




ELECTRODIAGNOSTIC MEDICINE



Is an EMG study the same as an electrodiagnostic consultation?

- No:
 - Strictly speaking, an EMG (electromyogram or electromyography) refers to the needle or surface examination of the bioelectrical activity of muscle, and is just one component of electrodiagnostic testing. The term is often used synonymously to describe the combination of EMG and nerve conduction studies.
 - An electrodiagnostic medicine consultant will provide a comprehensive and specialized clinical evaluation (history and physical examination), nerve conduction studies, and needle EMG.



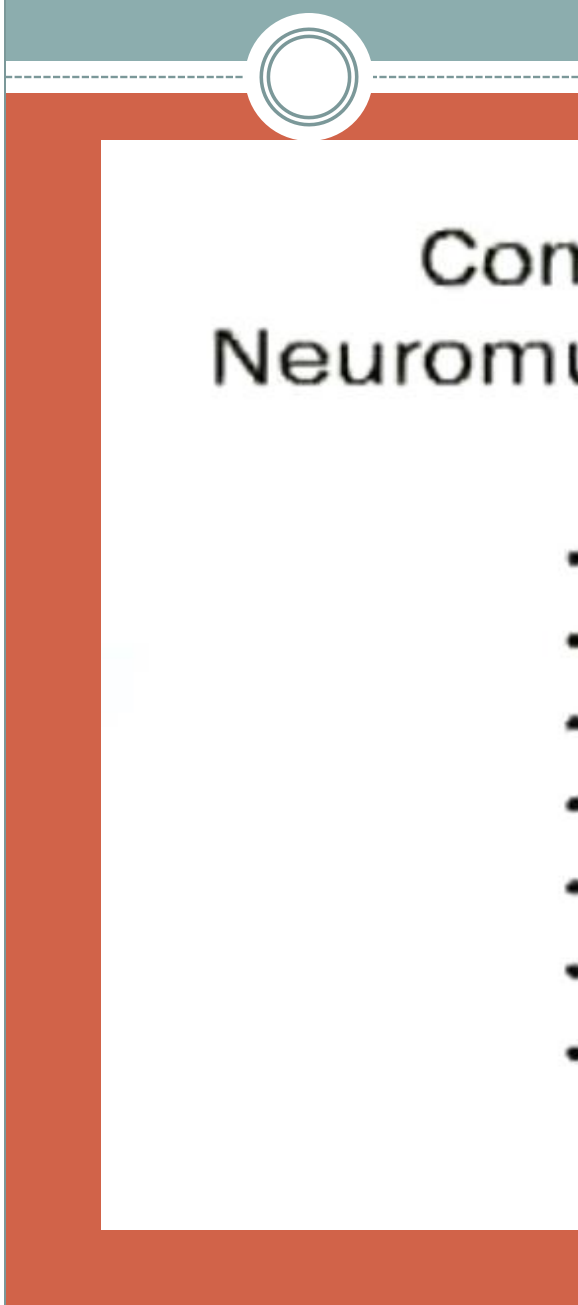
What is an EDX medicine consultation?

- Similar format to other medical subspecialty consultations
- Focused neuromuscular and musculoskeletal history and physical examination
- Synthesis of a differential diagnosis based on history and physical examination
- Electrodiagnostic examination of nerves using nerve conduction studies (NCSs) and muscles using needle electromyography (EMG)
- Formulation of a final diagnosis



Indications for an EDX Medicine Consultation

- Suspected neuromuscular or musculoskeletal disease involving the:
 - motor neuron
 - nerve root
 - plexus
 - peripheral nerve
 - neuromuscular junction
 - muscle



Complaints Suggestive of Neuromuscular or Musculoskeletal Pathology

- Numbness or Tingling
- Decreased Sensation
- Pain
- Cramping or Spasms
- Weakness
- Gait difficulty
- Fatigue



Indications for EDX Medicine Consultation in the Critical Care Setting

- Generalized weakness
- Acute/unexplained onset of respiratory failure
- Neuromuscular cause for failure to wean from mechanical ventilation
- Suspected critical illness neuropathy or myopathy



Utility of an EDX Medicine Consultation

- Clarify etiology of symptoms
 - Radiculopathy vs. Plexopathy vs. Neuropathy
 - Clarify the type of neuropathy
 - Identify a potential source of pain
- Localize a PNS lesion
- Assist in therapeutic decision making
- Predict neurological prognosis
- Exclude other disorders



What is an EMG?

