Editing File

Nerve Conduction Studies & EMG

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Ty to Hasan Alsugahyir for sketch (445 inshallah) <3

Objectives

01

Define nerve conduction study (NCS) and electromyography (EMG).

02

Define the normal conduction velocity in upper limb and lower limb nerves.

03

Define the motor unit potentials (MUPs) and how they are changed in muscle and nerve diseases.

Nerve conduction studies

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.

- Standard nerve conduction studies typically include:

1-motor nerve conduction
2-sensory nerve conduction.

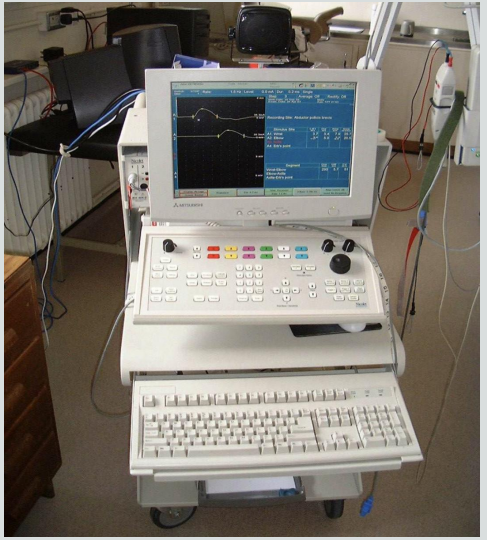
- Sensory and motor nerve conduction studies involve analysis of specific parameters, including:

1-latency
2-conduction velocity
3-amplitude.

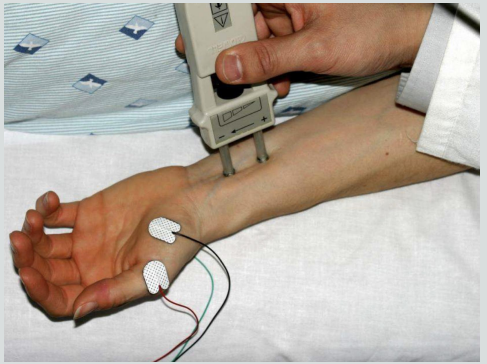
Nerve conduction velocity (NCV): is a common measurement made during this test. (443: the most important parameter)

439:

NCS: اختبار يقيس قدرة توصيل الكهرباء للأعصاب (sensory+motor)
NCV: هو القياس الشائع لهذا الاختبار (سرعة التوصيل)



Nerve conduction study and EMG



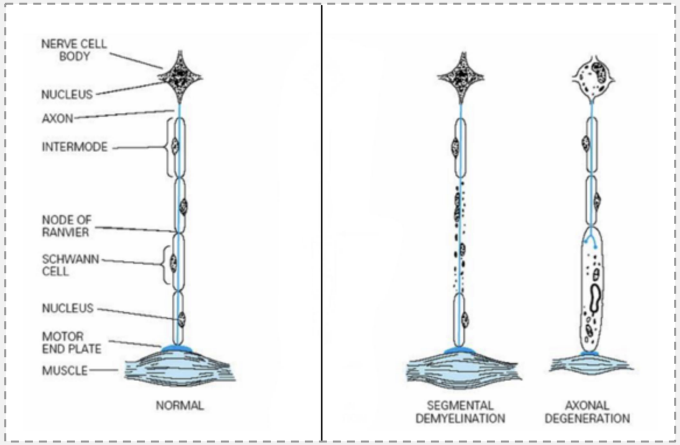
Motor Nerve Conduction Velocity

- Motor nerve conduction velocity of peripheral nerves may be closely correlated to their functional integrity or to their structural abnormalities.
- <u>Two types of peripheral nerve lesions</u> based on the nature of conduction abnormalities:

1-Axonal degeneration

2-Segmental demyelination.

(443: this test helps in diagnosing peripheral neuropathies)

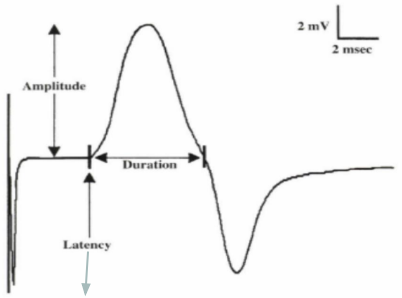


Motor Conduction Studies (MCS)

The most commonly tested nerve is the median nerve

Compound muscle action potential (CMAP): the recorded potential that represents the summation of all underlying individual muscle fiber action potentials.

