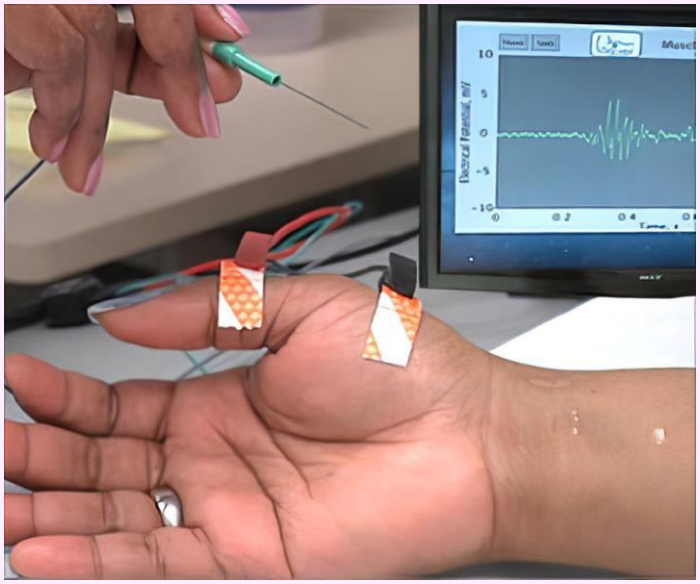
Lecture- 04

Electromyography (EMG) and
Motor Nerve Conduction Study (Motor NCS)



Electromyography

Electromyography

Electro

Involving Electricity

Myo

Relating to Muscle

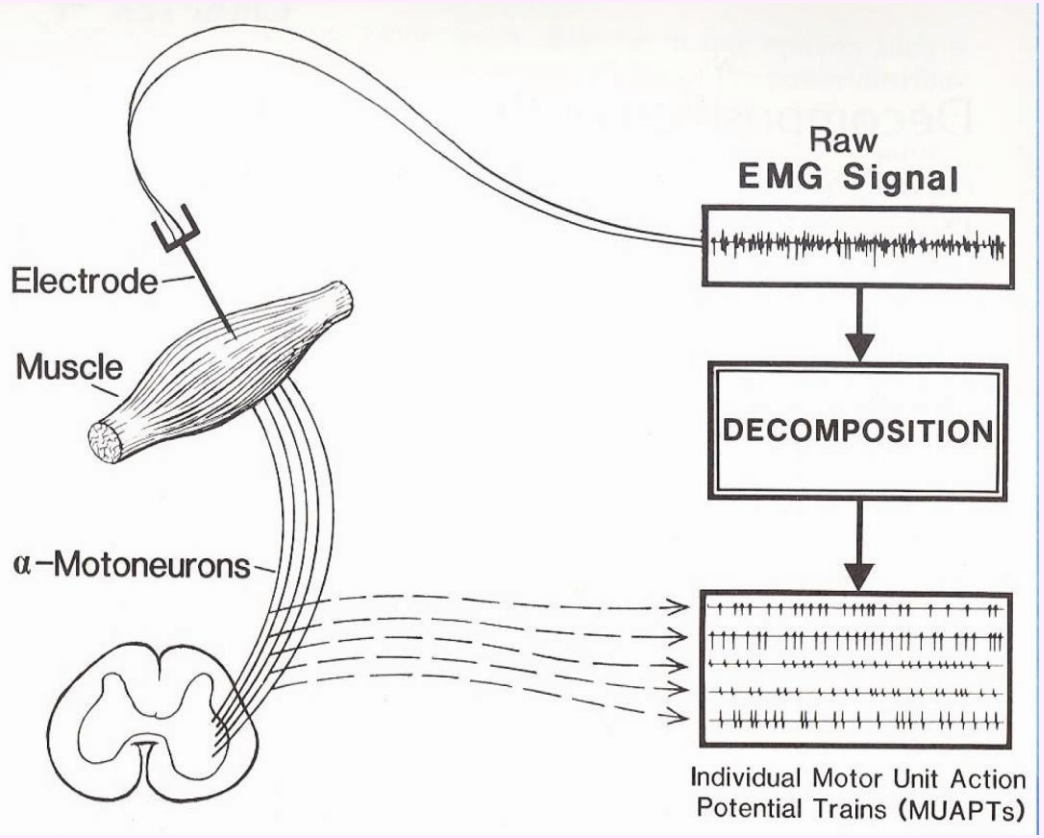
Graphy

Technique of producing Images

- Electromyography is a technique for evaluating and recording the electrical activity produced by skeletal muscles.

Electromyography (EMG)…

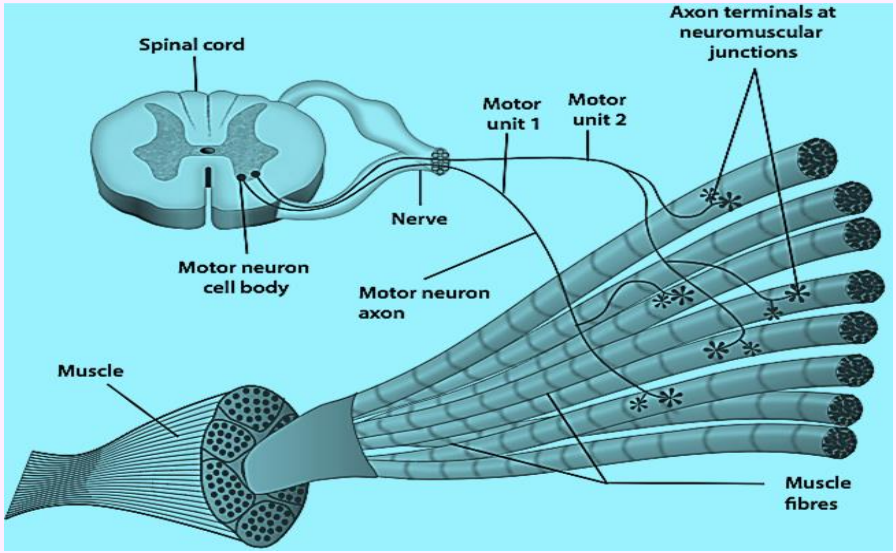
- EMG is a technique for evaluating and recording physiologic properties of muscles at rest and while contracting.