- EDX testing is used to assess the function and integrity of the peripheral nervous system.
- EDX testing is considered an extension of a comprehensive clinical evaluation that includes a detailed history and specialized physical examination.
- Components:
 - Nerve conduction studies (NCS)
 - Electromyography (EMG)
 - Special tests (repetitive nerve stimulation, single fiber evaluation, etc.)

Components of an EMG

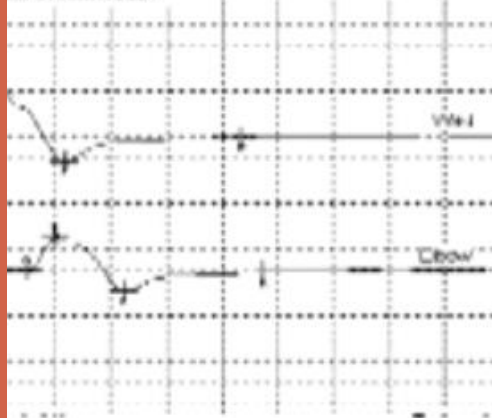
Nerve conduction studies

- Motor nerves
- Sensory nerves
- Repetitive Stimulation

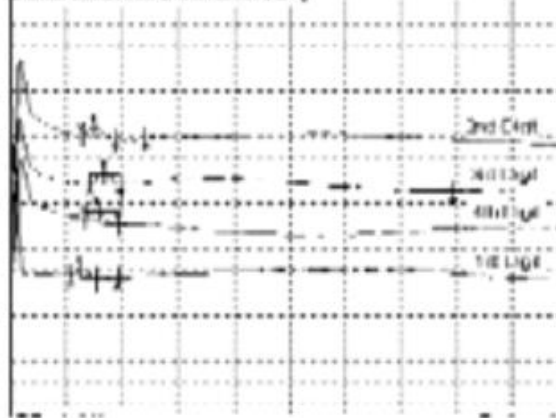
Electromyography

- Qualitative
- Quantitative
- Single fiber

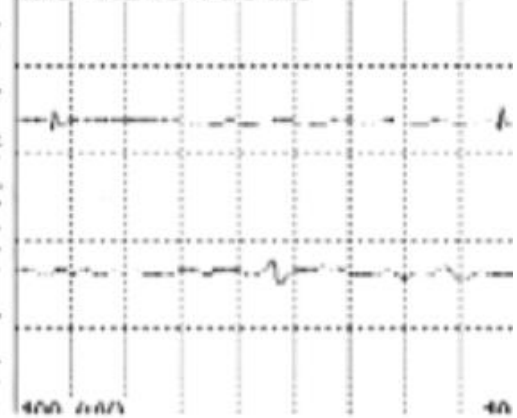
Median Motor



Left Median Sen Sensory



EMG - Left CervPara Mid

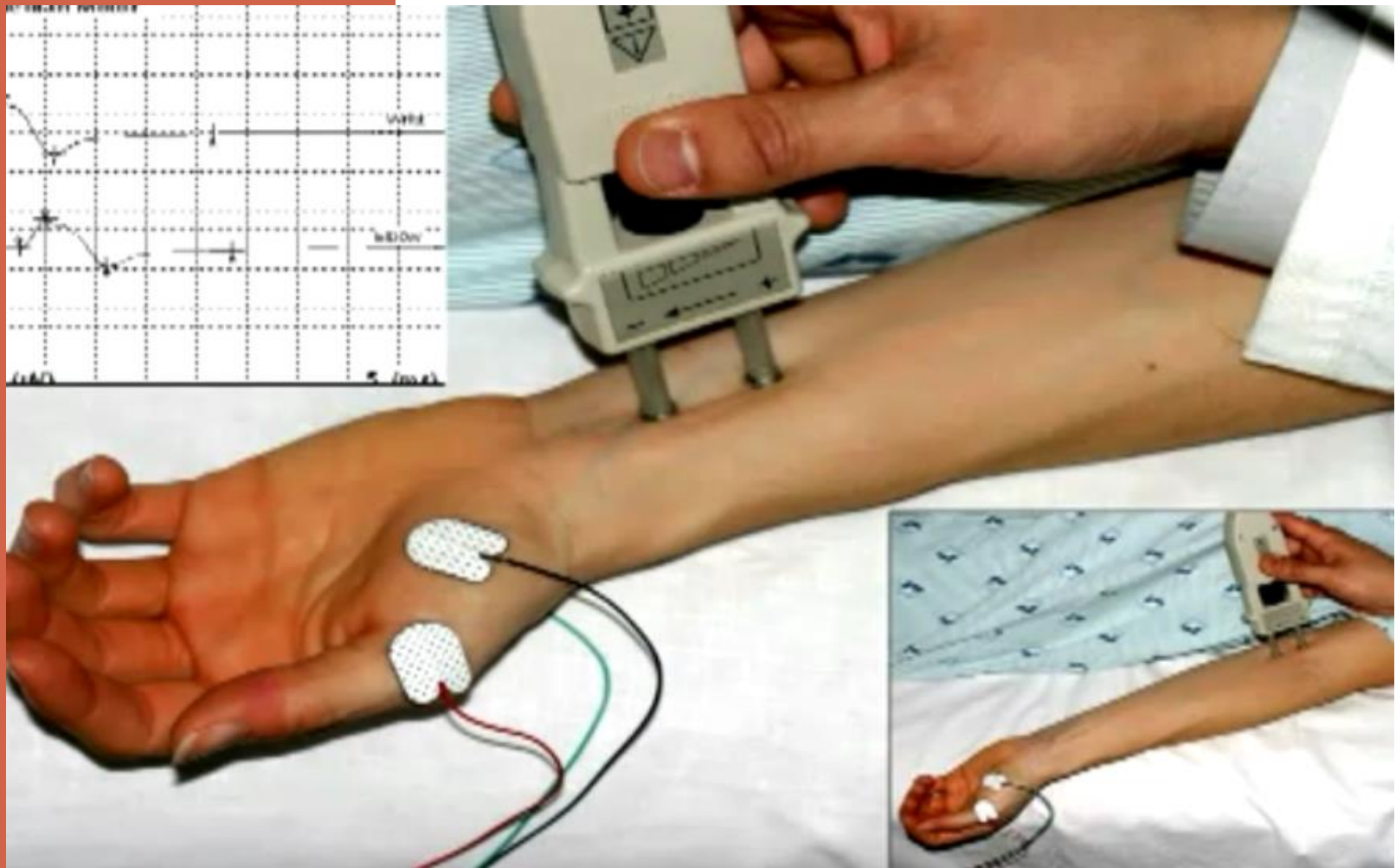
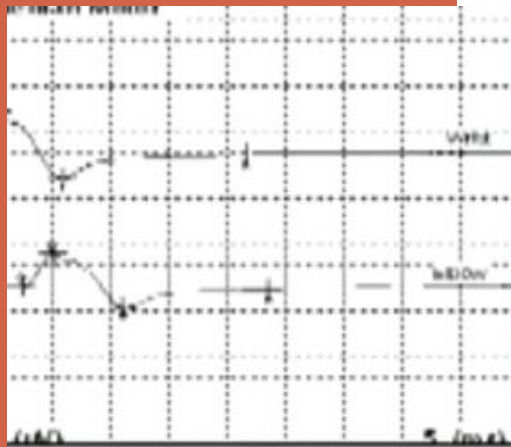


