

Electromyography (EMG)

&

Motor Nerve Conduction Velocity

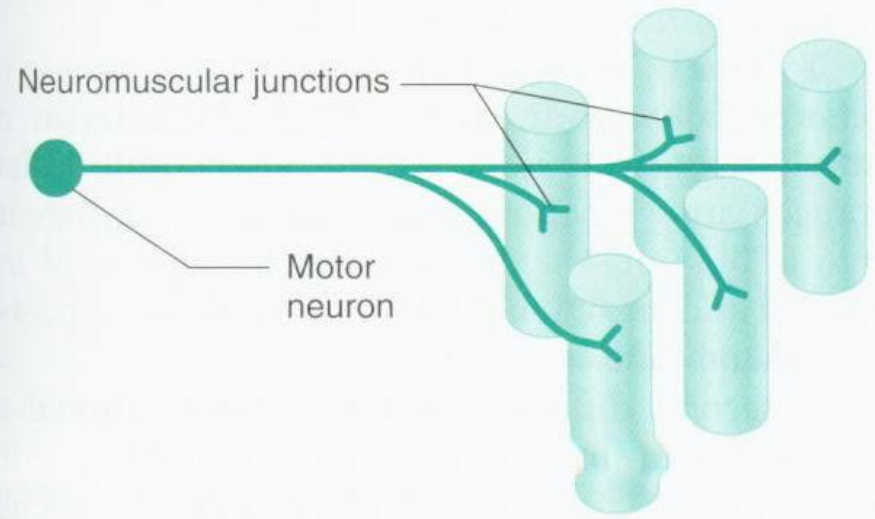
Dr. Thevaya Said



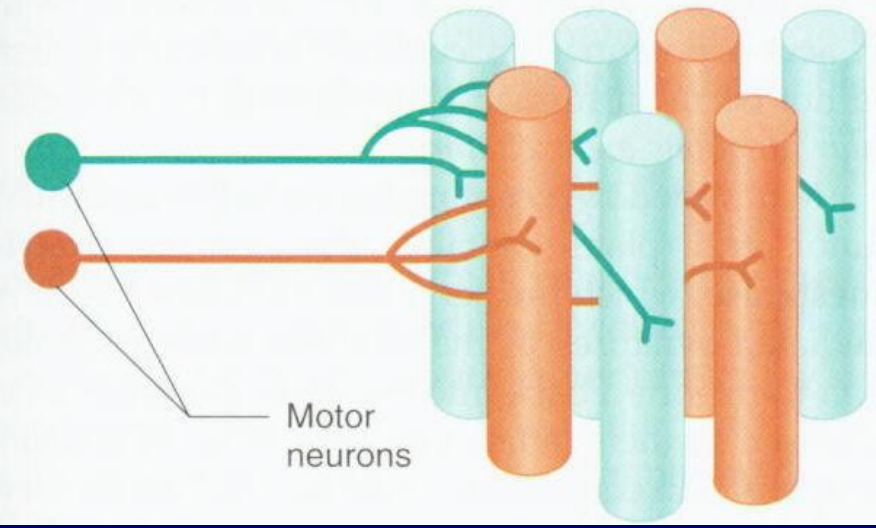
Motor Unit

- ❖ 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



(b) Two motor units



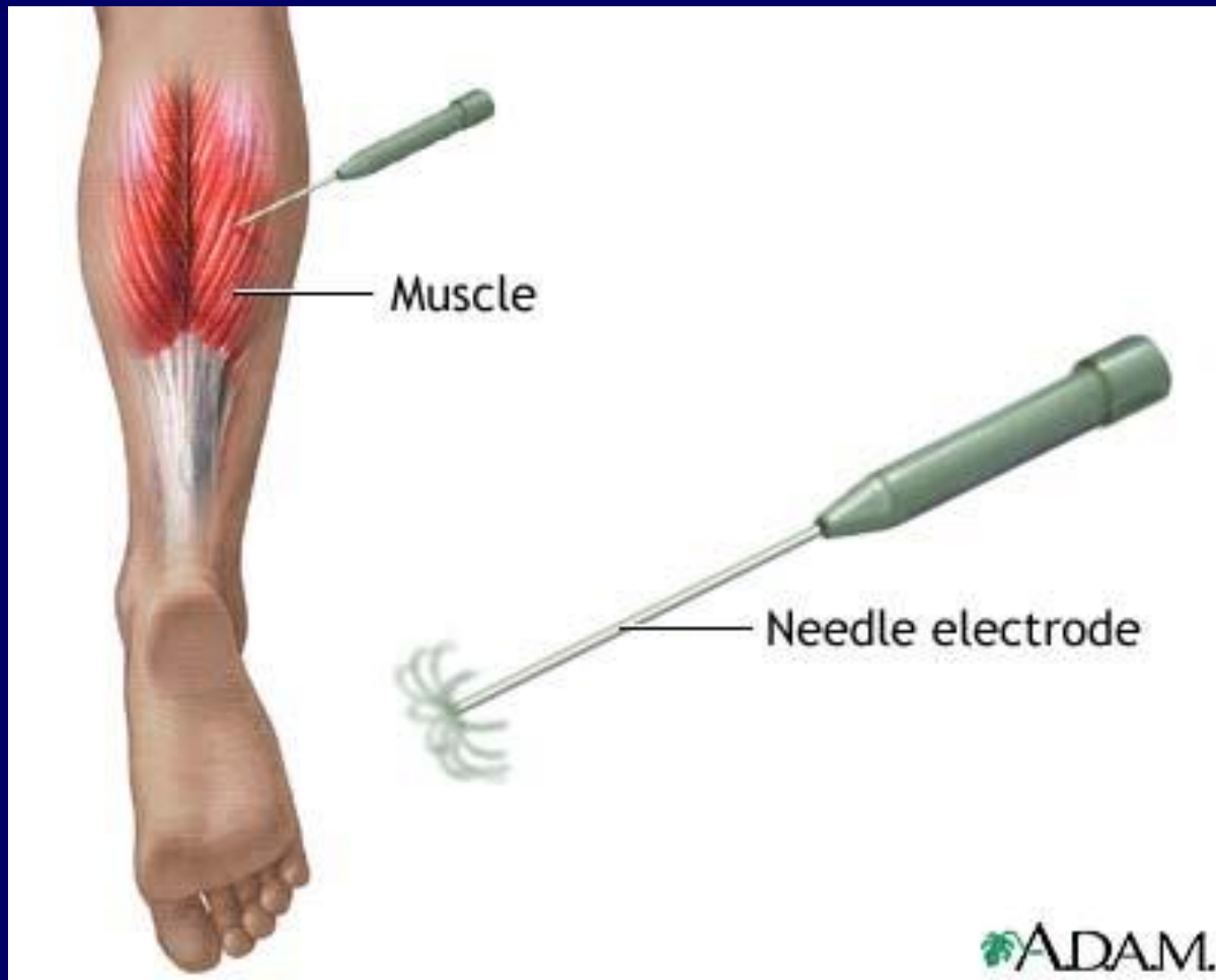
EMG is the recording of electrical activity of a muscle at rest & during contraction:
(to evaluate the electrophysiology of a MU)

Activity is amplified and displayed on an oscilloscope.