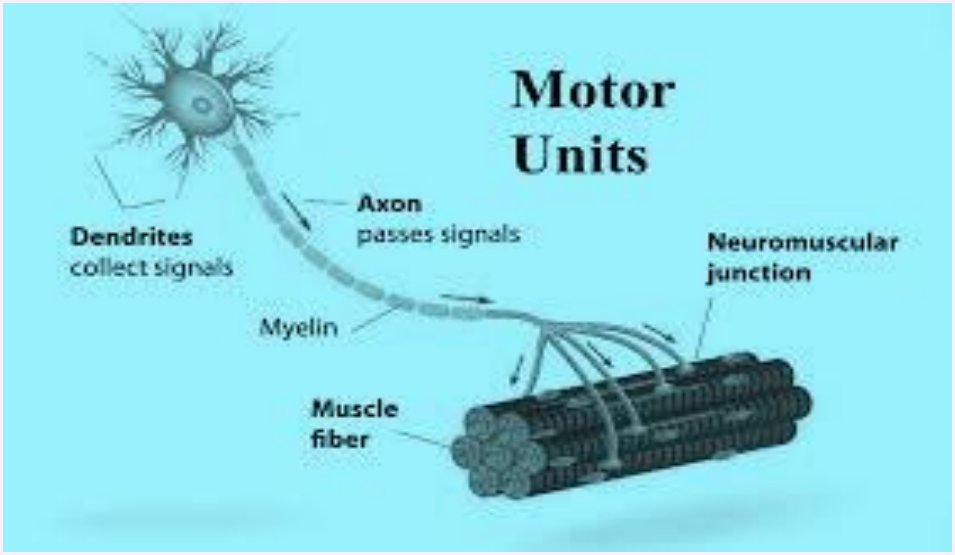


Source of EMG signal

- The source of the SEMG signal is the motor unit action potentials (MUAP)

Motor Unit: One motor neuron + all the muscle fibres it innervates.





- A motor unit is composed of one motor neuron & all the muscle fibres it innervates.

Motor Unit Action Potential (MUAP)

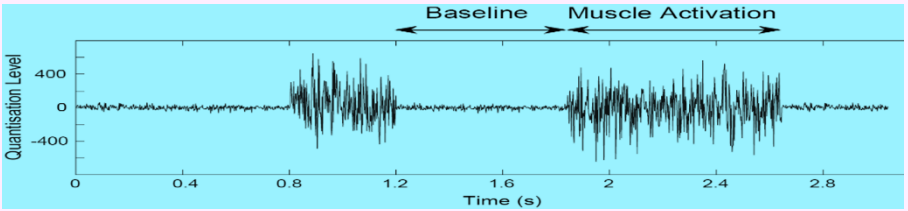
When a motor unit fires, the impulse (i.e., the *action potential*) is carried down the motor neuron to the muscle. The area where the nerve contacts the muscle is called the *neuromuscular junction*, or the motor end plate. After the action potential is transmitted across the neuromuscular junction, an action potential is elicited in all the innervated muscle fibers of that particular motor unit.

The sum of all this electrical activity is known as a *motor unit action potential (MUAP)*. This electrophysiologic activity from multiple motor units is typically evaluated during an EMG. The composition of the motor unit, the number of muscle fibers per motor unit, the metabolic type of muscle fibers and many other factors affect the shape of the motor unit potentials in the electromyogram.

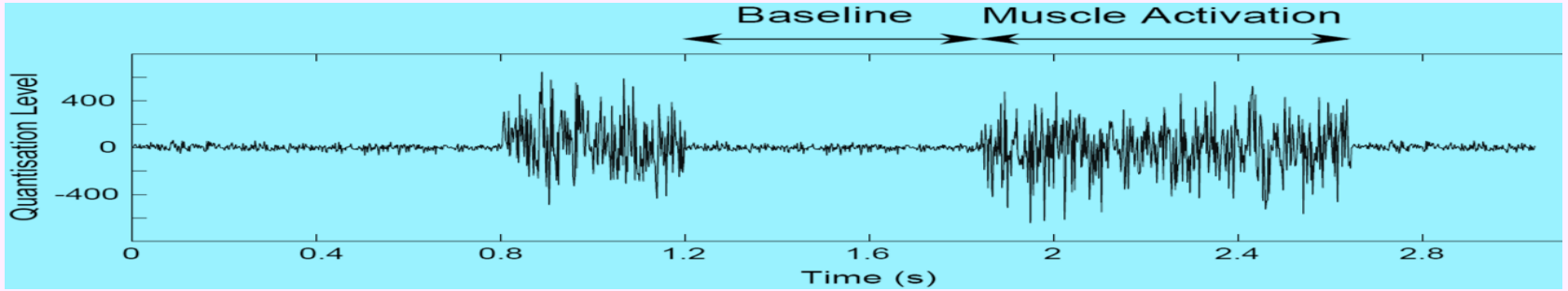
Electromyograph vs. Electromyogram

- The instrument used to measure the electrical activity of muscles is called **Electromyograph.**

- The recorded pattern of the electrical activity of muscles is called **Electromyogram.**



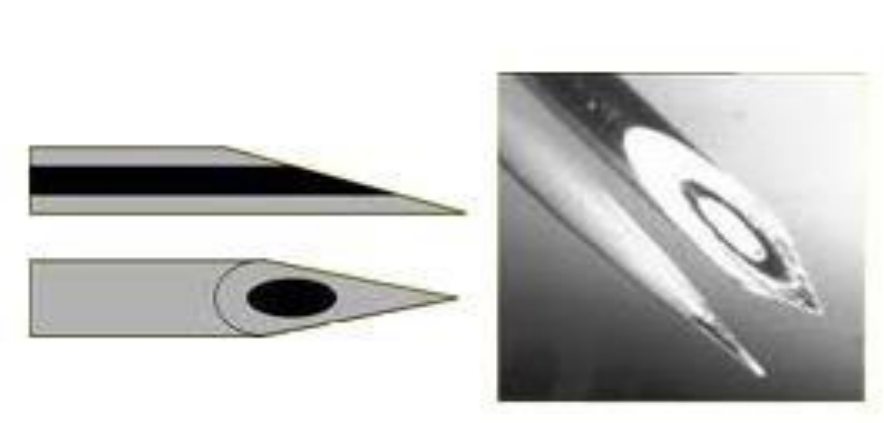
- A resting muscle does not show recordable electrical potential but with increase force of contraction, amplitude of potential increases.



