5 Nerve Conduction Study & EMG

- Very important
- Extra information
- Terms

كل إناء يضيق بما جعل فيه إلا وعاء العلم فإنه يتسع

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objectives

- Define what is nerve conduction study (NCS) and electromyography (EMG).
- Explain the procedure of NCS using Abductor Pollicicis Brevis muscle.
- Define the normal conduction velocity in upper limb and lower limb nerves .
- Define the motor unit potentials (MUPs) and how they are changed in muscle and nerve diseases.

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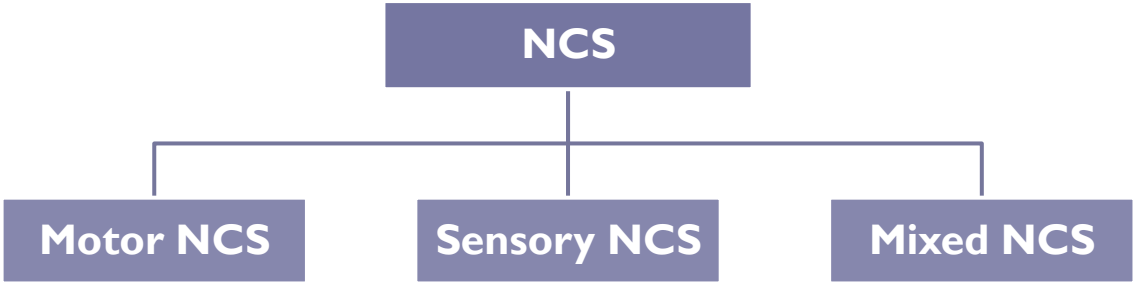
Introduction

- Nerve conduction study (NCS) : is an electrophysiology test commonly used to evaluate the function of peripheral nerves of the human body.

- It could be motor nerve conduction study (motor NCS), sensory nerve conduction study or mixed nerve conduction study :



- In this lecture, only motor nerve conduction study will be discussed.
- In the motor test the recorded response is the muscle CMAP "compound muscle action potential"

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Overview of NCS

- Nerve conduction studies give doctors information about how well and how fast the nerves in your body send waves of electricity (electrical impulses). This test can be used to check for various different types of problems with the peripheral nervous system

- Diabetic patients loss the sensation which means their nerves are affected. The patient comes to you and complains : I cannot fell of my feet. Here you have to send him to do nerve conduction study to see if he has a normal conduction or not. Another example : the elder people usually have numbness , so we aim here to study the nerves of the body (The conduction of the nerves).

- How can we do the test?

Electrical stimulus is applied to the nerve to give the action potential " median nerve usually" , the recording electrode (Active electrode) is placed over the muscle which supplied by motor nerve then, the stimulus arrives 2 sites : distal site at the wrist and the proximal one "antecubital fossa , elbow". The reference electrode about 3 cm away from the recorder electrode.

- To have the AP you must stimulate the nerve : we stimulate the nerve to see the AP coming from this nerve.
- The name of AP here is : compound muscle action potential (CMAP).
- To record the AP you must have 3 types of electrodes :"to study the nerve"

1-Recording Electrode.
2-Reference Electrode : we usually put it in bony area while the recording electrode in the muscle which supplied by median nerve.
3-Ground electrode : (to neglect any waves other than the stimulated nerve)

- The machine that shows the AP is called (oscilloscope).
- As we took in action potential lecture , there is depolarization, Repolarization and Hyperpolarization which occur only after stimulation so when we want to see these stages or record it we must have : recording electrode , reference electrode "which is the most important one" and ground electrode.

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Overview of NCS

- The benefit : to know if the nerve is normal or not : Normal nerves have normal conduction velocity.
  "Each nerve has specific conduction velocity" : for motor nerves it is around 50-70 m/s.
- When we do this study we will have 2 stimulus : one at wrist and the other at elbow.
- To calculate the velocity : Distance / Time.
- Why do we apply it to 2 sites ? to have 2 AP, one at the wrist and the other at the elbow then we will measure the distance between the wrist & elbow.
- To measure the time : the time from the stimulus up to reach the Action potential "peak of AP".
- If the result of patient' s NCS was 40, after the treatment :

If he said : I feel much better > 50
If he said : I feel the same or I did not improve > 40 or less than 40

- In general, the Normal conduction velocity is about 45-65 meter per second. It is vary from individual to another.

In arm – 50 – 70 m / sec. In leg – 40 – 60 m / sec.
If it is decreased : 36-41 > abnormal.

- Median nerve is covered by ligament , in some patients this ligament will be affected by a disease" carpal tunnel syndrome" that compresses the nerve > result in numbness.

