

Electromyography and Nerve Conduction Studies. Basic Understanding and Applications for the Ordering Provider

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CPS Annual Meeting 2019

Disclosures

- None

PRESENTATION OVERVIEW

Definition

Indications and NCS and EMG

Basic nerve and muscle anatomy and physiology

Components of the NCS and EMG evaluation

Clinical application of NCS and EMG

Basic interpretation of the NCS and EMG report

DEFINITION

EMG

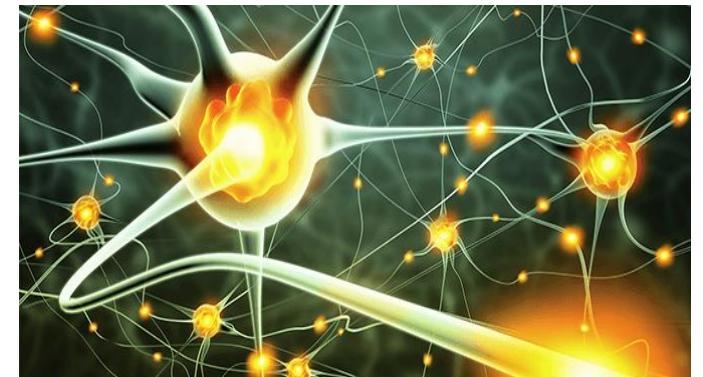
- Study of muscle function through analysis of electrical activity both with the muscle at rest and during activation

NCS

- Study of motor and sensory nerve function by way of percutaneous electrical stimulation

Invented in the 19th Century

- With more sophisticated equipment it has been consistently used over the last 40+ years to diagnose muscle and nerve related disorders



INDICATIONS FOR NCS AND EMG

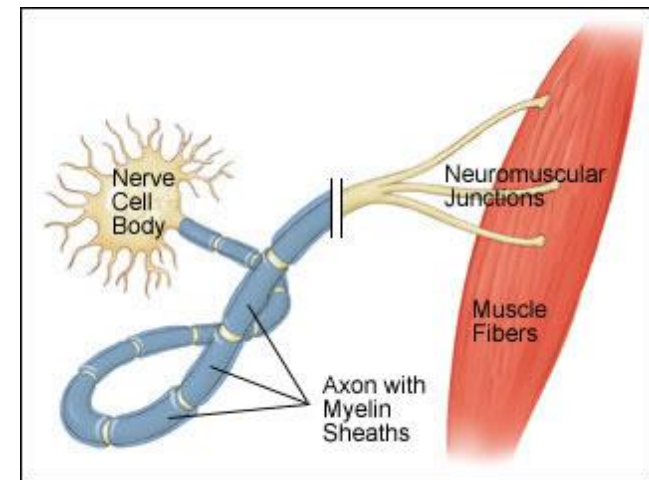
Evaluation of the nature of the pathophysiology of neurologic/muscular deficit