EMG Electrodes

Three types of EMG electrodes-

i. Needle electrodes,
ii. Fine-wire electrodes, and
iii. Surface electrodes.



The most commonly used EMG electrode is needle type. This electrode's tip is exposed, and it has an embedded core inside which jointly works as the detection surface. The signal quality is relatively superior to the other two kinds.

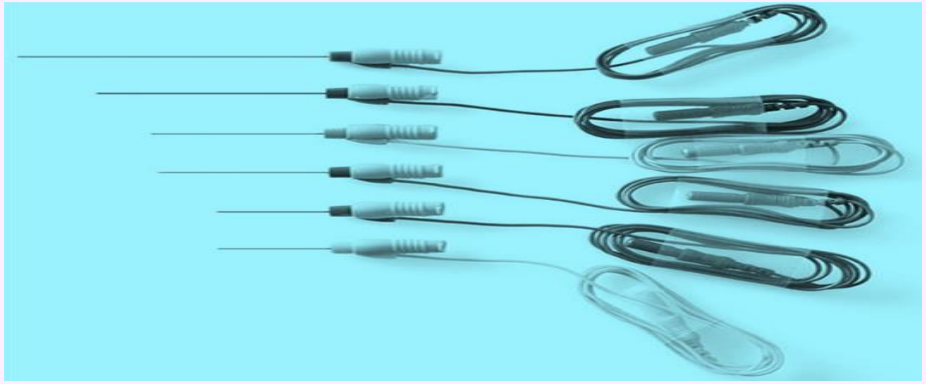
EMG Electrodes…

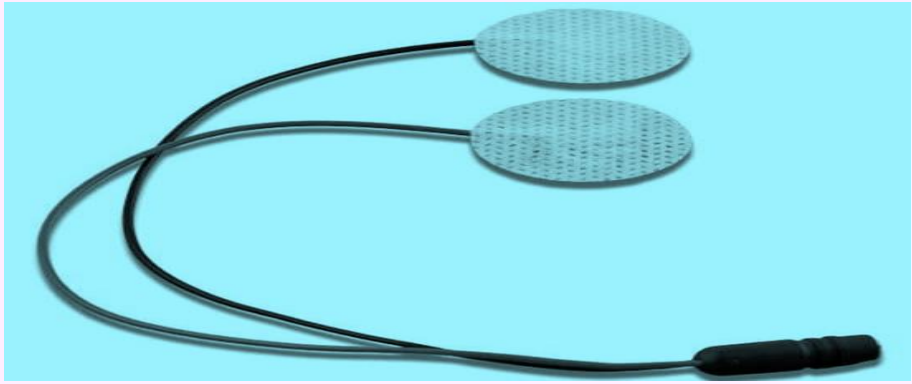
Fine-wire electrodes are smaller in diameter and less painful than the needle type.

The third kind is called surface EMG electrodes, and they are entirely non-invasive. However, as these electrodes are placed on the skin, they can only collect signals from superficial muscles and contain a relatively large amount of noise.

Types of EMG

- Intramuscular: -Invasive recording of EMG directly from the Motor Unit
  -Needle electrode & Fine wire electrode
  -Used in Nerve Conduction study
- Extramuscular: -Noninvasive recording of EMG from the surface of the muscle
  -Surface electrode
  -Used in muscle study





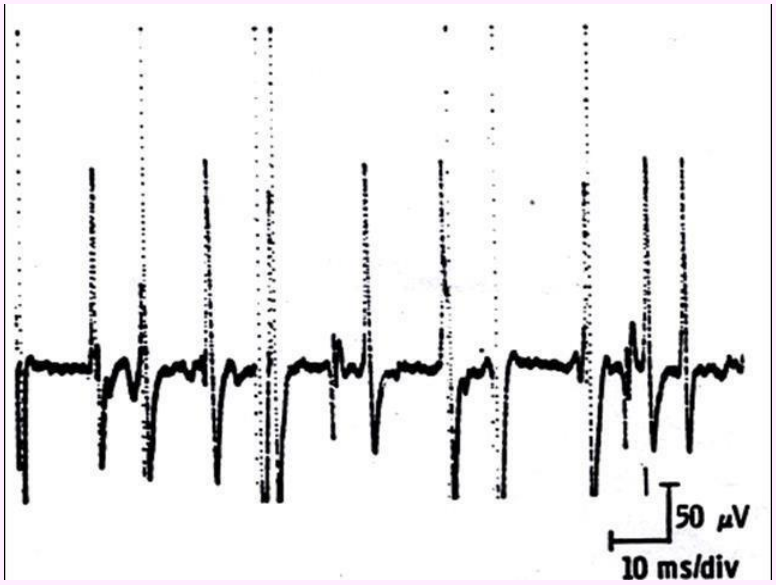
EMG Analysis

EMG

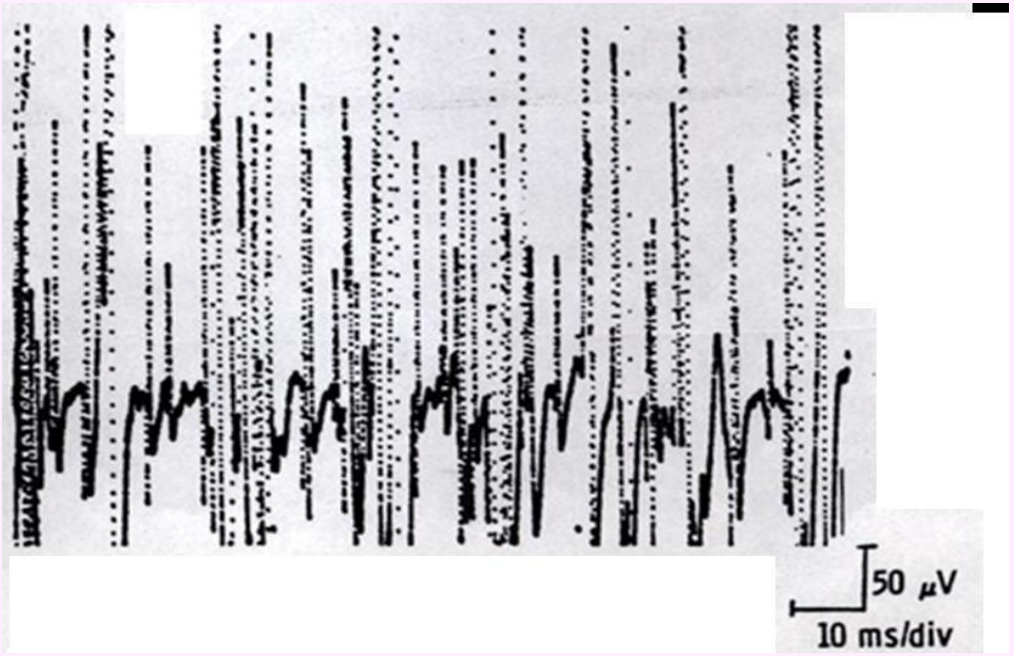
- Spontaneous activity
  - In normal EMG, the skeletal muscle is silent at rest, hence spontaneous activity is absent.
- Normal duration: 3-15 ms
- Normal amplitude: 300μV-5 mV