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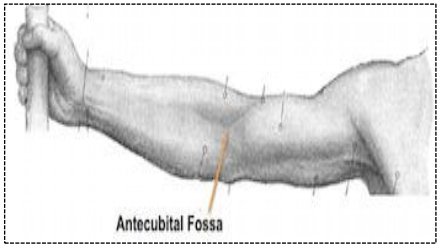
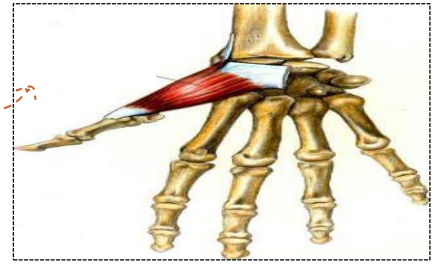
Procedure

An electrical stimulus is applied over a nerve (median nerve) and a recording electrode is placed over the muscle supplied by that motor nerve .

The stimulus is applied at two sites : a distal site **(wrist)** and a proximal one **antecubital fossa (elbow)**



The muscle usually chosen in this routine test is the Abductor Pollicis Brevis



The active recording electrode (G1) is placed over the thenar eminence which overlies the muscle .

The Reference recording electrode (G2) about 3 cm away

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Procedure

The oscilloscope (CRO) sweep speed is adjusted to **2 ms/cm**.

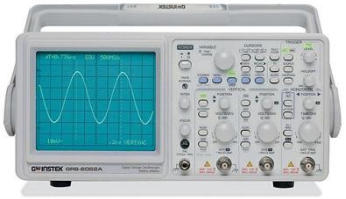
The stimulus duration used is **0.2 ms** and stimulus frequency to **1/sec**.

Apply the stimulus and record the response from stimulation at the **wrist**.

Store the **CMAP** in the first channel of the oscilloscope.

Change the stimulating site from wrist to **antecubital fossa (elbow).**

Stimulate the nerve & record the **CMAP** for median nerve stimulation at the elbow .



It is a type of electronic test instrument that allows observation of constantly varying signal voltages.

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Muscle Nerve Conduction Velocity

1. Measure the distance from elbow to wrist with a measuring tape
2. Measure the latency in first CMAP & in the next CAMP
3. Enter the distance between the elbow and wrist

- **MNCV will appear, It can also be calculated by formula :**

$$\textbf{MNCV (m/sec)} = \frac{\text{Distance (mm)}}{\text{L2-L1 (ms)}}$$

L1 = latency at wrist
L2 = latency at elbow

Conduction of velocity could be more than the normal which is very good and the patient is not complaining from any thing BUT the abnormal when its become lower than the normal (slower conduction velocity)

Normal values for conduction velocity:

Arm : 50-70 m/ sec.

Leg : 40-60 m/ sec.

في حال وردت الوحدة بالـ cm يجب تحويلها إلى متر

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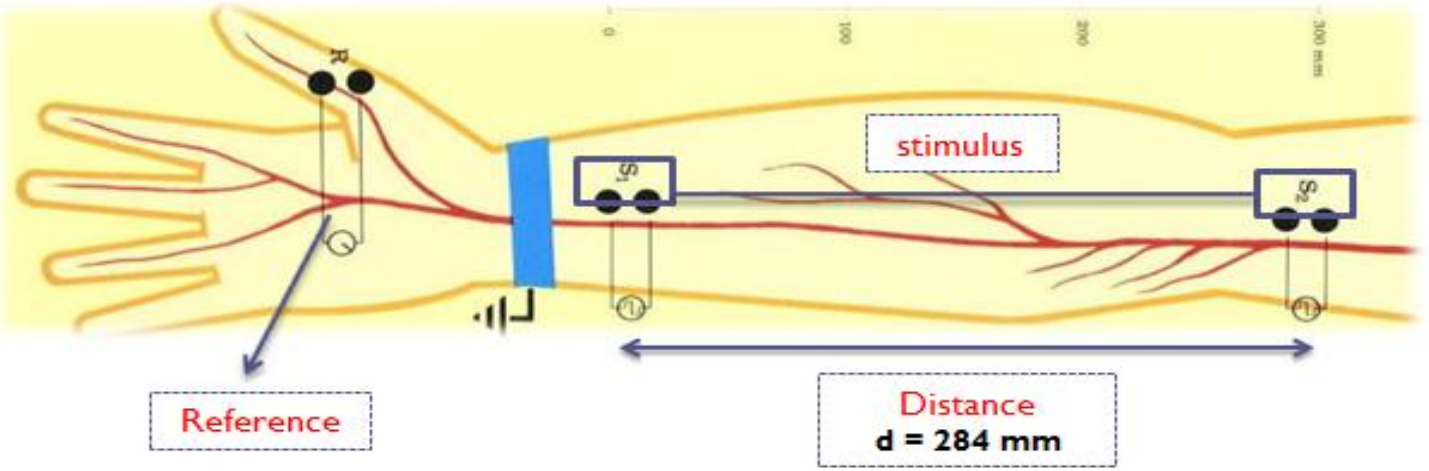