Instrument: **Electromyograph**

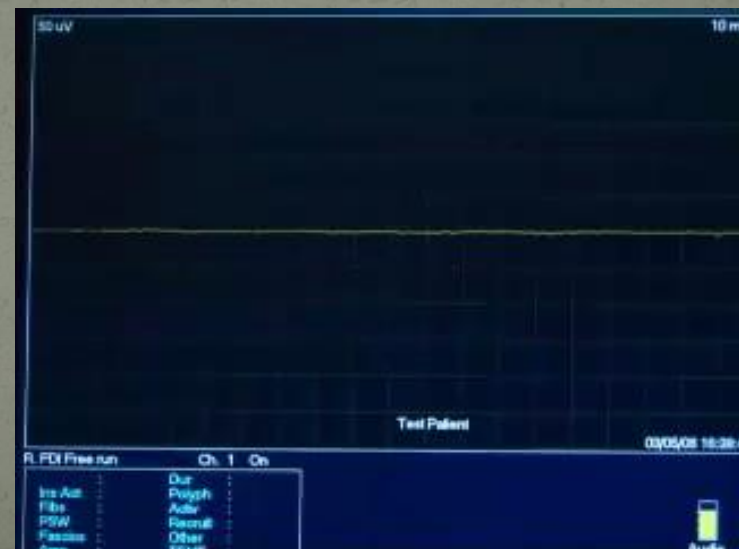
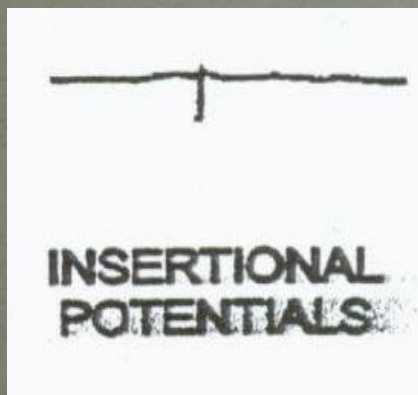
Record: **Electromyogram**

■ 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.

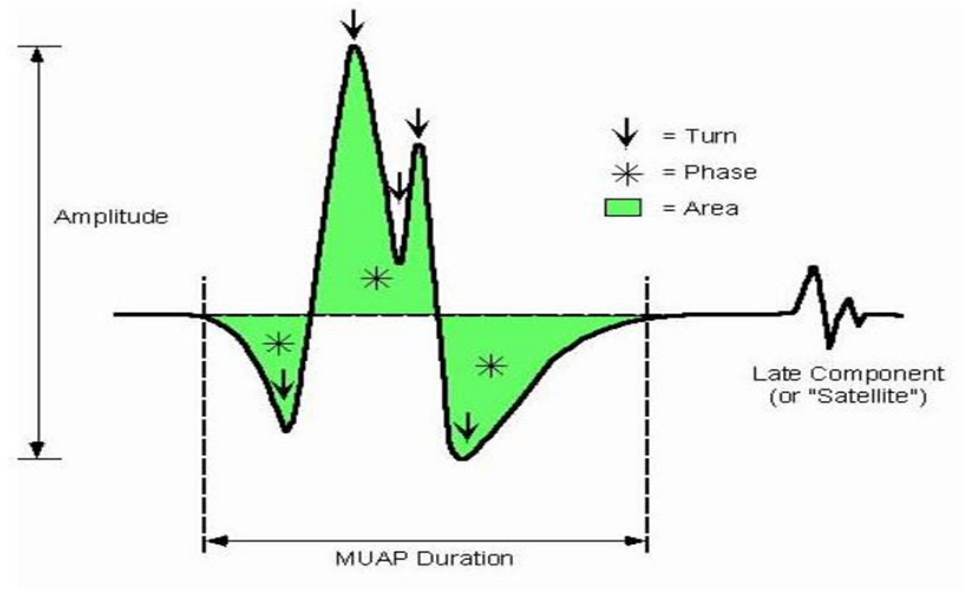
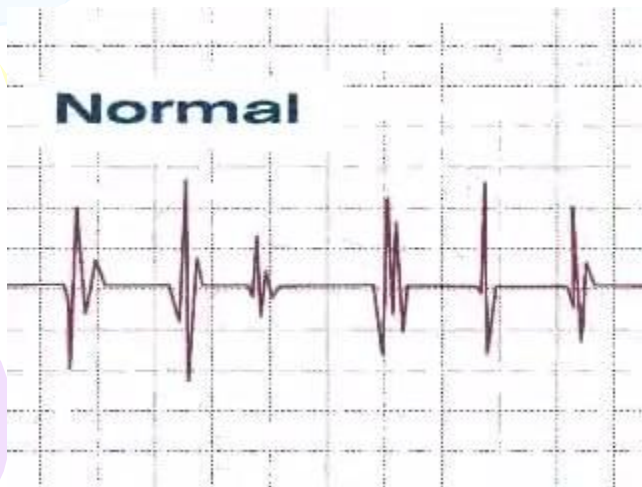
- With muscle contraction, MUs are activated and **MUAPs** appear on the screen:




- **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 – 300 μ V – 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