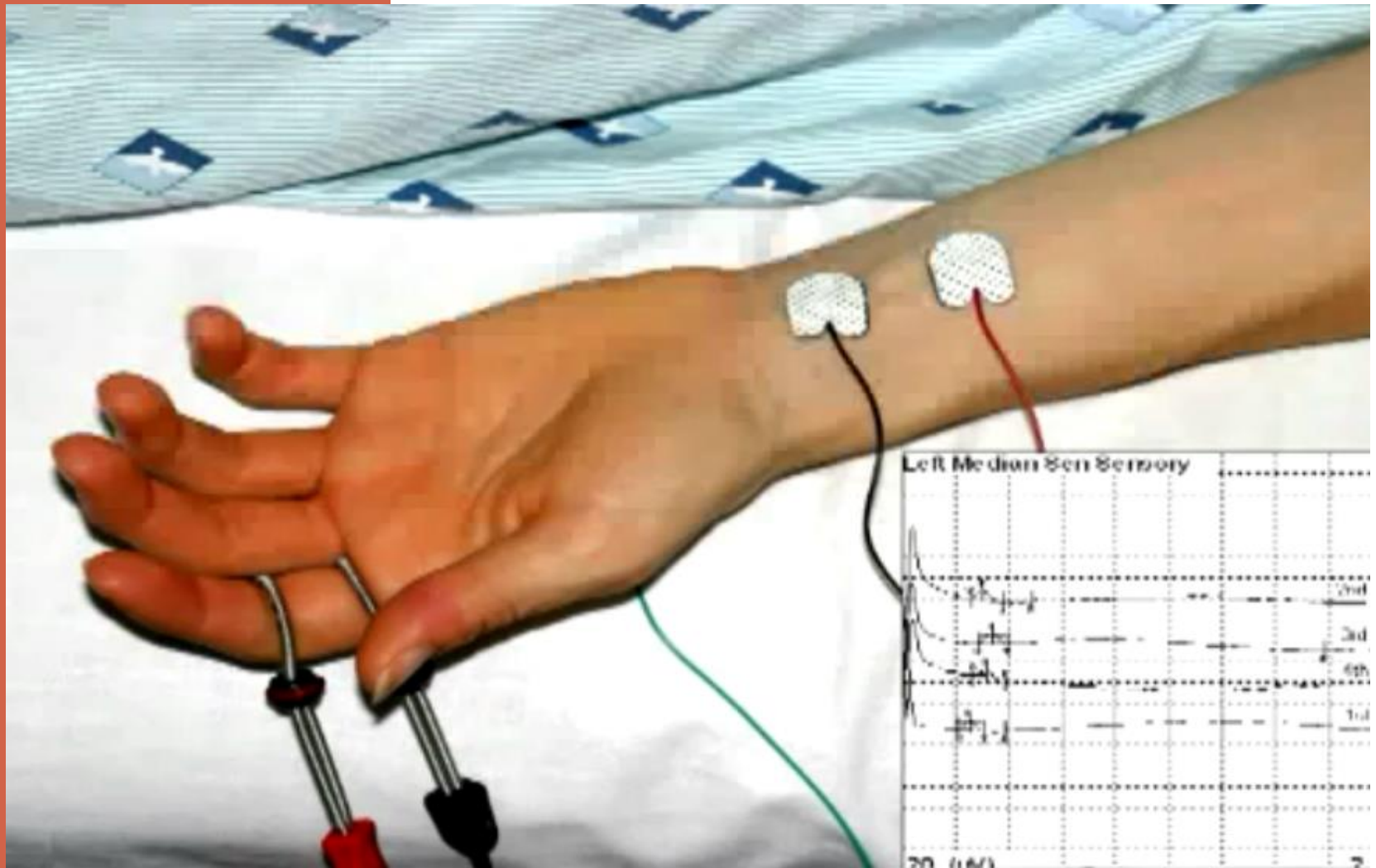




Nerve Conduction Studies

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







Nerve Conduction Studies: Basic Elements

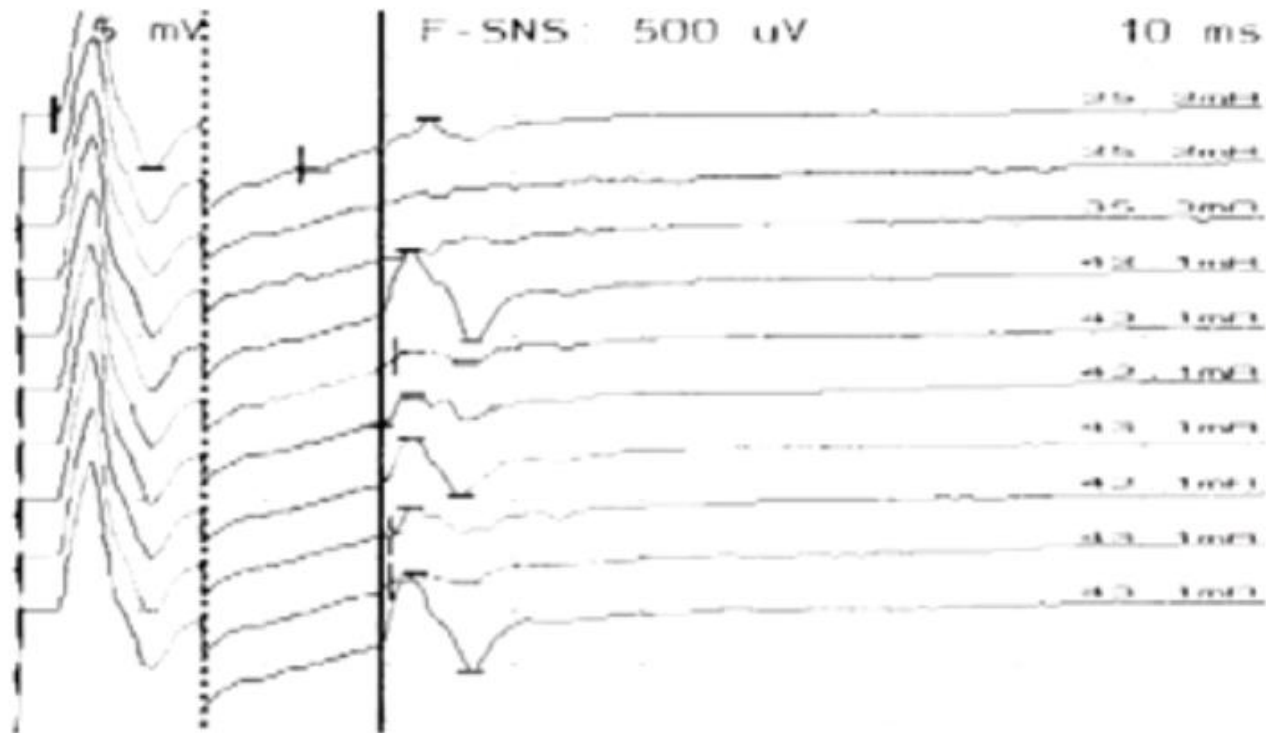
- Motor Nerve Conductions
- Sensory Nerve Conductions
- Late Responses
 - F Wave Latency Measures
 - H Reflexes



