Editing file

Nerve conduction studies and EMG

•Red : important
•Black : in male / female slides
•Pink : in female slides only
•Blue : in male slides only
•Green : notes
•Gray : extra

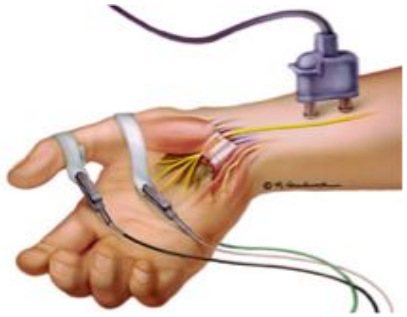
Objectives

At the end of the lecture student should be able to:

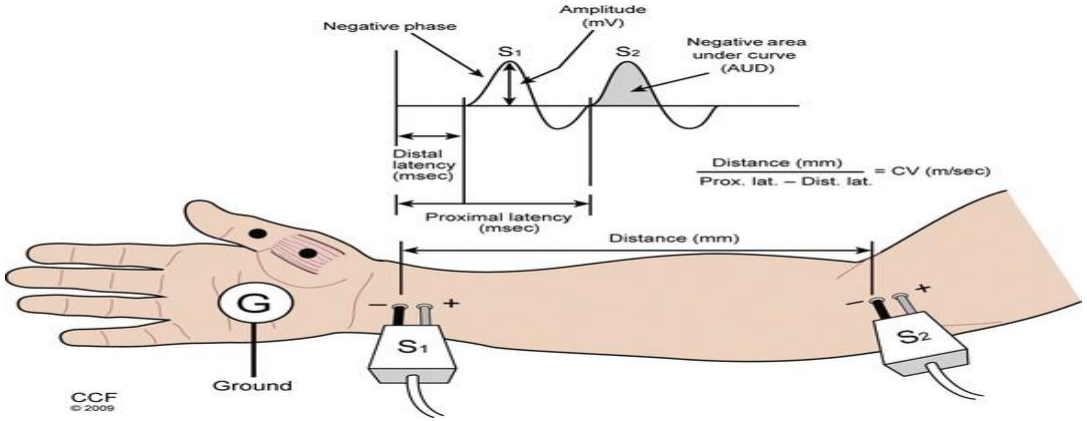
- Define nerve conduction study (NCS) and electromyography (EMG) .
- Explain the procedure of NCS.
- Define the normal conduction velocity in upper limb and lower limb nerves .
- Define the motor unit potentials (MUPs) and how they are changed in muscle and nerve diseases .

Definition of Nerve Conduction Studies (NCS):

in male slides	in female slide
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	A nerve conduction study (NCS) is an electrophysiology test test commonly used to evaluate the function of peripheral nerves of the human body, It could be motor, sensory or mixed nerve conduction study .



Nerve conduction velocity (NCV) is a common measurement made during this test.



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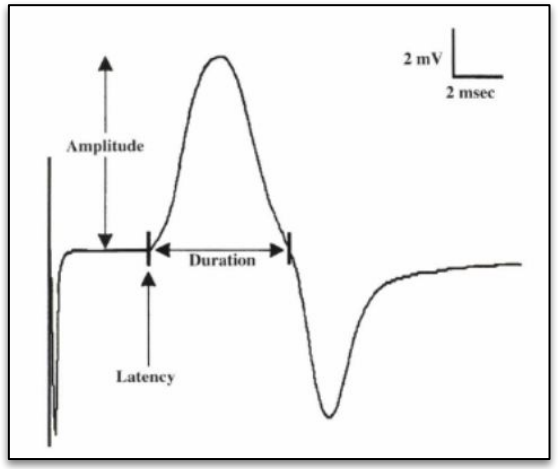
Motor Nerve Conduction Velocity :

- Motor nerve conduction velocity of peripheral nerves may be closely correlated to their functional integrity or to their structural abnormalities.
- Based on the nature of conduction abnormalities two principle types of peripheral nerve lesions can be identified: **Axonal degeneration and segmental demyelination.**
- In the patients of muscular weakness, muscle atrophy, traumatic or metabolic neuropathy, these tests are considered as an extension of the physical examination rather than a simple laboratory procedure.

Motor Conduction Studies:

- The recorded potential, known as the compound muscle action potential (CMAP) , represents the summation of all underlying individual muscle fiber action potentials.
- CMAP is a biphasic potential with an initial upward deflection from the baseline
- For each stimulation site : the latency, amplitude, duration, of the CMAP are measured .
- A motor conduction velocity can be calculated after two sites of stimulation, one distal and one proximal.