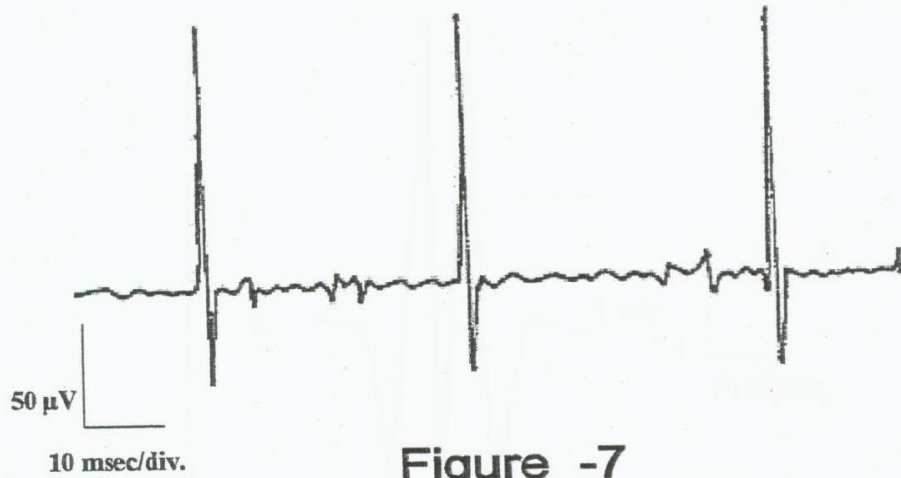
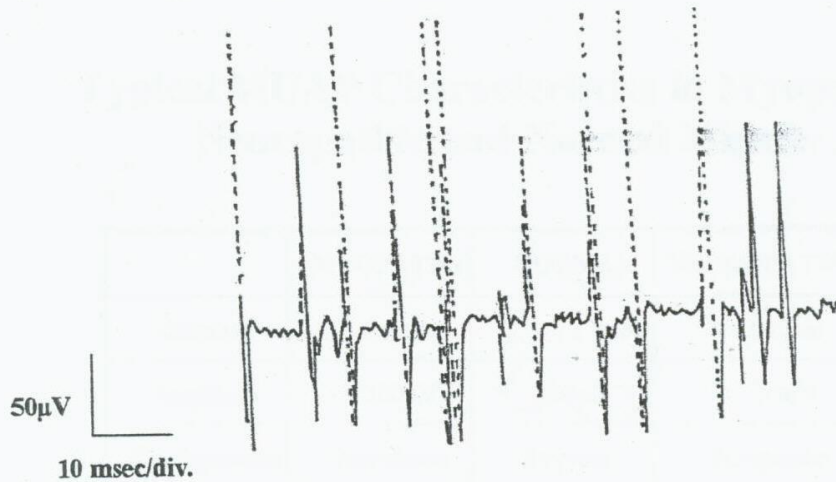


Figure -7

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.**

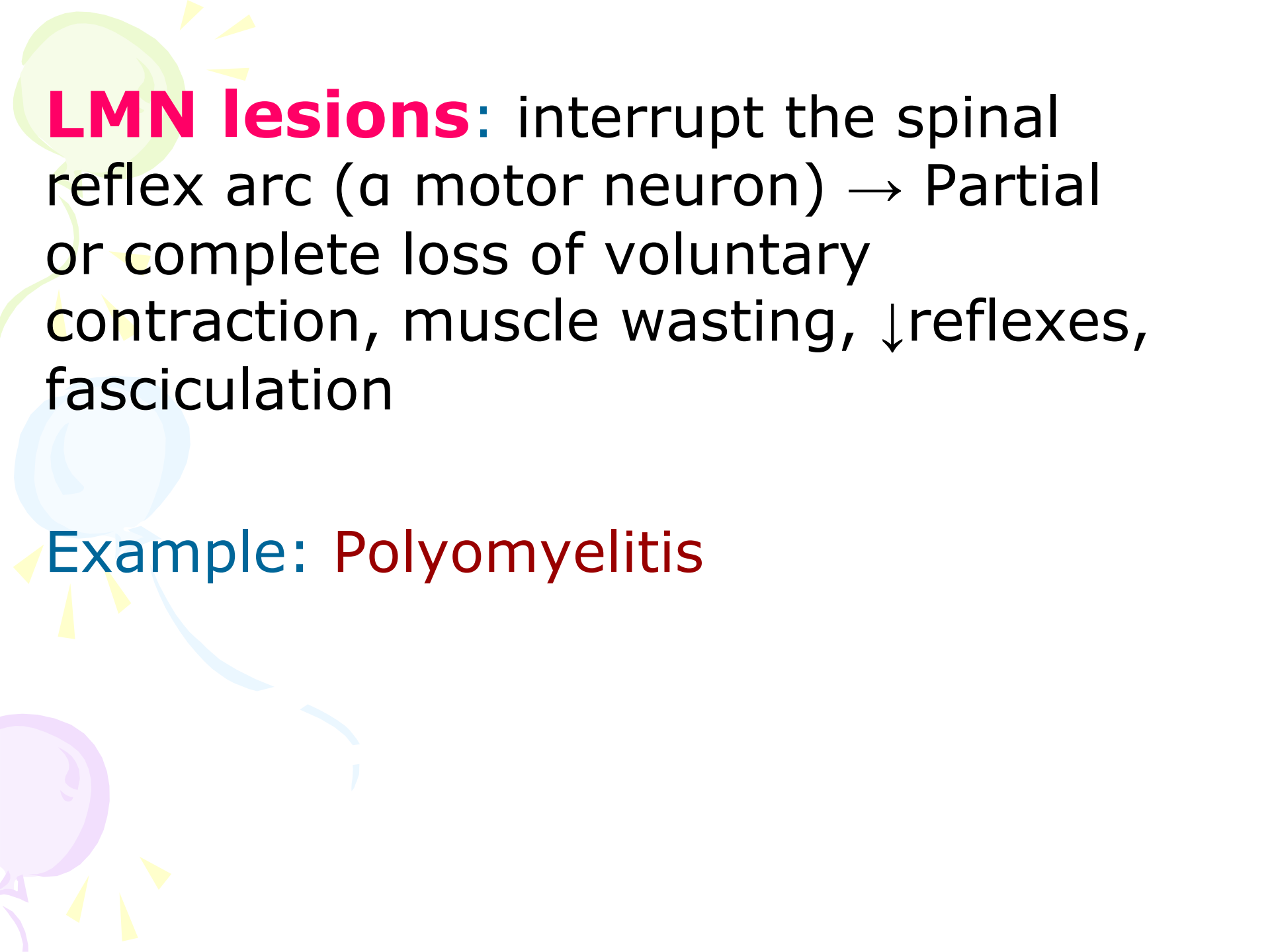
- 
- **Myopathy**: progressive degeneration of skeletal muscle fibers.