Nerve Conduction Studies: Measured Parameters

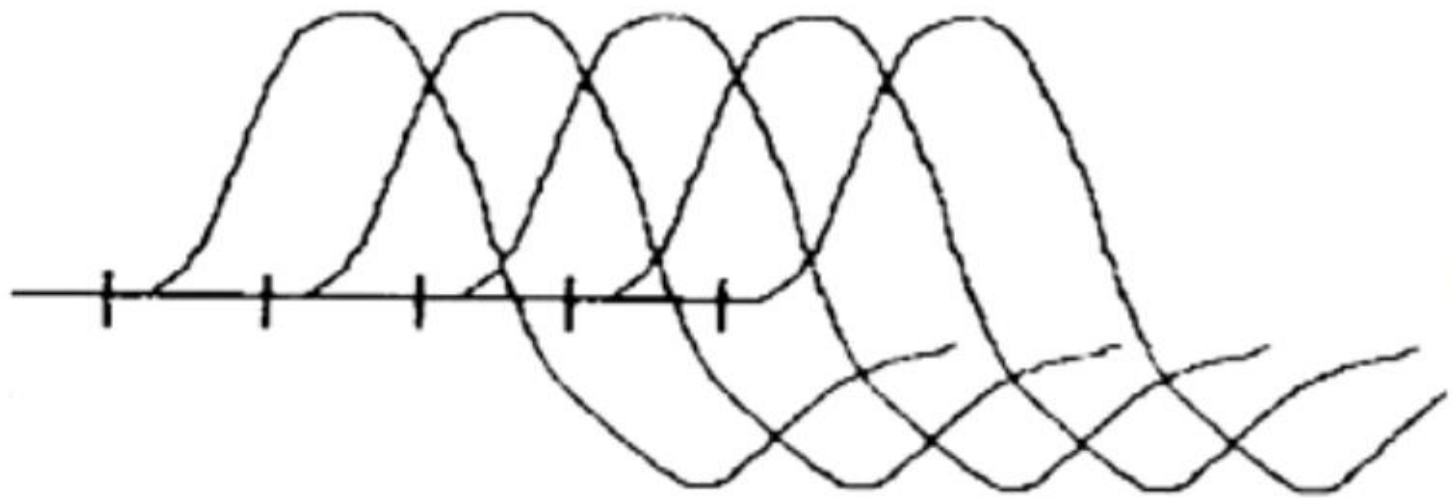
- **Motor Latency**
 - Measure of conduction time from stimulation across a nerve segment through the neuromuscular junction to initial activation of muscle fibers
- **Sensory Latency**
 - Measure of conduction time of action potential from stimulation across a nerve segment
- **Motor Amplitude**
 -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

