Faculty of Medicine 2012

Dr name : Eman Al-Khateeb

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lecture no. : 5

Physiology

Sheet

Medical Committee
The University of Jordan

الجامعة الأردنية

Price :

Done by :

Aseel Olaimat

Hope this sheet is useful .. Especially for Absent students of 15/4 Physiology lecture :P

Diagnosing of abnormalities

Review for last slide of previous lecture:

If we have stimulated a radial nerve by stimulating electrodes we'll record a compound action potential .. and according to the strength of our stimuli we'll get the following results :

A) minimal stimuli (0.1 mv for example) .. we will record nothing Because the stimuli is subthreshold (very small stimuli) and that means that no electrical activity happened

B) increasing the stimulus to 0.5 mv -For example - we'll Start recording a small electrical activity which means that only the superficial nerve fibers are stimulated and signaling their AP (closer to the skin)

Q : WHY the signals are displayed in this manner (as it was graded potential ?)

Because the machine has the capability to summate all these Action potentials together (This is not physiological this is something technical) and this summation will tell us how many nerve fibers have been discharged .

c) Increasing the electrical stimulation -for example- to 5 mv … electricity is going deeper and stimulating more nerve fibers , here we'll be able to reach the maximum amplitude of AP . (why it is maximum ? because at this point all nerve fibers are stimulated even the deeper and smaller ones under the effect of this powerful stimuli so they will be able to reach the threshold and fire an action potential)

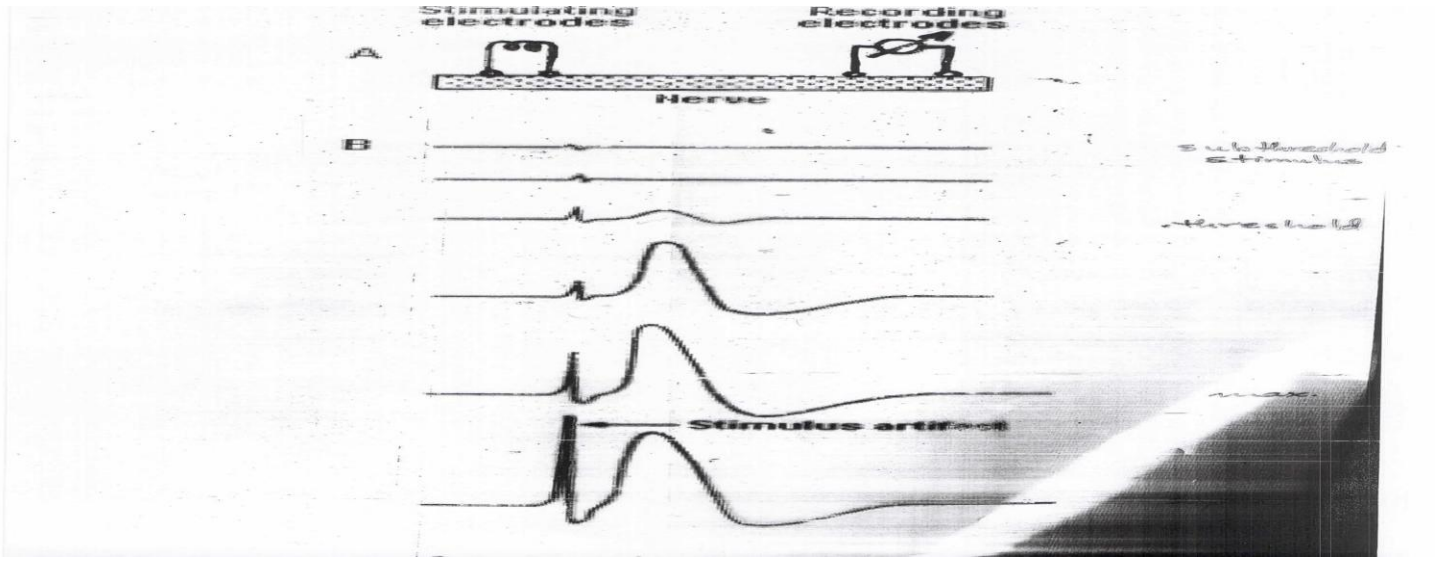
Q : How Can we prove that the AP is all or non ?! i.e it is not graded ?

Giving even higher stimuli for example 3-5 v (here we used Voltes ! Because we need a strong stimuli ;) (supra maximum) .. the amplitude of the AP will never change this indicates that the AP has a fixed amplitude (all nerve fibers had been stimulated by maximum stimulus so by the supra maximum nothing will change)

*If the maximum stimuli is 5 mv .. we have to give the patient 20-30 % stronger stimuli above the maximum , to make sure 100% that all nerve fibers have been stimulated.