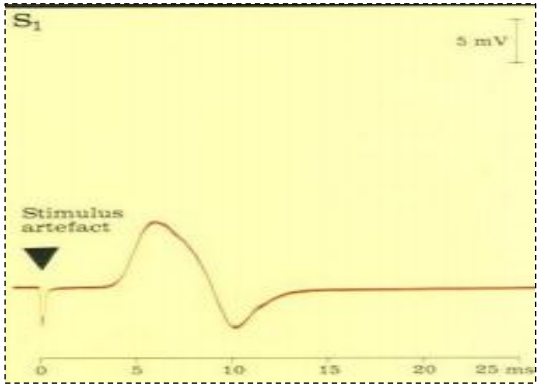

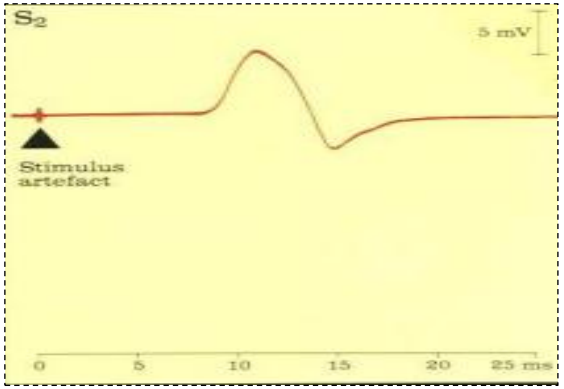

L1 = latency at wrist
L2= latency at elbow

L1 Latency At **wrist**= 3.5 ms

L2 Latency At **elbow** = 8.5 ms

Latency is the time between the stimulus artifact and the action potential

