Electromyography (EMG)

&

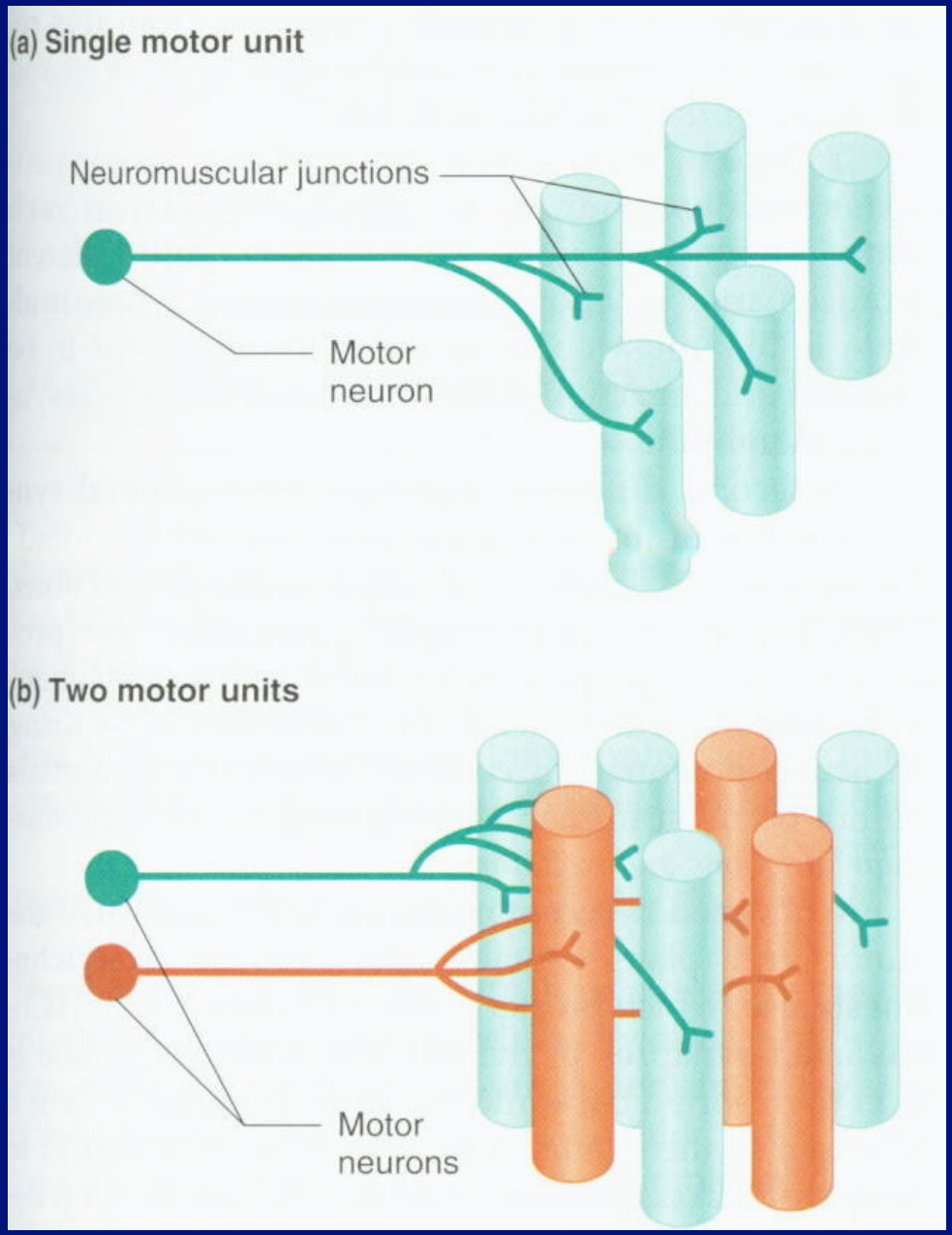
Motor Nerve Conduction Velocity

Dr. Thouraya Said

Motor Unit

- Consists of **a motor neuron and all the muscle fibers it innervates.**

- When an action potential occurs in a motor neuron, all the muscle fibers in its MU are stimulated to contract.


(a) Single motor unit
Neuromuscular junctions
Motor neuron
(b) Two motor units
Motor neurons

EMG is the recording of electrical activity of a muscle at rest & during contraction:

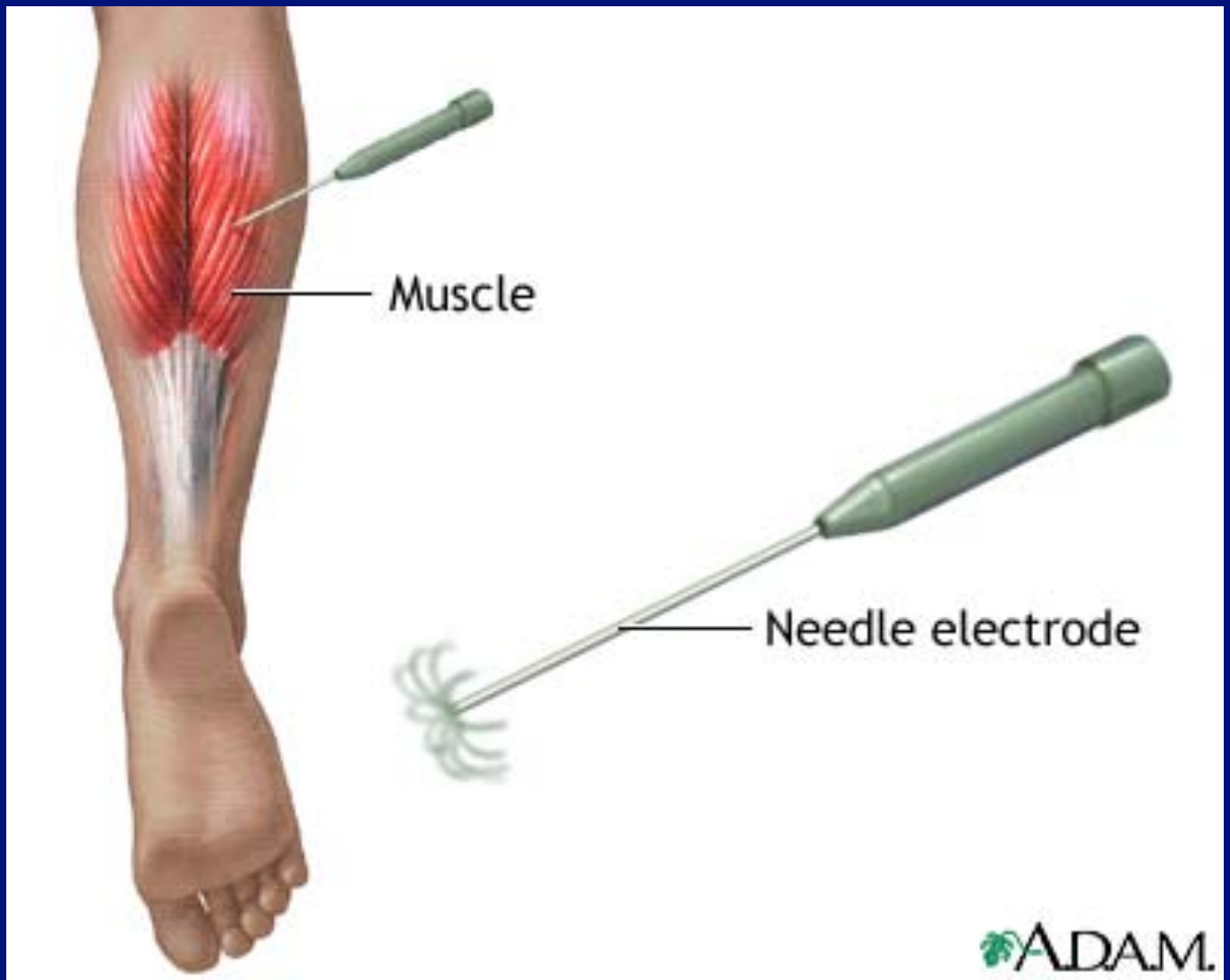
(to evaluate the electrophysiology of a MU)

- Activity is amplified and displayed on an oscilloscope.

Instrument: **Electromyograph**

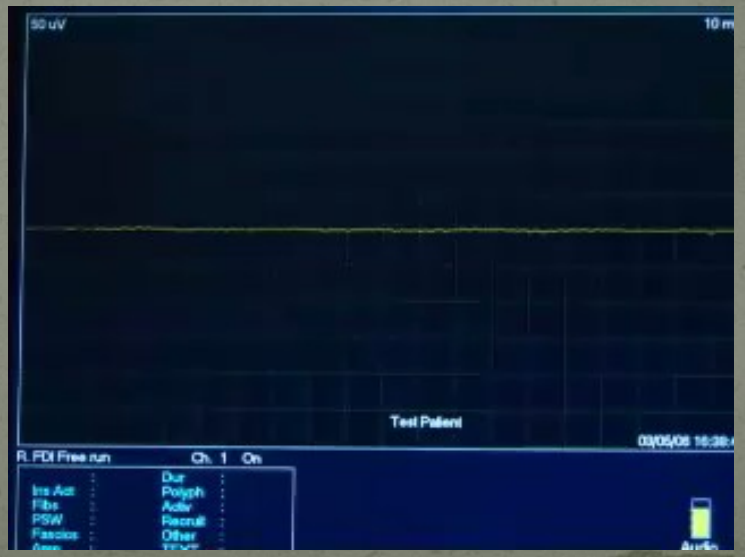
Record: **Electromyogram**

- A concentric needle electrode is inserted into the belly of the muscle .



- Needle EMG does not introduce any electrical stimulation instead it records the **intrinsic electrical activity of skeletal muscle fibers**.

- Normally a muscle is **silent at rest** after insertional activity has ceased.



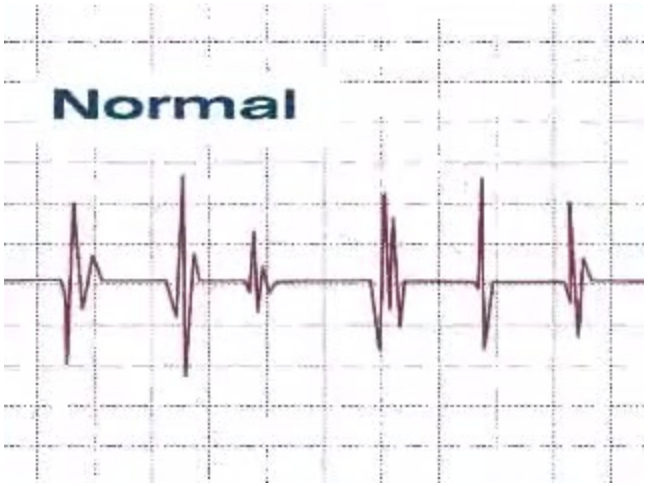
- Then the patient is asked to contract the muscle smoothly.

- With muscle contraction, MUs are activated and MUAPs appear on the screen:

- **Motor unit potential**: represents the summation of the potentials generated by **muscle fibers** belonging to the MU.

Normal MUPs

- Bi – Triphasic
- Duration – 3 – 16 mSec.
- Amplitude – 300μV – 5 mV



- With increasing strength of contraction → recruitment of MUs → ↑ number & size of MUAPs

- At full contraction separate MUAP will be indistinguishable resulting in a complete recruitment = **interference pattern**

