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Fundamentals of NCS and NMJ Testing

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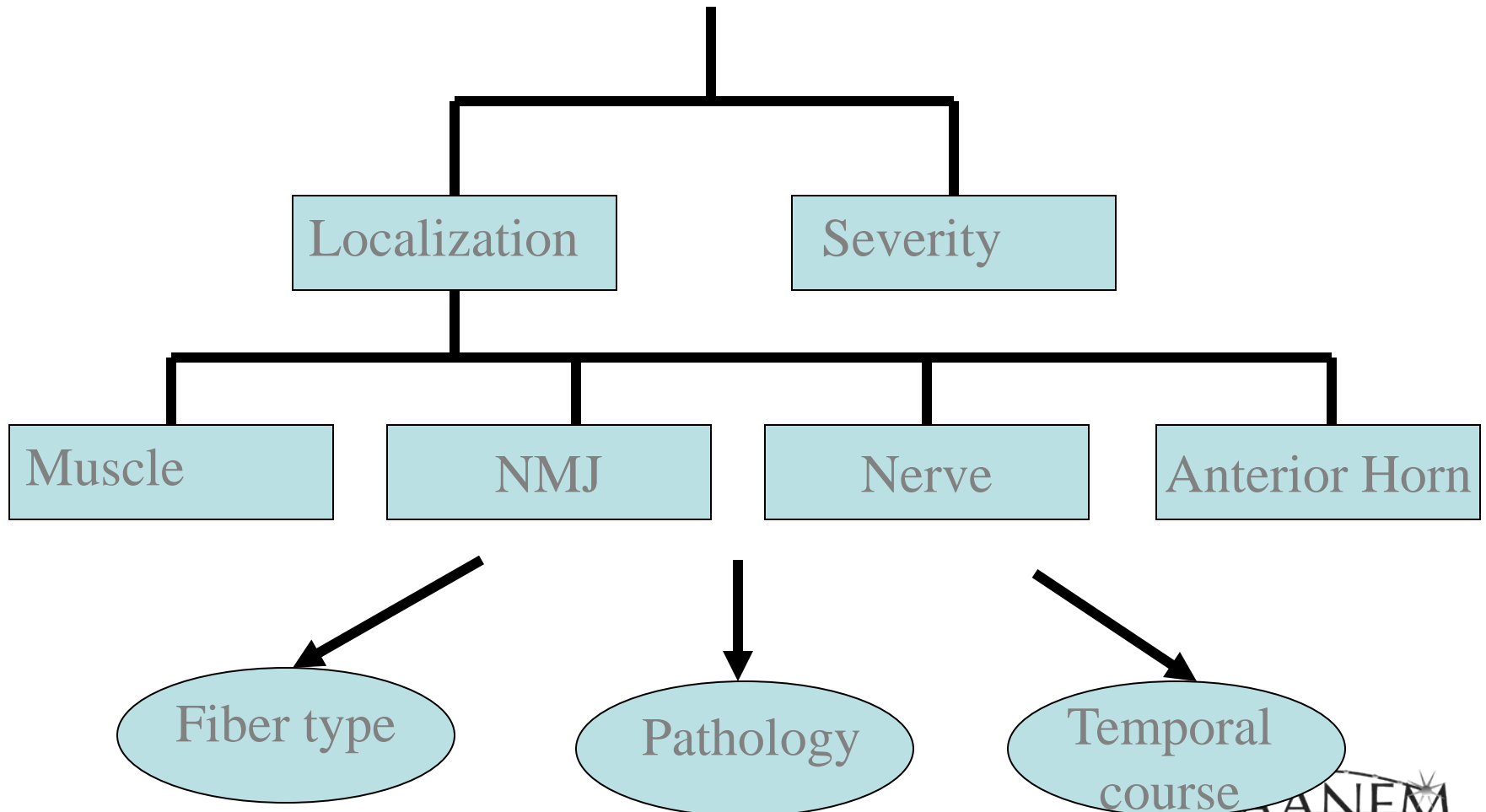


Disclosure

Potential Conflict of Interest

- I have no financial relationships to disclose that are relative to the contents of this presentation.

Goals of EDX Testing



Adapted from fig 1-2, Preston and Shapiro

What are the indications for electrodiagnostic consultation/testing?