- it is a biphasic potential with an initial upward deflection from the baseline



The time needed for the action to appear

A motor conduction velocity can be calculated after two sites of stimulation:

- one distal (wrist)
- one proximal (elbow)

For each stimulation site (proximal and distal) the following parameters of CMAP are measured:

- latency
- amplitude
- duration

It is like calculating the velocity of a car.

$$\frac{\text{Distance (between the two ends)}}{\text{Latent period (the time needed for stimulation)}}$$

MCS Procedure:

Female Slides Only

1. 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

2. The stimulator then is placed over the nerve that supplies the muscle.

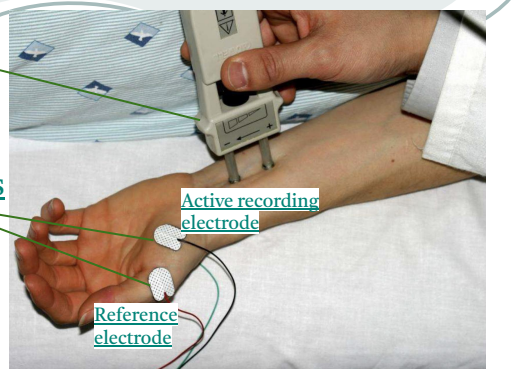
3. As current is slowly increased from a baseline: more of the underlying nerve fibers are brought to action potential, and subsequently more muscle fiber action potentials are generated.

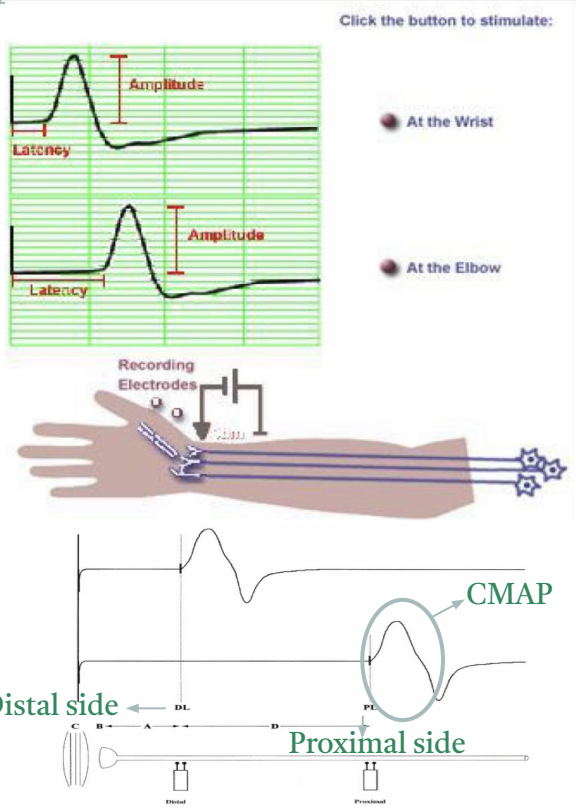
4. most nerves require a current in the range from 20 to 50 mA to achieve supramaximal stimulation.

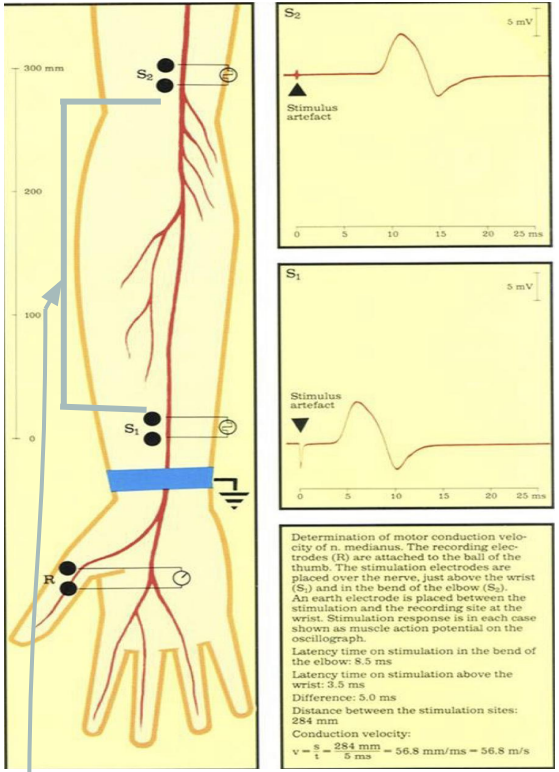
5. The recorded potential, known as the compound muscle action potential (CMAP), represents the summation of all underlying individual muscle fiber action potentials.