EMG Analysis…

During Mild Effort



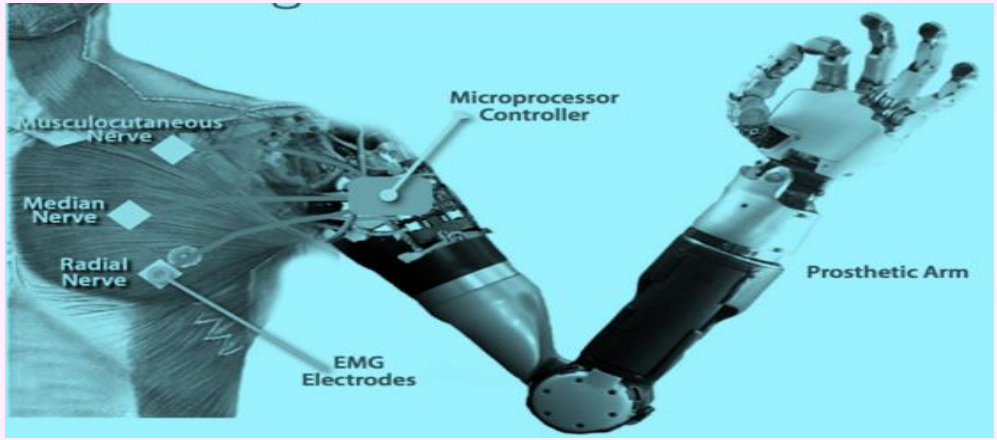
During Moderate Effort:
recruitment of additional motoneurons



During Full Voluntary Effort:
There is full recruitment
(baseline is not noticeable)

Applications of EMG

- EMG is used as a diagnostic tool for identifying:
  - Neuromuscular diseases, assessing low back pain
  - Disorders of motor control
- EMG signals are also used as :
  - A control signal for prosthetic devices such as prosthetic hands , arms and lower limbs
- Many more …….

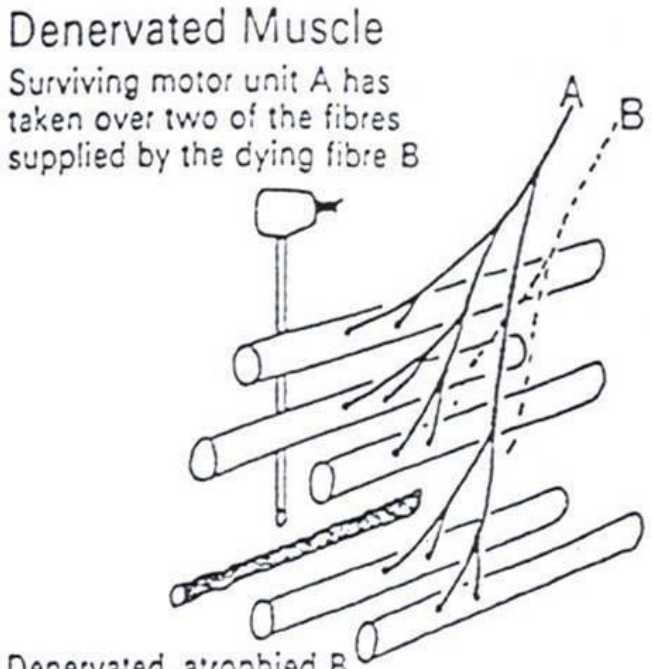


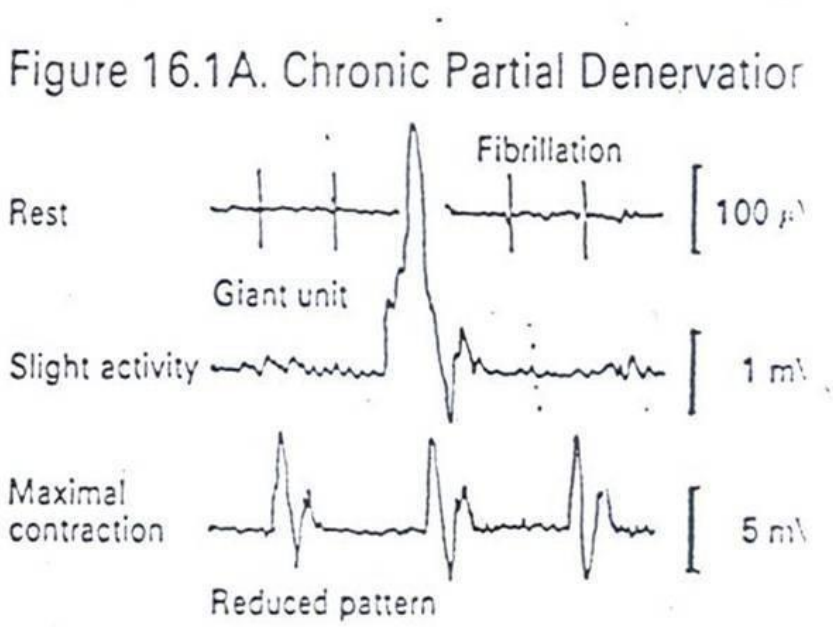
Neuropathy and Myopathy

- Neuropathy is a disease affecting the peripheral nerves near the muscle tissues. This may impair motor function, resulting in muscular weakness.
  - ✓ Even though the peripheral nerves are degraded in neuropathy, the muscle tissue remains functional. Furthermore, as the nerve cell diminishes, additional muscle cells may occupy the vacant place.