Quantification of the severity of involvement

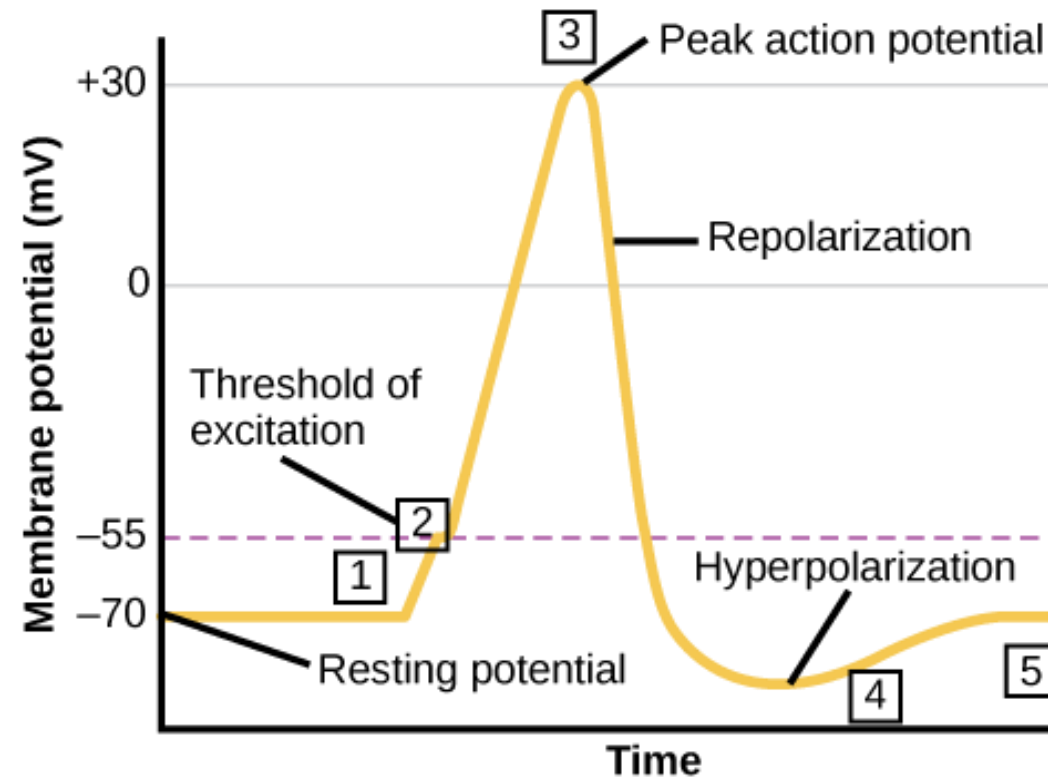
Determine acuity/chronicity of injury

Detection of the level of a neurologic deficit

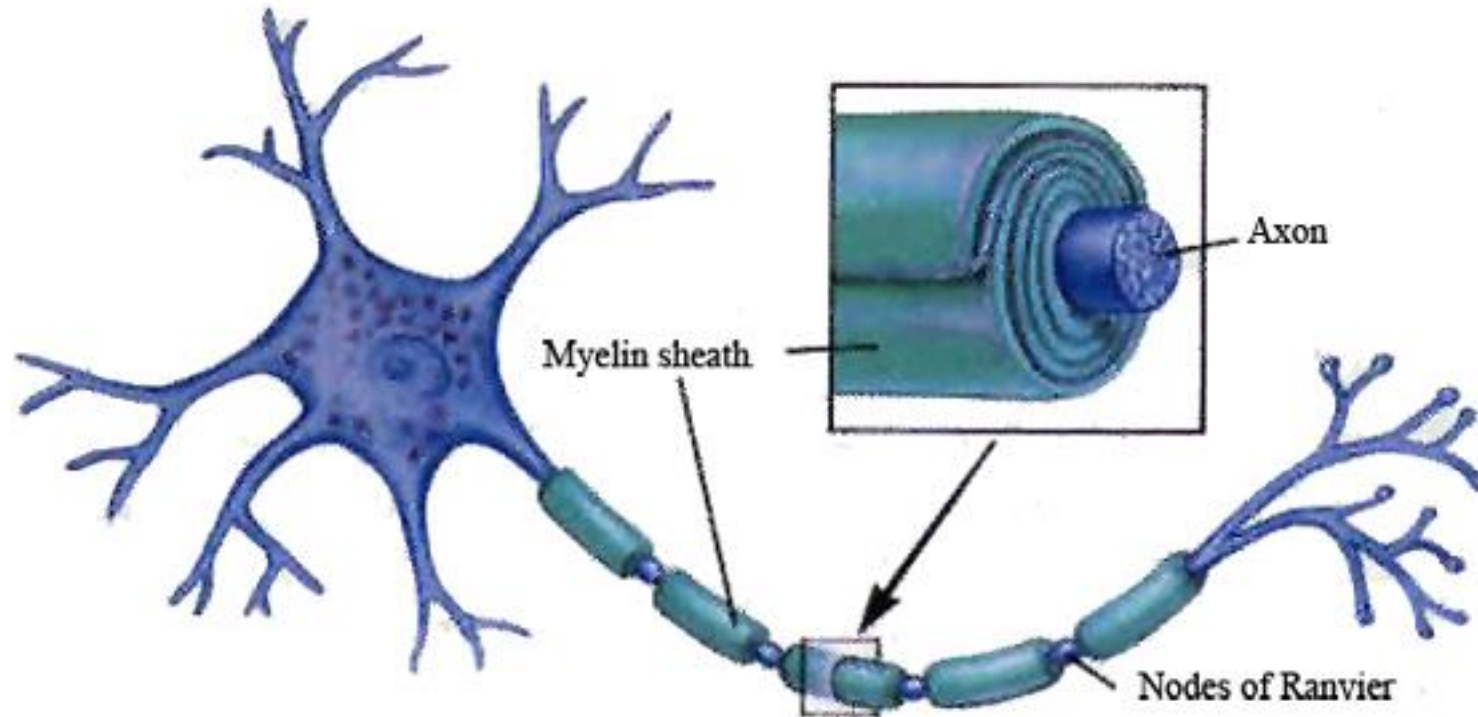
Determine prognosis



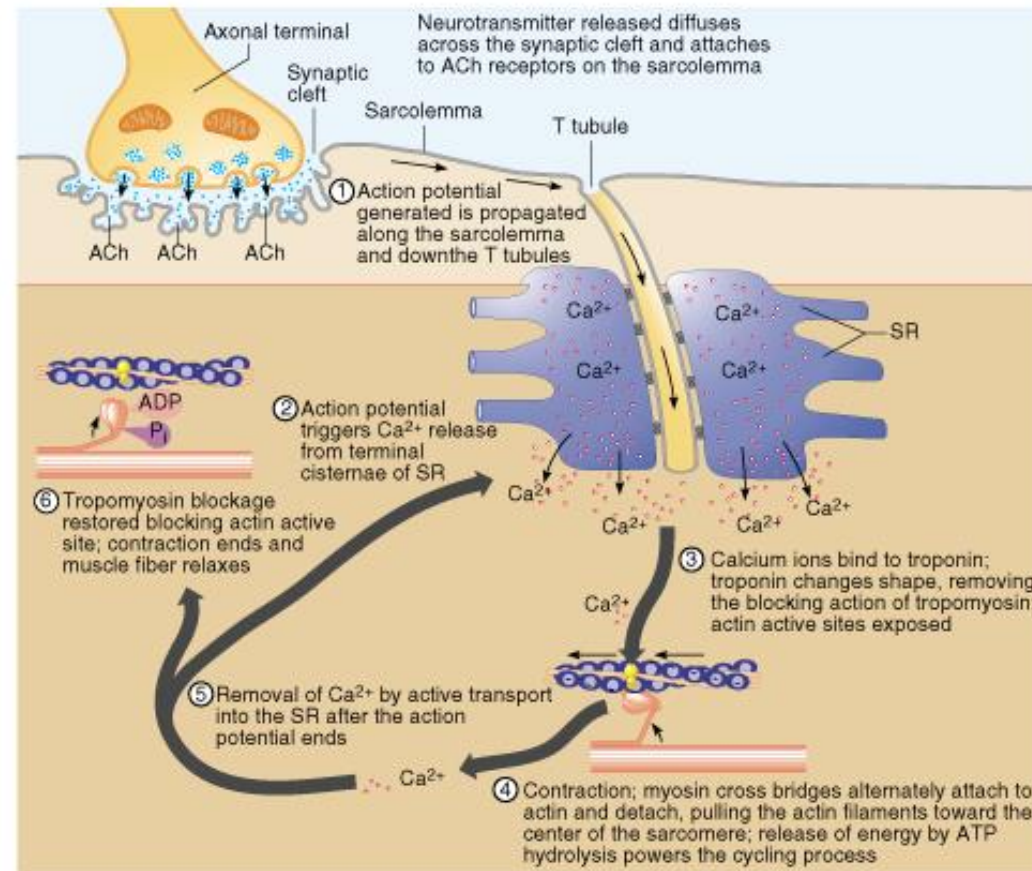
BASIC ANATOMY AND PHYSIOLOGY



AXON AND MYELIN



BASIC ANATOMY AND PHYSIOLOGY



MOTOR UNIT

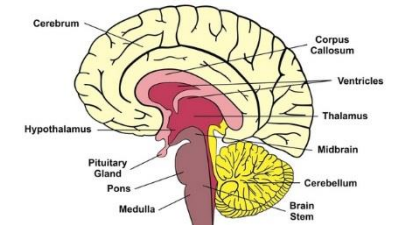
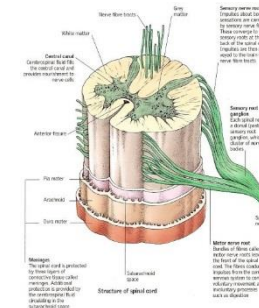
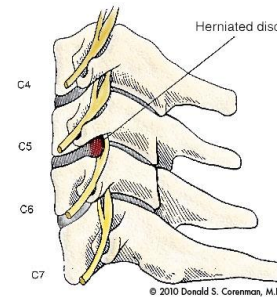
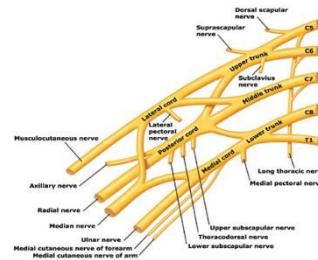
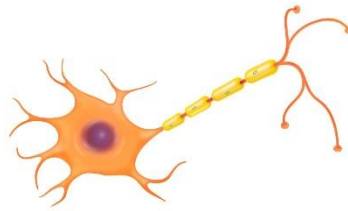
Definition: Alpha Motor Unit and all the Skeletal Muscle Fibers it Innervates

Size Varies by Muscle

Muscle	Number of Motor Axons	Number of Muscle Fibers	Innervation Ratio	Reference