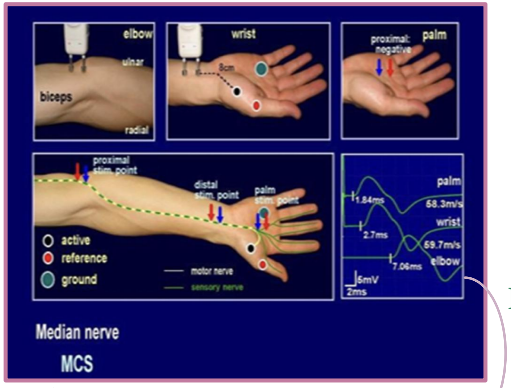
6. When the current is increased to the point that the CMAP no longer increases in size, one presumes that all nerve fibers have been excited and that supramaximal stimulation has been achieved.

7. The current then is increased by another 20% to ensure supramaximal stimulation.









This chart will appear when we do not put the ground electrode → electrical signals in the room interrupt the graph. (The ground electrode provides a zero voltage reference point).

We want to measure this area

MCS/NCS Procedure

Vectors of NCS/MCS

Amplitude

-CMAP amplitude reflects the numbers 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

Most commonly measured from baseline to peak (baseline-to-peak)

Latency

Measurements usually are made in milliseconds (ms) or (mSec)

Latency: time from the stimulus to the initial deflection from baseline

Conduction Velocity

Conduction velocity: Measurement of the speed of conducting nerve axons

Calculated by: (next slide)
Normal values:
Arm:50-70 m/sec
Leg: 40-60 m/sec

Duration

Duration: measured from initial deflection from baseline to final return

Characteristically increases in conditions that result in slowing of some motor fibers (e.g., in a demyelinating lesion) نقص او تكسر الميلين

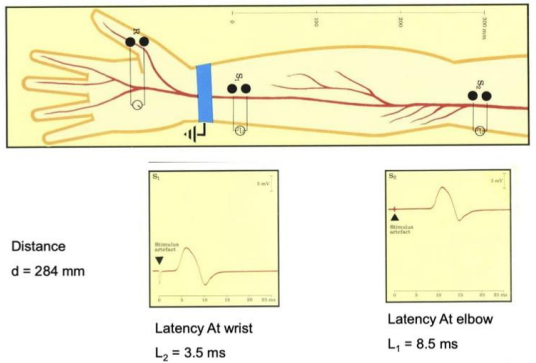
Motor Nerve Conduction Velocity (MNCV)

MNCV can be calculated by:

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

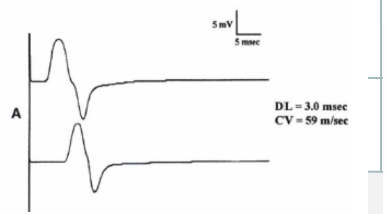
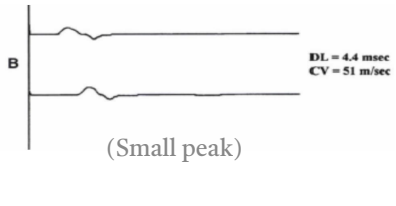
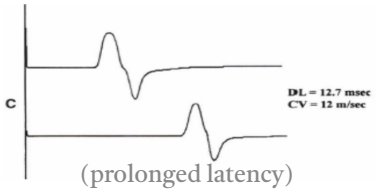
-Distance between proximal and distal stimulation sites

-Change in time [proximal latency - distal latency]
L1: Latency at the elbow (proximal)
L2: Latency at the wrist (distal)



We know from physics that velocity is distance/time.
If the following is given:
Distance = 284 mm
L1= 8.5 ms
L2= 3.5 ms
We can calculate velocity: MNCV = (284) / (8.5 - 3.5) = 56.8 m/sec → It is within the normal range of arm (50 - 70)