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

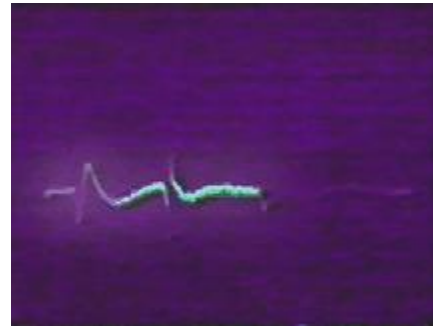
◆ **Fibrillation potentials:**

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

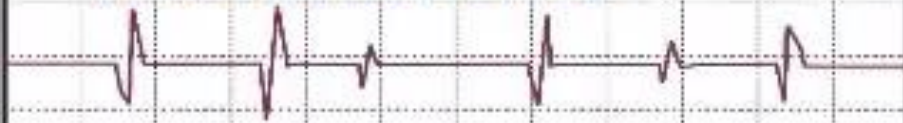
Fine invisible, irregular contractions of individual muscle fibers.

◆ **Positive sharp waves**

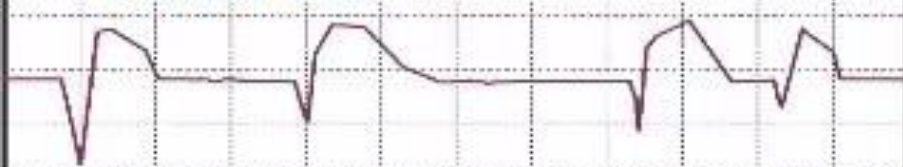
Small fibrillation APs (50 to 100 μV , 5 to 10 msec duration) whose propagation is blocked at the level of the recording Ede