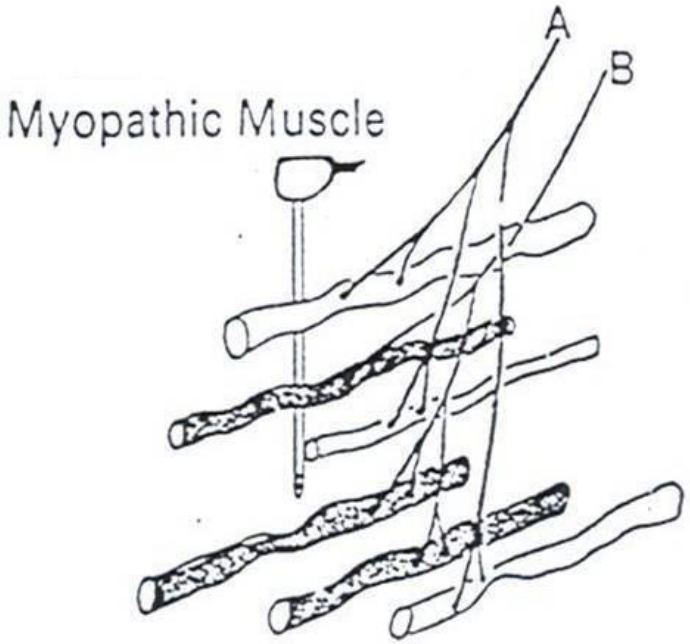
- Myopathy is a disease of the muscle in which the muscle fibers do not function properly. This results in muscular weakness.
  - ✓ Myopathy disrupts the structural integrity of the muscle cells and damages its metabolic process. As a result, the affected cells shrink or expire.

Neuropathic EMG changes

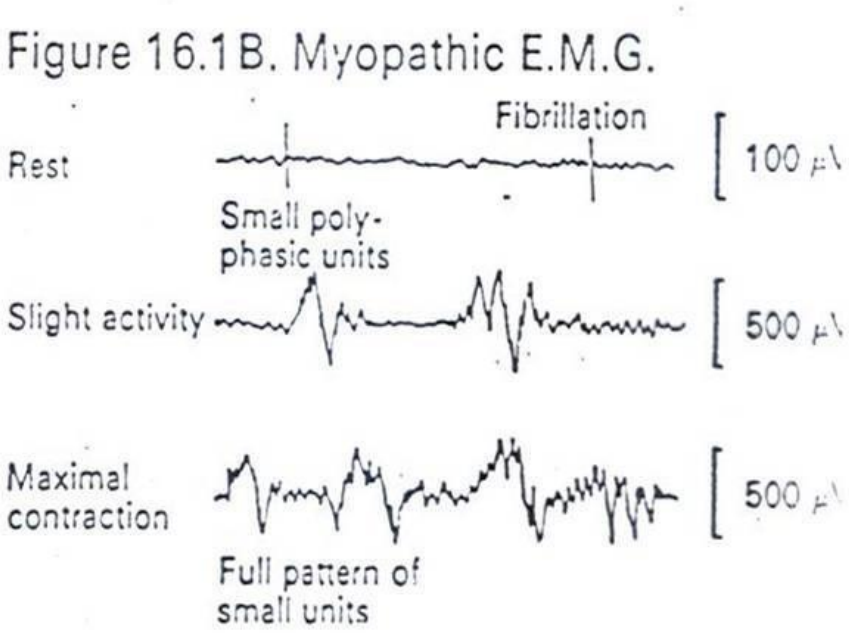




Myopathic EMG changes

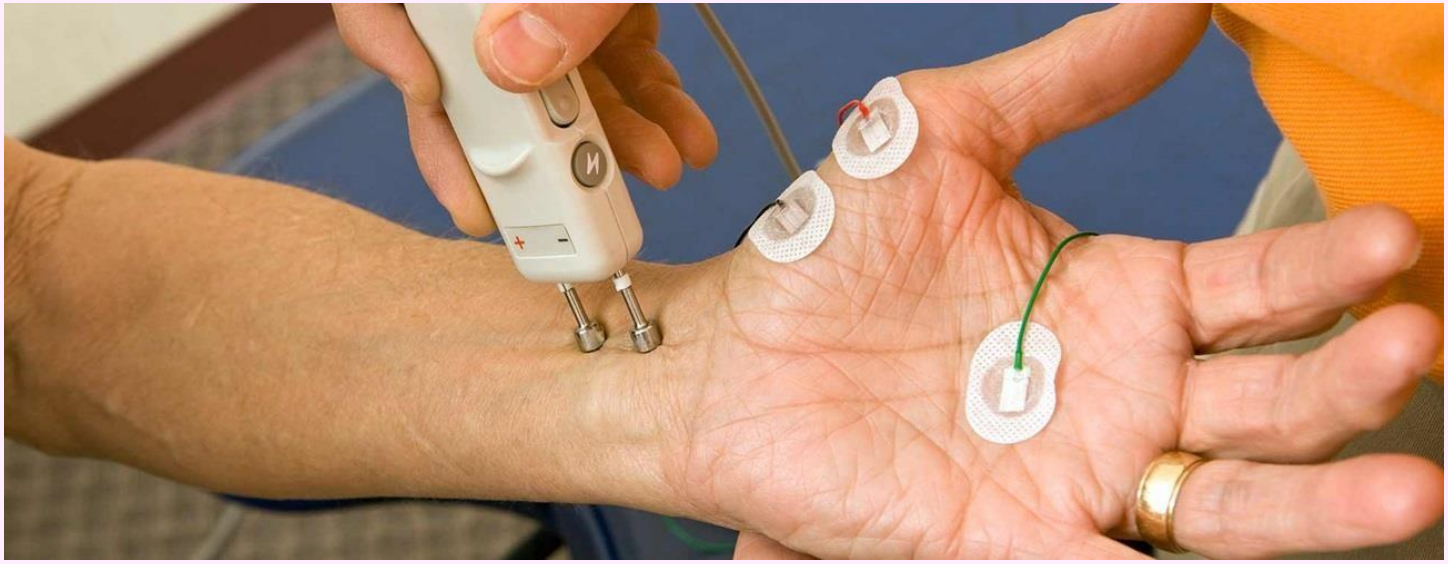


Muscle fibres supplied by both A and B are indiscriminately affected, although both nerve fibres are normal