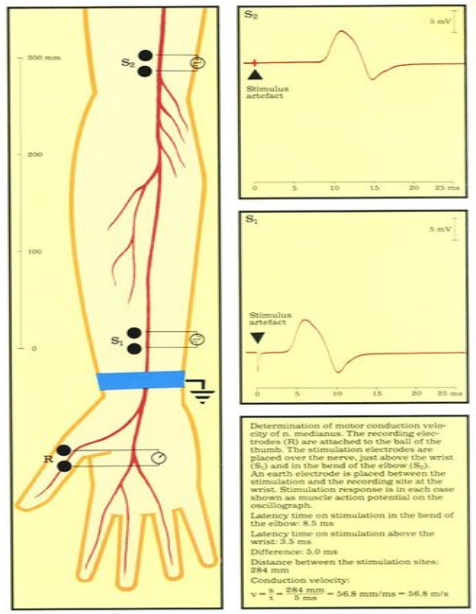


this graph will be explained later in the lecture

Motor Conduction Studies (MCS) procedure:

- The active recording electrode is placed on the center of the muscle belly (over the motor endplate), and the reference electrode is placed distally about 3-4 cm (will be converted to millimeters (mm) later).
- The stimulator then is placed over the nerve that supplies the muscle.
- As current is slowly increased from a baseline: more of the underlying nerve fibers are brought to action potential, and subsequently more muscle fiber action potentials are generated.
- most nerves require a current in the range from 20 to 50 mA to achieve supramaximal stimulation.
- When the current is increased to the point that the CMAP no longer increases in size, one presumes that all nerve fibers have been excited and that supramaximal stimulation has been achieved. The current then is increased by another 20% to ensure supramaximal stimulation.

(Medial nerve)



vectors of NCS/MCS :

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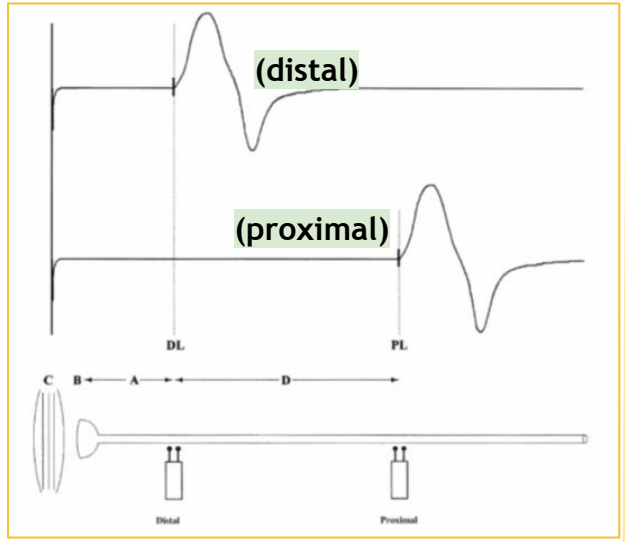


Latency :

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

Conduction Velocity :

- It's measurement of the speed of the conducting nerve axons.
- It is calculated by dividing the change in distance (between proximal stimulation site & distal stimulation site in mm) by the change in time (proximal latency in mSec minus distal latency in mSec).
- It's normal values are :

50 to 70 m/sec (in the arm)

40 to 60 m/sec (in the leg)

For arm:
40 is very slow (Abnormal)
80 is very fast (Normal)
If the value was greater than normal range it's not problem (normal), but it was lower than normal range it will cause an abnormality

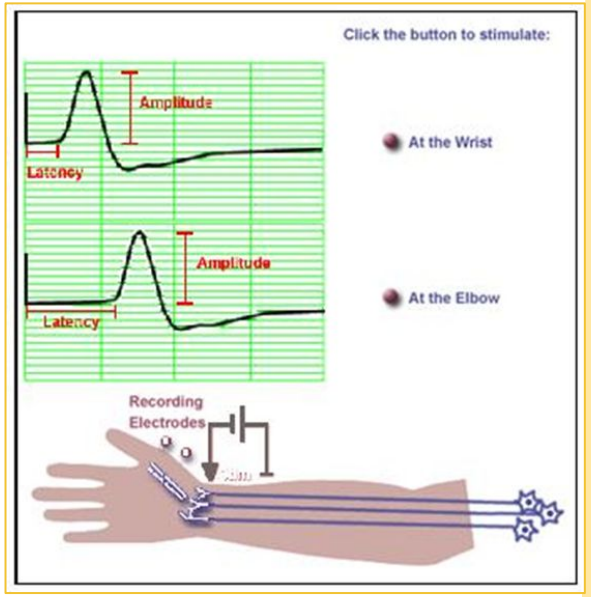
Amplitude :

• it is most commonly measured from baseline to the peak (baseline-to-peak) and less commonly from the first upward peak to the next downward peak (peak-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).**