Biceps	774	580,000	750	Buchtal, 1961
Brachioradialis	315	129,000	410	Feinstein <i>et al</i>
First dorsal interosseous	119	40,500	340	Feinstein <i>et al</i>
Medial gastrocnemius	579	1,120,000	1,934	Feinstein <i>et al</i>
Tibialis anterior	445	250,200	562	Feinstein <i>et al</i>

BASIC ANATOMY AND PHYSIOLOGY

Muscle → Peripheral Nerve → Plexus → Root(s) → Cord → Brain



COMPONENTS OF THE NCS AND EMG STUDY

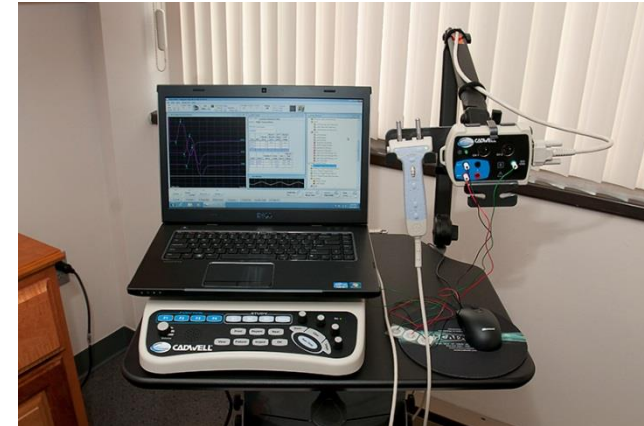
Sensory nerve conduction studies

Motor nerve conduction studies

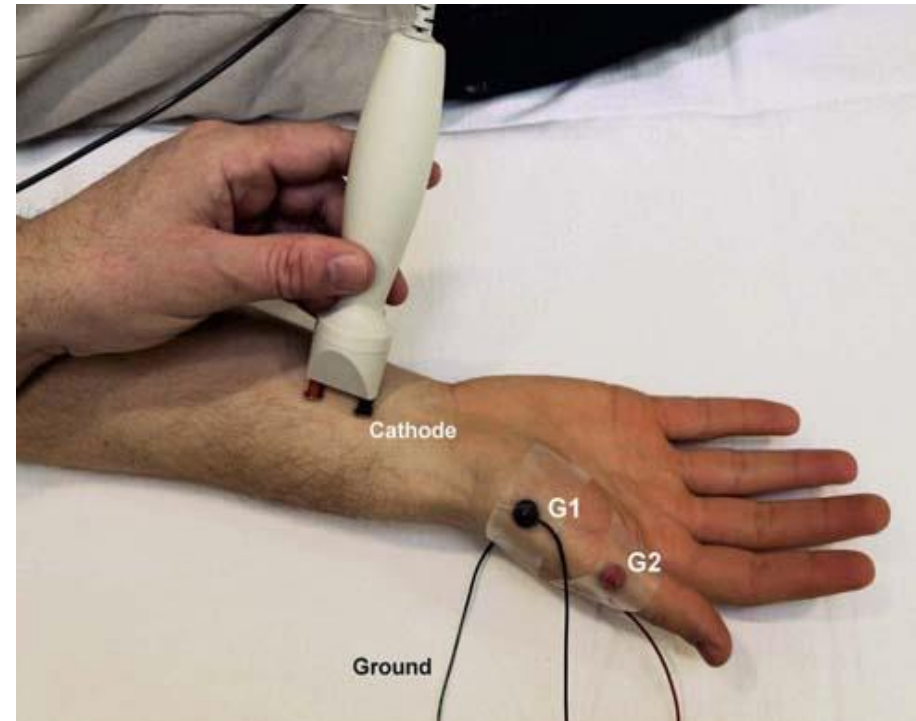
F-waves

H-reflexes

Needle electromyography (EMG)



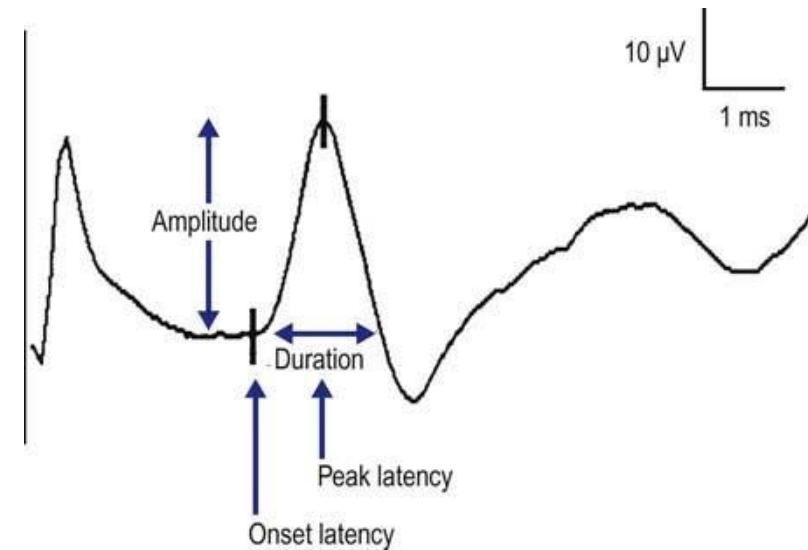
NERVE CONDUCTION STUDIES



SENSORY NERVE CONDUCTION STUDIES

THE SENSORY NERVE ACTION POTENTIAL (SNAP)