Typical characteristics in myopathic, normal and neuropathic EMG

EMG	*Myopathy*	*Normal*	*Neuropathy*
Duration	< 3 msec	3 – 15 msec	> 15 msec
Amplitude	< 300 μV	300-5000 μV	> 5 mV
Configuration	polyphasic	triphasic	Polyphasic
Resting Activity	Present	Absent	Present



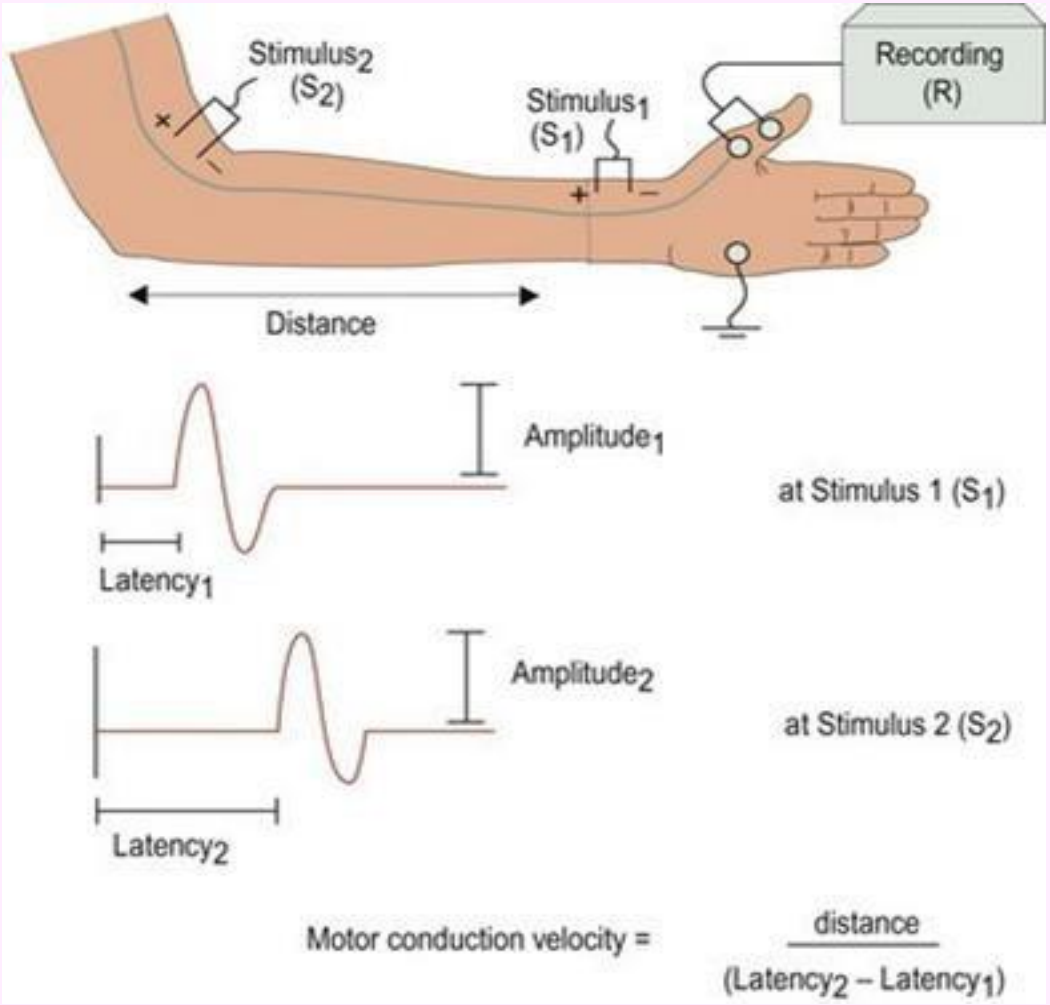
Nerve Conduction Study

Nerve Conduction Study

- ✓ A nerve conduction study (NCS) is a test commonly used to evaluate the function, especially the ability of electrical conduction, of the motor and sensory nerves of the human body.
- ✓ Nerve conduction velocity (NCV) is a common measurement made during this test.

Motor NCS

- ✓ Motor NCS are obtained by stimulating a motor nerve, then recording from a muscle supplied by that nerve.