MOTOR UNIT POTENTIAL DURING MILD EFFORT

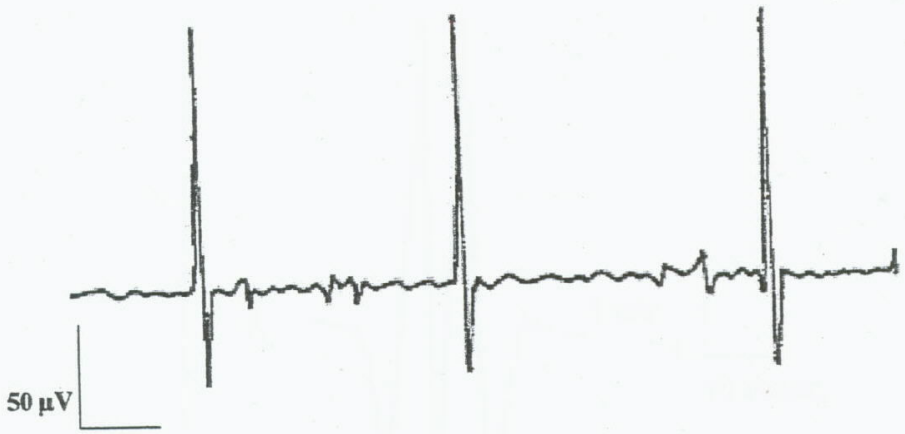
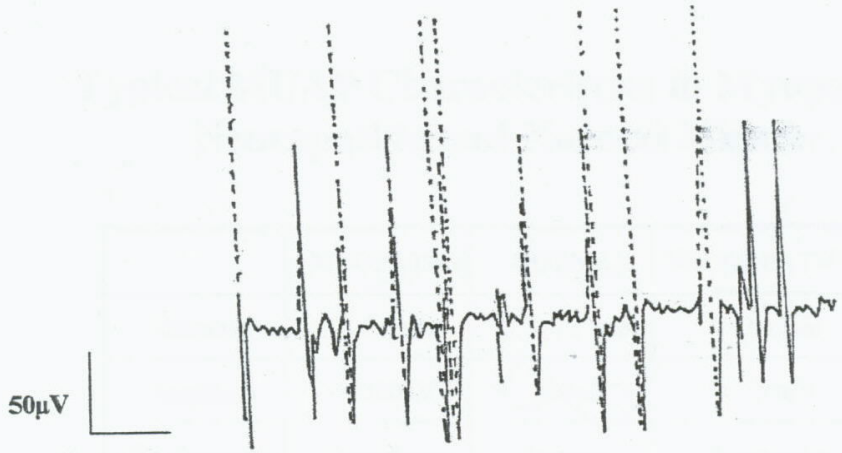
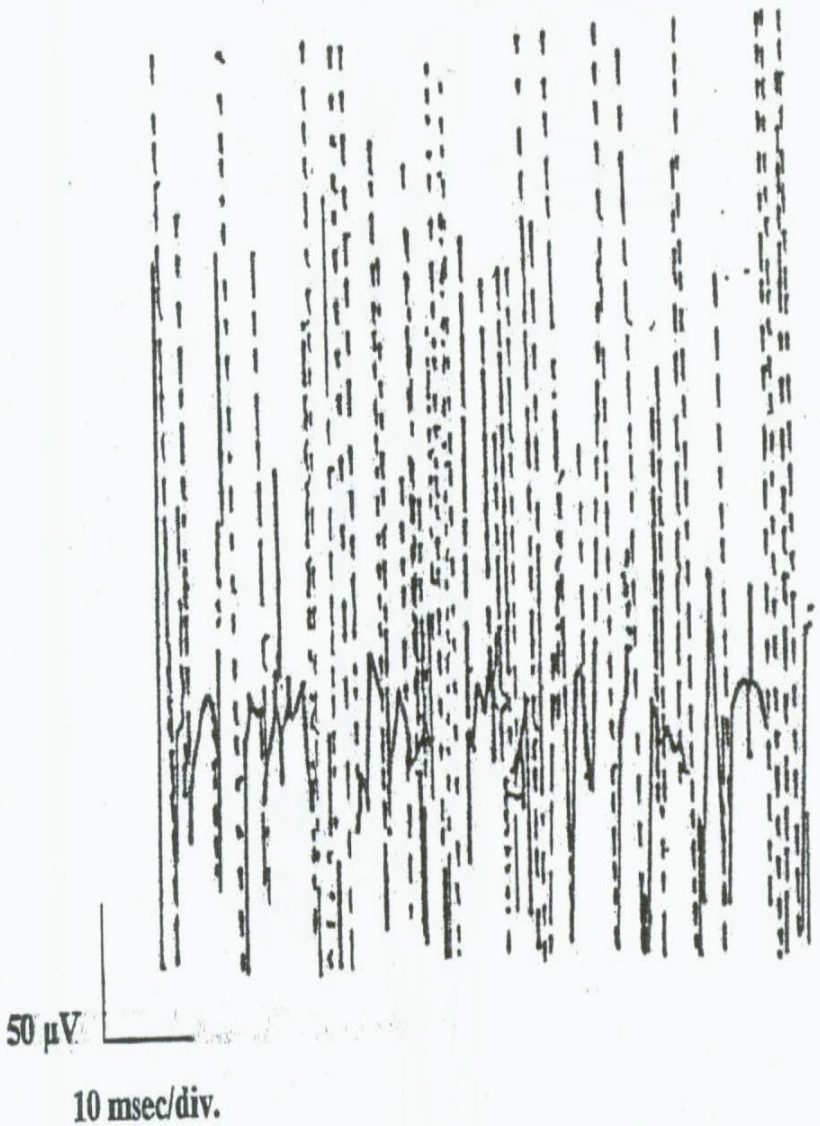


Figure -7

MOTOR UNIT POTENTIAL DURING MODERATE EFFORT



MOTOR UNIT POTENTIAL AT FULL VOLUNTARY EFFORT



Analysis

The EMG is used to investigate both neuropathic and myopathic disorders (weakness, numbness, pain)

- **The size, duration & frequency of the electrical signals generated by muscle cells help determine if there is damage to the muscle or to the nerve leading to that muscle.**

- **Myopathy**: progressive degeneration of skleletal muscle fibers.

  Eg: Duchenne Muscular dystrophy

- **Neuropathy**: Damage to the distal part of the nerve.

- Peripheral neuropathy mainly affects feet & legs.