Patterns of nerve conduction

	Normal study of median nerve	Axon degeneration neuropathy (Axonal loss)	Demyelination neuropathy associated with inherited disorders
Amplitude	≥4 mV	Decreased (low)	Normal
Distal latency (DL)	<4.2 ms	Normal or slightly prolonged (delay)	Markedly prolonged (delay)
Conduction velocity (CV)	>49 m/s	Normal or slightly slowed	Markedly (significantly) slowed
Morphology of potential Between proximal and distal sites		configuration of the potential does not changed between proximal and distal sites	No change in configuration between proximal and distal sites
Graph		 (Small peak)	 (prolonged latency)

ELECTROMYOGRAPHY (EMG)

Definition

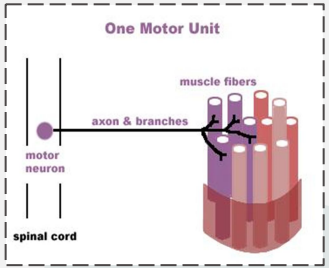
- It's a recording of electrical activity of the muscle by inserting needle electrode in the belly of the muscles or by applying the surface electrodes.

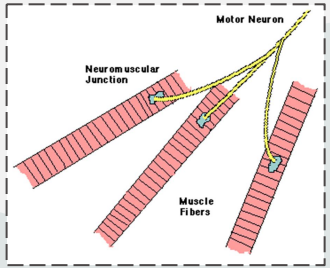
Mechanism

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

Motor unit

- It is one motor neuron and all of the muscle fibers it innervates.





Analysis

Decreased in

Atrophied muscle or fatty tissue.

Increased in

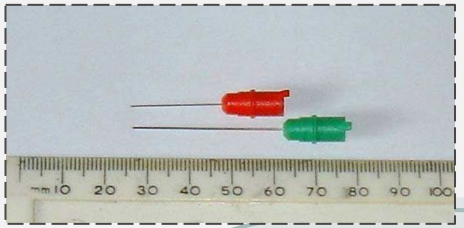
many abnormal conditions that cause membrane instability, such as: neuropathies, radiculopathies, and inflammatory myopathies.

Insertional activity

The electrical activity present as the electrode is passed through muscle cells. These are discharge potentials provoked by the disruption of the cell membrane itself.

Spontaneous activity

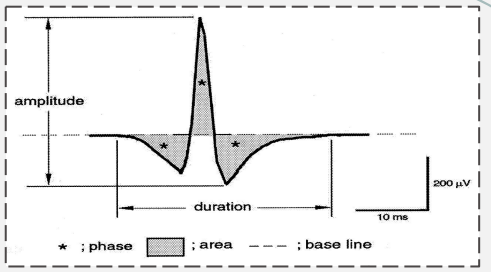
The skeletal muscle is silent at rest, hence spontaneous activity is absent.



MUPs

Definition

The sum of action potentials produced in the muscle fibers stimulated by single motor neuron.



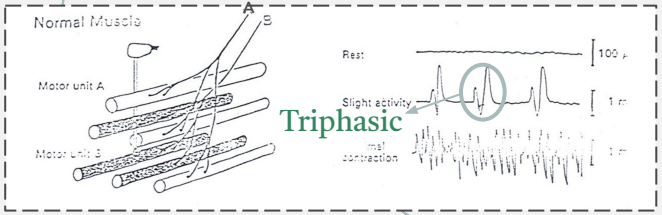
Normal MUPs

Morphology: Bi – Triphasic.

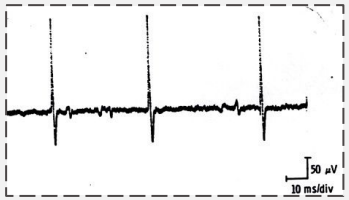
Duration: 3 – 15 msec.

Amplitude: 300µV – 5 mV.