- Suspected neuromuscular disease
 - Anterior Horn Cell Disorders
 - Nerve root pathology
 - Peripheral nerve/plexus pathology
 - Neuromuscular junction pathology
 - Muscle pathology

Value of NCSs/EMG

- When neuromuscular disease is present, electrodiagnostic testing can:
 - Clarify the type of pathology (i.e. AHC, root, neuropathy, NMJ, or myopathy)
 - Determine severity & extent of pathology
 - Confirm site of pathology
 - Estimate chronicity of pathology

Disorders Diagnosed/Evaluated by NCSs/EMG

- Generalized Neuropathies
 - Axonal (Many etiologies)
 - Demyelinating
 - Acquired
 - » Acute: GBS
 - » Chronic: CIDP
 - Hereditary
 - Mixed
 - Diabetic sensorimotor neuropathy
 - Uremic neuropathy

Polyneuropathies

Continued

- Polyneuropathies associated with many medical conditions
- Multiple investigations often needed
- NCSs/EMGs: best initial test to clarify underlying pathophysiology (i.e., axonal vs demyelination)
- Results may help focus rest of work-up

Disorders Diagnosed/Evaluated by NCSs/EMG

- Focal Neuropathies
 - Carpal Tunnel Syndrome (median neuropathy at the wrist)
 - Ulnar Neuropathy
 - Peroneal Nerve Palsy
 - Others: brachial plexus lesions, tarsal tunnel syndrome, etc.

Disorders Diagnosed/Evaluated by NCSs/EMG

- Radiculopathy
 - Cervical
 - Lumbar
- Motor Neuron Disease
 - Amyotrophic lateral sclerosis (ALS)
 - Spinal muscular atrophy (SMA)

Disorders Diagnosed/Evaluated by NCSs/EMG

- Muscle Disease
 - Inflammatory
 - Polymyositis, Dermatomyositis
 - Metabolic
 - Hereditary or Congenital

Disorders Diagnosed/Evaluated by NCSs/EMG

- Neuromuscular Junction Disease
 - Myasthenia Gravis
 - Lambert Eaton Myasthenic Syndrome
 - Botulism
 - Medications

Nerve Conduction Studies (NCSs)

Technical Information

- Peripheral nerves are stimulated with an controlled electrical stimulus
- Responses recorded
 - Compound motor action potential (CMAP)
 - Sensory nerve action potential (SNAP)
 - F wave
 - H- reflex

Nerve Conduction Studies

- **Motor Latency**
 - Measure of conduction time from nerve segment through neuromuscular junction to muscle fibers
- **Sensory Latency**
 - Measure of conduction time of action potential across a nerve segment
- **Conduction Velocity**
 - Measure of the velocity of the fastest conducting axons
- **Motor Amplitude**
 - Measure of the number of activated axons and muscle fibers
- **Sensory Amplitude**
 - Measure of the number of activated axons