Fibrillations



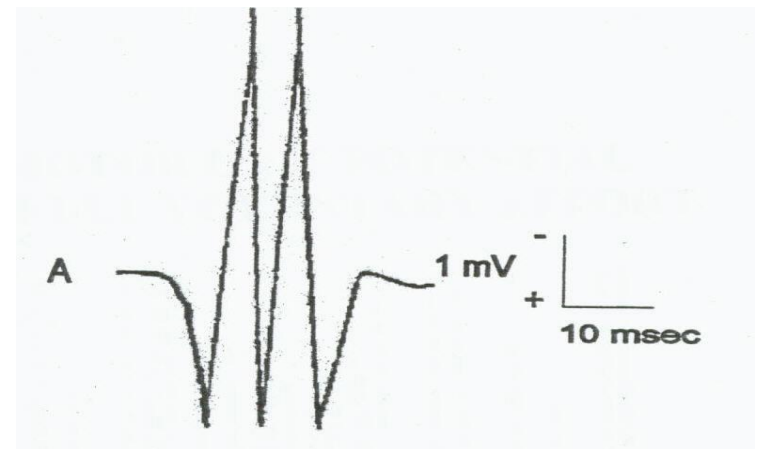
Positive Sharp Waves



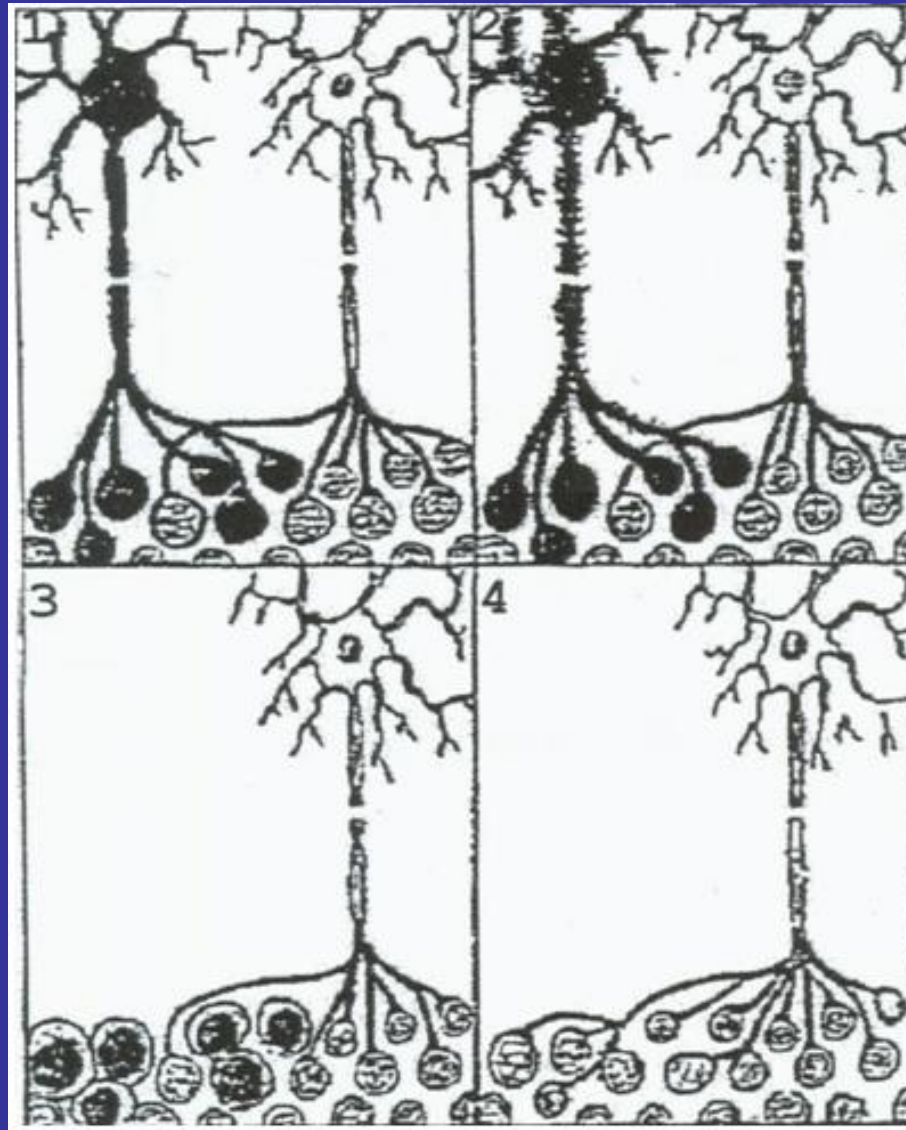
◆ Fasciculation potentials

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)**

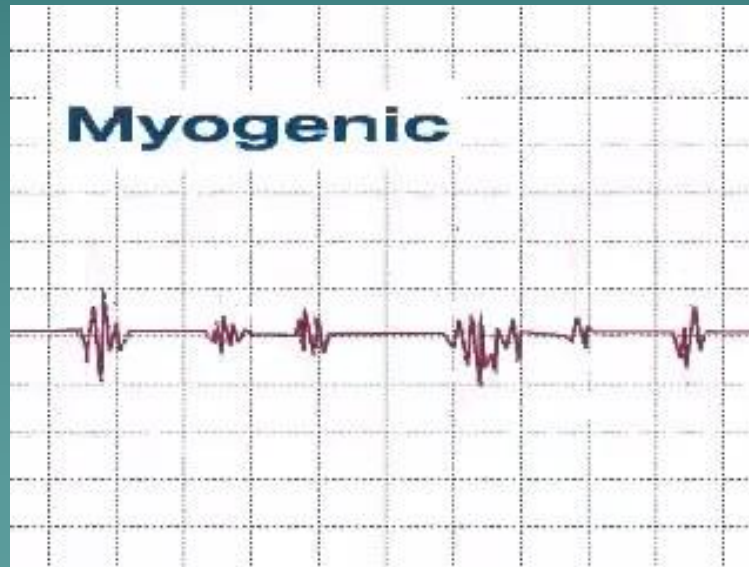


RE-INNERVATION BY COLLATERAL SPROUTING



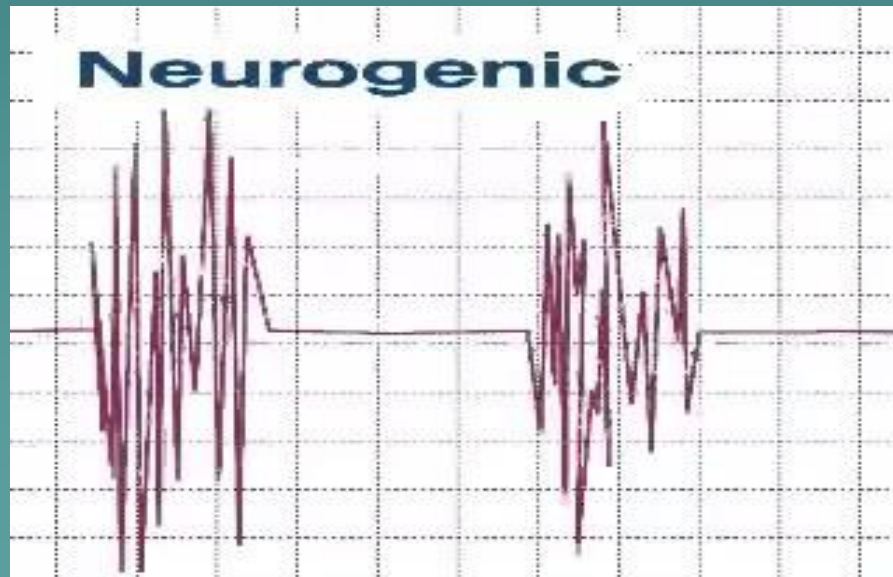
Myopathic alteration of the EMG:

Polyphasia , short duration , reduced voltage of MUPs



Neuropathic alteration of the EMG:

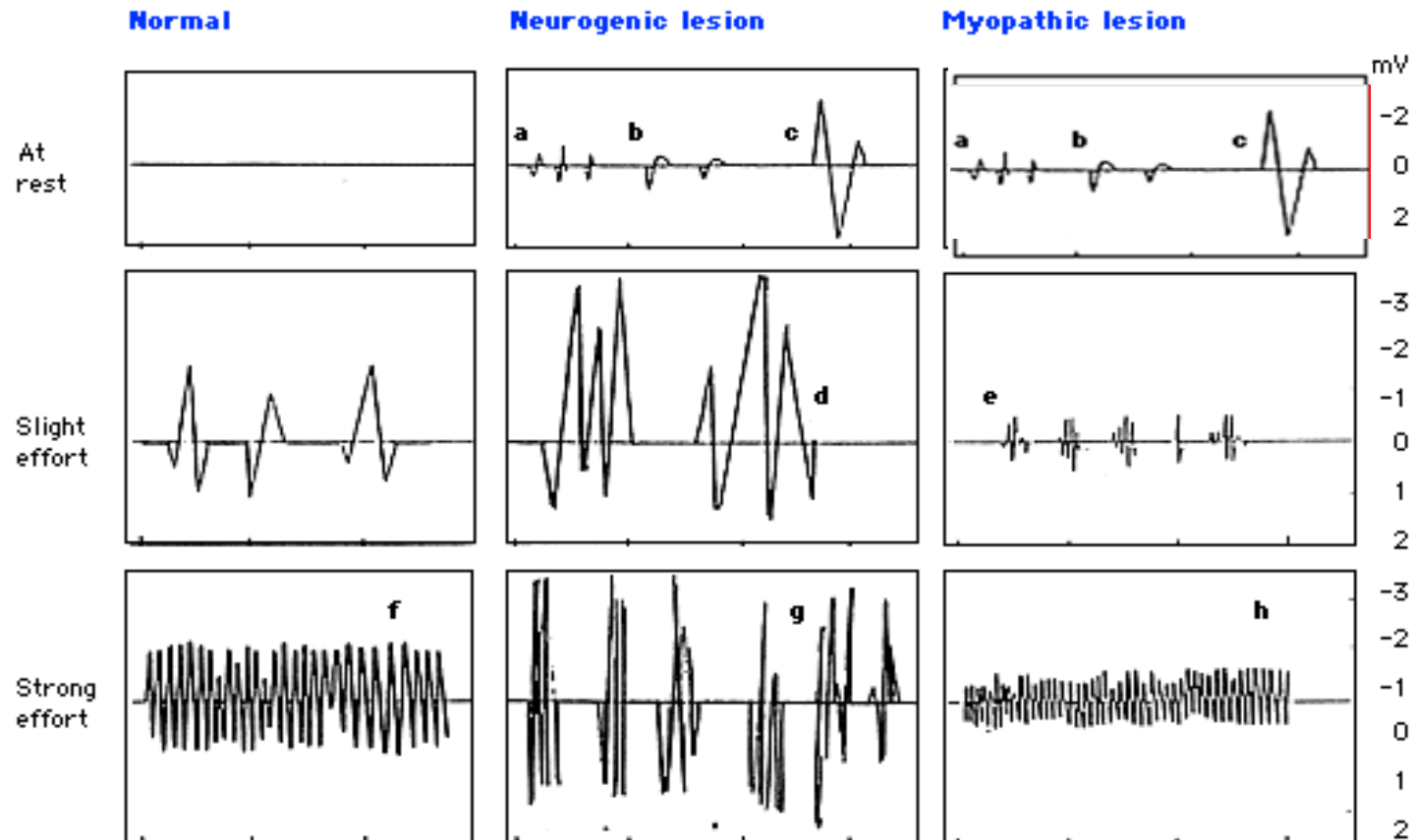
- ◆ Polyphasia , long duration , high voltage of MUPs