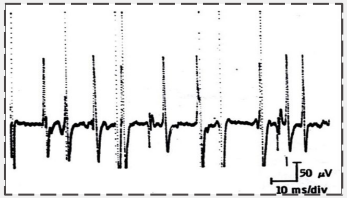
Recruitment (Interference) pattern:



During mild effort

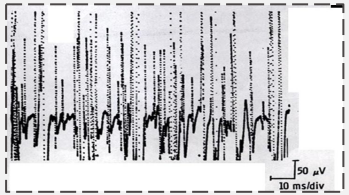


During Moderate Effort



*Note recruitment of additional motoneurons

During Full Voluntary Effort



*There is full recruitment (you can not see the baseline)

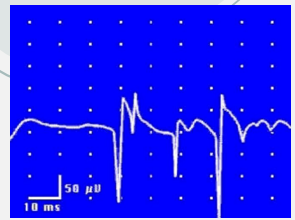
- Normally number of MUPs activated and their frequency rises with increased exertion until it become full with maximal voluntary contractions.
- Reduced and incomplete (partial) recruitment signifies neurogenic lesion.
- Early and full recruitment with a small voluntary force can be seen in myopathy.

Abnormal MUPs

Presence of resting activity in form of:

Positive sharp wave

- A small potential of 50 to 100 μV, 5 to 10 msec duration with abrupt onset and slow outset. It is the earliest manifestation of axonal denervation .

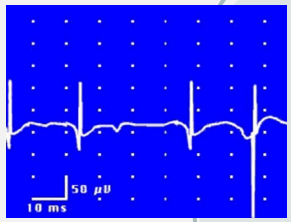


Fibrillation potential

Indicates denervation

From single muscle fiber (can't be seen grossly)

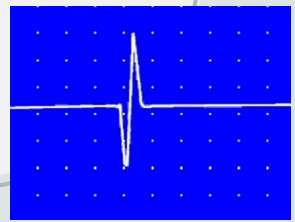
- These are randomly occurring small amplitude potentials or may appear in runs. The audioamplifier gives sounds, as if somebody listen sounds of rains in a tin shade house. These potentials are generated from the single muscle fiber of a denervated muscle, possibly due to denervation hypersensitivity to acetylcholine.
- They are not visible through the skin.
- Fibrillations are not found exclusively in neurogenic disease, however; they also occur in inflammatory and dystrophic muscle disease.



Fasciculation potential

From motor unit (can be seen grossly)

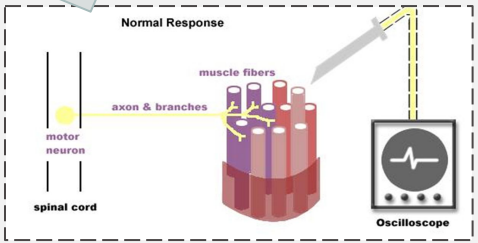
- These are high voltage, polyphasic, long duration potentials appear spontaneously associated with visible contraction of the muscle. They are generated from individual motor units
- May be benign and they occur in motor neuron disease, radiculopathy and neuropathy