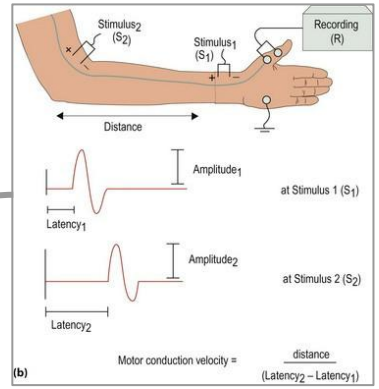
Motor Nerve Conduction Velocity (MNCV):

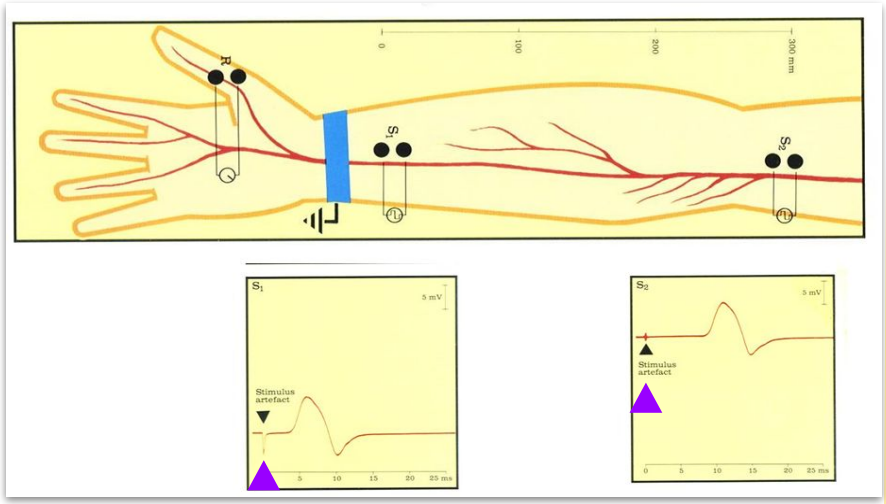
- MNCV (m/Sec) can be calculated by the formula: $MNCV = \frac{\text{Distance (mm)}}{\text{L1-L2(mSec)}}$

L1=latency at elbow (proximal).
L2= latency at wrist (distal).

- Distance = 284 mm
- Latency at wrist (distal) ,(L2) = 3.5 ms
- Latency at elbow (proximal) ,(L1) = 8.5 ms

How to measure the latency ?
From the stimulus artefact until the peak of action potential (AP)



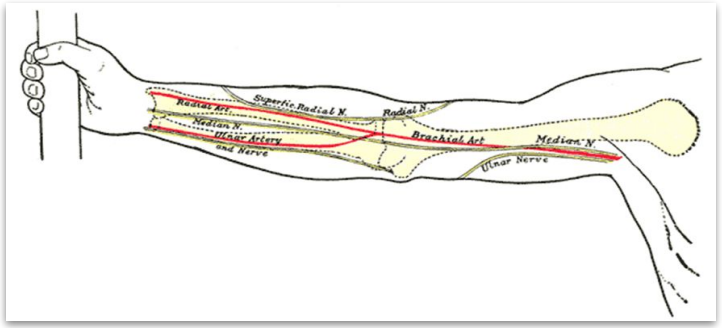


How to measure the MNCV?

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

Or use the equation to measure MNCV.

Course of the nerves in the arm:



Patterns of nerve conduction:

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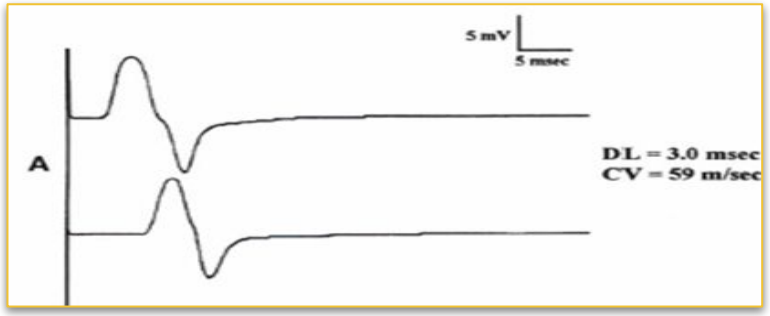
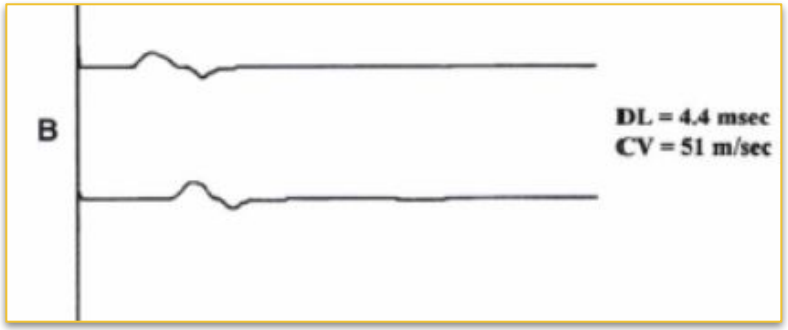
Normal study of the Median nerve: (most common for NCS)

Note the normal median distal latency (DL) 3 ms, amplitude >4 mV, and conduction velocity (CV) >49 m/s.