- Onset and Peak Latency
- Conduction Velocity
- Amplitude

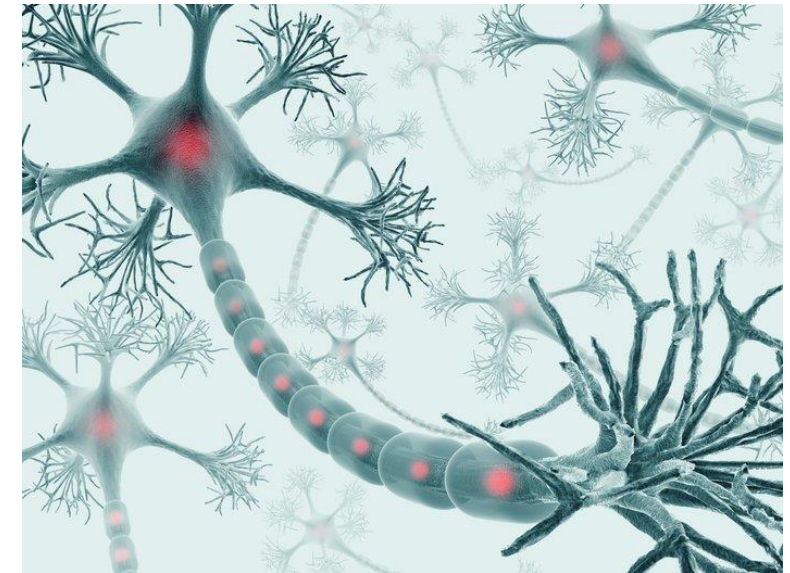


SENSORY NERVE CONDUCTION STUDIES

THE SENSORY NERVE ACTION POTENTIAL (SNAP)

Typical nerves examined:

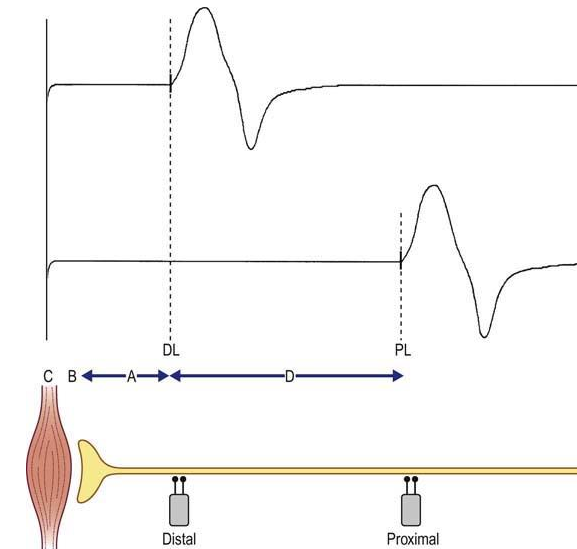
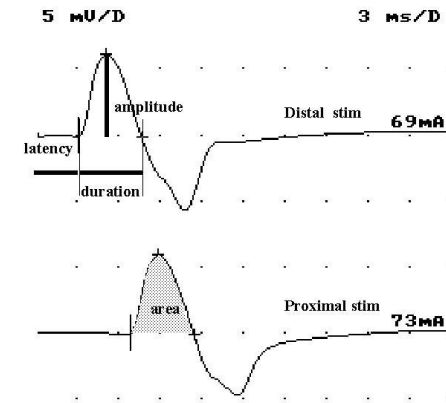
- Sural, ulnar, median, occasionally radial or superficial peroneal



MOTOR NERVE CONDUCTION STUDIES

THE MOTOR NERVE ACTION POTENTIAL (CMAP)

- Distal Latency
- Amplitude
- Proximal conduction velocity



MOTOR NERVE CONDUCTION STUDIES

THE MOTOR NERVE ACTION POTENTIAL (CMAP)

Typical nerves examined:

- ulnar, median, peroneal, tibial

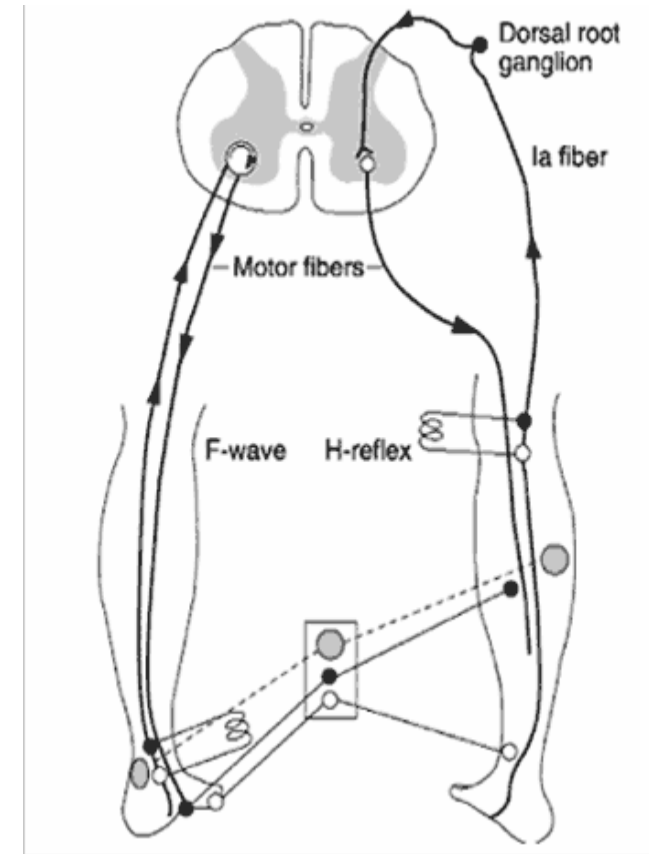


F-WAVES AND H-REFLEX

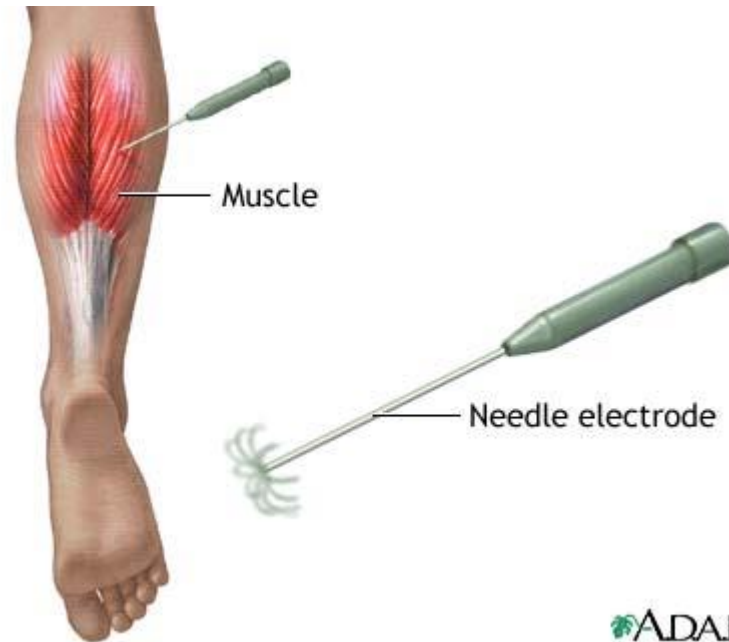
Useful for identifying
proximal segmental
demyelination

H-reflex

- Essentially a recording of the calcaneal reflex



NEEDLE ELECTROMYOGRAPHY (EMG)



NEEDLE ELECTROMYOGRAPHY (EMG)

TECHNIQUE

Small needle inserted into muscle (27 gauge)

Different muscles are sampled based on clinical question and findings during the exam

- Root screen
 - Lower limb: medial gastroc, anterior tib, vastus medialis, TFL, Glut Max, Lumbar Paraspinals
 - Upper limb: FDI, APB, Pronator Teres, Biceps, Triceps, Deltoid, Cervical Paraspinals

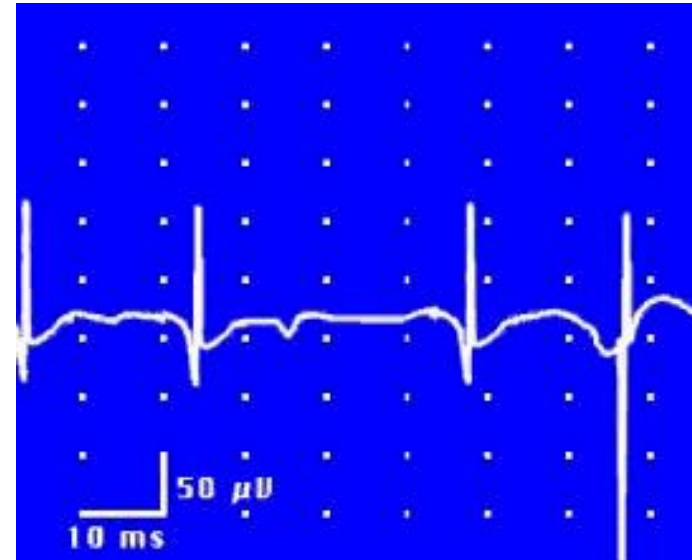
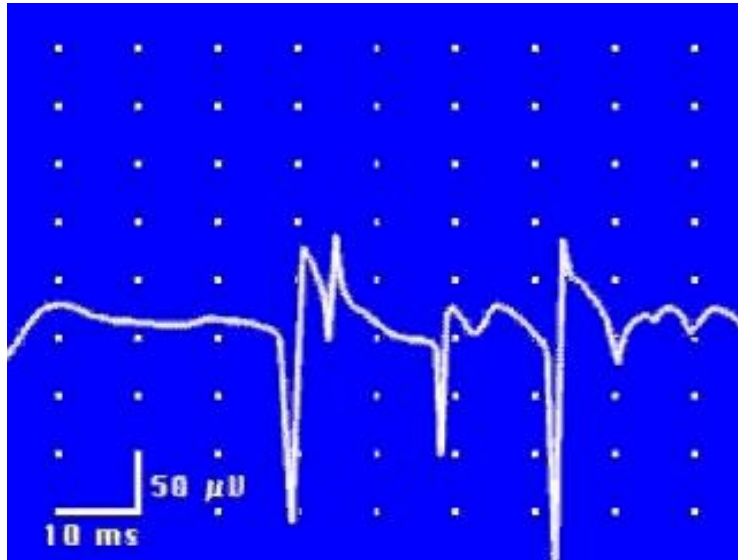
Discomfort is usually minimal

NEEDLE ELECTROMYOGRAPHY (EMG)

COMPONENTS

Insertional Activity (muscle is quiet)

- Increased
- Sharp waves
- Fibrillation Potentials



NEEDLE ELECTROMYOGRAPHY (EMG)

COMPONENTS

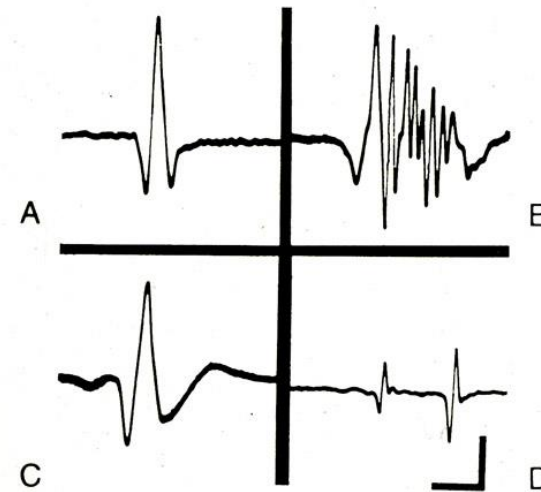
Have patient activate the muscle

Motor Unit Evaluation

- Morphology
 - Complexity
 - Amplitude
 - Duration
- Recruitment
 - Normal
 - Reduced
 - Rapid

Figure 44-8

Single voluntary motor unit potentials. A. Normal. B. Prolonged polyphasic potential seen with reinnervation. C. "Giant unit"—normally shaped but of much greater amplitude than normal. D. Brief, low-amplitude "myopathic" units. Calibrations: 5 ms (horizontal) and 1 mV in A and B; 5 mV in C; 100 μ V in D (vertical).



