Physiology practical

Neuropsychiatry block

Lecture one :

{ Electromyography and motor nerve conduction velocity}

- **Objectives :**

➔ Acquire a skill to perform the test by themselves.

➔ Analyze the motor unit potentials and states their uses in health and diseases.

➔ Determine and calculate motor calculation velocities of the peripheral nerves.

- **Team leaders :**

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- **Team members :**

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  Raghda alqasim
  Mohammed Aldegaither

- **Recourses :**

  Physiology practical boys & girls slides + Physiology practical handouts.

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❖ Introduction (overview for better understanding) :

We have 2 Electrophysiological tests : EMG & MNCV :

➔ **They are completely different :**

- EMG : recording of the electrical activity in muscles at rest and contraction, it measures muscle response to nervous stimulation.
- MNCV : The speed of propagation of an action potential along the nerve. "يقيس سرعة السيالات العصبية".

➔ **In EMG :** signals come from brain to enhance muscle contraction.

➔ **In MNCV :** there is an external stimulus applied to nerves to see the response.

➔ When does the doctor ask for these 2 tests ? if the patient is suffering from weakness of his muscles.

1) Motor Unit[1] :

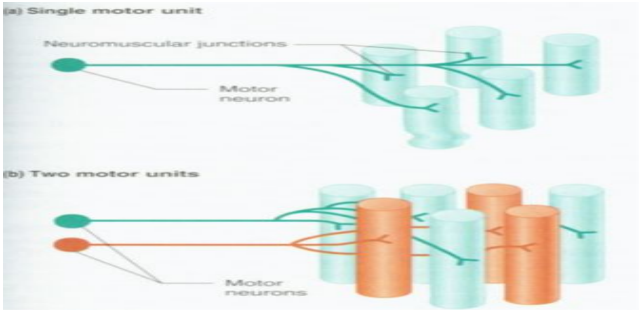
Consists of a motor neuron and all the muscle fibers it innervates.

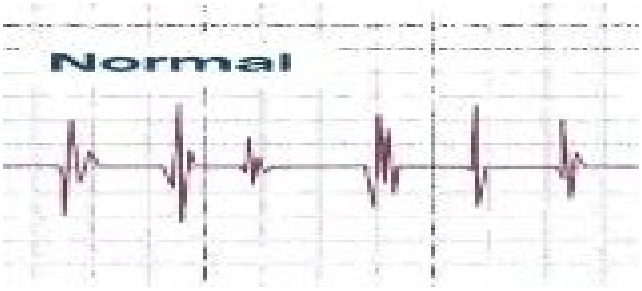
- **Normal motor unit potential(MUPS):**

➔ Bi – Triphasic[2]

➔ Duration : 3 – 16 mSec.

➔ Amplitude"The peak" : (300µV – 5 mV)





[1] Motor unit : motor neuron + all the muscle fibers which are innervated by that motor neuron. When the motor neuron reaches there, its axon divides into many branches, each branch forms a single junction with a muscle fiber. It means that each motor neuron innervates many muscle fibers of the same type. When an action potential runs down motor neuron, all the muscle fibers belonging to that motor neuron will be innervated.

[2] Phase : the part of the wave which starts from the beginning of the baseline and returns back to that baseline.

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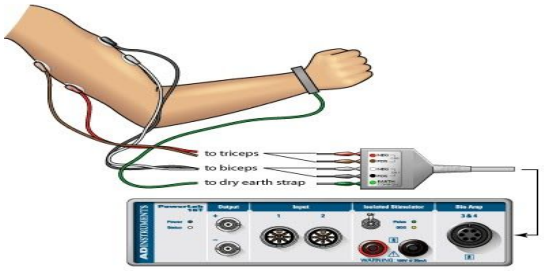
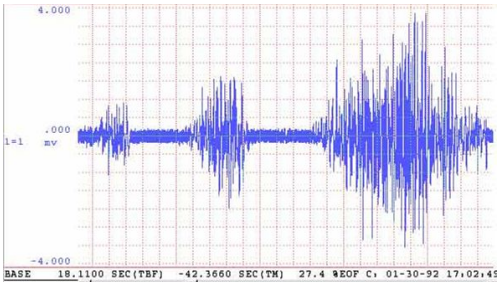
2) Electromyogram[3] :

The recording of electrical activity of a muscle **at rest** and **during contraction**.

- **Function:** To evaluate the electrophysiology of a motor unit (MU)
  [Activity is amplified and displayed on an Oscilloscope].