Most common etiologies:

- Guillain Barré syndrome
- Diabetes mellitus
- Alcohol abuse

LMN lesions: interrupt the spinal reflex arc (α motor neuron) → Partial or complete loss of voluntary contraction, muscle wasting, ↓ reflexes, fasciculation

Example: Polyomyelitis

In neurogenic lesion or in active myositis, the following **spontaneous activity** is noted:

- Positive sharp waves
- Fibrillations
- Giant motor unit potentials or fasciculations

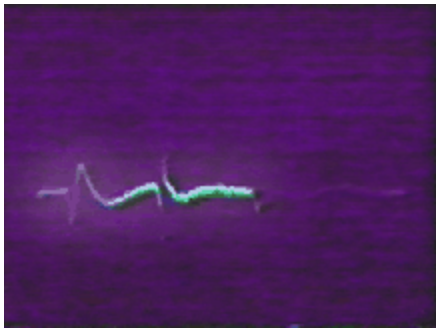
Fibrillation potentials:

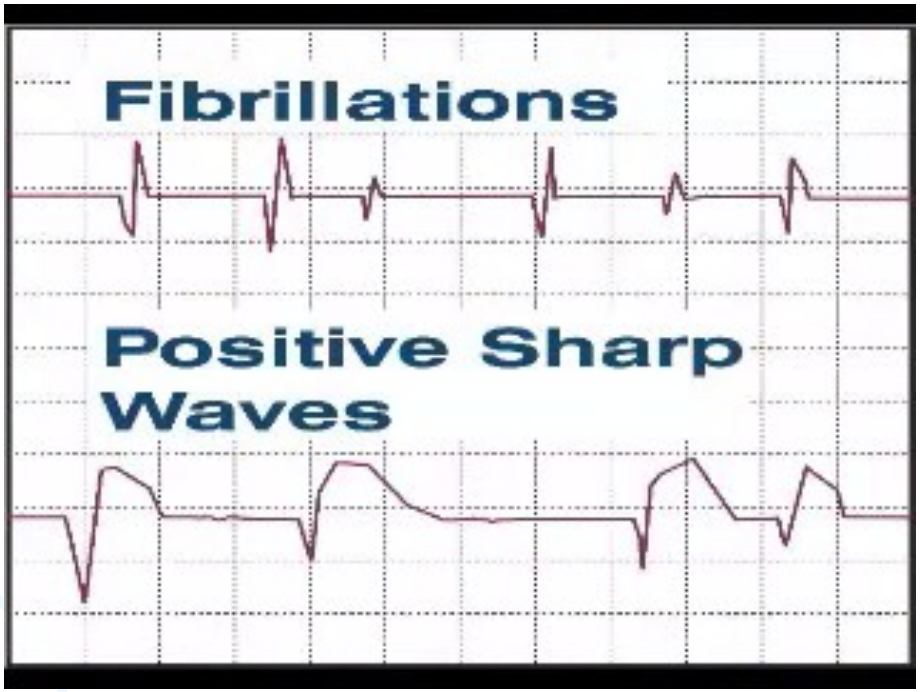
Low amplitude, short duration, biphasic potentials, correspond to the spontaneous discharge of a **denervated single muscle fiber** due to denervation hypersensitivity to acetylcholine.

Fine invisible, irregular contractions of individual muscle fibers.

Positive sharp waves

Small fibrillation APs (50 to 100 μV, 5 to 10 msec duration) whose propagation is blocked at the level of the recording Ede