Adams and Victor, 1981

WHEN TO ORDER AND EMG/NCS

Radiculopathy

Mononeuropathy

Plexopathy (Brachial or Lumbosacral)

Peripheral Neuropathy

Myopathy

Neuromuscular junction disorder

Anterior Horn Cell Disease

Cranial neuropathies

WHEN NOT TO ORDER AN EMG/NCS

Suspected Central Nervous System Disorder

- Stroke
- TIA
- Encephalopathy
- Spinal cord injury
- Multiple Sclerosis

Diffuse Body Pain

- Fibromyalgia, etc..

Joint Pain

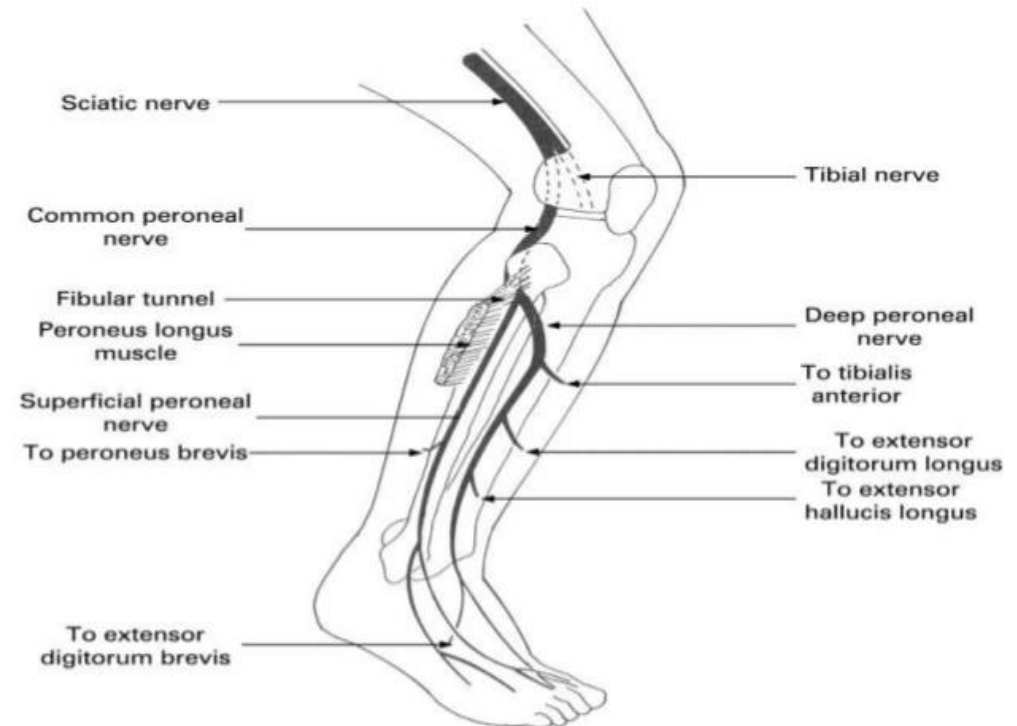
Unexplained weakness

GOALS OF EMG/NCS

Localization of injury

- Nerve conduction studies are more precise than needle examination

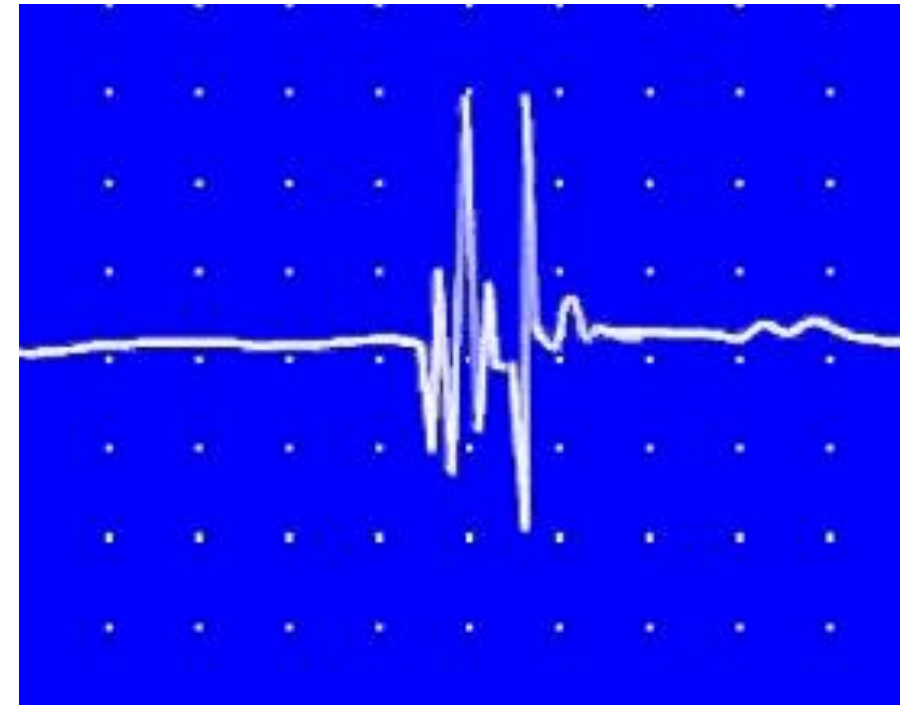
COMMON PERONEAL NERVE



GOALS OF EMG/NCS

Differentiating acute vs. chronic injuries

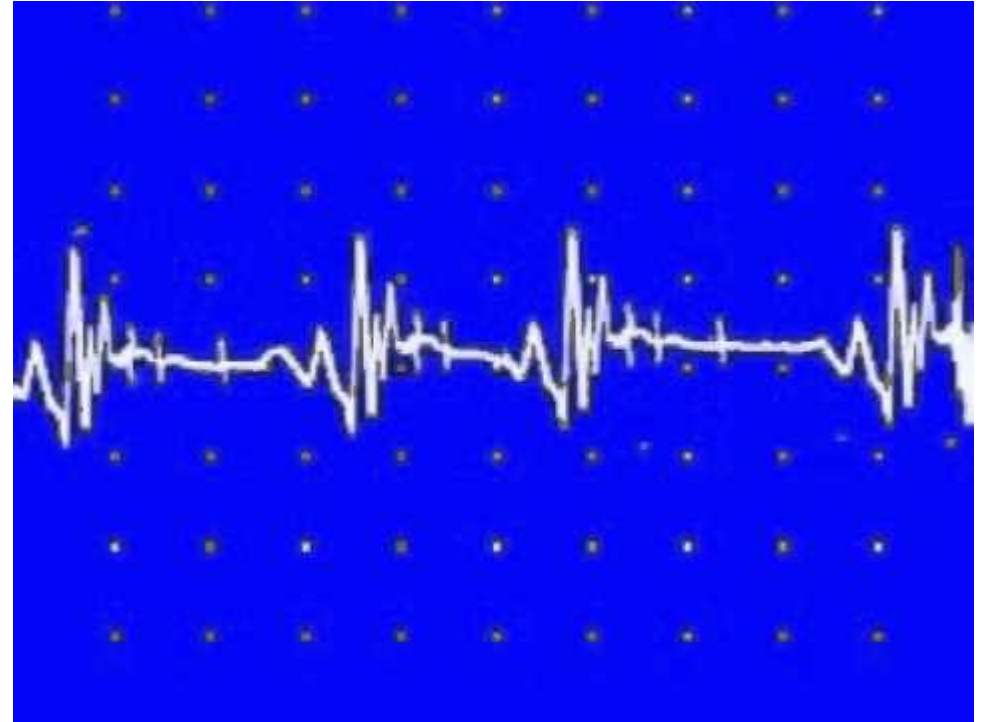
- Needle examination more helpful for this
 - Insertional activity
 - Increased insertional activity
 - Sharp Waves