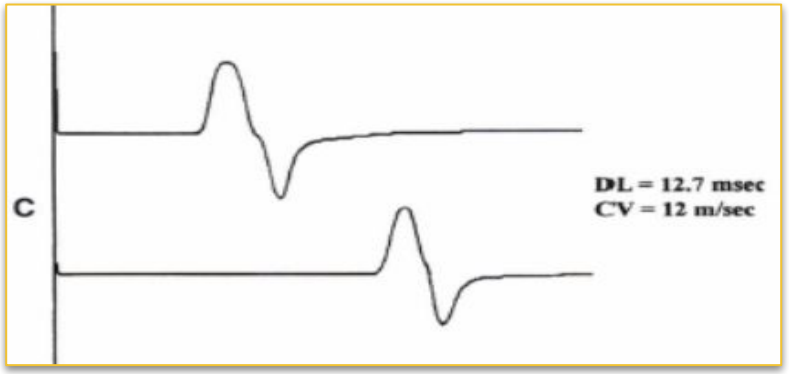
Axonal loss:

- amplitudes decrease.
- *CV is normal or slightly slowed.*
- DL is normal or slightly prolonged.
- The morphology of the potential does not change between proximal and distal sites.

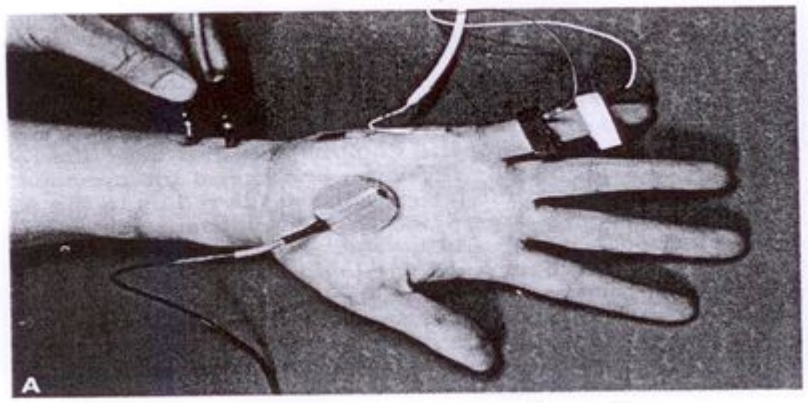


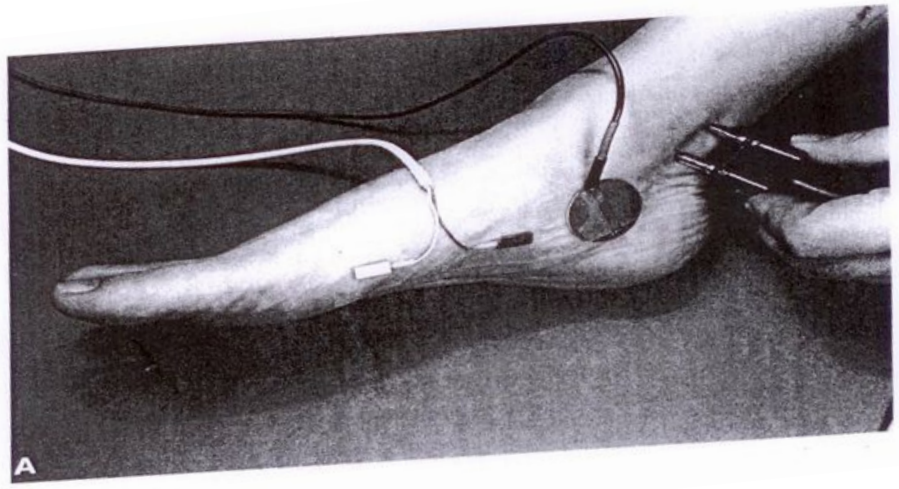
Demyelination associated with inherited disorders:

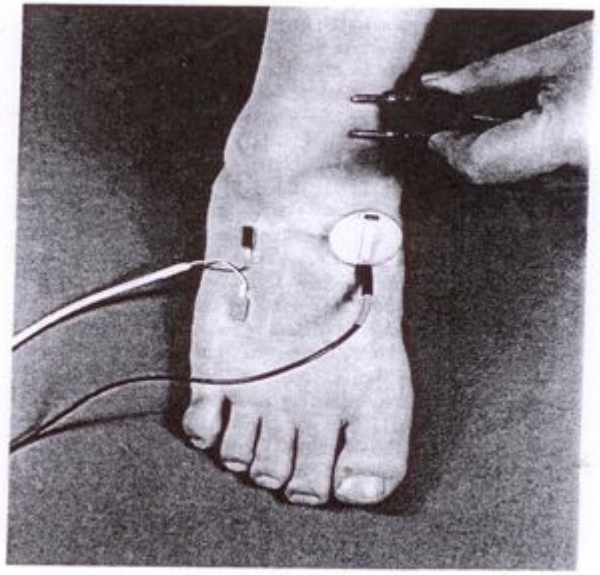
- CV is markedly slowed (< 75% lower limit of normal).
- DL is markedly prolonged (>130% upper limit of normal).
- However, there usually is no change in configuration between proximal and distal stimulation.



Pictures of the “NCS” test being conducted :





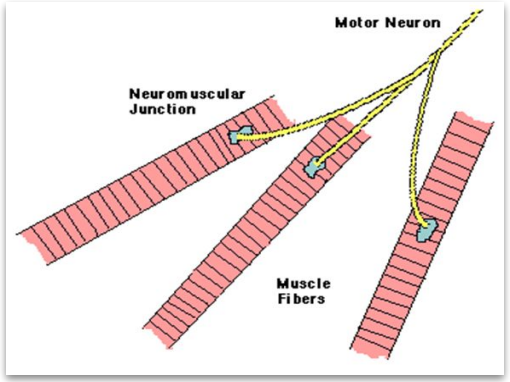


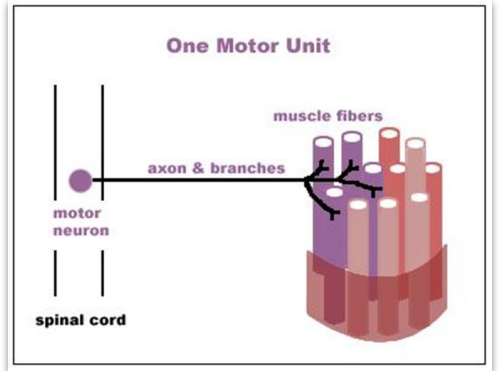
Definition of ElectroMyoGraphy (EMG) :

In male slide	In female slide
It’s a recording of electrical activity of the muscle by inserting needle electrode in the belly of the muscles or by applying the surface electrodes.	is a technique for evaluating and recording physiologic properties of muscles at rest and while contracting.

The potentials recorded on volitional effort are derived from motor units of the muscle, hence known as motor unit potentials (MUPs).

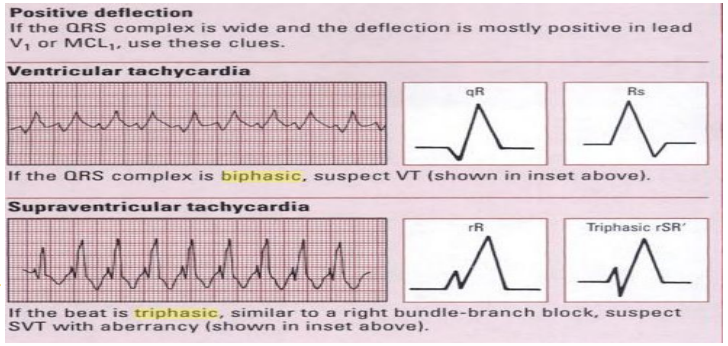
A motor unit is defined as one motor neuron and all of the muscle fibers it innervates.





Analysis of the “EMG” :

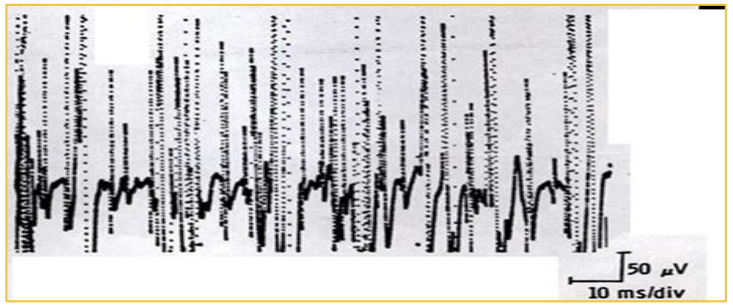
- **Spontaneous activity:**
  - The skeletal muscle is silent at rest, hence spontaneous activity is absent.
- **Normal Motor Unit Potentials (MUPs):**
  - Bi :Triphasic. (ثنائي \ثلاثي الموجة)
  - Duration :3 – 15 mSec.
  - Amplitude :300µV – 5 mV.