F Waves: Normal Median



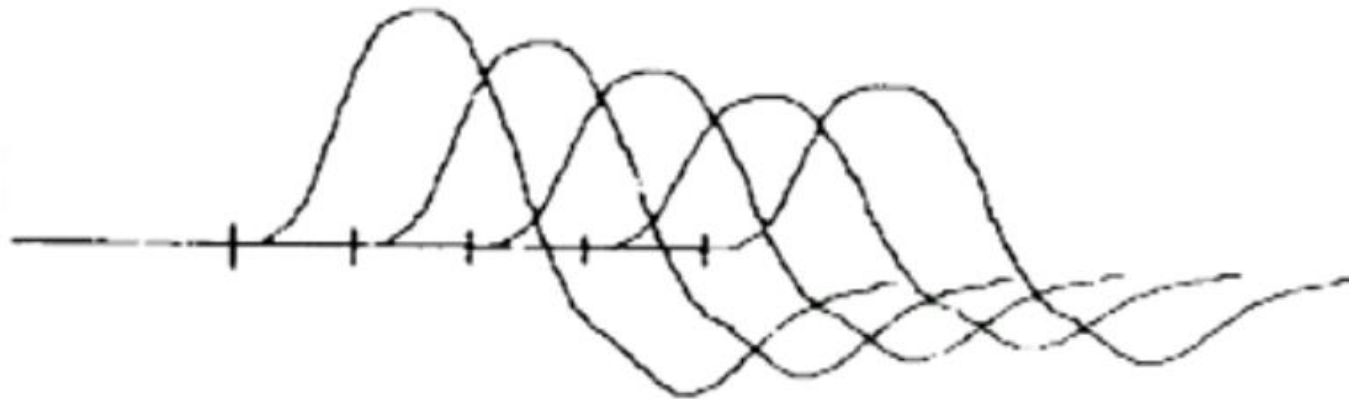


Repetitive Nerve Stimulation: Normal



3Hz stimulation

Repetitive Nerve Stimulation: Myasthenia Gravis



3 Hz stimulation rate



Needle Electromyography

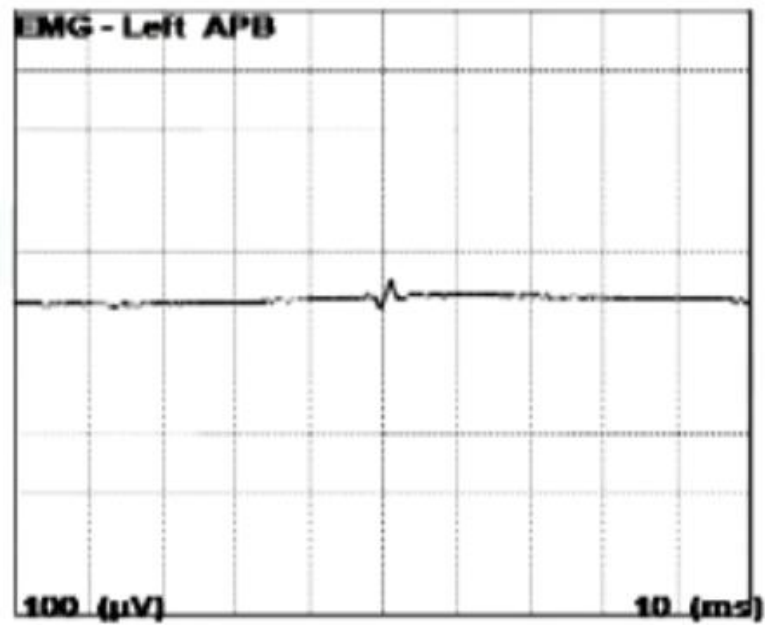
- Needle electrode is inserted into the muscle
 - Needle is disposable, single use
- Multiple muscles are accessible for examination
- Combination of muscles tested
 - Dependent upon clinical question
- Level of discomfort is mild



Needle Electromyography

- Muscle is studied at rest and at different levels of sustained, voluntary contraction.
- At rest, the muscle should be silent--any spontaneous activity may signal a nerve or muscle abnormality.
- During activity, the electrical shape and pattern of the response can distinguish between nerve and muscle disease.