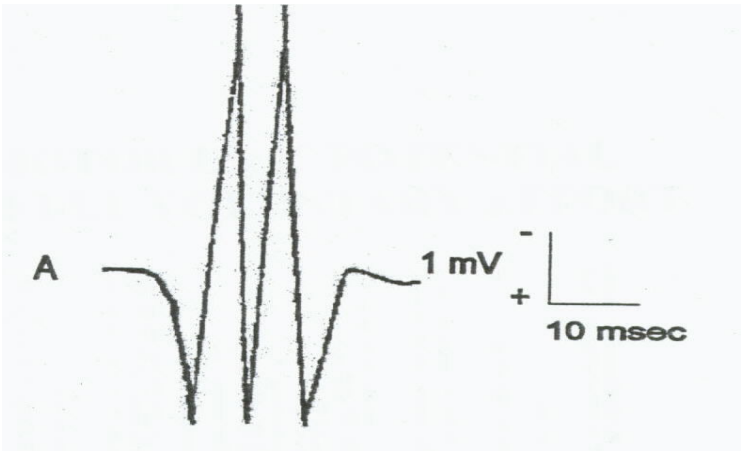



Fibrillations
Positive Sharp Waves

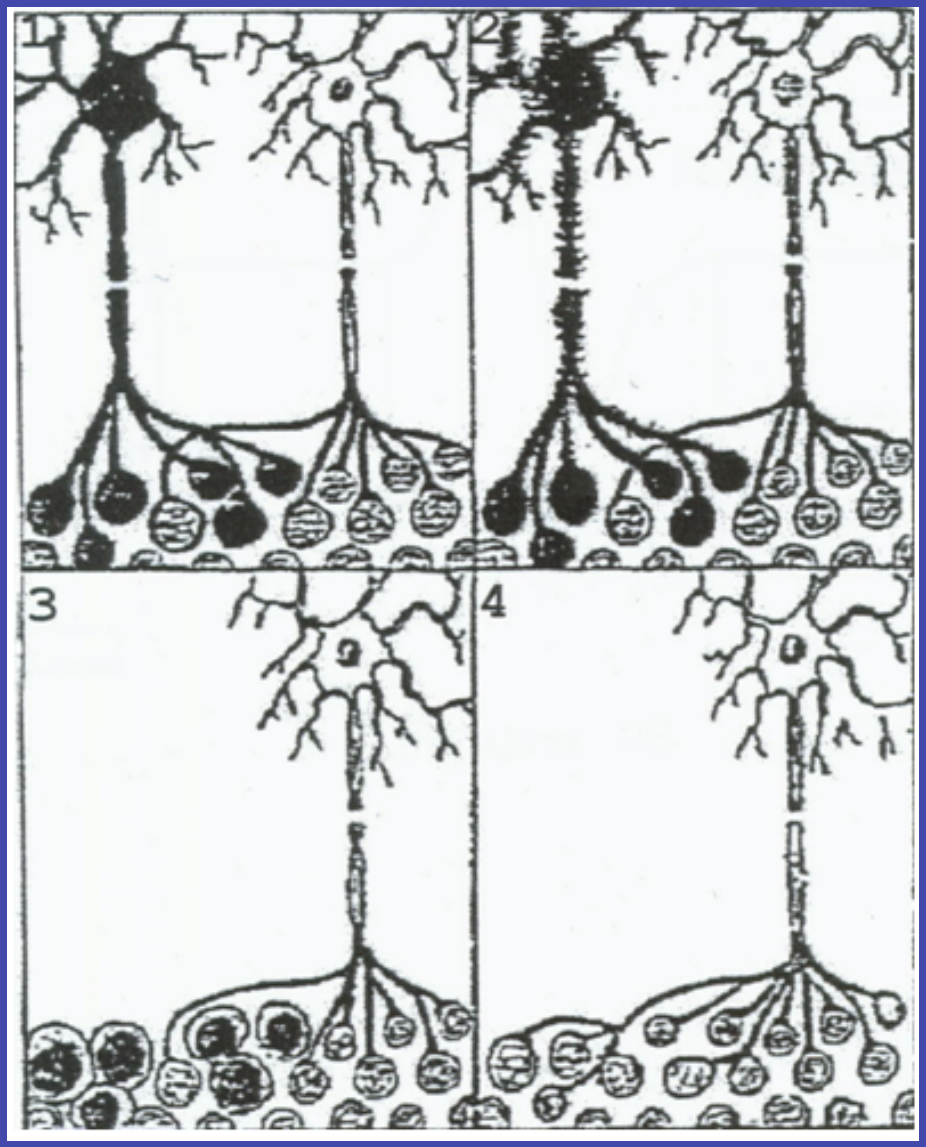
Fasciculation potentials

Spontaneous discharge of a **MU** at **rest**, can be seen and felt by the patient.

- Partial re-innervation of denervated muscle, by sprouting of the remaining nerve terminals, produces abnormally **high voltage**, **polyphasic, long duration potentials (Giant Potentials)**

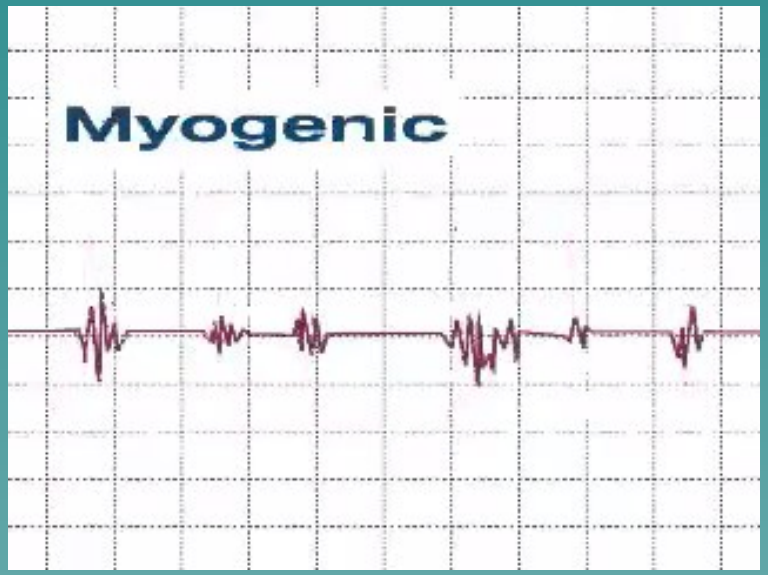


RE-INNERVATION BY COLLATERAL SROUTING



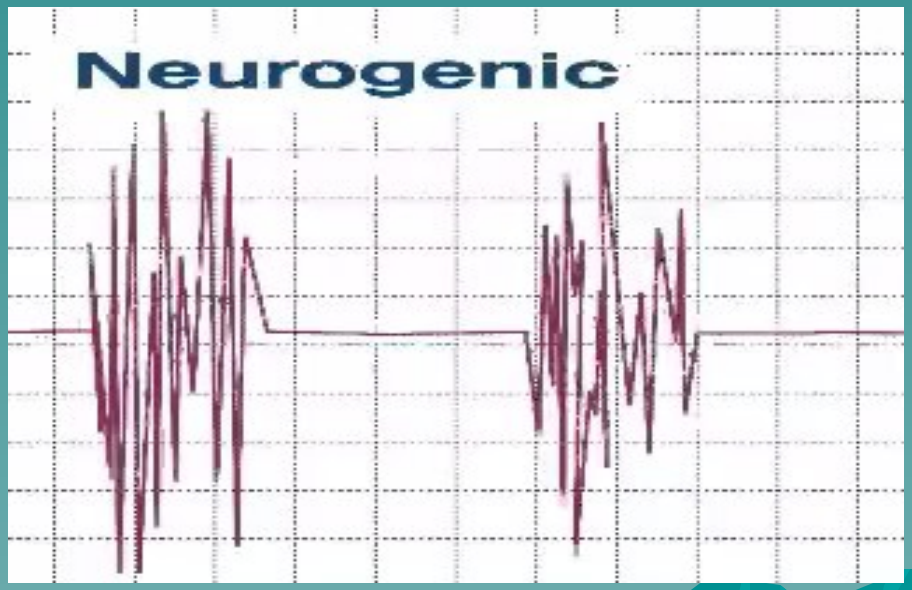
Myopathic alteration of the EMG:

Polyphasia ,short duration ,reduced voltage of MUPs



Neuropathic alteration of the EMG:

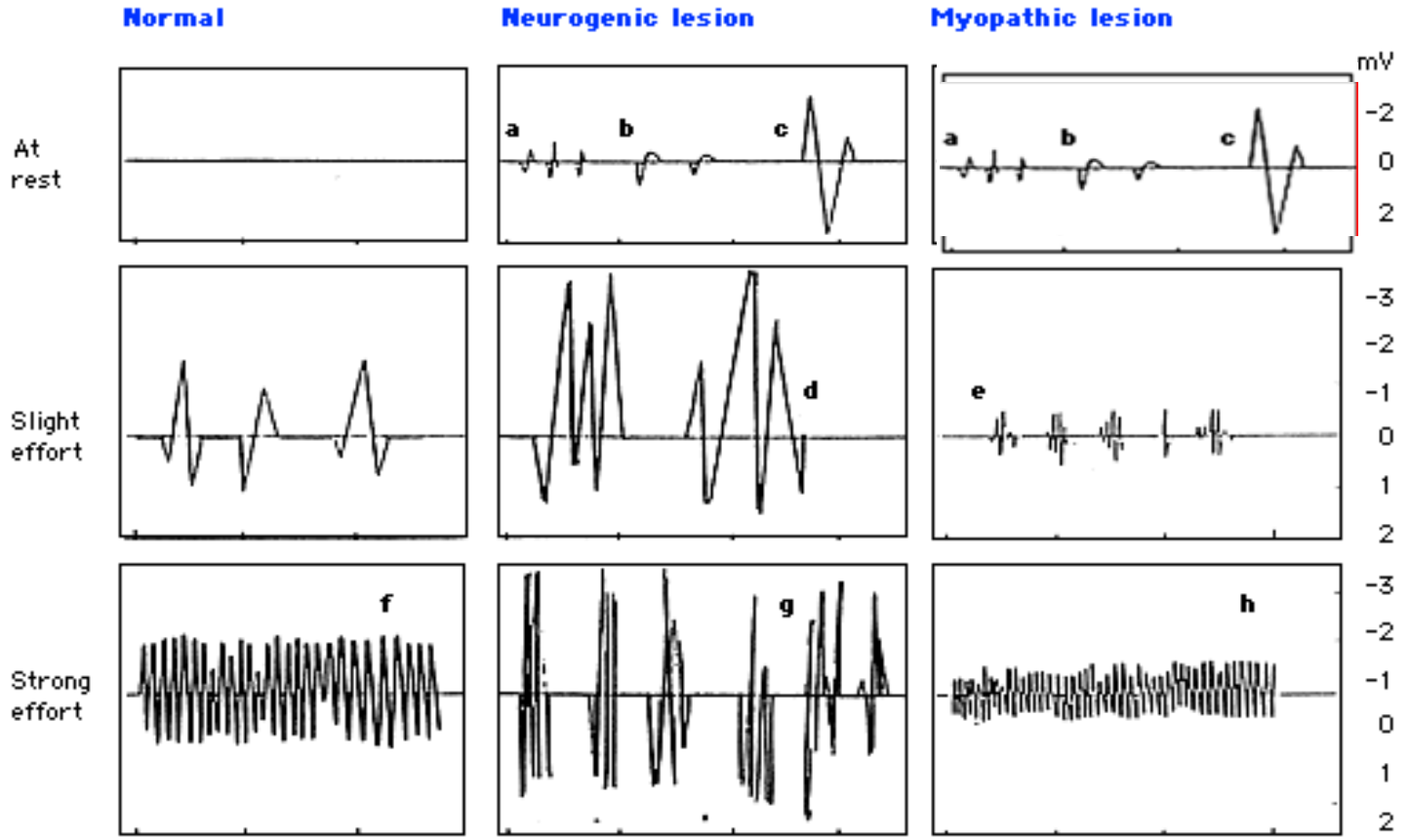
- Polyphasia ,long duration ,high voltage of MUPs



Analysis of MUP

MUP	NORMAL	NEUROGENIC	MYOPATHIC
Duration msec.	3 – 16 msec	> 16 msec	< 3 msec
Amplitude	300 – 5000 µV	> 5 mV	< 300 µV
Phases	Biphasic / triphasic	Polyphasic	May be polyphasic
Resting Activity	Absent	Present	Present
Interference pattern	full	partial	full

Electromyography*



1. At rest (spontaneous activity): a. fibrilations, b. positive sharp waves, c. fasiculation.
2. Slight effort (motor unit potentials): d. giant polyphasic, e. BSAPS (brief-small-abundant polyphasic).
3. Strong effort (interference pattern); f. full, g. reduced units, h. reduced amplitude.

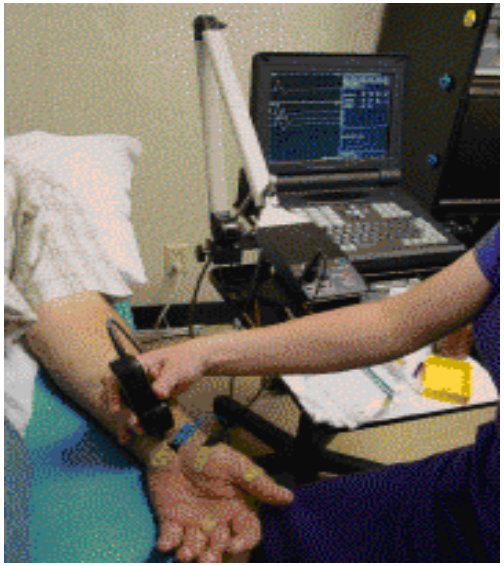
* (helpful in selecting denervated muscles [in radiculopathies (myotomal), mononeuropathies (distal to lesion), generalized neuropathies (distal muscles)] and myopathies)

Motor Nerve Conduction Velocity (MNCV) Study

MNCV is a test to evaluate the function, especially the ability of electrical conduction, of a nerve; or the speed of propagation of an action potential along a nerve.