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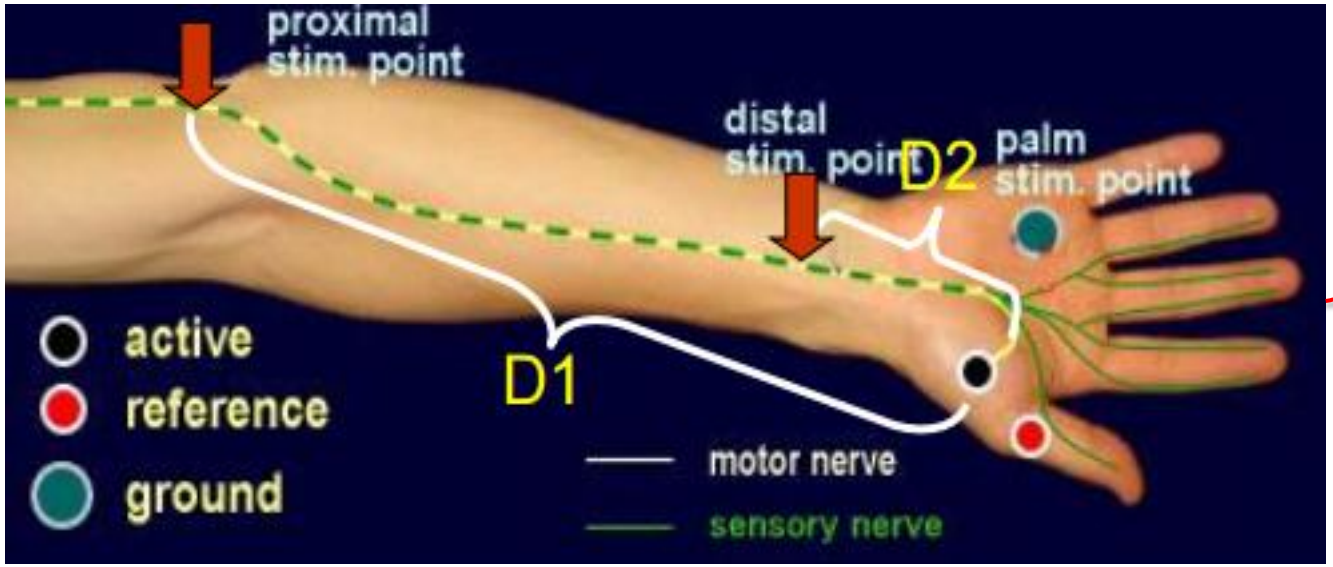
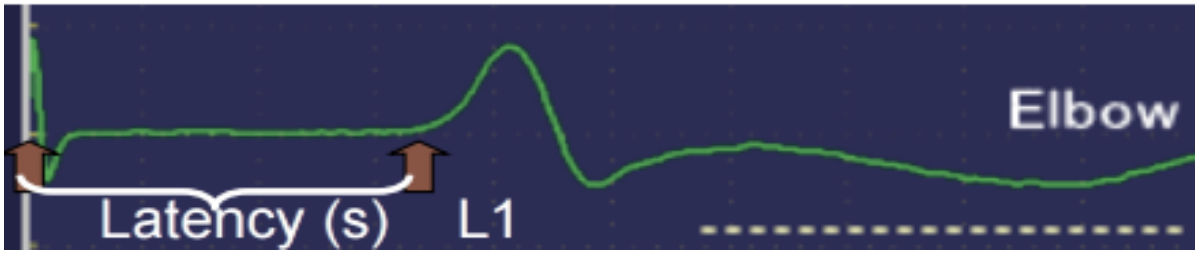
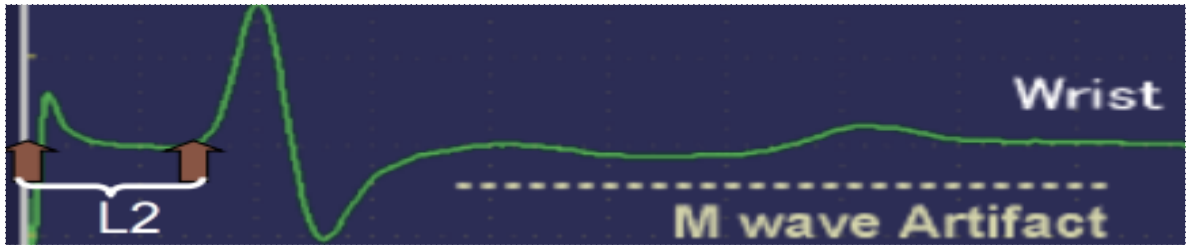
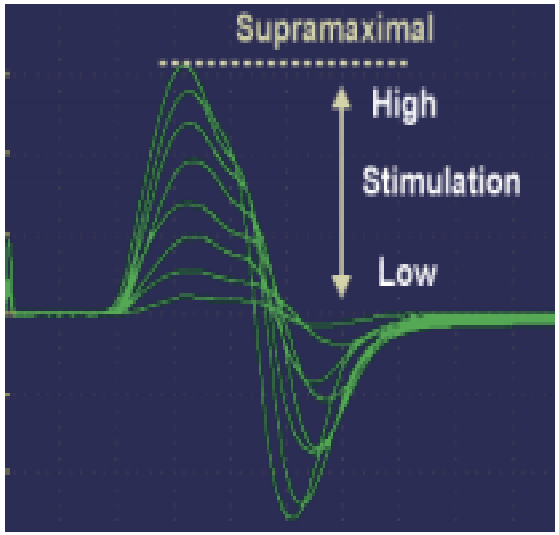
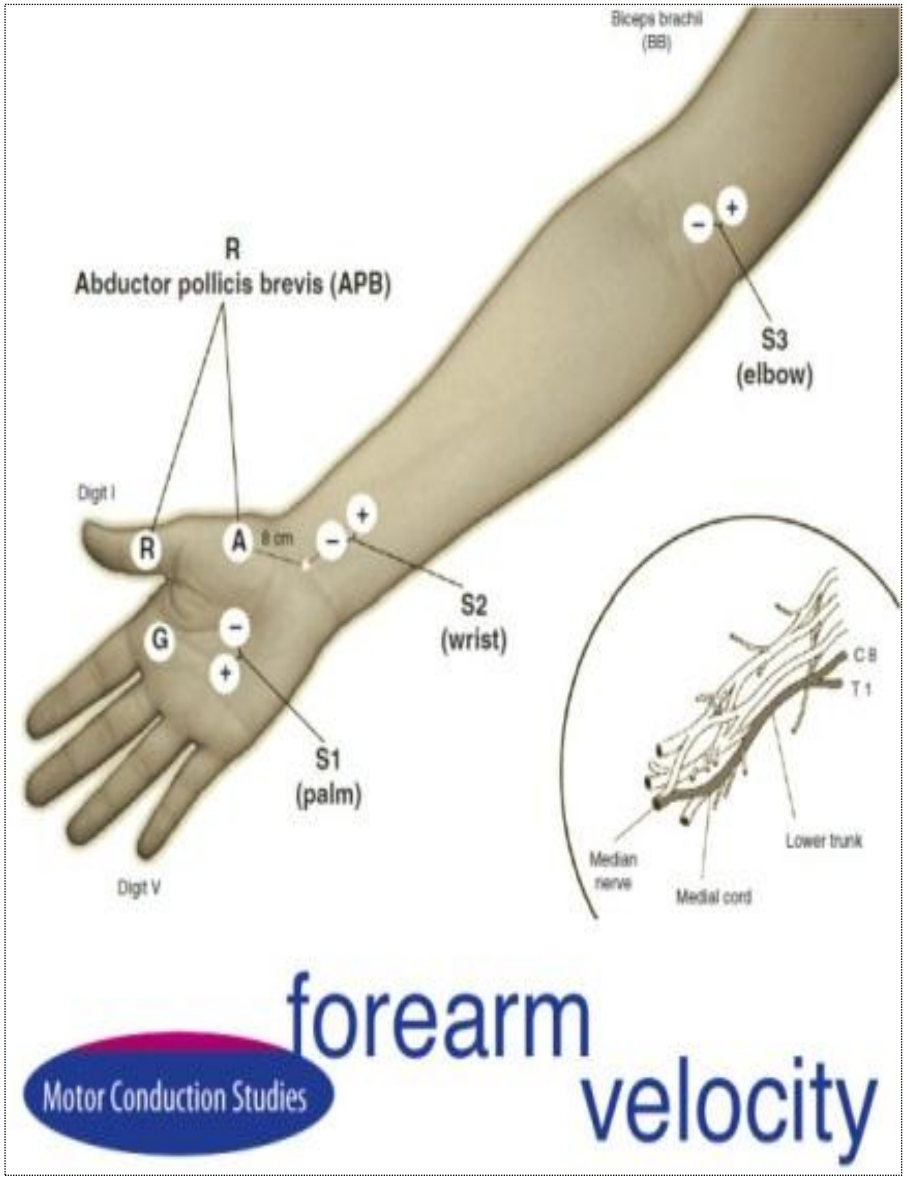