Needle Electromyography





Needle Electromyography: Parameters Evaluated

- Insertional activity
- Spontaneous activity
- Motor unit configuration
- Motor unit recruitment
- Interference pattern

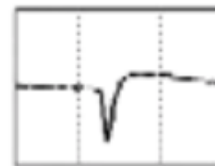


Needle Electromyography: Parameters Evaluated

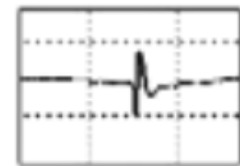
- **Insertional Activity**
 - Burst of electrical activity as needle is inserted into muscle
 - Due to disruption of muscle fiber membranes
 - Prolonged with denervation, some muscle diseases
- **Spontaneous Activity**
 - Fibrillations, positive sharp waves, fasciculations
 - Hallmark of denervation, muscle membrane irritation

Needle Electromyography: Spontaneous Activity

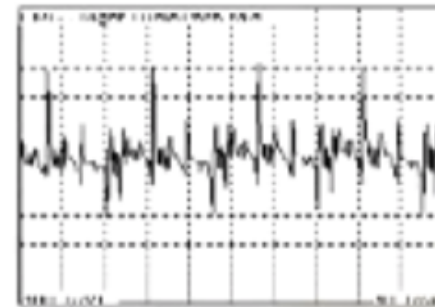
- Fibrillation potentials
- Positive sharp waves
- Fasciculations
- Complex repetitive discharges
- Myokymia
- Myotonia



Positive Sharp Wave



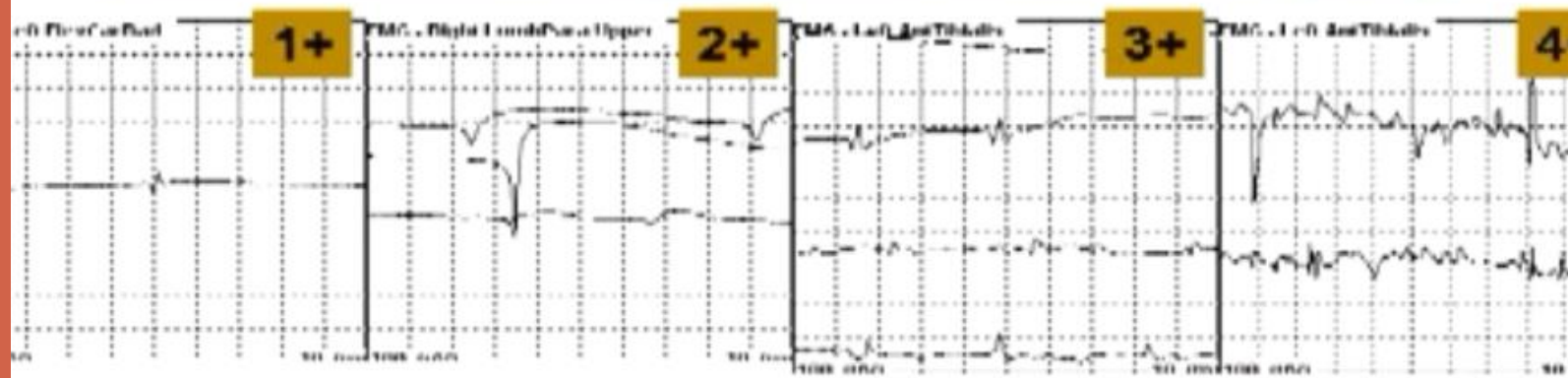
Fibrillation Potential



Complex Repetitive Discharge

Needle Electromyography: Grading of Spontaneous Activity

0	No Fibs/PSWs
+/-	Fibs/PSWs that are not persistent
1+	Persistent Fibs/PSWs in at least 2 areas
2+	Persistent Fibs/PSWs of moderate #'s in three or more areas
3+	Persistent Fibs/PSWs of large #'s but not obscuring baseline
4+	Baseline obliterated in all areas examined





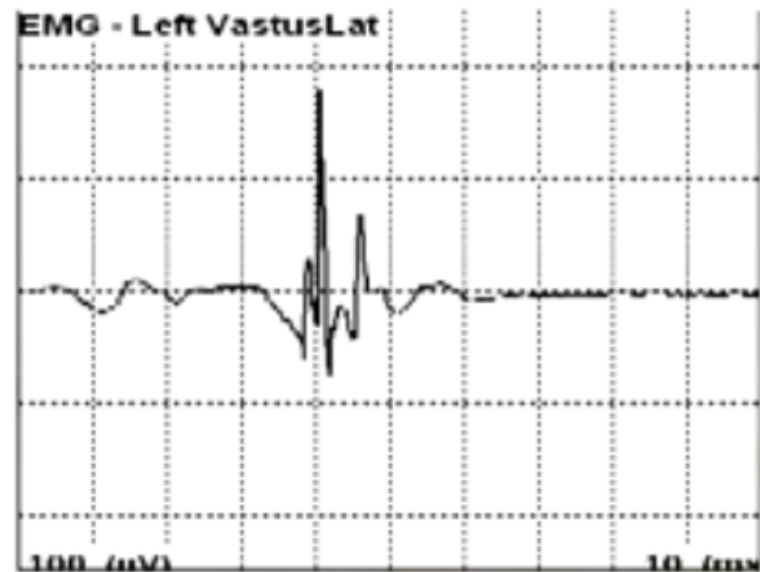
Needle Electromyography: Parameters Evaluated