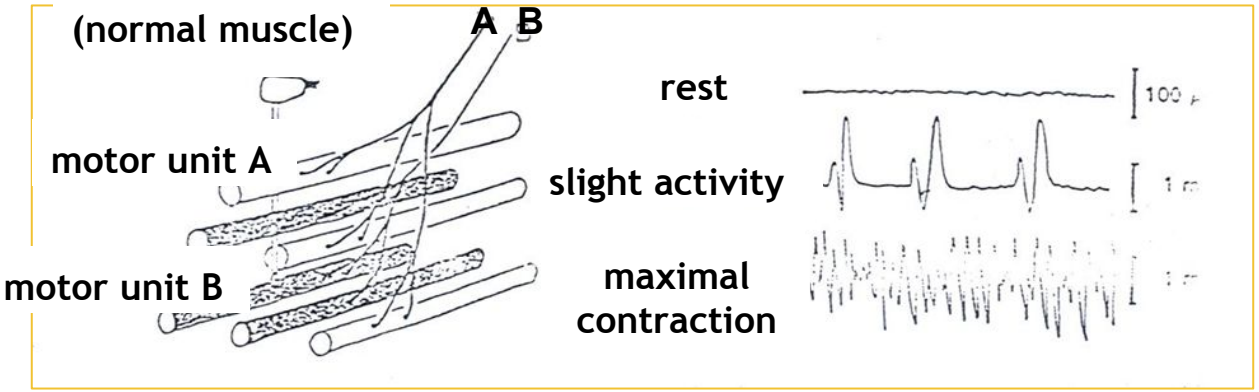
Normal MUPs :

(Mild effort)

(During Moderate Effort)
note recruitment of additional motoneurons.



(During Full Voluntary Effort)
There is full recruitment (you can not see the baseline)

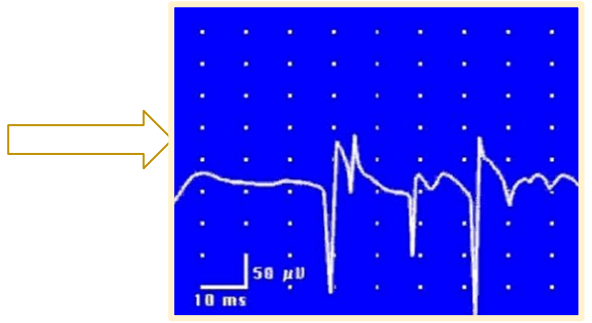


Abnormal MUPs :

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

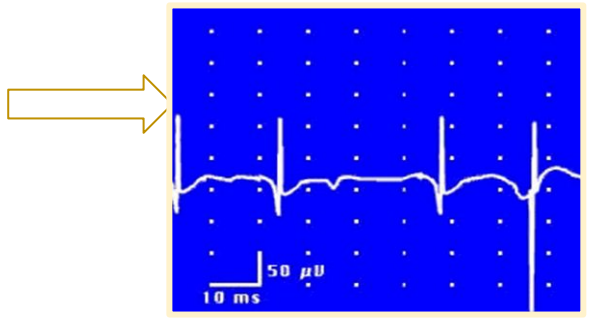
Positive sharp wave:

A small potential of 50 to 100 μV, 5 to 10 mSec duration with abrupt onset and slow outset.



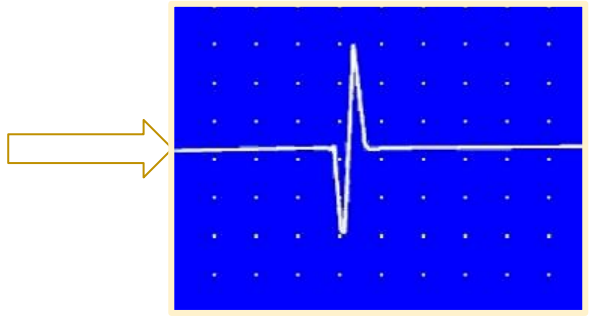
Fibrillation potential :

these are randomly occurring small amplitude potentials or may appear in runs. The audio amplifier gives sounds, as if somebody listen sounds of rains in a tin shade house. These potentials are generated from the single muscle fiber of a denervated muscle, possibly due to denervation hypersensitivity to acetyl choline.