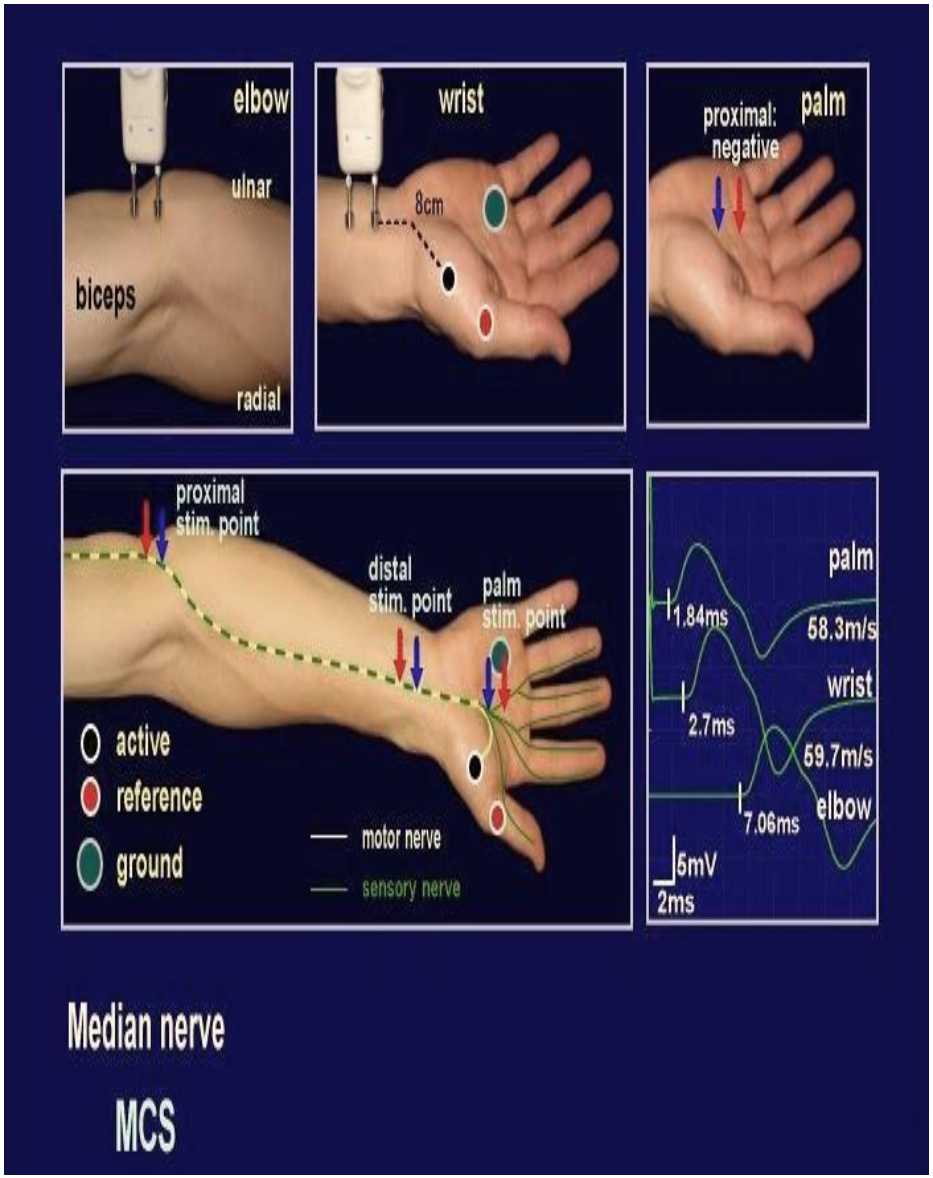
$$NCV = \frac{D1-D2}{L1-L2}$$

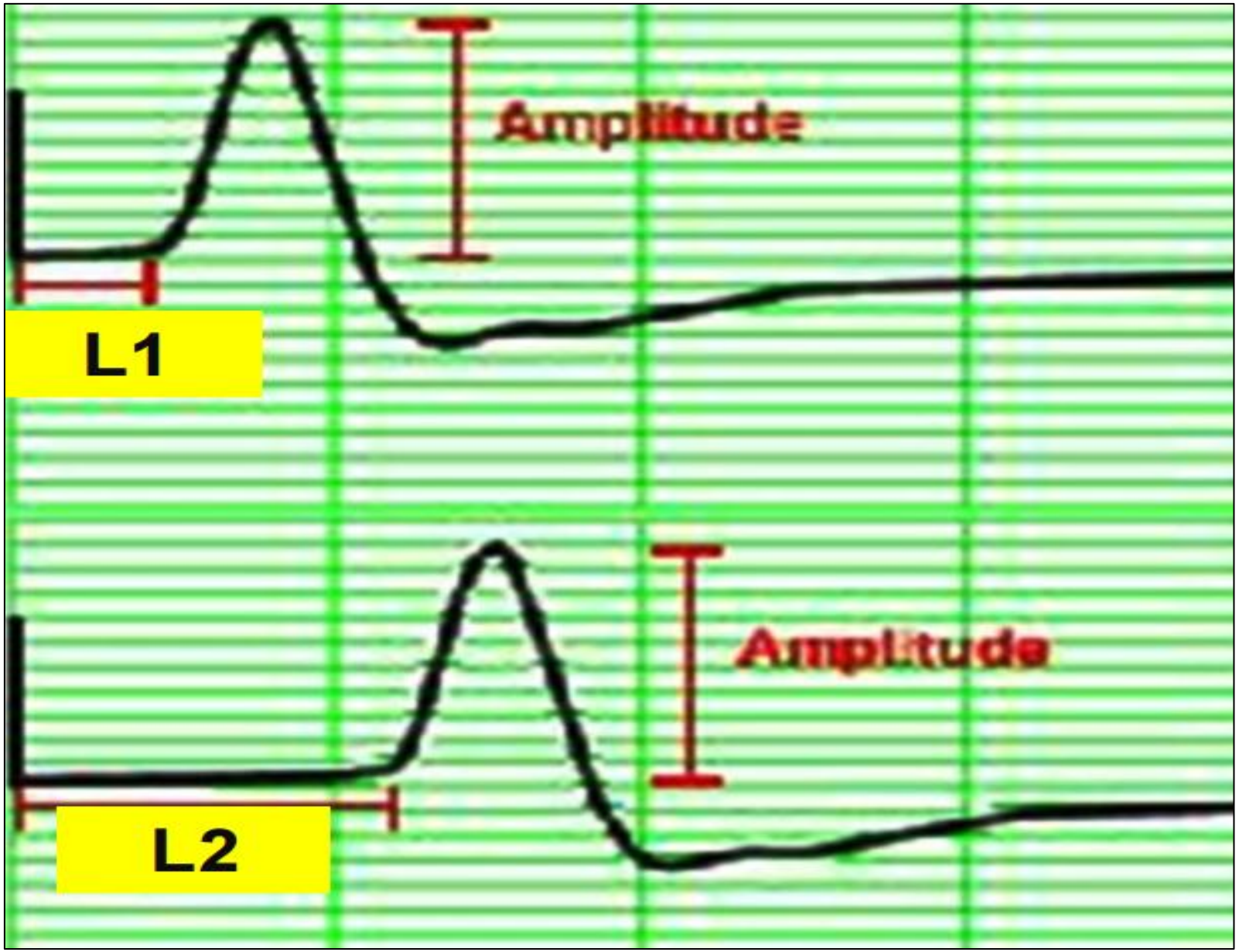











Amplitude
L1
Amplitude
L2

Electromyography (EMG)

- Electromyography (EMG) : **is a technique for evaluating and recording physiologic properties of muscles at rest and while contracting**.

("Electromyography (EMG) is a diagnostic procedure to assess the health of muscles and the nerve cells that control them "motor neurons").

- **It is a recording of electrical activity of the muscle by :**

`1- inserting needle electrode in the **belly** of the muscles (Needle EMG)
2- or by applying the surface electrodes (surface EMG).

- **The potentials recorded in needle EMG are derived from motor units of the muscle, hence known as** motor unit potentials (MUPs).

- **A motor unit is defined as one motor neuron and** all of the muscle fibers it innervates

"When a motor unit fires, the impulse called an action potential is carried down the motor neuron to the muscle".

Electromyography : to study the muscle activity.