- **Motor Unit Configuration**
 - Muscle is volitionally activated at different force levels
 - Single motor units are assessed
 - Single motor unit: A motor axon and all its muscle fibers
 - Motor Unit Configuration: Amplitude, Duration, Morphology
- **Motor Unit Recruitment**
 - Pattern of motor unit activation with increasing volitional activation
- **Interference Patterns**
 - Motor unit pattern with full voluntary activation

Needle Electromyography: Neurogenic Motor Unit

This unit demonstrates:

- Reduced recruitment
- Increased amplitude
- Increased duration
- Polyphasia






General EDX Options

- Normal
- Radiculopathy
- Plexopathy
- Neuropathy
- Myopathy
- Widespread denervation (MND)
- Disorders of neuromuscular transmission



Specific EDX Options

- Acute vs. Chronic vs. Acute & Chronic
- Mild vs. Moderate vs. Severe
- Anatomic Location
 - Root
 - Plexus
 - Nerve
 - Neuromuscular junction
 - Muscle
- Distribution
 - Polyradiculopathy
 - Trunk, Cord
 - Mono vs. Multiplex vs. Distal Symmetric



Select Disorders Diagnosed or Evaluated by EDX Testing

- **Motor Neuron Disease**
 - Amyotrophic lateral sclerosis (ALS)
 - Spinal muscular atrophy (SMA)
- **Radiculopathy**
 - Cervical
 - Lumbar
- **Plexopathy**
 - Brachial
 - Lumbosacral
- **Muscle Disease**
 - Inflammatory
 - * Polymyositis, Dermatomyositis
 - Metabolic
 - Hereditary or Congenital
- **Neuromuscular Junction Disease**
 - Myasthenia Gravis
 - Lambert-Eaton Myasthenic Syndrome
 - Botulism
 - Medications
- **Neuropathy**
 - Generalized
 - * Axonal
 - Demyelinating
 - Acquired (GBS/CIDP)
 - Hereditary
 - * Mixed
 - Diabetic
 - Mononeuropathy multiplex
 - * Vasculitic/ischemic
 - Demyelinating
 - * Infections
 - * Neoplastic
 - * Granulomatous
 - Focal (mono)
 - * Median (CTS)
 - * Ulnar
 - Peroneal
 - * Sciatic



What to Expect From an EMG Report

- 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



EMG “Pearls”

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



Pathophysiology of Nerve Injury

- Neuropraxia
 - Mildest; transient disruption of nerve function
 - Ischemic, metabolic or microstructural abnormalities
 - Axonal integrity maintained
 - Reversible failure of nerve conduction
 - Most often compressive/ischemic
 - Normalizes in hours to weeks



Pathophysiology of Nerve Injury

- Axonotmesis
 - Disruption of the axon and myelin sheath
 - Supporting and connective tissue spared
 - Recovery
 - May be minimal, incomplete, or full
 - Dependent upon severity and length of nerve injured
 - Via axonal sprouting and regeneration
 - Growth rate of about 1-3 mm/day
 - Crush, stretch most common causes
 - Slower, usually months



Pathophysiology of Nerve Injury

- Neurotmesis
 - Nerve transection
 - Disruption of axons, myelin sheaths, and supporting connective tissue
 - Most commonly due to transection, severe crush, avulsion
 - Recovery
 - Requires juxtaposition of transected ends and axonal growth
 - Early surgical intervention and juxtaposition often needed



EMG Report: Example of an Impression

"There is electrophysiological evidence for a severe and acute left femoral mono-neuropathy at the inguinal ligament. There is no evidence for radiculopathy, plexopathy, other neuropathy, or myopathy. A follow-up study in approximately one week may help predict prognosis for recovery. Clinical correlation is suggested."