 - Fibrillation Potentials
 - Activation
 - Reduced recruitment
 - Polyphasic motor unit potentials
 - Giant Motor Unit Potentials



GOALS OF EMG/NCS

Prognosticating Outcome

Monitoring progression of disease



LIMITATIONS OF EMG/NCS

Cannot detect central nervous system disease

Does not test the small fibers

While it is highly specific, especially in cases of radiculopathy, it is not 100% sensitive

- Unable to determine exact sensitivity because there is no gold standard to compare it against

May not be able to detect exact level of pathology

- Reasons to follow

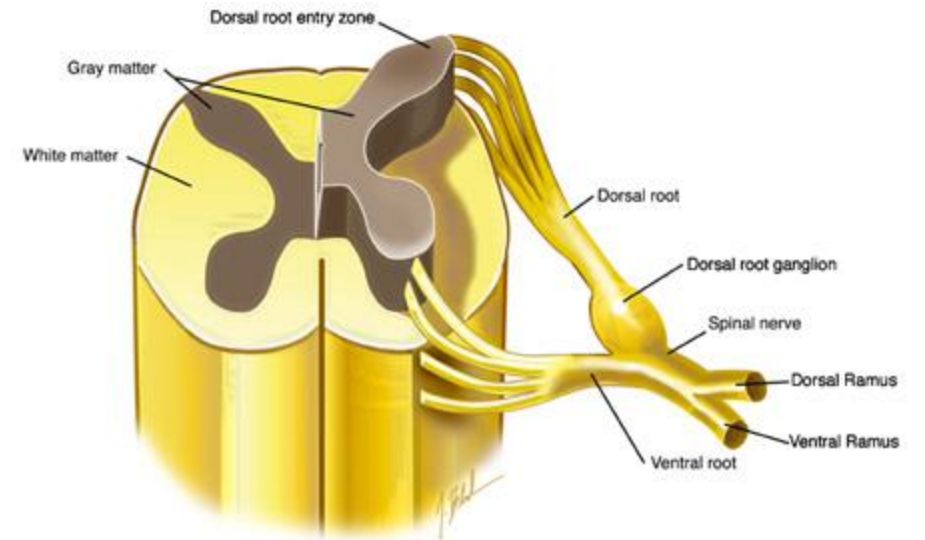
Examiner expertise

LIMITATIONS OF EMG/NCS

CONTINUED

Explanation for reduced sensitivity in radiculopathy

- Pure sensory radiculopathy
- Subtotal nerve root involvement



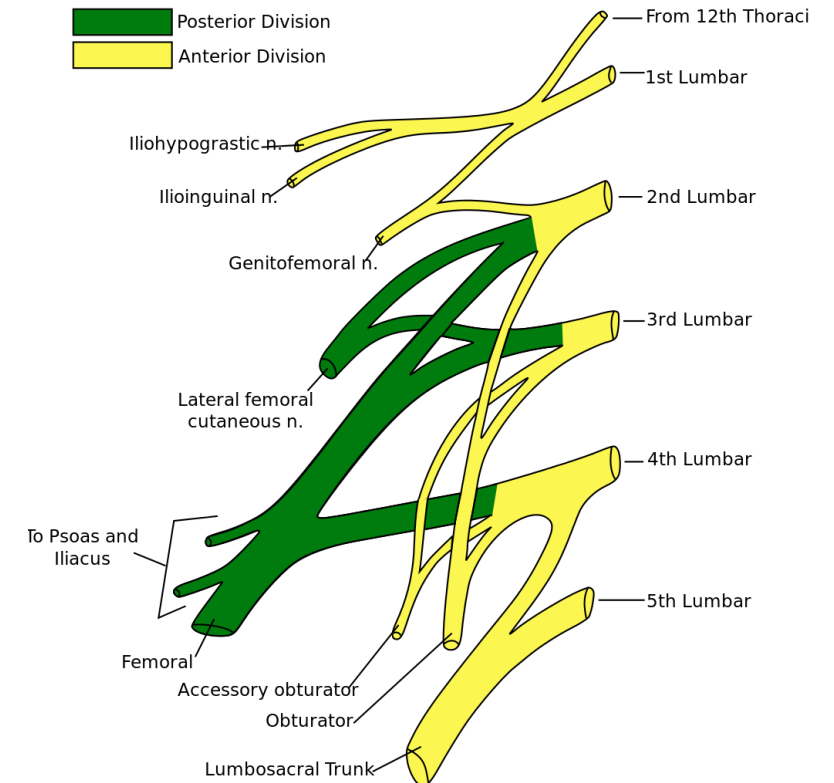
DIFFICULTY DETECTING THE LEVEL OF INVOLVEMENT