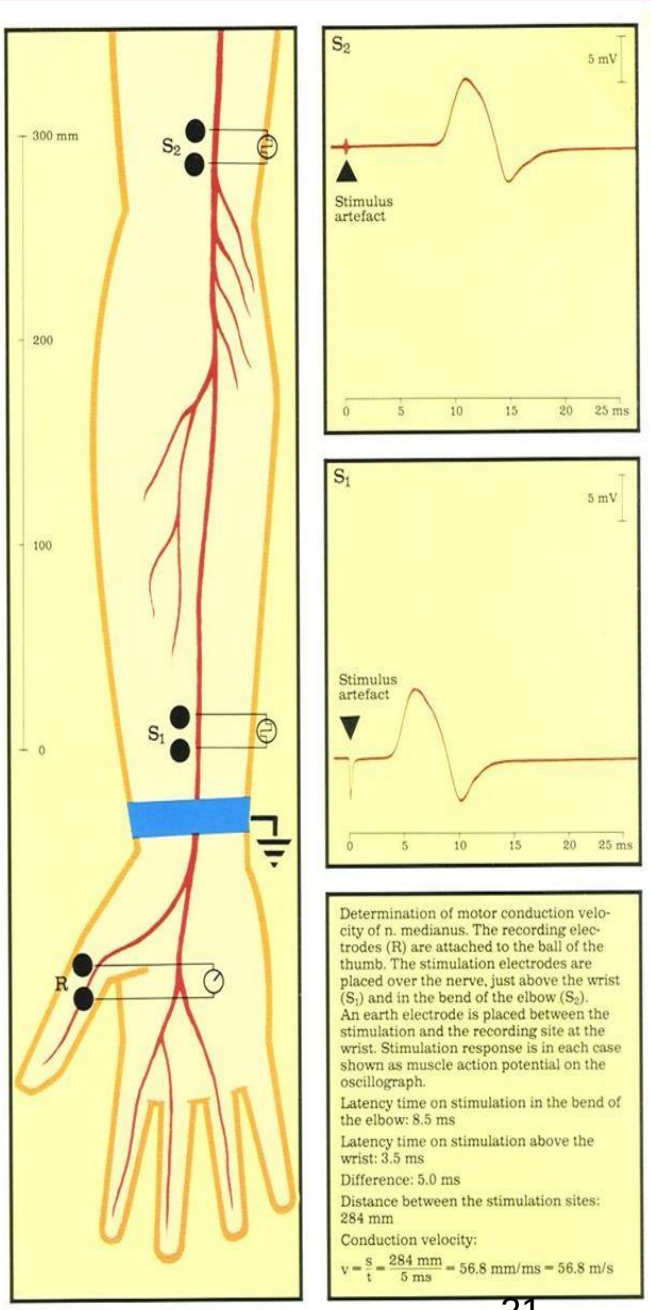


<u>Typical MCV Values</u>

- ✓ In arm
  - 50 – 70 m / sec.
- ✓ In leg
  - 40 – 60 m / sec.

Motor NCS…

- The recorded potential, known as the *compound muscle action potential* (CMAP), represents the summation of all underlying individual muscle fiber action potentials.



Latency

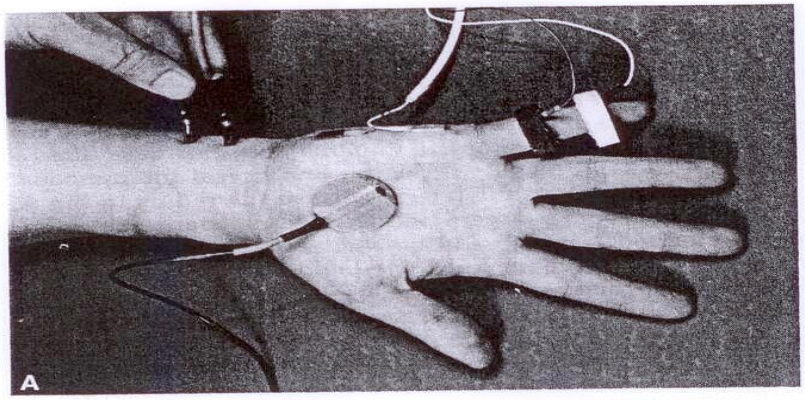
- Latency measurements usually are made in milliseconds (ms).
- The latency is the time from the stimulus to the initial deflection from baseline.

Amplitude

- It is most commonly measured from baseline to the peak (baseline-to-peak)
- CMAP amplitude reflects the number of muscle fibers that depolarize.
- low CMAP amplitudes most often result from loss of axons (as in a typical axonal neuropathy)
- average CMAP amplitude 3 mv

Duration

- This is measured from the initial deflection from baseline to the final return
- Duration characteristically increases in conditions that result in *slowing of some motor fibers (e.g., in a demyelinating lesion).*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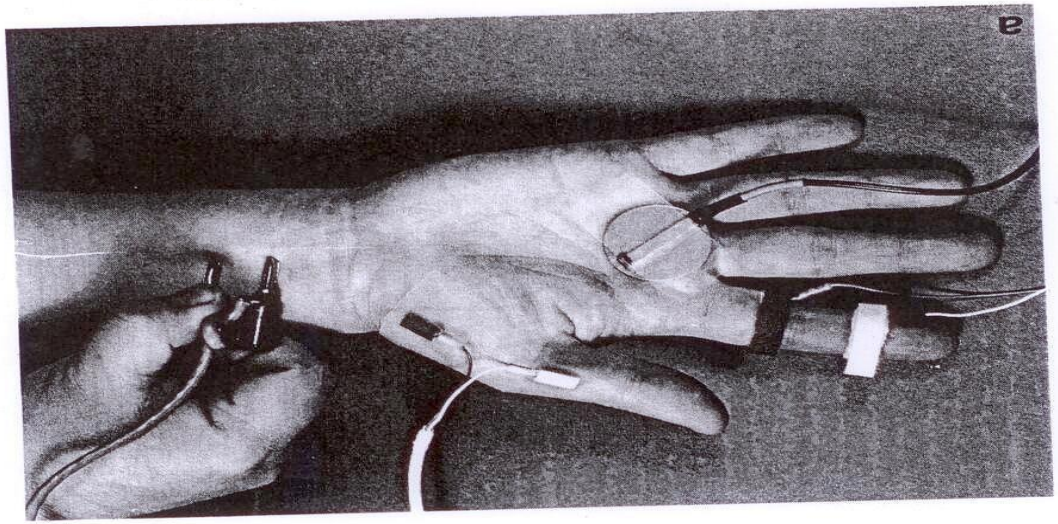
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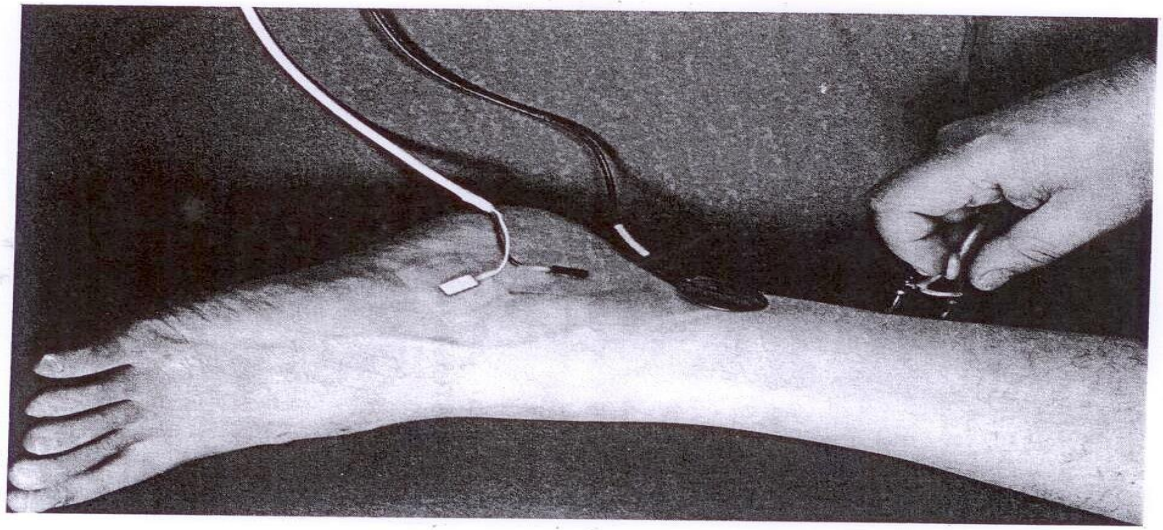
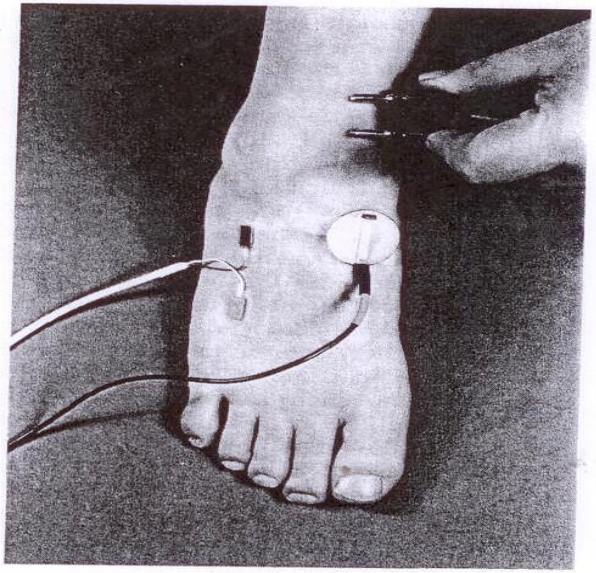
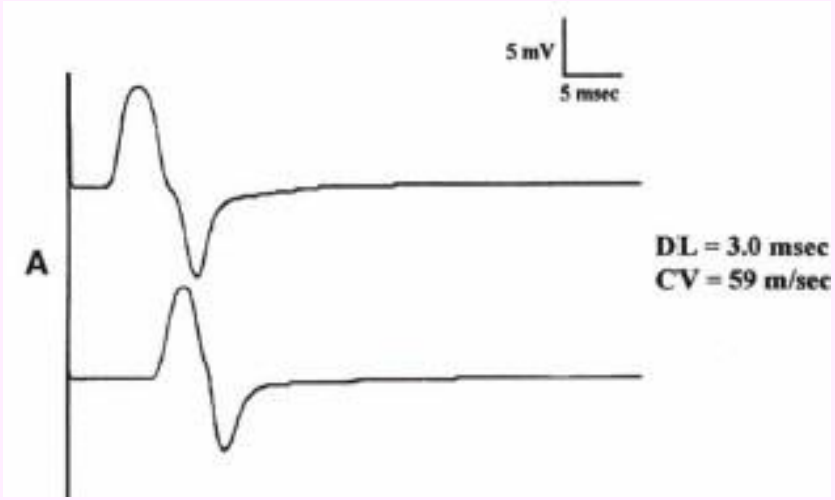