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*



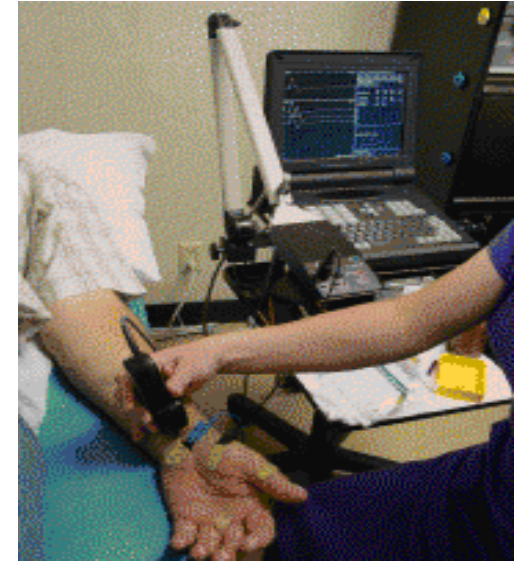
1. At rest (spontaneous activity): a. fibrillations, b. positive sharp waves, c. fasciculation.
 2. Slight effort (motor unit potentials): d. giant polyphasic, e. BSAPS (brief-small-abundant polyphasic).
 3. Strong effort (interference pattern); f. full, g. reduced units, h. reduced amplitude.
- * (helpful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

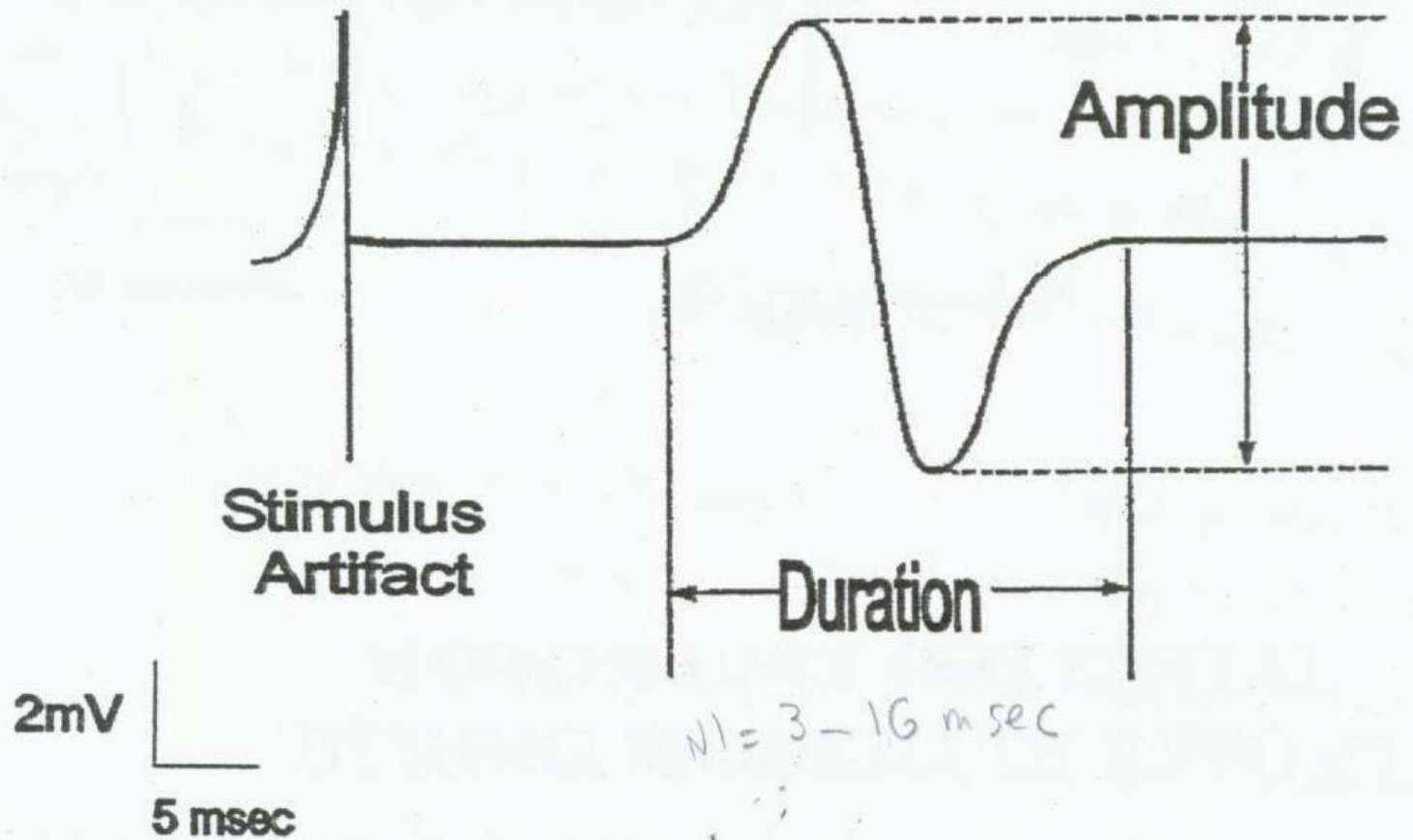
Procedure

- 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.