Procedure

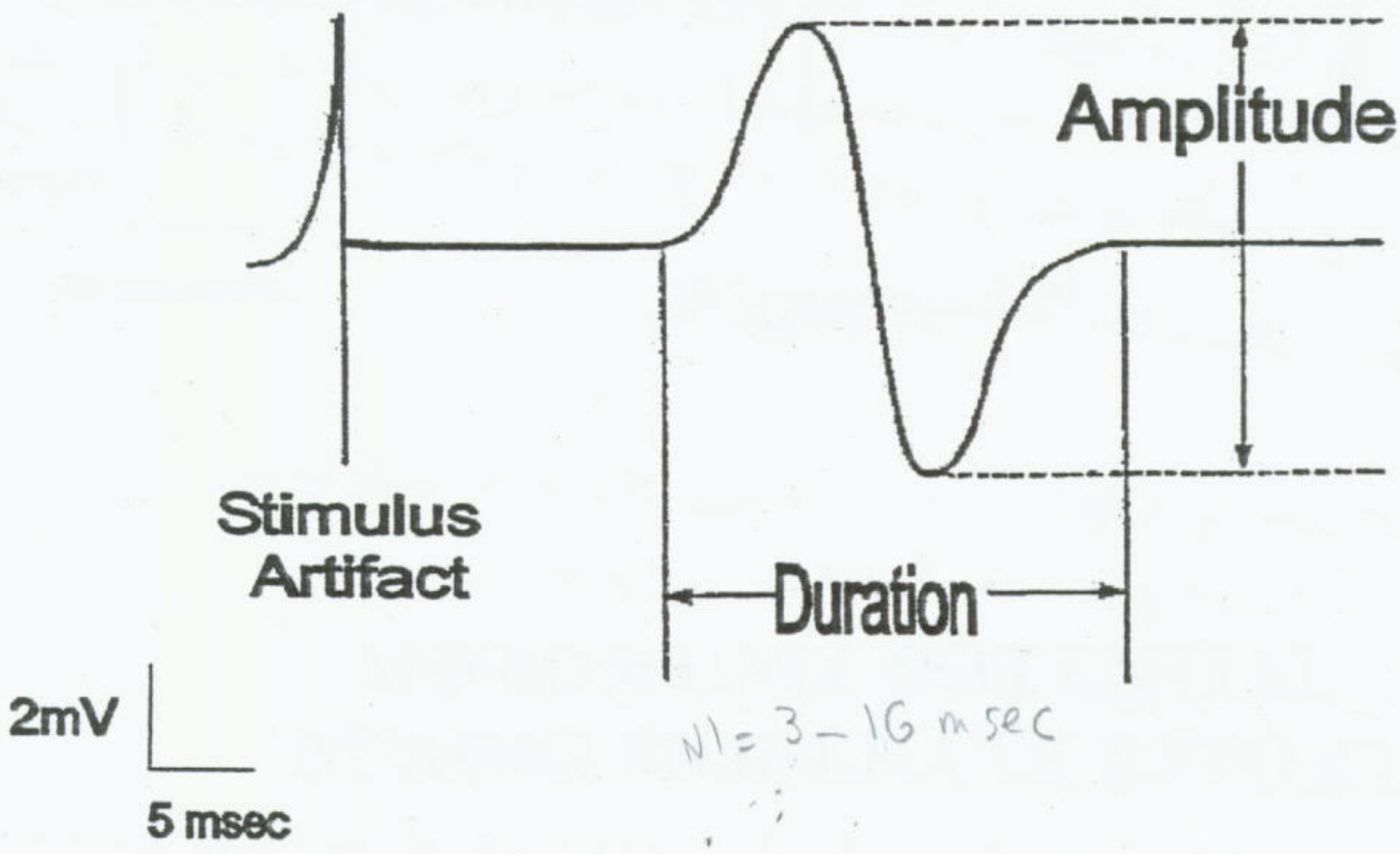
- Stimulation of median nerve at two points until visible muscle contraction is seen and a reproducible **Compound Muscle Action Potential** (CMAP) is recorded.



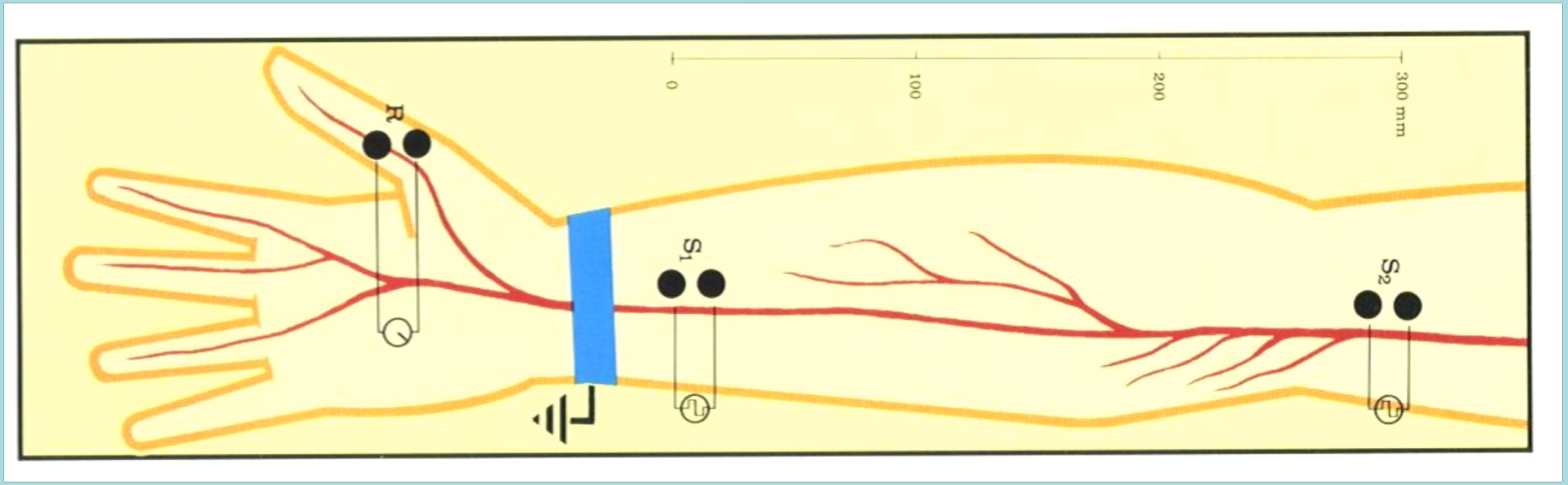
- Recording electrode over the thenar eminence.