Q : How we will know that there is a problem in the nerve we are diagnosing ?

Suppose that we're diagnosing the radial N and I expect to have an amplitude of 3 cm but I only got 1 cm instead .. this indicates a problem .

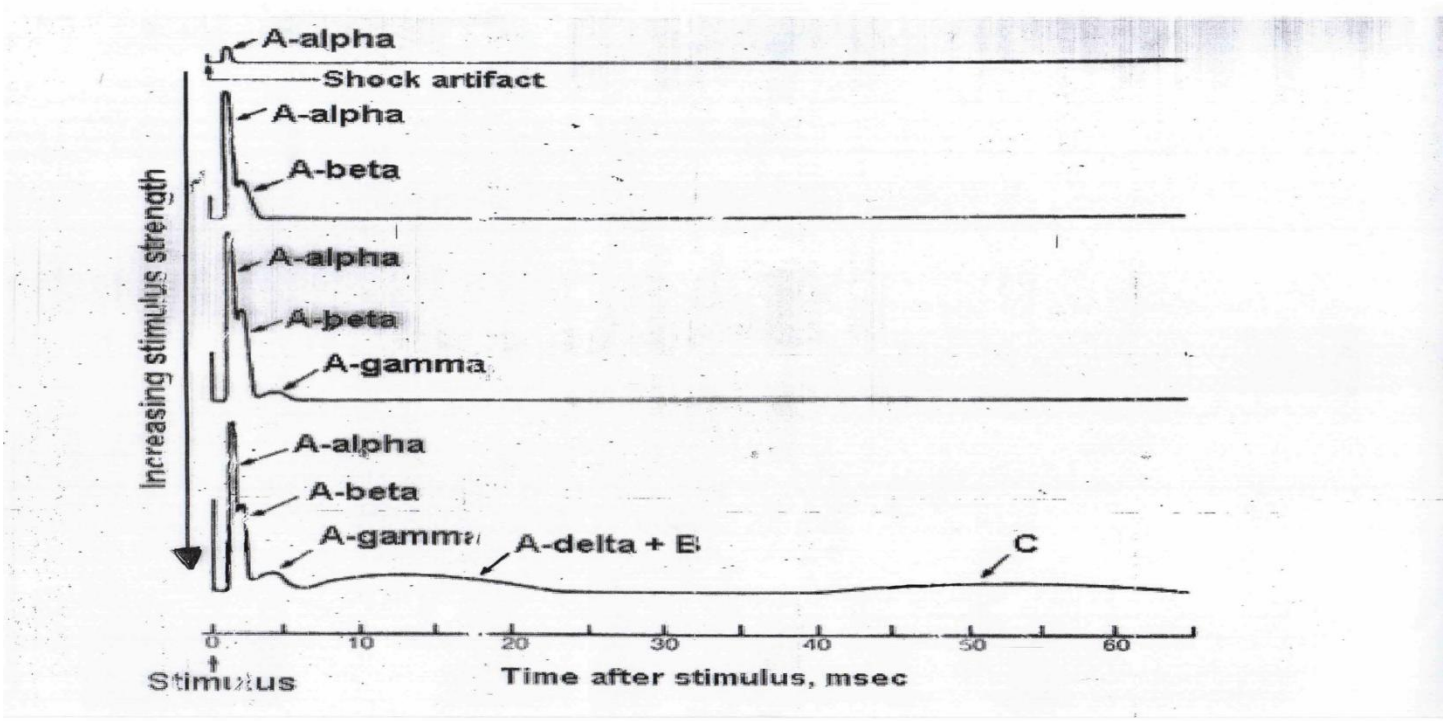


Other criteria in Compound AP :

Increasing stimuli strength will lead to multiple peaks of the compound AP and this is very clear if we are recording from an area far away from the stimuli (stimulating from fingers and recording from the wrist these peaks won't be very clear but recording from the elbow this will give a clear multiple peaks) Why is that ?!

Explanation : In Myelinated large conductive N.fibers .. electrical Activity will reach first .. { A-Alpha,A-Beta (responsible for equilibrium and balance) .. While In unmyelinated N.fibers will be the last to arrive . So Compound AP depends on the conduction velocity .

Compound AP Has these criteria : looks like graded potential until reaching the Maximum stimuli and having multiple peaks because each nerve is composed of multiple nerve fibers some are fast others are slow in conduction .