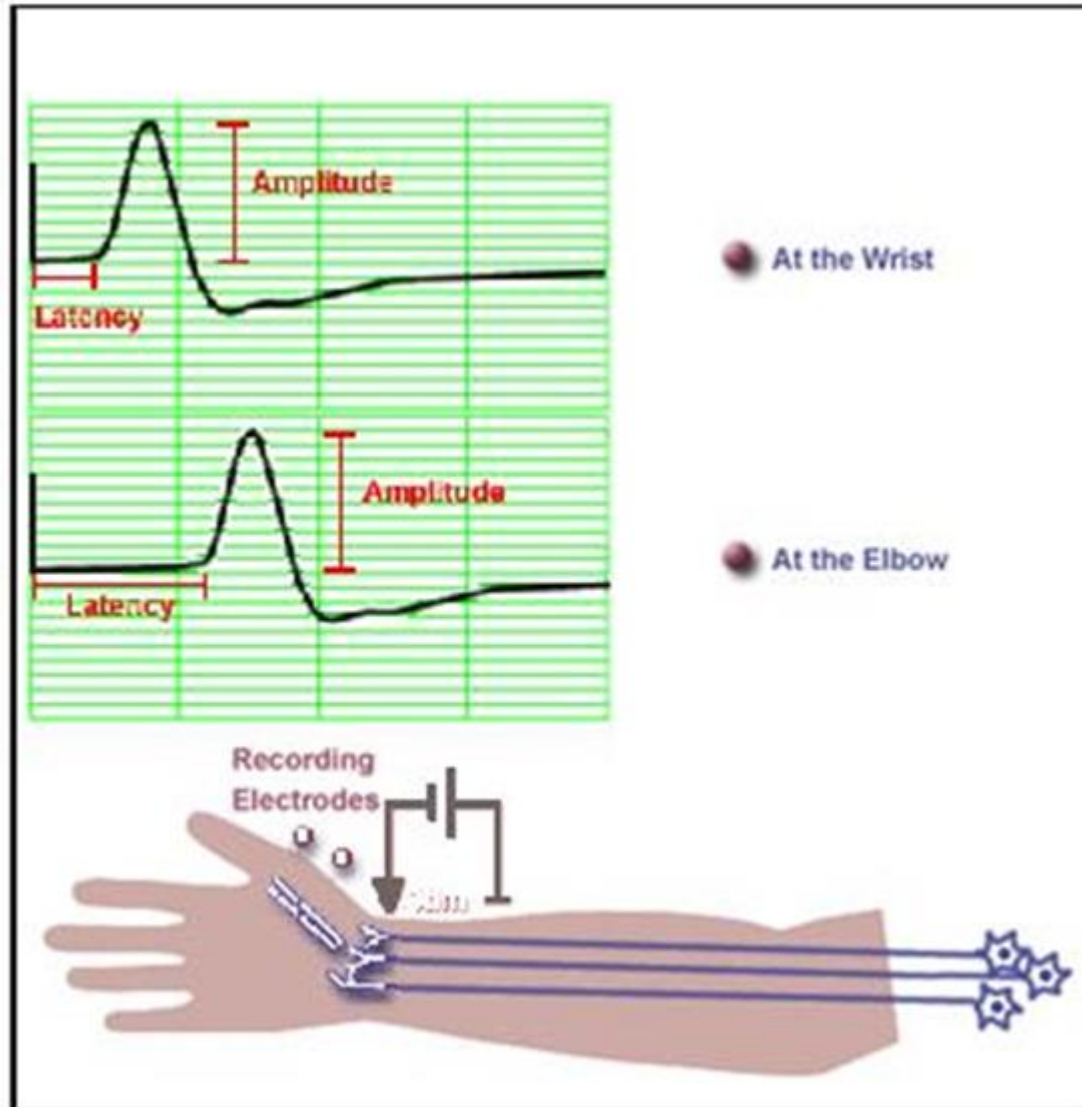


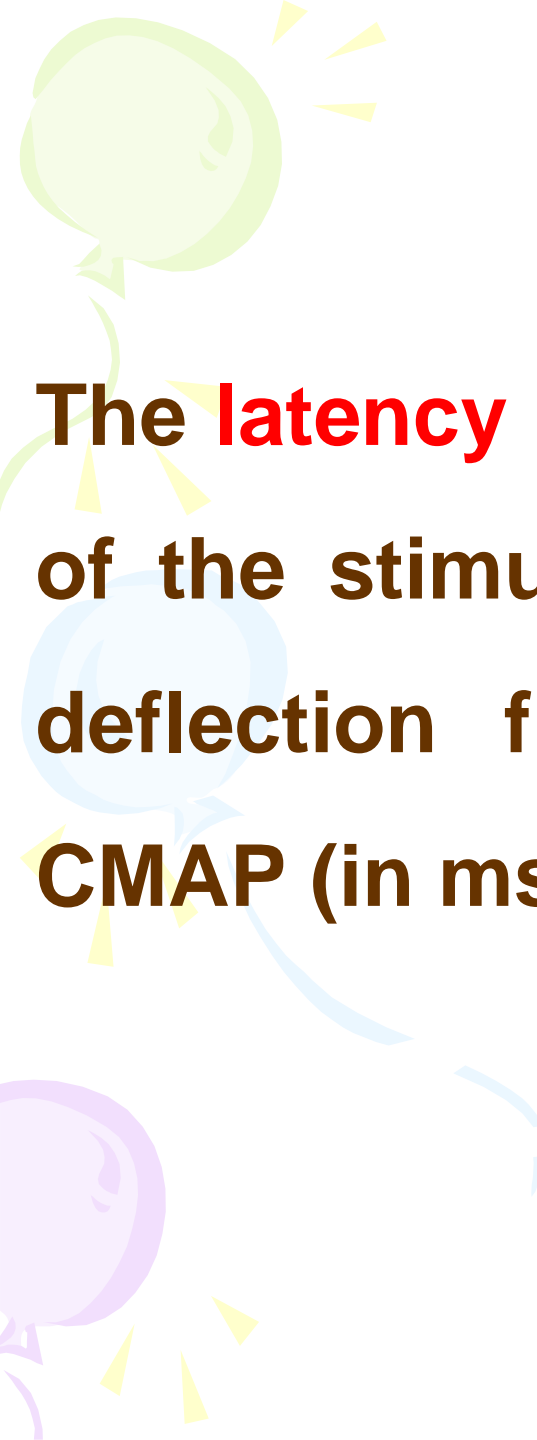
CMAP: summated potentials from all Motor Units in a muscle