Nerve Conduction: Late Responses

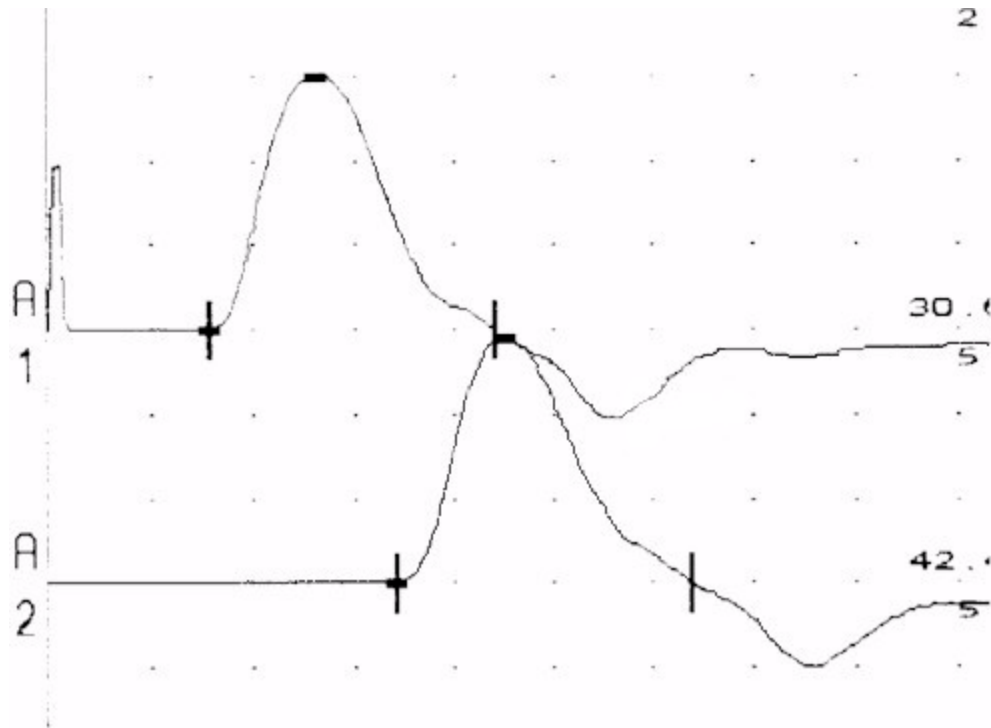
- **F Wave Latency**

- Retrograde “rebound” motor impulse
- Travels full length of motor axon and back
- Information about proximal segments
- Limited sensitivity/specificity

- **H Reflex**

- Afferent Path: Sensory axons (group Ia fibers)
- Efferent Path: Motor Axons (alpha motor neurons)
- Follows muscle stretch reflex arc
- Side to side latency most valuable

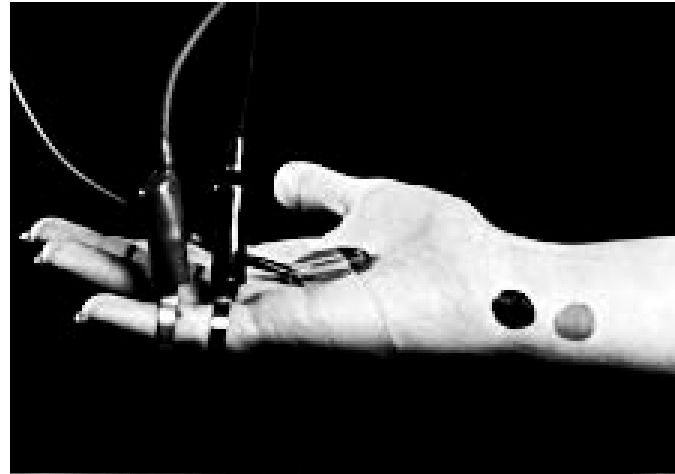
Normal Median Motor Study



	DL (msec)	CV (m/s)	Amp (mV)
Wrist-APB	3.2		15.0
Elbow-Wrist		55	14.8

Types of nerve conduction studies

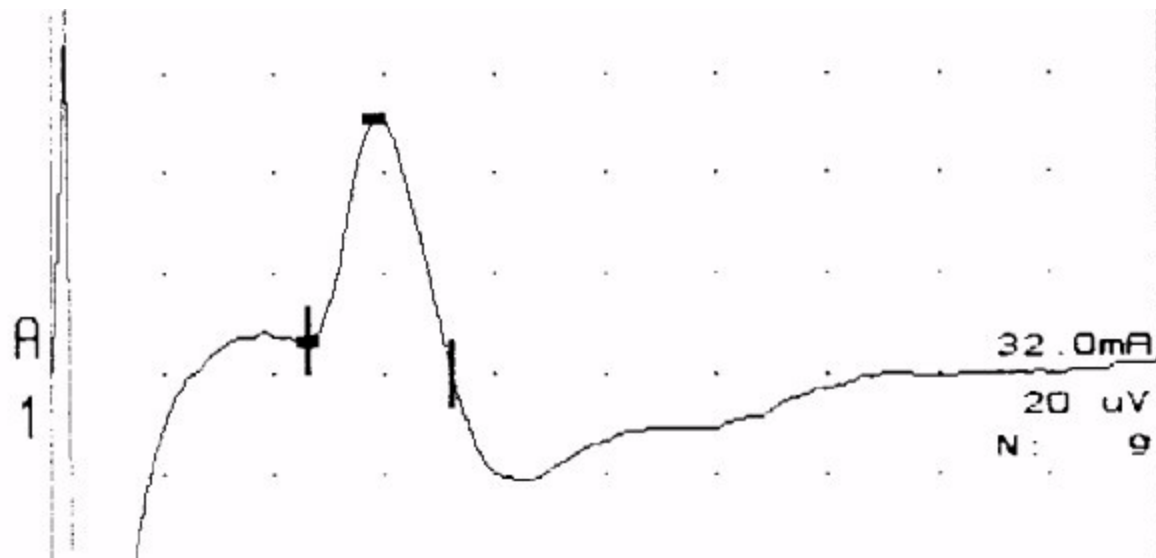
- Sensory: typically antidromic
- Typical nerves examined: Sural, ulnar, median, occasionally superficial radial, superficial peroneal



