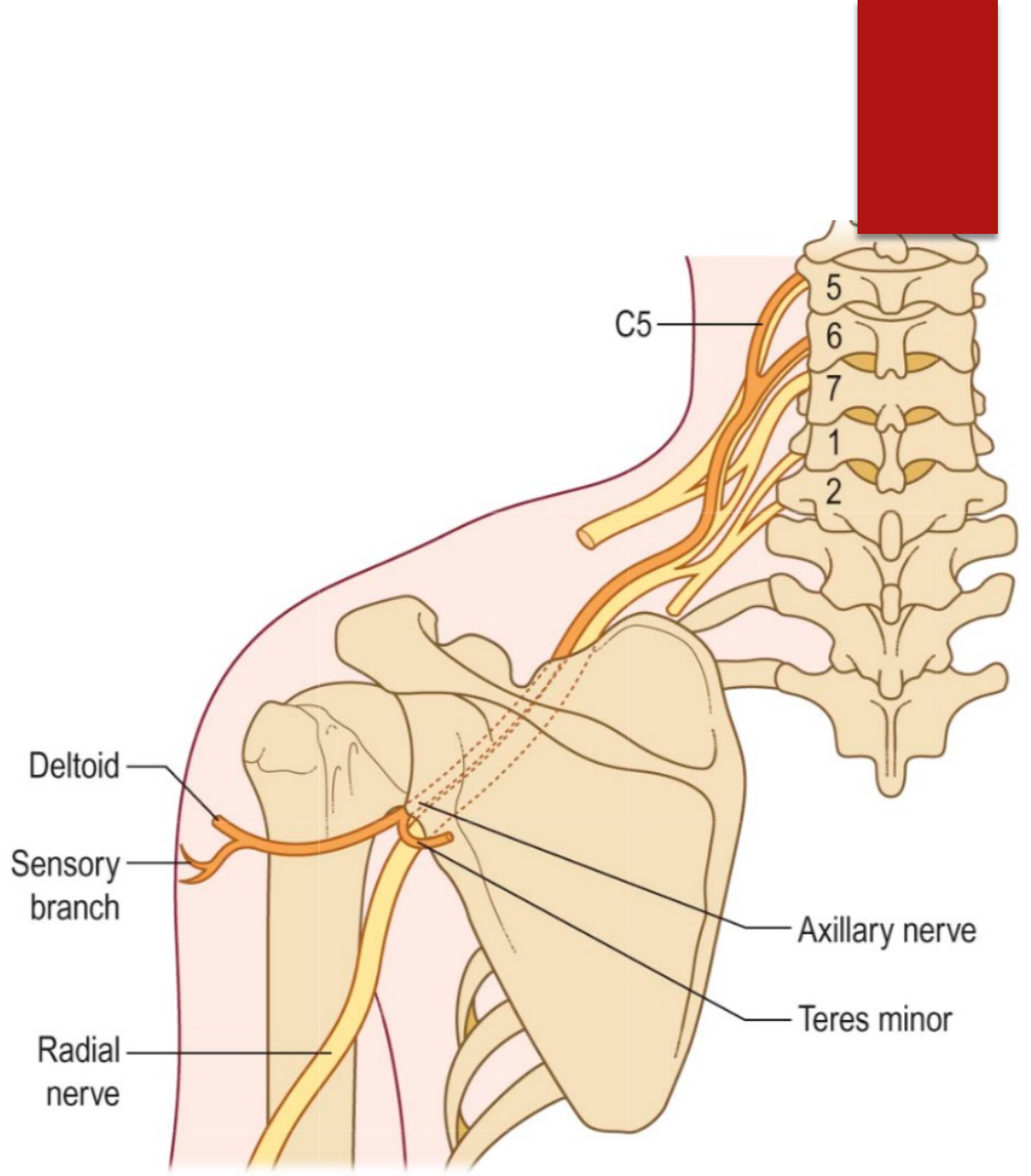
Brachial Plexopathy

- Traumatic
- Hematoma
- Inflammatory
- Mass



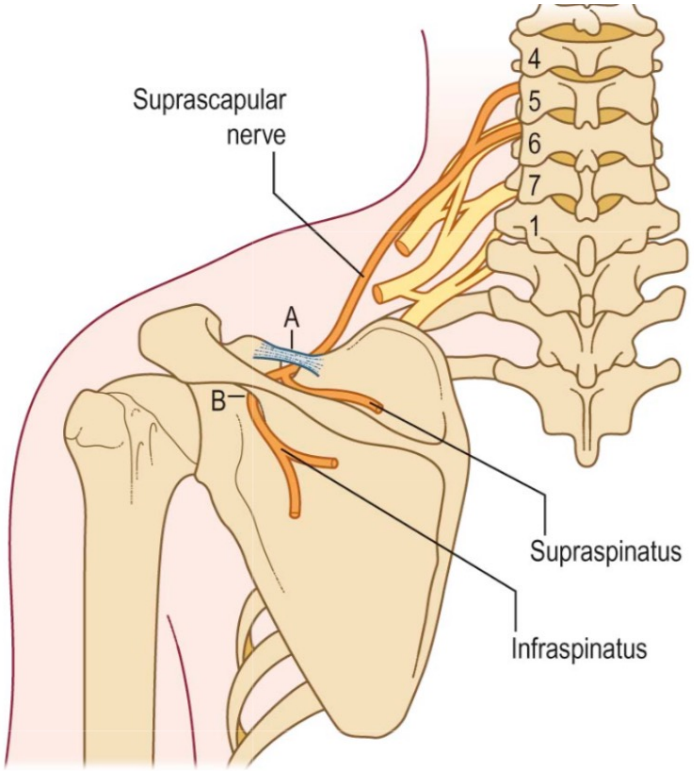
Axillary Neuropathy

- Etiologies
  - Compressive:
    - Quadrilateral space syndrome (rare)
  - Traumatic:
    - Shoulder dislocation
    - Humerus fx
- Clinical Exam
  - Numb patch
  - Shoulder abduction weakness