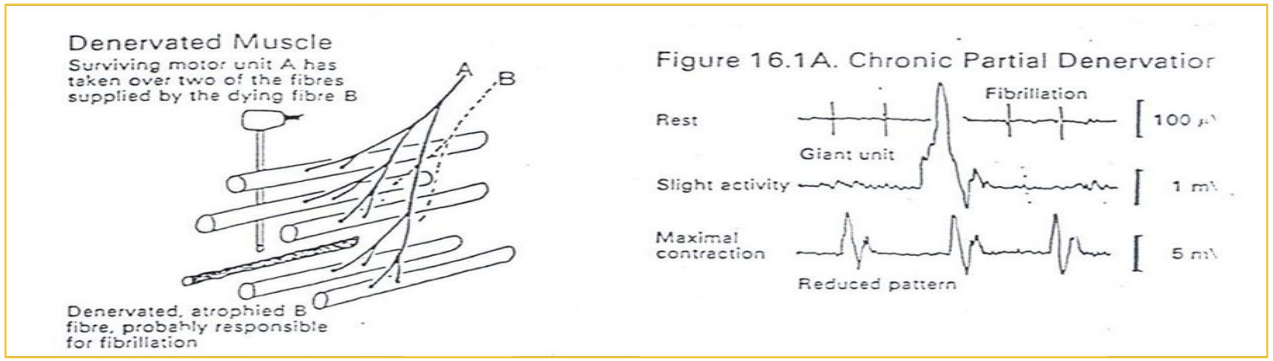
Fasciculation potentials :

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 the neighboring motor unit.

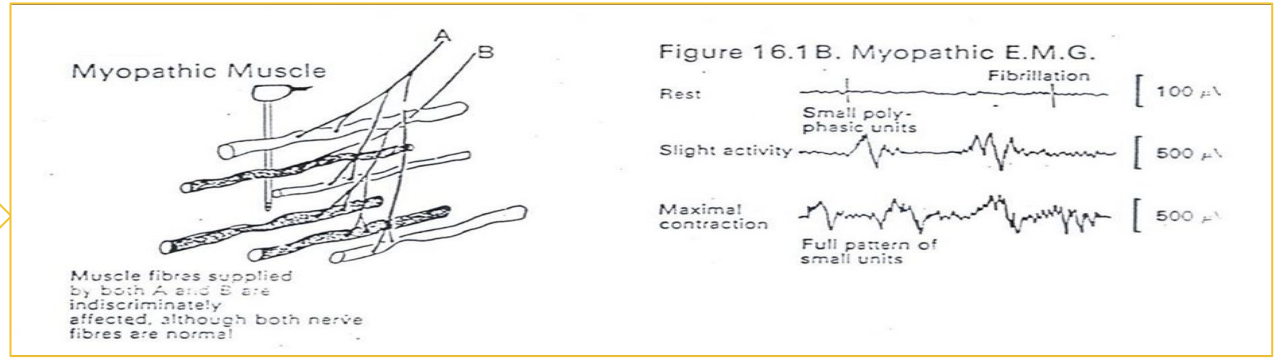


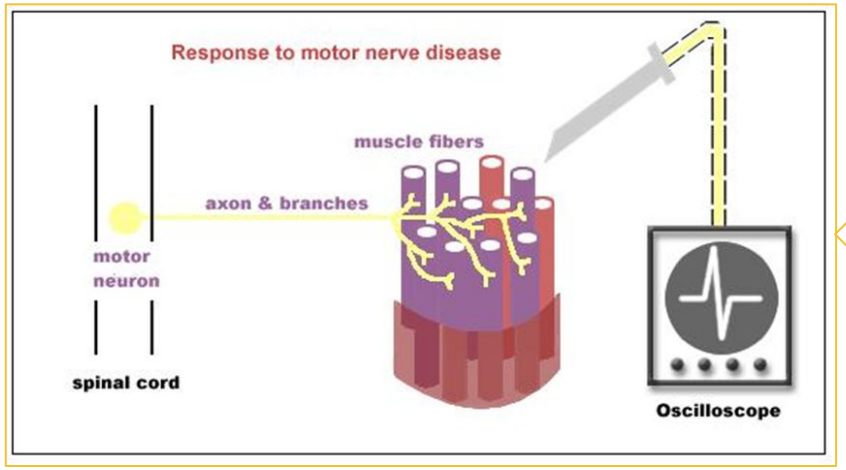
Neuro/Myopathy:

Neuropathic EMG changes



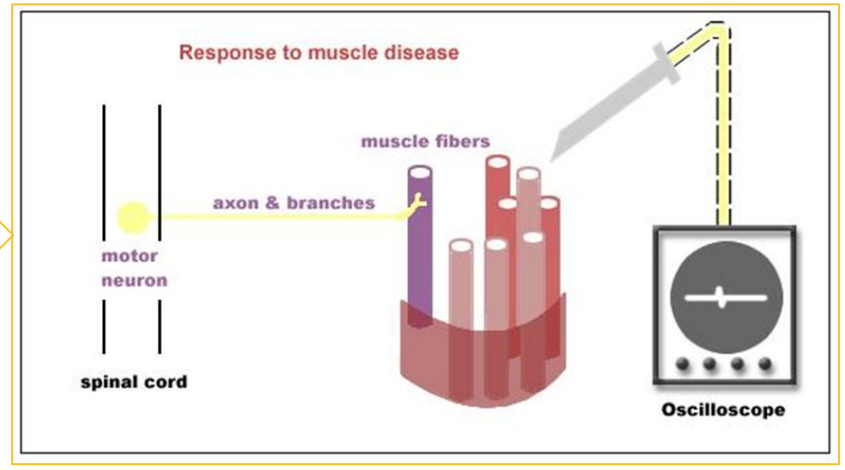
myopathic EMG changes





Neuropathy

Myopathy

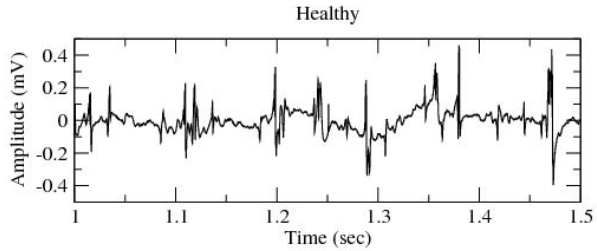


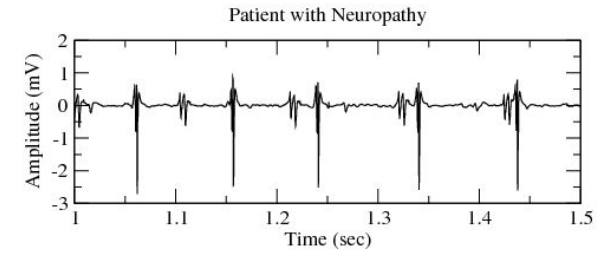
Analysis of motor unit potentials (MUPs) :

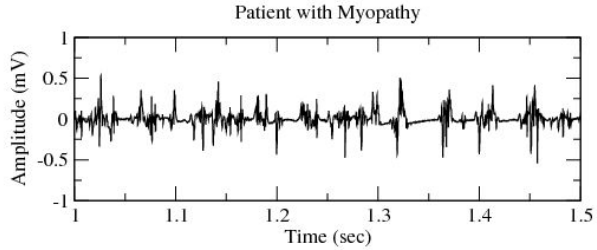
Doctor's note: this table is very very very important

MUP	NORMAL	NEUROGENIC	MYOPATHIC
Duration msec.	3 – 15 msec	longer	Shorter
Amplitude	300 – 5000 µV	Larger(Giant MUPs)	Smaller
Phases	Biphasic / triphasic	Polyphasic	May be polyphasic
Resting Activity	Absent	Present	Present
Interference pattern	full	partial	Full

Here comparison between the healthy diagram and neuro/myopathy







Typical MUPs characteristics in myopathic, neuropathic & normal muscle:

MUP	Myopathy	Normal	Neuropathy
Duration	< 3 msec	3 – 15 msec	> 15 msec
Amplitude	< 300 µV	300-5000 µV	> 5 mV
configuration	polyphasic	triphasic	Polyphasic

Quiz

SAQ

Q1- How to measure the latency ? (From slides)

Q2-Compare between myopathy and neuropathy in phases and amplitude.

Answers

SAQ1-From the stimulus artefact until the peak of action potential (AP)

SAQ2-myopathy:

Amplitude : < 300 µV

Phases: polyphasic

Neuropathy:

Amplitude : > 5 mV

Phases: polyphasic

1) inserting needle electrode in the belly of the muscles or by applying the surface electrodes to record electrical activity of the muscle		2)It's measurement of the speed of the conducting nerve axons.	
A.	Action potential (AP)	A.	Latency
B.	ElectroMyoGraphy (EMG)	B.	Conduction Velocity
C.	Nerve Conduction Studies (NCS)	C.	Amplitude
D.	Contraction of the muscle	D.	Duration
3) is formed due to reinnervation of another motor unit from the neighboring motor unit.		4) Nerve conduction study (NCS) could be:	
A.	Positive sharp wave	A.	Sensory
B.	Fibrillation potential	B.	Mixed
C.	Fasciculation potentials	C.	Motor
D.		D.	All of above

Answers key: 1)B 2)B 3)C 4)D

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Thank you

@physiology438

Editing file

Summary file for your revision