Instrument: **Electromyograph**



Record: **Electromyogram**

- **Steps:**

1. **A concentric needle electrode[4] is inserted into the belly of the muscle which is patient is suffering from it.**
2. **Normally a muscle is silent at rest after insertional activity[5].**

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

3. **Then the patient is asked to contract the muscle smoothly.**

➔ With muscle contraction, motor unit are activated and Motor unit action potential (MUAP). **MUAP** represents the summation of the potentials generated by muscle fibers appear on the screen.[6]

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[3] EMG : evaluation of electrophysiology of the motor unit and test the integrity of the entire motor system.
[4] Inserted to detect any muscle activity during contraction. This needle will not record anything during relaxation of the muscle.
[5] Insertion of the needle electrode.
[6] We can't detect the action potential of a single muscle fiber.

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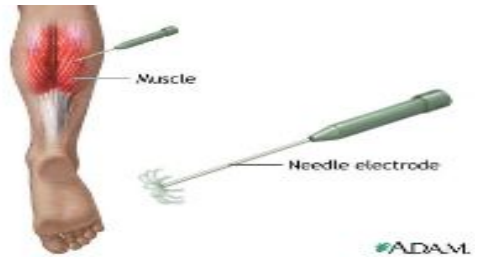
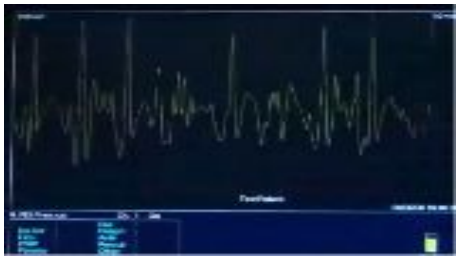
4. **While the patient increasing strength of contraction →recruitment of Motor units → ↑ number & size of Motor unit potentials.[7]**

➔ At full contraction separate MUAP will be indistinguishable resulting in a complete recruitment which called interference pattern[8]

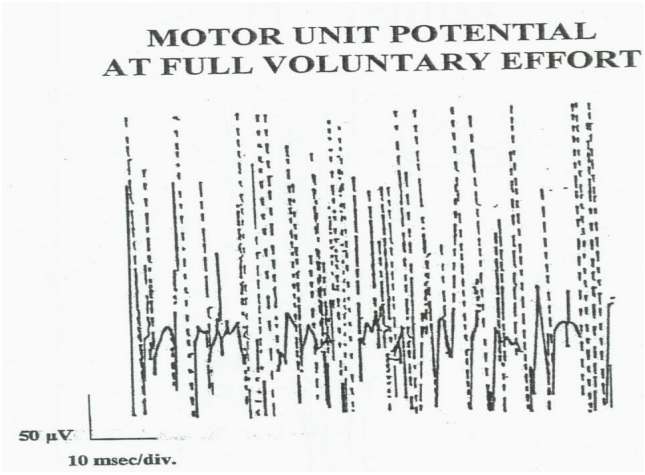


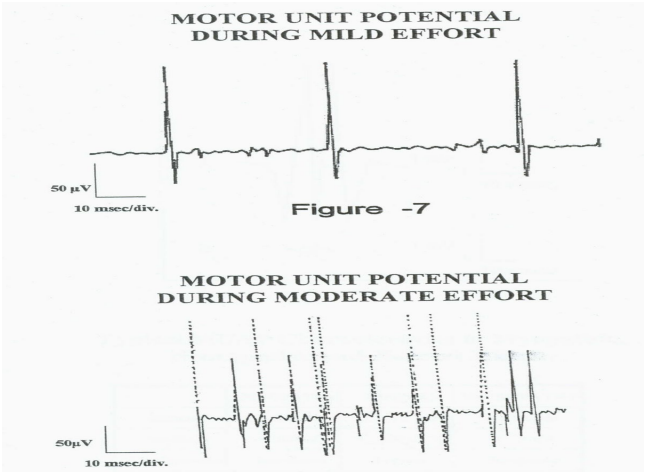
Step1

Step2



Step3





"Interference pattern"

[7] During contraction, motor units appear on the screen. This contraction means that there is recruitment "توظيف" of motor units.

[8] **Interference pattern**: in maximal voluntary effort, the number of MUPs are so many that the oscilloscope is completely filled up with them. Identification of each MUP will be impossible because of the overlap of one potential with the other potentials (Complete recrutement).