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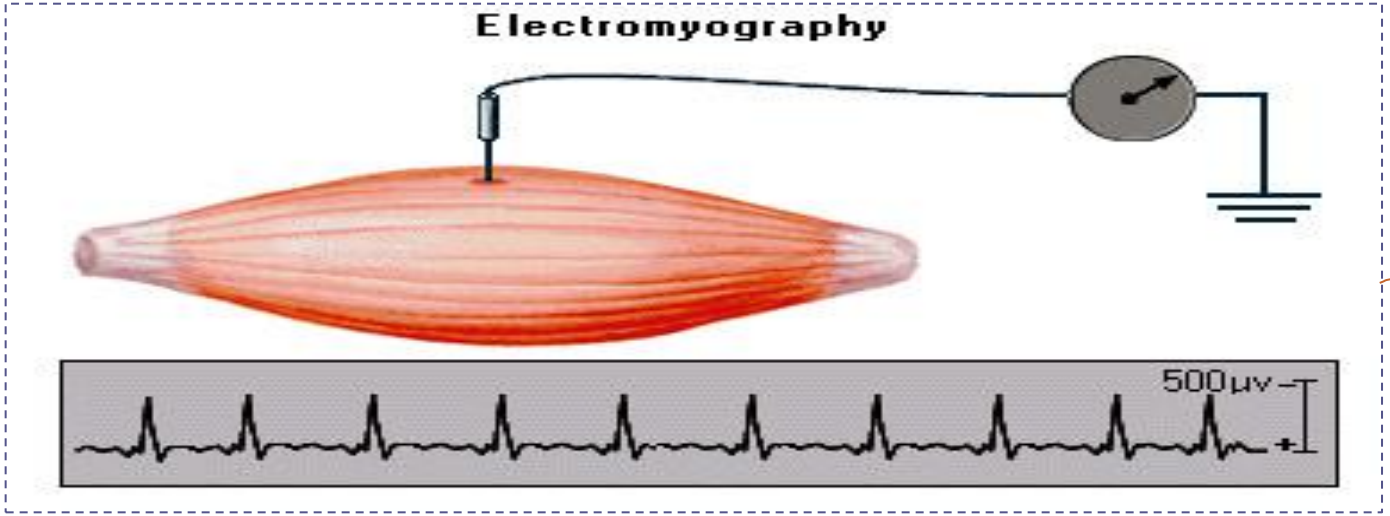
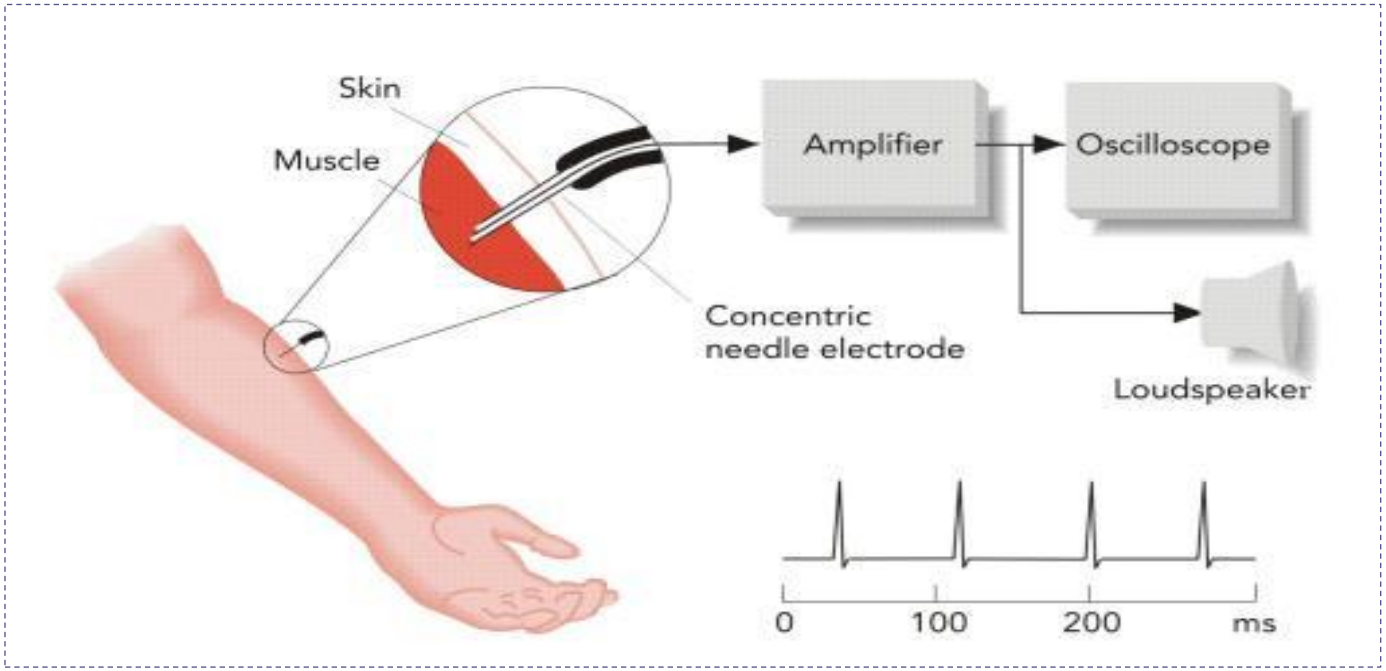
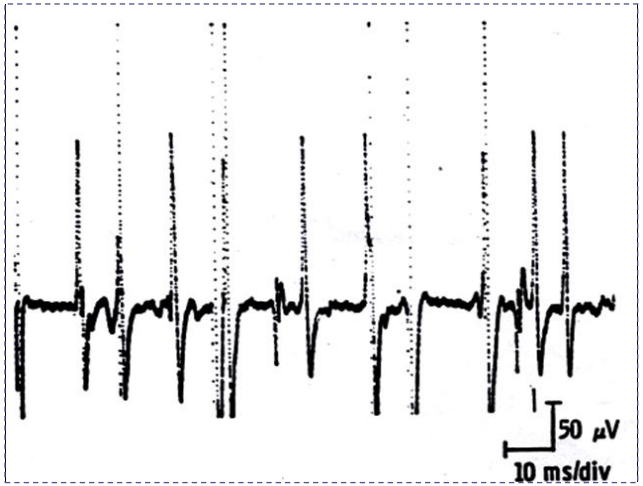