Sensory NCS Parameters

- Onset and peak latencies
- Conduction velocity
 - determined by velocity of a few fast fibers
- Amplitude
 - determined by the number of large sensory fibers activated

Normal Median Sensory Study



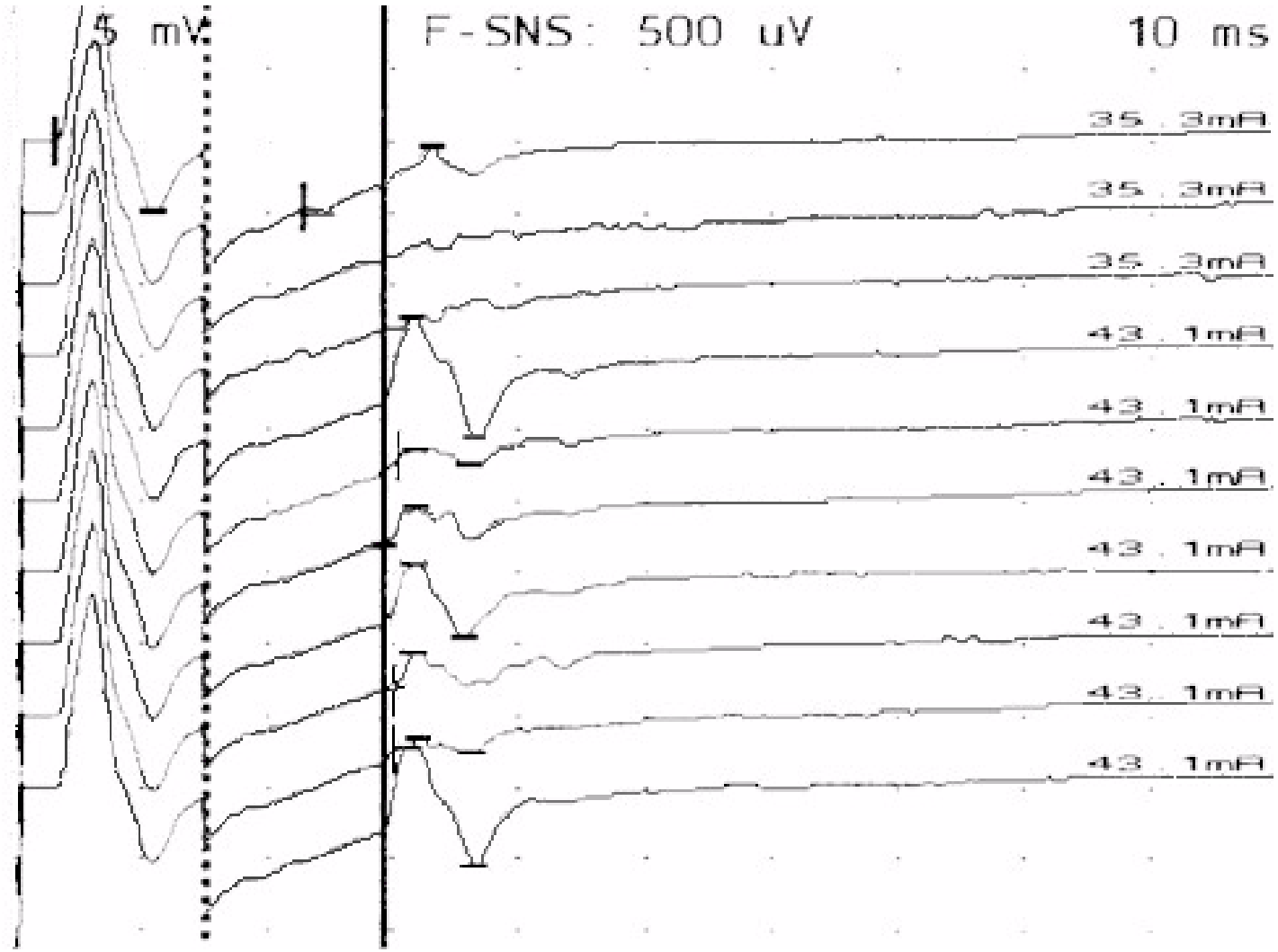
1 msec/div

	Latency (msec)	CV (m/s)	Amp (uV)