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- **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].[9]

➔ **Neuropathy:** Damage to the distal part of the nerve , mainly affects feet & legs

Most common etiologies for neuropathy:

1. Guillain Barré syndrome.
2. Diabetes mellitus.
3. Alcohol abuse.

- **Lower motor neuron lesions :**

1. interrupt the spinal reflex arc (α motor neuron).
2. Partial or complete loss of voluntary contraction.
3. Muscle wasting.
4. Decreased reflexes.
5. Fasciculation[10]

➔ **Example:** Poliomyelitis[11]

[9] **Duchenne muscular dystrophy** (**DMD**) is a severe type of muscular dystrophy.The symptom of muscle weakness usually begin around the age of four in boys and worsens quickly.
[10] Fasciculation :a brief spontaneous contraction affecting a small number of muscle fibres, often causing a flicker of movement under the skin.
[11] An infectious disease caused by the poliovirus.

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- **In neurogenic lesion or in active myositis, the following <u>spontaneous activity</u> is noted:**

1. Positive sharp waves:

Small fibrillation APs (50 to 100 µV, 5 to 10 msec duration) with abrupt onset and slow outset , whose propagation is **blocked** at the level of the recording Ede.

2. Fibrillation potentials :

- **<u>Features :</u>**

1. Low amplitude.
2. Short duration.
3. 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.*[12]

These are randomly occurring small amplitude potential or may appear in runs. The Audio-amplifier gives sounds , as if somebody listen sound of rains in a thin shade house.

[12] Destroyed muscles become very sensitive to Ach by over-activation of receptors so, muscles will discharge spontaneously.

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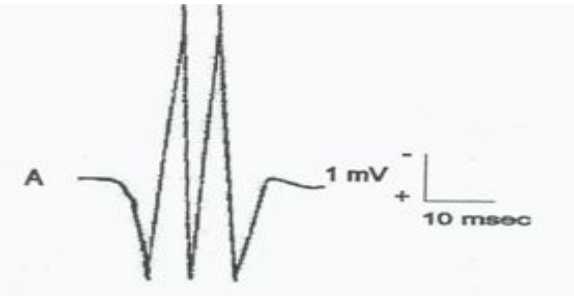
3. Fasciculation potentials :[13]

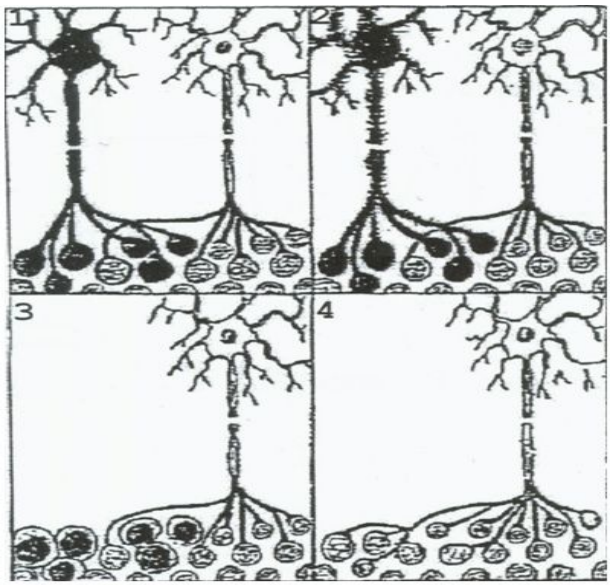
- ➔ Spontaneous discharge of a **motor unit (MU)** at **rest** can be seen and felt by the patient.
- ➔ **Partial re-innervation** of denervated muscle, by sprouting of the remaining nerve terminals, produces abnormally high voltage, polyphasic, long duration potentials (Giant Potentials).



Reinnervation by collateral sprouting :

FASCICULATION POTENTIALS:
these are high voltage, polyphasic, long duration potentials, appear spontaneously associated with visible contraction of the muscle.They originate from a large motor unit which is formed due to reinnervation of another motor unit from neighboring motor unit.

More explanation :
In this picture we can see two motor units, the black motor neuron has been damaged (destroyed) so the other motor neuron send collateral fibers to innervate the black muscle fiber which is paralysed. "The white neuron took over"
So the white motor unit is now called GIANT MOTOR UNIT. This giant motor unit will produce abnormally large polyphasic action potential, long duration and high voltage. These are called **FASCICULATIONS.**



[13] They will appear as visible contractions which can be seen and felt by the patient while the fibrillation cannot be felt by the patient.