Diagnosing of abnormalities :

We Have two types of nerve fibers :

Sensory N fibers that are usually ascending and Motor N fibers that are usually descending.

So if we want to diagnose a sensory N , Ex : Median \ ulnar or Radial N the normal physiological transporting of sensory AP is from peripheral to CNS (brain).

There are 2 types of recordings :

a) Orthodromic (physiological, follows the sensation direction): For ex: stimulating the ulnar N from the little finger and recording from the wrist .

BUT .. physiologists found that following the physiological pathway stimuli will record a small activity and easily mixed with external noise (background noise) SO they decided to use another type of recordings .

b) Antidromic (against physiological pathway) : stimulating (proximally) from the wrist for example and recording (distally) from the fingers , here physiologists found that the electrical activity recorded is clearer and larger ☺

Notice that in both Recording types the latent period is the same (If we have a constant distance from fingers to wrist) but we get a better record (bigger amplitude) in the antidromic way .

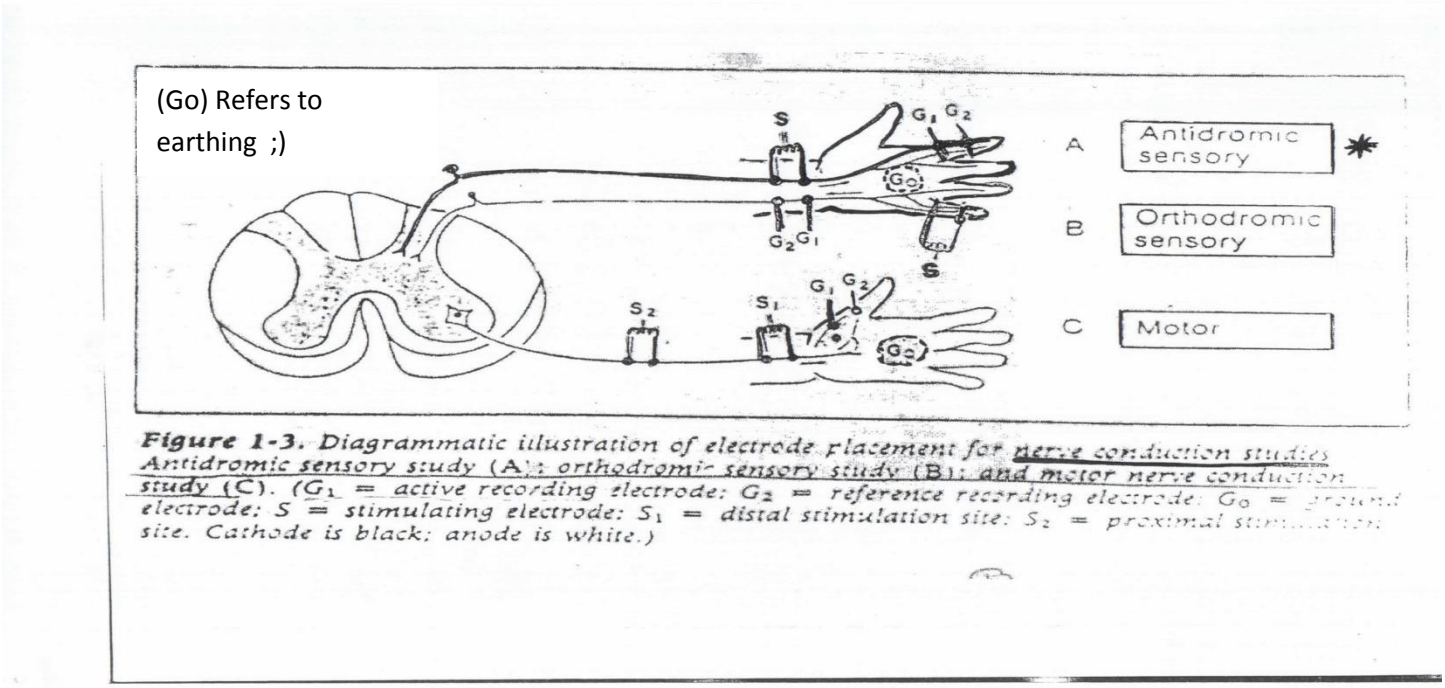


Figure 1-3. *Diagrammatic illustration of electrode placement for nerve conduction studies. Antidromic sensory study (A); orthodromic sensory study (B); and motor nerve conduction study (C). (G_1 = active recording electrode; G_2 = reference recording electrode; G_0 = ground electrode; S = stimulating electrode; S_1 = distal stimulation site; S_2 = proximal stimulation site. Cathode is black; anode is white.)*

WHY Antidromic gave a better recording ?!