belly of the muscles



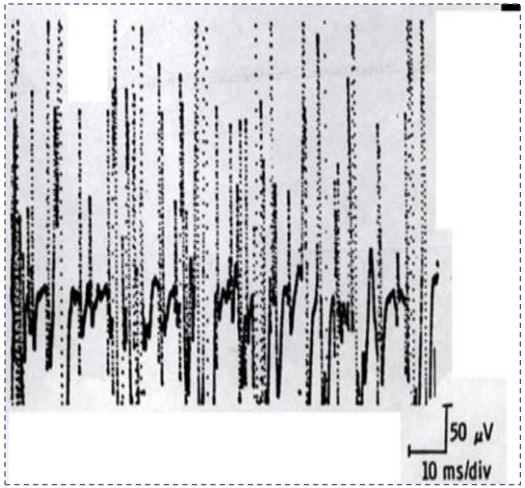
EMG

During Mild Effort



During Moderate Effort

Note: recruitment of additional motoneurons "Motor neurons"



During Full Voluntary Effort

There is full recruitment

(you can not see the baseline)

Note: All of them normal but the difference is in effort.
the increase of muscle contraction effort will increase the motor neurons recruited.

EMG

- **Normal MUPs** (Motor unit potential) :

- **Amplitude : [** 300 µV (microvolt) – 5 mV (millivolts) **]**
- **Duration : [** 3 – 15 ms (millisecondes) **]**

- **Examples of Abnormalities of MUPs :**

In Nerve disease :

Giant MUPs due to reinnervation > 5 mV
"more than 5 mV"

In Muscle disease :

Small MUPs < 300µV
"Less than 5 µV"

In nerve diseases the MUPs are large because they can reinnervate while muscle in won't that's why it has small MUPs.

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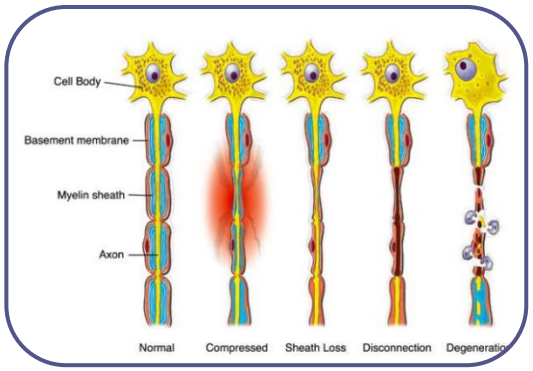
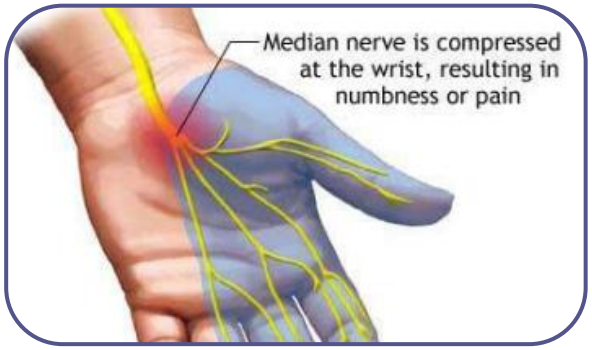
Clinical Application

Myasthenia gravis



Nerve injury



Carpal tunnel syndrome

Will be discussed in neuromuscular transmission lecture

Carpal tunnel syndrome: the ligament of the median nerve is injured so it will compress the nerve.

videos

-What are NCS & EMG ?

-Median motor nerve conduction study

-Nerve conduction test

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QUIZ I

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