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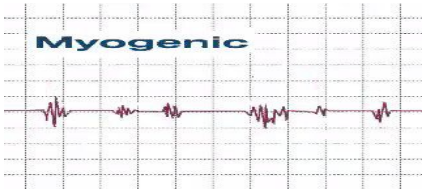
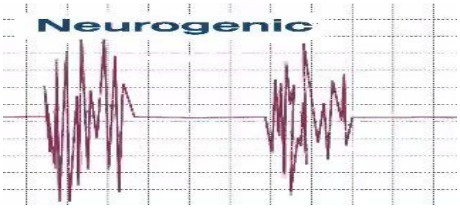
Myopathic alteration of the EMG	Neuropathic alteration of the EMG
• Polyphasia • Short duration • Reduced voltage of MUPs 	• Polyphasia • Long duration • High voltage of MUPs 

- **Analysis of MUP :** القيم المذكورة بوحداتها مهمة

Motor unit potential	Normal	Neurogenic	Myopathic
Duration/msec	3-16 msec	>16 msec "longer"	<3 msec "Shorter"
Amplitude	300 - 5000 µV (or 300 µV - 5 mv)	>5 mV "higher" (or > 5000 µV)	< 300 µV "lower"
Phases (configuration)	Biphasic/triphasic	Polyphasic	May be polyphasic
Resting activity	Absent	Present	Present
Interference pattern	Fulll[14]	Partial[15]	Full[16]

[14] The screen is completely filled with MUPs.
[15] There are gaps due to nerve damage which lead to loss of motor units.
[16] Because there is no nerve damage.

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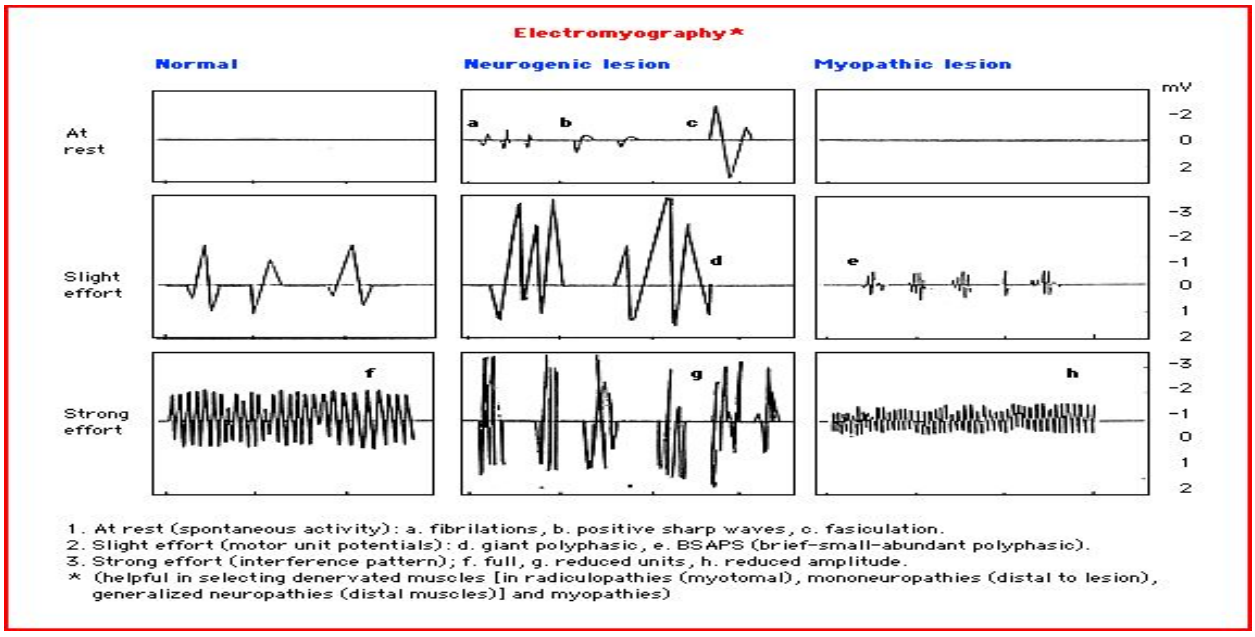

Analysis of MU

- ## Motor Nerve Conduction Velocity (MNCV) Study[17] :

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:[18]

➔ Stimulation of median nerve at **two points** "distal & proximal" until visible muscle contraction is seen and a reproducible Compound Muscle Action Potential (CMAP) is recorded. { **CMAP :** Summated potentials from all Motor Units in a muscle }.

➔ Recording electrode over the **thenar eminence**.(abductor and plantar muscles are recorded).

[17] دراسة سرعة السيالات العصبية.

[18] We electrically stimulate nerves by surface -non invasive- electrode.