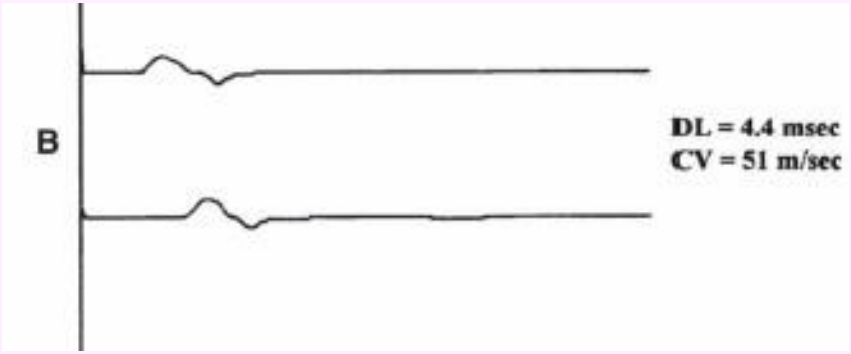
Patterns of Nerve Conduction

- **Normal study of Median Nerve:**
- *Note the normal median distal latency (DL) 3 ms, amplitude >4 m V, and conduction velocity (CV) >49 mls.*



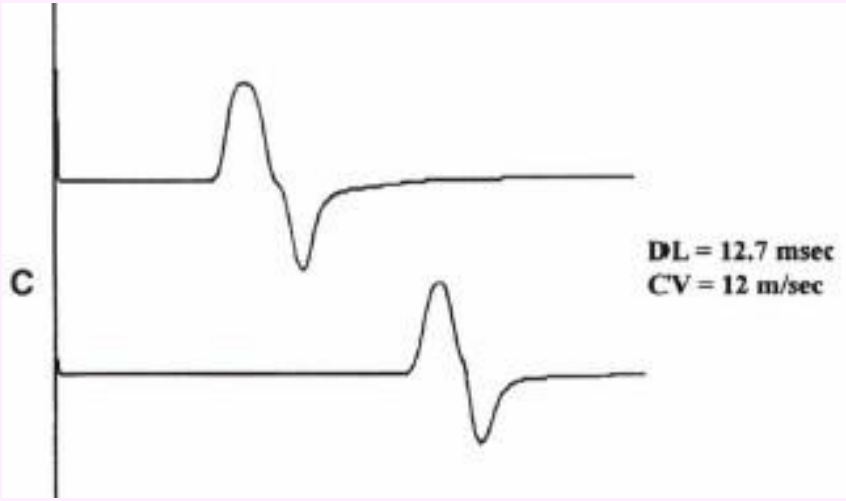
Patterns of Nerve Conduction…

- Axonal loss
- Amplitudes decrease
- CV is normal or slightly slowed.
- Latency is normal or slightly prolonged.
- The morphology of the potential does not change between proximal and distal sites.



Patterns of Nerve Conduction…

- Demyelination
- CV is markedly slowed (<75% lower limit of normal)
- Latency is markedly prolonged (>130% upper limit of normal).
- However, there usually is no change in configuration between proximal and distal stimulation



THANK YOU