CMAP: summated potentials from all Motor Units in a muscle

COMPONENTS OF THE CMAP

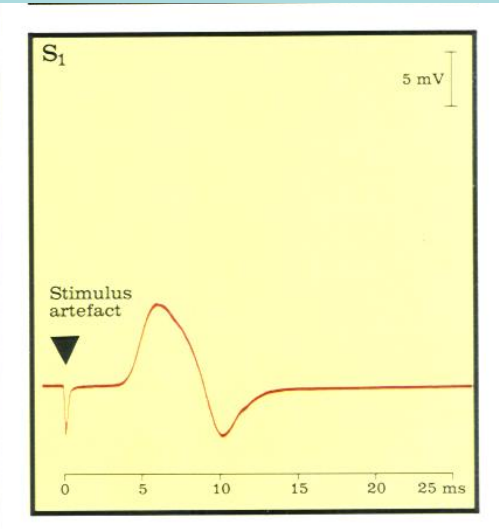


NI = 3 – 16 msec



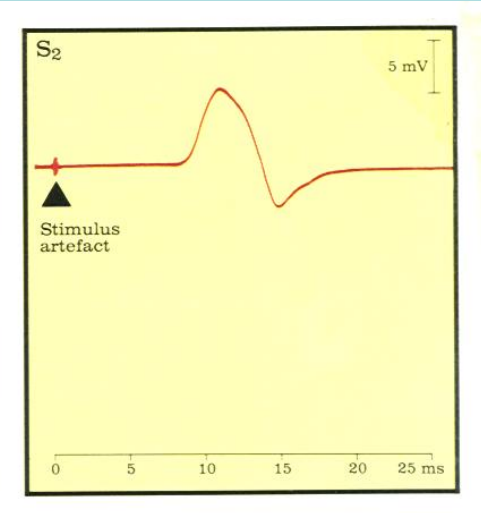
Distance

d = 284 mm



Latency At wrist

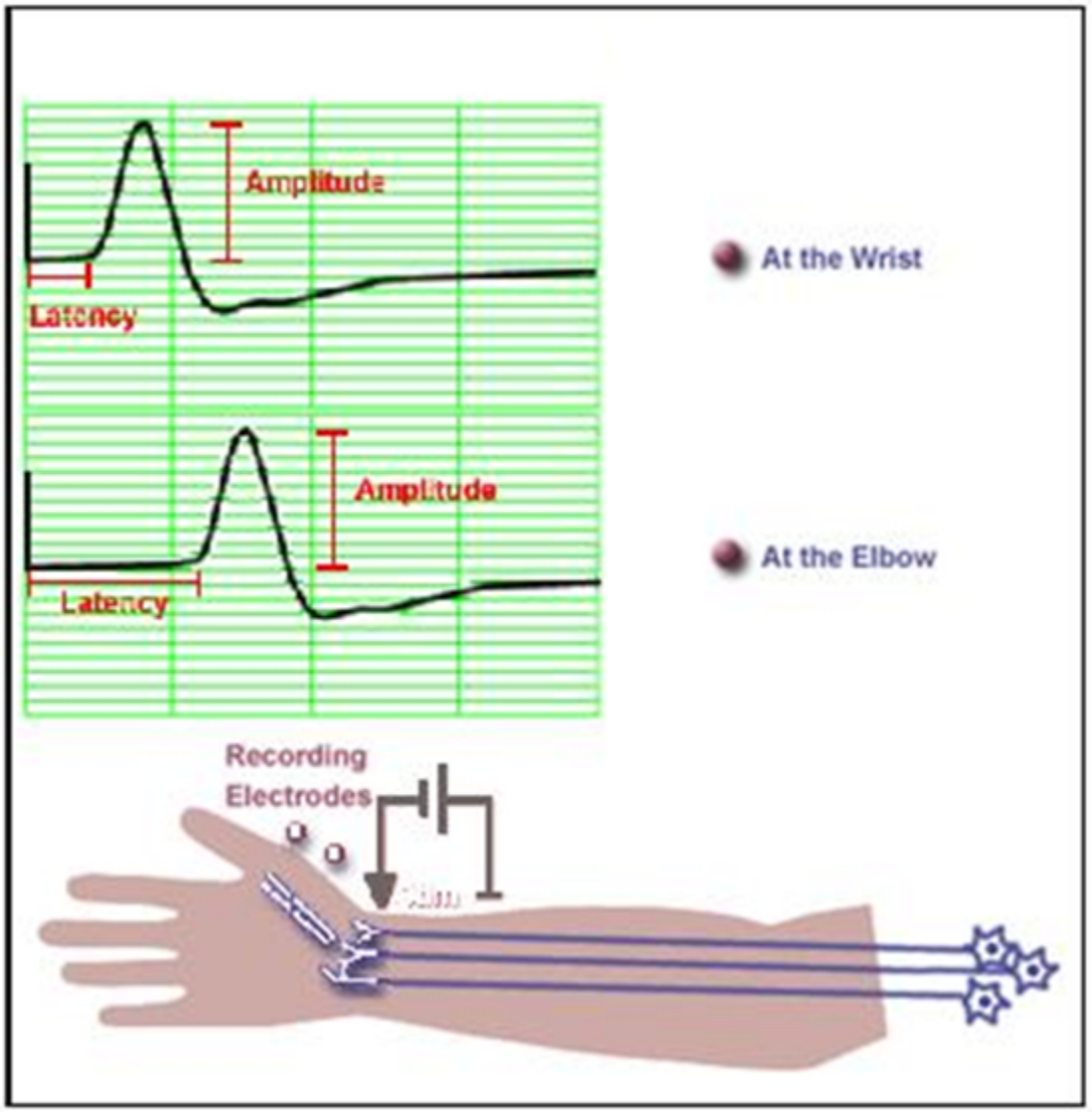
L_2 = 3.5 ms



Latency At elbow

L_1 = 8.5 ms

MOTOR NERVE CONDUCTION VELOCITY (MNCV)



The latency is the interval between the onset of the stimulus to the onset of the initial deflection from baseline of the resultant CMAP (in ms).

$$\text{MNCV} = \frac{d\ (mm)}{l_1 - l_2\ (ms)}\ (\boldsymbol{m/s})$$

l_1 = latency at elbow (in the first CMAP).

l_2 = latency at wrist (in the next CMAP).

d = distance between the two stimulating electrodes: from elbow to wrist.

Abnormal if < 40 m/s

Normal values for conduction velocity

- In arm
  - 50 - 70 m/s.
- In leg
  - 40 - 60 m/s.

- Conduction is faster in myelinated fibres.

- Diseases which produce demyelinated peripheral nerves (diabetes, Gillain Barré) slow the conduction greatly (20-30 m/s).

THANK YOU...

Off to the Lab!