Wrist-D2	2.2	58	44.1

F Waves

- Useful to assess proximal nerve conduction
- Helpful in the evaluation of:
 - Radiculopathy
 - Guillian-Barre Syndrome
 - Peripheral neuropathy
 - Other demyelinating neuropathies

F Waves: Normal Median

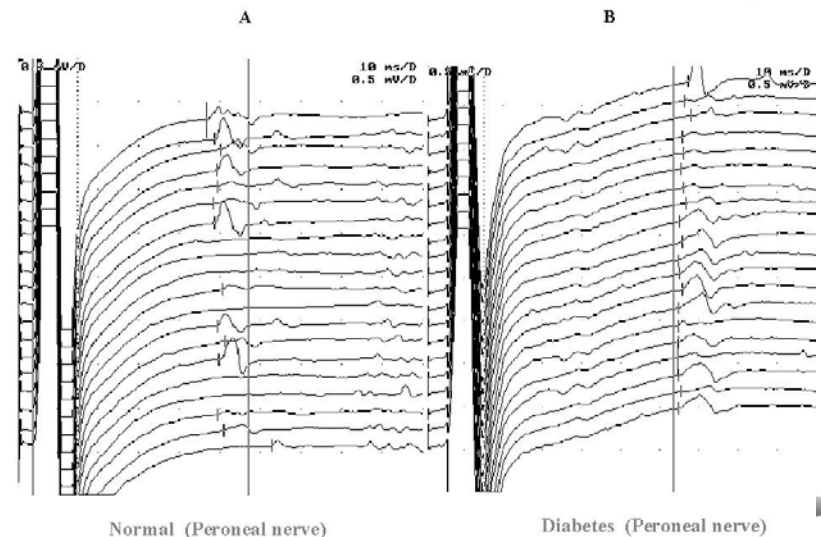
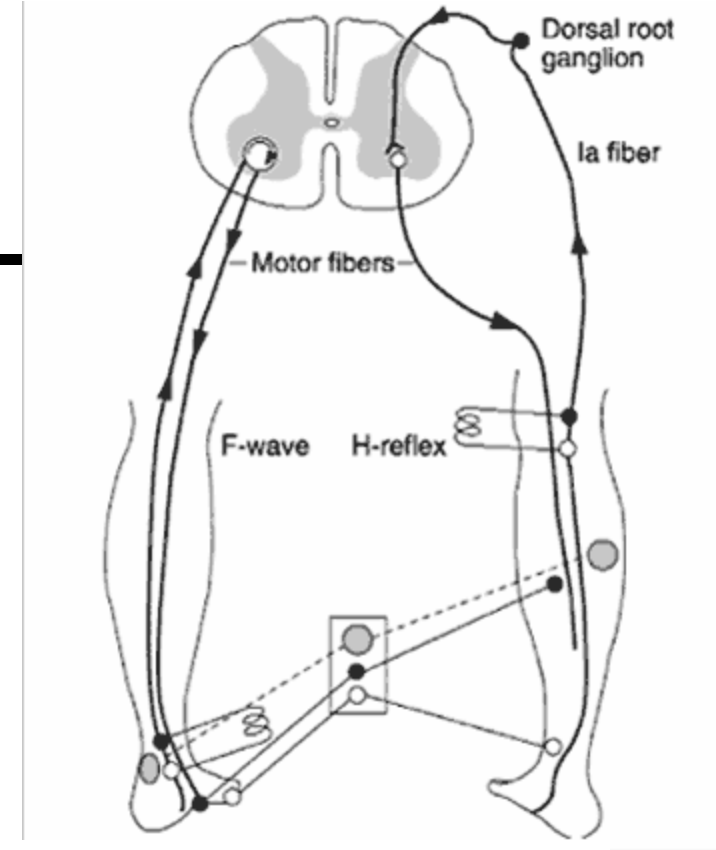