COMPONENTS OF THE CMAP

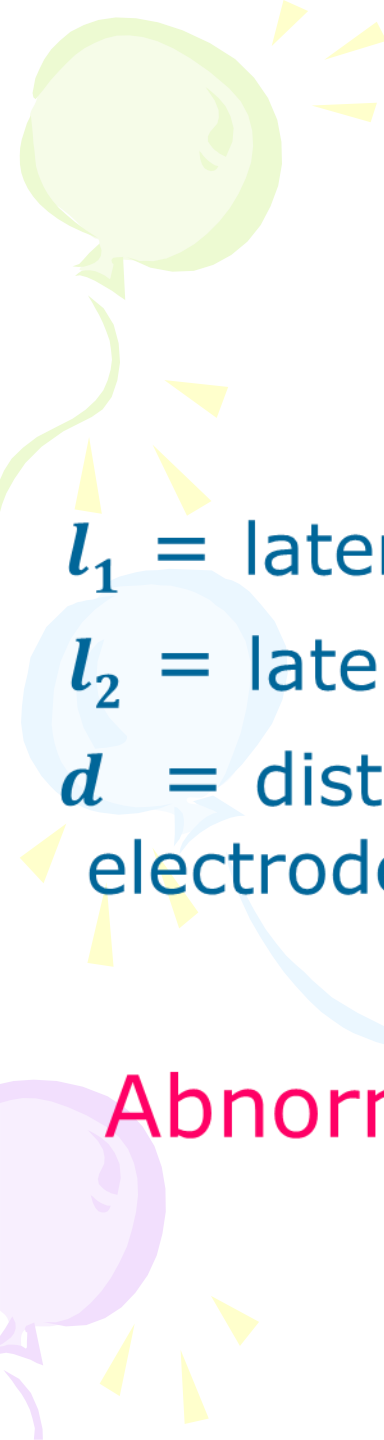


MOTOR NERVE CONDUCTION VELOCITY (MNCV)





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

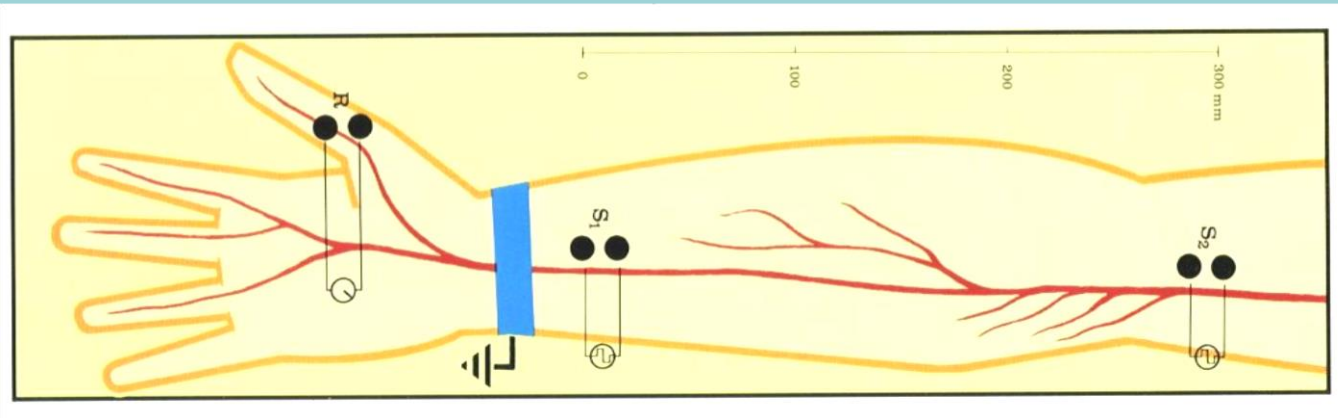

$$\text{MNCV} = \frac{d \text{ (mm)}}{l_1 - l_2 \text{ (ms)}} \text{ (m/s)}$$

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

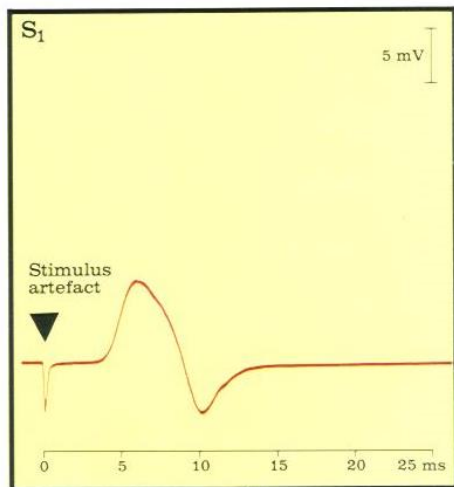
l_2 = latency at wrist (in the next CMAP).

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

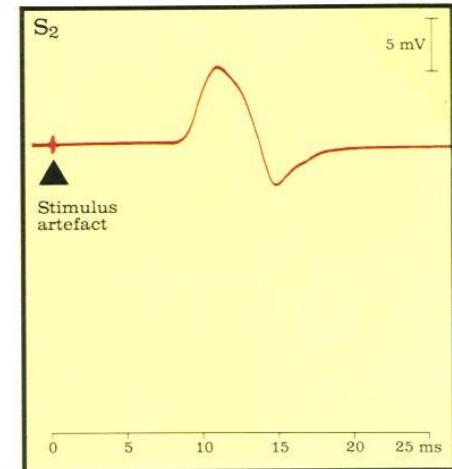
Abnormal if < 40 m/s



Distance
 $d = 24 \text{ cm}$



Latency At wrist
 $L_2 = 2.5 \text{ ms}$



Latency At elbow
 $L_1 = 6.5 \text{ ms}$

$$\frac{\text{Distance(mm)}}{L_1 - L_2(\text{msec})}$$

$$\text{MNCV} = (24 \times 10) \div (6.5 - 2.5)$$

$$\text{MNCV} = 240 / 4.0 = 60 \text{ m/sec}$$

Normal values for conduction velocity

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



Conduction is **faster** in **myelinated** fibers.

Conduction is dramatically **slowed** (20-30 m/s)

in **demyelinating peripheral neuropathies**

(**diabetes, Guillain Barré**) and in some **nerve**

compression/entrapment (**carpal tunnel**

syndrome).

A vibrant graphic with the text 'THANK YOU...' in large, multi-colored letters. The letters are: T (purple), H (red), A (orange), N (yellow), K (green), Y (blue), O (dark blue), U (purple), followed by three small purple squares. The text is set against a white background with decorative elements: a green balloon in the top left, a light blue balloon in the middle left, and a purple balloon in the bottom left. Yellow streamers and confetti are scattered around the balloons. The text has a slight shadow effect.

THANK YOU...

Off to the Lab!



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