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مهم جداً في هذه التركيز على الوحدات والتحويل بينها، يكون الناتج دائماً متر /ثانية
وكذلك التركيز على القيم الطبيعية & المرَضية المذكورة في الجدول

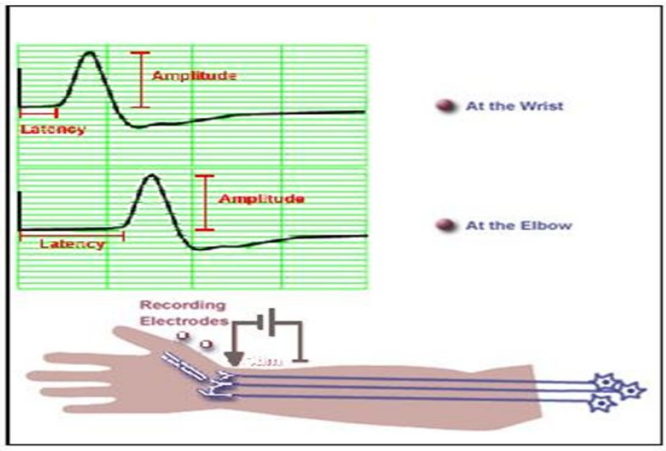
• Calculation of Motor Nerve Conduction Velocity :

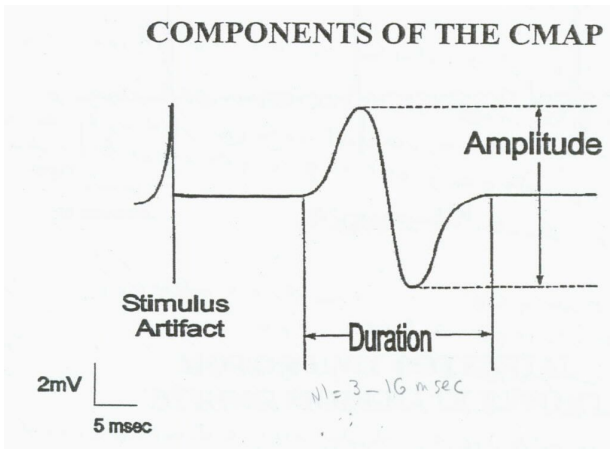
$$\text{MNCV}^{19} = \frac{\text{Distance (mm)}}{\text{L1-L2 (msec)}}$$

Normal values for conduction velocity		Abnormal
Arm	Leg	‹40 m/s "less than 40"
50 - 70 m/s.	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).





[19] Distance : the distance between the 2 stimulating electrodes (from elbow to wrist).
The result of MNCV will be in (m/s).

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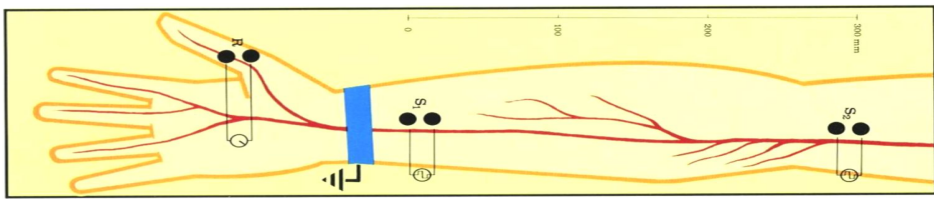
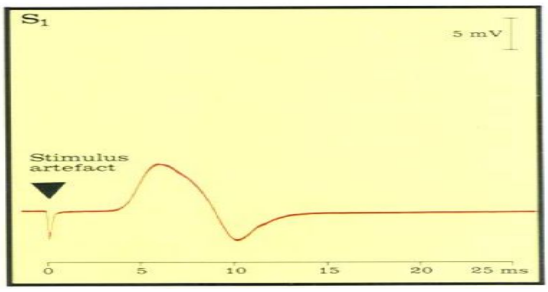
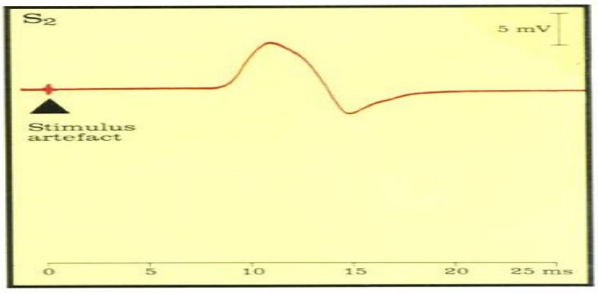


Distance (d) = 284 mm



Latency At wrist (L_2)= 3.5 ms
"shorter"



Latency At elbow (L_1)= 8.5 ms
"longer"

➔ **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). Notice That the latency at the wrist is shorter than the latency at the elbow.