H Reflexes

- Useful to assess proximal nerve conduction
- Helpful in the evaluation of:
 - Polyneuropathy
 - S1 radiculopathy
 - Upper Motor Neuron lesions

F-waves and H-

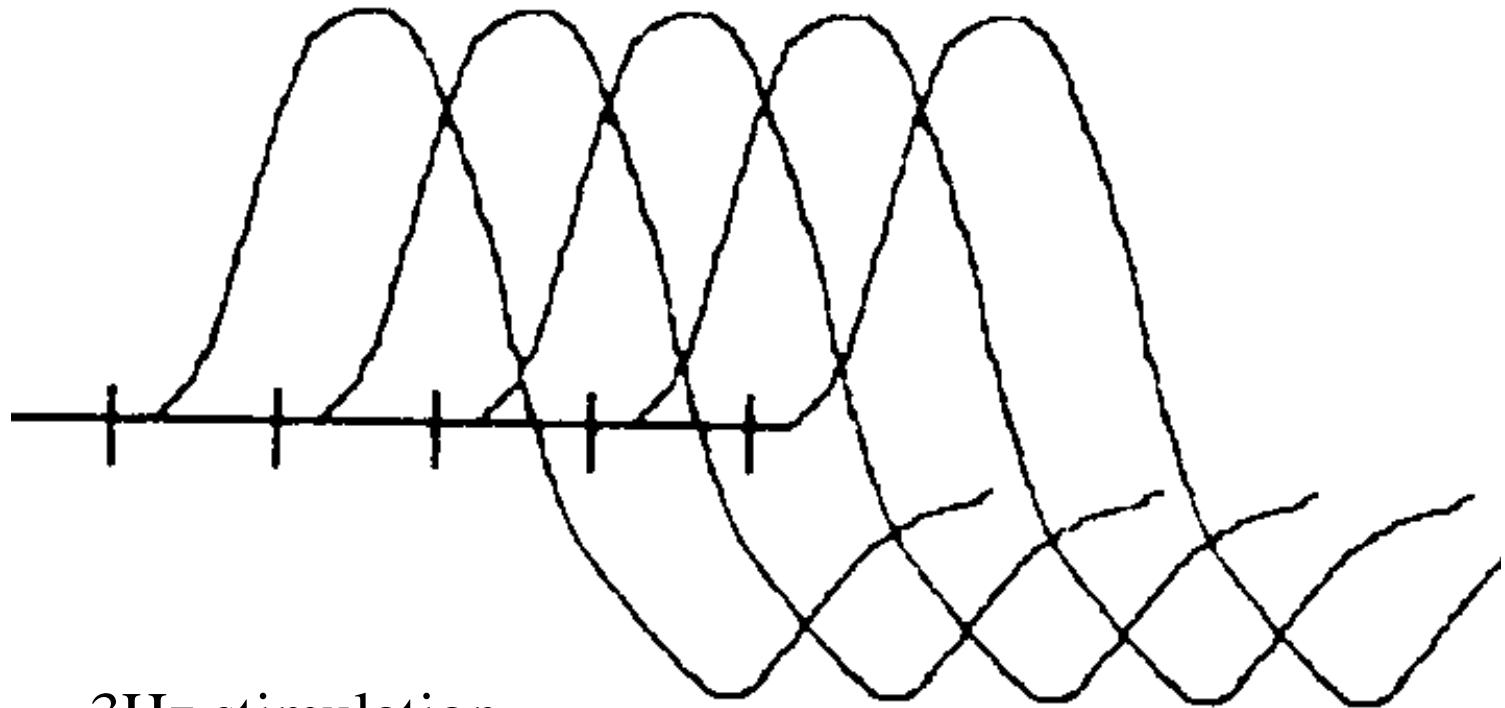
- Useful for identifying proximal segmental demyelination
- Can only be done when motor amplitude is > 1 mV
- Height-dependent



Neuromuscular Junction Testing

- Repetitive Nerve Stimulation
 - Stimulate nerve with train of supramaximal stimuli before and after exercise
 - Record from muscle
 - Attention to technical factors important
 - More sensitive recording from proximal muscles