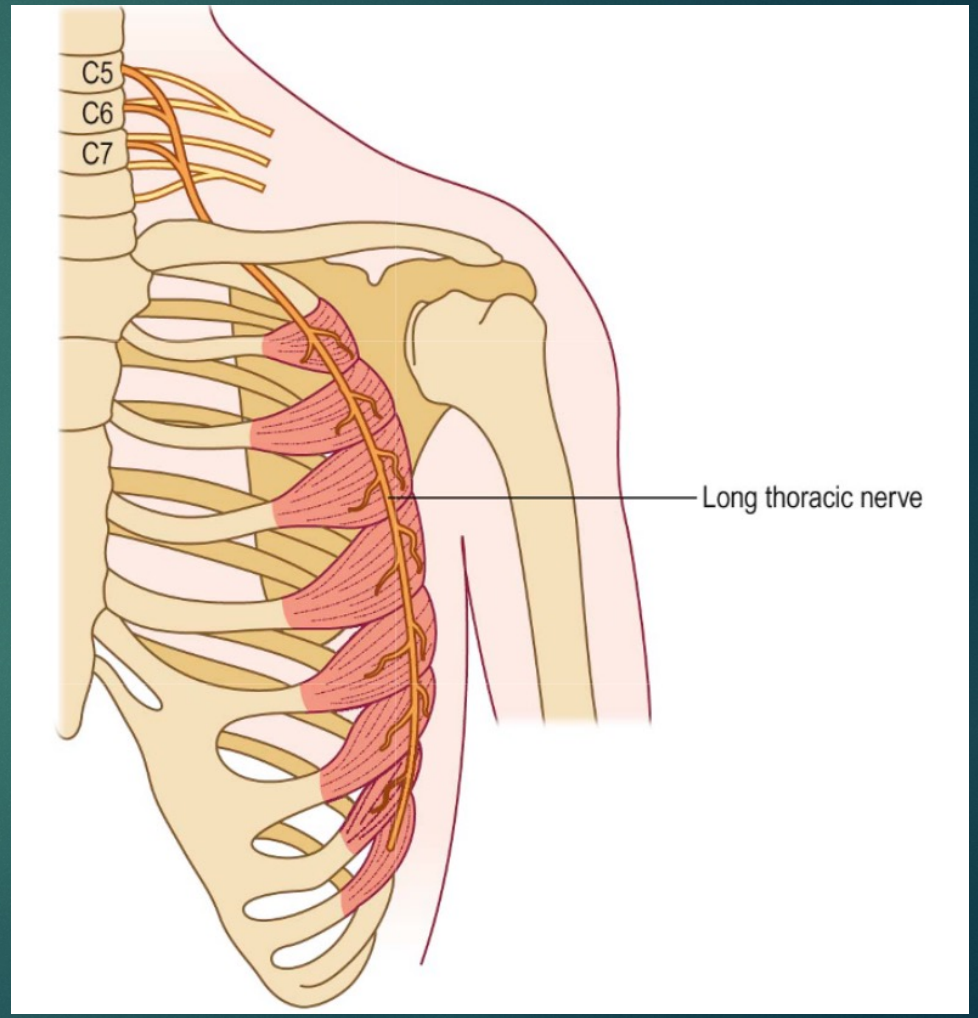
Suprascapular Neuropathy

- Etiologies
  - Compressive:
    - Ganglion Cyst
    - Rotator cuff tear
  - Traumatic:
    - Repetitive overstretch in athletes
    - Surgical positioning
- Clinical Exam
  - Pain with shoulder movements
  - IS/SS weakness



Long Thoracic Neuropathy

- Etiology:
  - Most from inflammation
  - Ruck sack palsy
  - Other stretch/compression
- Clinical exam:
  - Medial winging



19M with shoulder weakness

- EMG performed:
  - Spontaneous activity
    - Infraspinatus
    - Deltoid
    - Supraspinatus
  - Normal distal nerve conduction studies

- Diagnosis?

Neuralgic Amyotrophy

- Presentation:
  - Severe pain for days to a couple weeks
  - Symptom resolution, marked weakness
- Clinical exam:
  - Atrophy
  - Weakness
- Evaluation: Exclusion workup.
- 1 in 1000 incidence

Peripheral Nerve Clinic

- Disposition:
  - Referral to peripheral nerve clinic for surgical consultation

- Neurology
- Physical Medicine & Rehabilitation
- Plastic Surgery
- Neurosurgery
- Orthopedic Hand surgery

Surgical Options for nerve injury

- “5 best for Brachial Plexopathy:
  - Oberlin Procedure
  - Leechavengvongs procedure
  - Free functional muscle transfer
  - Radial nerve tendon transfers
  - C5-C6 nerve grafting in obstetric birth palsy
- Neurolysis
- Primary nerve repair
- Nerve grafting
- Nerve transfer
- Muscle transfer
- AIN to ulnar Motor

References:

- Preston, D. C., & Shapiro, B. E. (2013). *Electromyography and neuromuscular disorders: Clinical-electrophysiologic correlations*. Elsevier Saunders.
- Robinson, L. (2015). How electrodiagnosis predicts clinical outcome of focal peripheral nerve lesions. *Muscle & Nerve*, 321–333.
- Maldonado, Andrés A. M.D., Ph.D.; Bishop, Allen T. M.D.; Spinner, Robert J. M.D.; Shin, Alexander Y. M.D. Five Operations That Give the Best Results after Brachial Plexus Injury, Plastic and Reconstructive Surgery: September 2017 - Volume 140 - Issue 3 - p 545-556
- VanEijk, J., Groothuis, J., and Van Alften, N. (2016). Neuralgic amyotrophy: An update on diagnosis, pathophysicology, and treatment. Muscle & Nerve 53: 337-350,