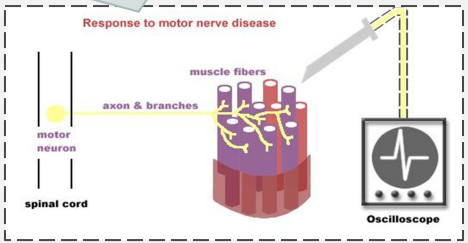


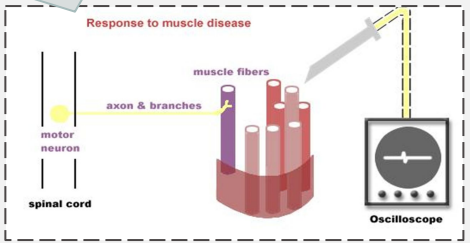
Normal EMG

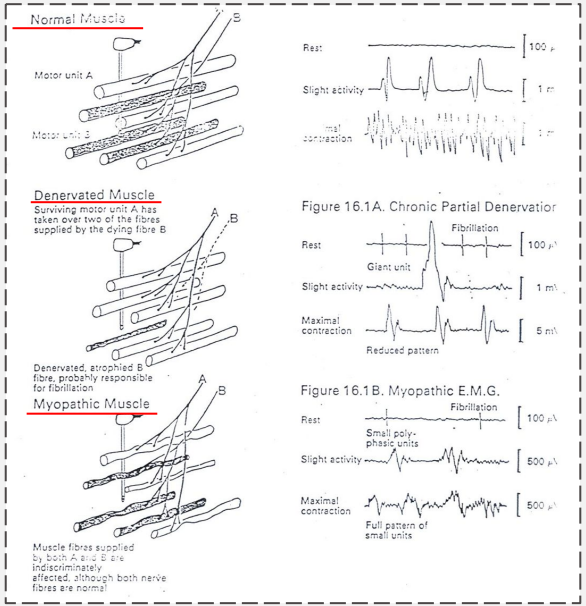
NEUROPATHY

MYOPATHY

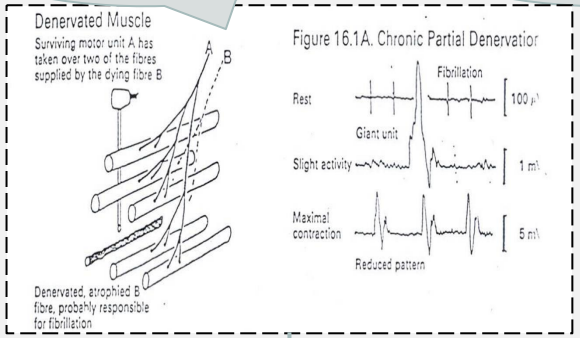






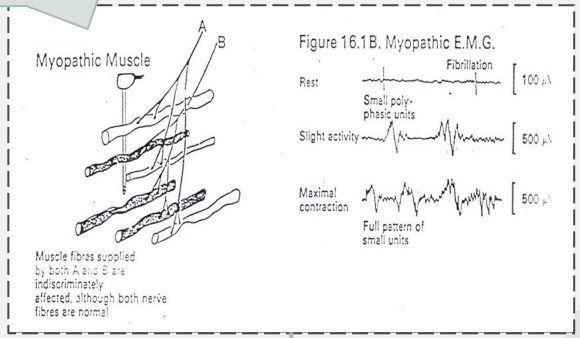


Neuropathic EMG changes



If B is dead then A will branch to innervate the fibers that used to be supplied by B.
(problem in nerves)

Myopathic EMG changes



e.g. if we need to left an object we will need 100 motor units instead of 50.
(problem in muscle fibers)

Analysis of a motor unit potential (MUP)

MUP	NORMAL	NEUROGENIC	MYOPATHIC
Duration msec.	3 – 15 msec	> 15 msec	< 3 msec
Amplitude	300 – 5000 μV	> 5000 μV (5 mV)	< 300 μV (0.3 mV)
Phases	Biphasic / triphasic	Polyphasic	Polyphasic
Resting Activity	Absent	Present	Present
Interference pattern	Full	Partial	Full pattern of small units

MCQs

Q1:Demyelination markedly affect :			
A-amplitude	B-conduction velocity	C-distal latency	D-B&C
Q2:When current is increased to the point that the CMAP no longer increases in size:			
A-action potential	B-supramaximal stimulation	C-amplitude	D-RMP
Q3:Motor conduction velocity can be calculated after 2 sites of stimulation:			
A-distal, proximal	B-anterior, inferior	C-medial, lateral	D-A&B
Q4:A common measurement made during the NCS test:			
A-EMG	B-ETC	C-MCV	D-MCS

1-D
2-B
3-A
4-C

MCQs

Q1: A 19 years old medical student presented to neurology department in KSU complaining of numbness of his right hand, nerve conduction study was done and showed the following findings: conduction velocity: 37 M/S, amplitude: 4.5 μV, distal latency: 8 mS. What is the diagnosis?

A- Fibrillation potential	B- Axonal loss	C- Demyelination	D- Fasciculation potentials

Q2: A 9 years old boy presented with muscle weakness in KSU neurology department, EMG done and showed the following: fibrillation potential at rest, MUP: polyphasic, amplitude: 200 μV, muscle action potential duration: 2 mS, during maximum contraction showed early recruitment of motor unit. (Note, the doctor might bring the diagram instead). What is the diagnosis?

A- Neuropathy	B- Myopathy	C- Normal	D- None

1-C
2-B

SAQs

Q1: In nerve conduction study, the CMAP represents what?

A1: summation of all underlying individual muscle fiber action potentials.

Q2: Mention the characteristics of normal MUPs.

A2: Morphology: Bi-Triphasic.
Duration: 3-15 ms.
Amplitude: 300-5000 μV.
Recruitment (Interference) pattern: full at maximum contraction.

Q3: What are the Two types of peripheral nerve lesions?

A3: 1- Axonal degeneration

2- Segmental demyelination.

Q4: What is the MNCV equation?

A4:

$$\frac{\text{Distance (mm)}}{\text{L1-L2 (mSec)}}$$

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Noor Altalag