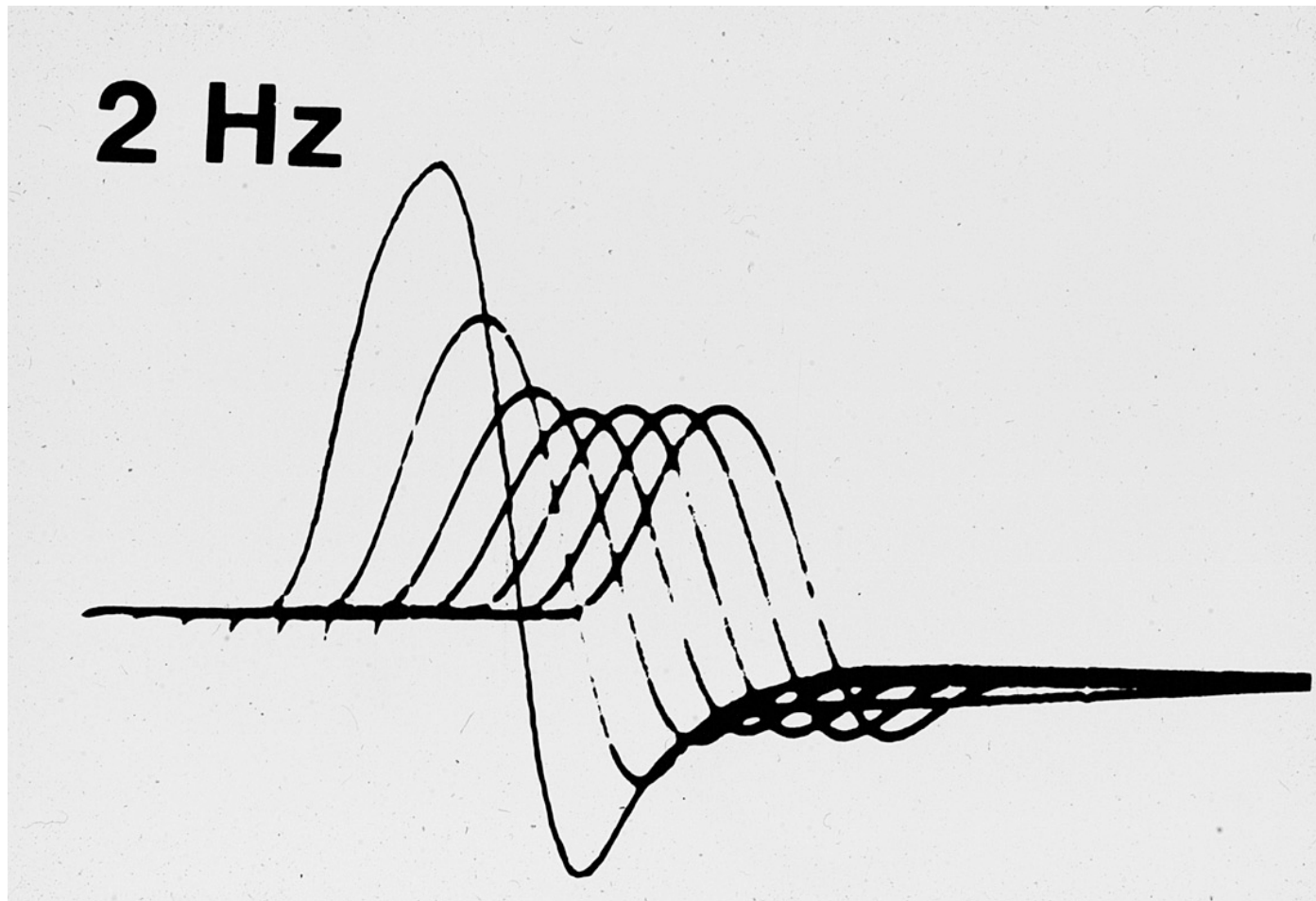
Repetitive Nerve Stimulation: Normal



3Hz stimulation

Myasthenia Gravis

Repetitive Nerve Stimulation



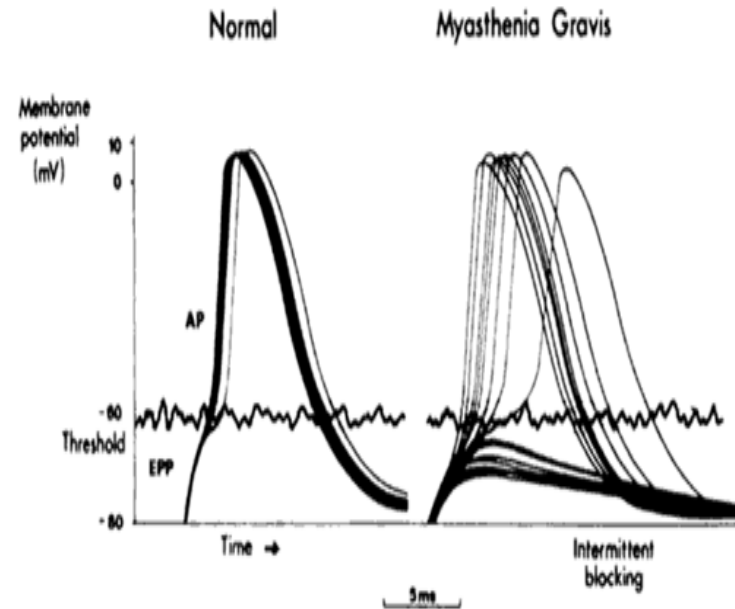
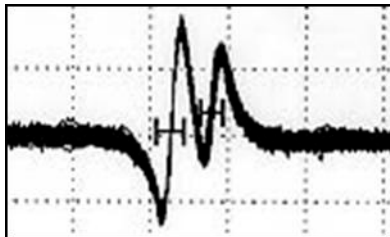
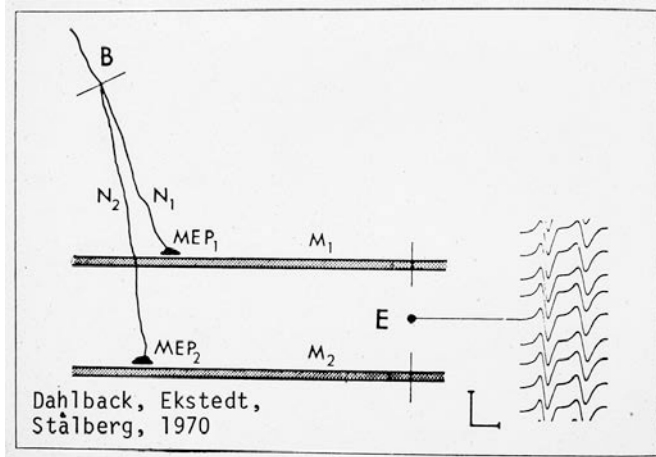
Repetitive Nerve Stimulation

Myasthenia Gravis



Single Fiber EMG

Model of Potential Pairs



Limitations of NCSs/EMG

- Generally not helpful in the evaluation/diagnosis of:
 - Pain from joint disease
 - Fibromyalgia or myofascial pain syndromes
 - Central nervous system disorders
 - Disorders that do not arise from the neuromuscular system

What to Expect From an EMG Report

- The reason for the referral is addressed
- A clinically and physiologically relevant interpretation/diagnosis
- An outline of the localization, severity, and acuity of the process
- Notation of other diagnoses that are detected/excluded
- Explanation of any technical problems

What to Expect From an EMG Report

- Data obtained during the study: (NCS)
 - Amplitude
 - Distal latency
 - Distance
 - Conduction velocity
 - Normal (Reference) data
 - Side-to-side comparison (when appropriate)
 - Limb temperature during the study

What to Expect From an EMG Report

- Data obtained during the study: (EMG)
 - Presence & type of abnormal spontaneous activity
 - Motor unit recruitment
 - Motor unit morphology

EMG “Pearls”

- Electrodiagnostic studies are a supplement to, and not a replacement, for the history and physical examination
- Electrodiagnostic results are often time-dependent
- Electrodiagnostic studies are not “standardized” investigations and may be modified by the practitioner to answer the diagnostic question

Pitfalls of nerve conduction studies

- Temperature effect and cold limb
- Sloppy measurement of distances
- Anatomic abnormalities of patient
- Technical factors: edema, large limbs, long limbs
- Too few nerve conduction studies, lack of comparisons
- Too many nerve conduction studies:
Interpretation of non-existing abnormality