Imprecision of the myotomal maps

Difficulty with precision of upper lumbar radiculopathies

Difficulty with precision of lower lumbar radiculopathies

- Multiple roots involved depending on location of disc pathology



EXAMINER EXPERTISE

6 cases of lumbar radiculopathy

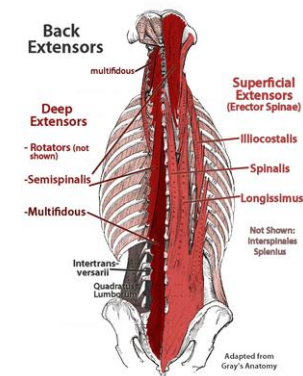
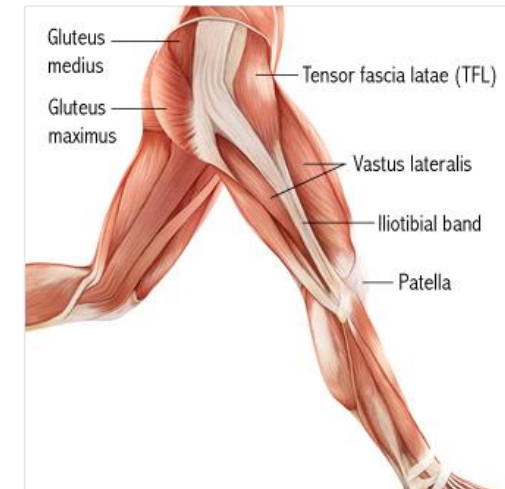
- 46.9% agreement on diagnosis
- Compared residents and faculty
 - Faculty twice as likely to agree on the diagnosis



NOTE

RADICULOPATHY

- NEUROGENIC CHANGE OCCURS FIRST IN THE PROXIMAL MUSCLES
- PARASPINALS ARE NOT RELIABLE IN THE SETTING OF SURGICAL INTERVENTION (POSTERIOR APPROACHES)



PEARLS FOR THE ORDERING PRACTITIONER

EMG/NCS is a diagnostic tool that can aide in the diagnosis of nerve and muscle disorders

- Should be used in addition to, and not in lieu of a solid physical exam, imaging (if indicated), and other necessary workup.

Before ordering an EMG/NCS it is best to have a specific question that needs to be answered based on the differential diagnosis

- ie. Peroneal neuropathy vs. L5 radiculopathy, peripheral neuropathy, CTS vs. C6 radiculopathy, etc....

EMG/NCS performed within three weeks of the injury may be normal, even if there is true pathology (Wallerian degeneration).

WHAT SHOULD YOU EXPECT FROM THE PROVIDER PERFORMING THE STUDY

Include Raw Data in Faxed Report

- Are temperatures documented?
- Were F-waves performed?
- Was it a complete Study?

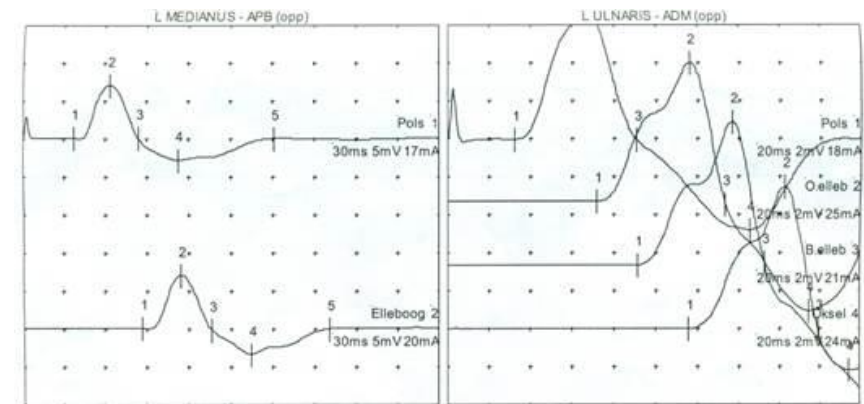


Table 1. Nerve conduction data.

	11/16/01		4/8/03 (PO 10 m)		Normal	
	L/NCV*	Amp**	L/NCV*	Amp**	L/NCV*	Amp**
Sensory nerve conduction						
Media	46.4	27.0	46.4	31.0	41.3	10
Ulnar	44.0	18.0	44.2	19.8	39.3	10
Medial ABC	NP***		48.1	3.3	41.7	10
Mixed nerve conduction						
Median: Wrist-elbow	55.6	64.0	54.5	51.0	49.4	10
Elbow-axilla	58.1	89.0	57.7	64.0	53.4	10
Ulnar: Wrist-elbow	61.0	18.0	53.4	40.0	47.5	10
Elbow-axilla	69.0	56.0	52.4	42.6	48.1	10
Motor nerve conduction						
Median: Terminal latency	2.9	6.6	2.9	11.8	3.6	5
Elbow-wrist	60.0	6.4	54.1	11.3	50.0	5
Axilla-elbow	56.3	5.6	54.2	11.2	56.0	5
F-wave	32.3		29.8		29.7	
Ulnar: Terminal latency	3.0	5.0	3.3	4.6	2.5	5
Elbow-wrist	58.9	4.5	51.4	4.0	50.6	5
Axilla-elbow	81.0	4.5	52.4	3.7	52.3	5
F-wave	36.3		34.2		30.3	

*L/NCV, Latency (msec)/ NCV (m/s); **Amplitude of compound nerve action potential (μV) for sensory and mixed nerve conduction and amplitude of compound muscle action potential (mV) for motor nerve conduction; ***Normal side: 52.2 m/s in NCV and 12 μV in amplitude. PO, post-operative; ABC, antebrachial cutaneous; NP, no potential. Bold numbers represent abnormal values.

Actual Report

- Findings
- Interpretation

THANK YOU

QUESTIONS