Because the Nerves in fingers are usually superficial and we can easily record the normalities and abnormaleties but as they get deeper while moving away from the fingers the record become weaker .

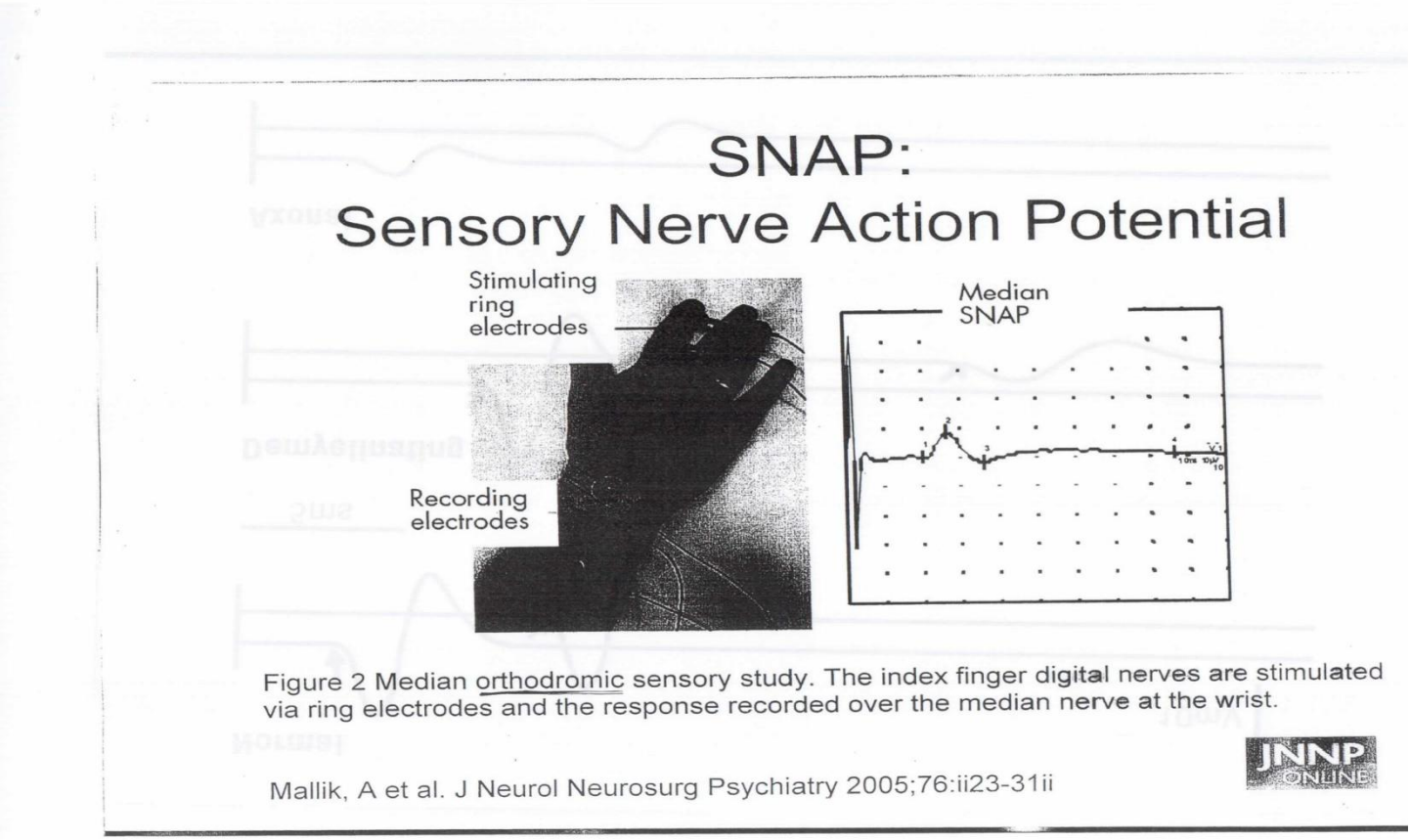
Remember we don't insert a needle to record we only record from the skin !

If we want to record Motor AP from N.fiber we'll record from the muscles supplied by that motor nerve (Median N → Thenar MS , Ulnar N → Hypothenar Ms)

And we put the active (recording) electrode on the muscle's belly facing the stimulating electrode and the reference non active electrode is on the tendon of that muscle .

***Sensory Nerve AP "SNAP" Slide :**

Its Orthodromic type ..(Not Favorable)Stimulating electrode on the finger , Recording electrode at wrist .

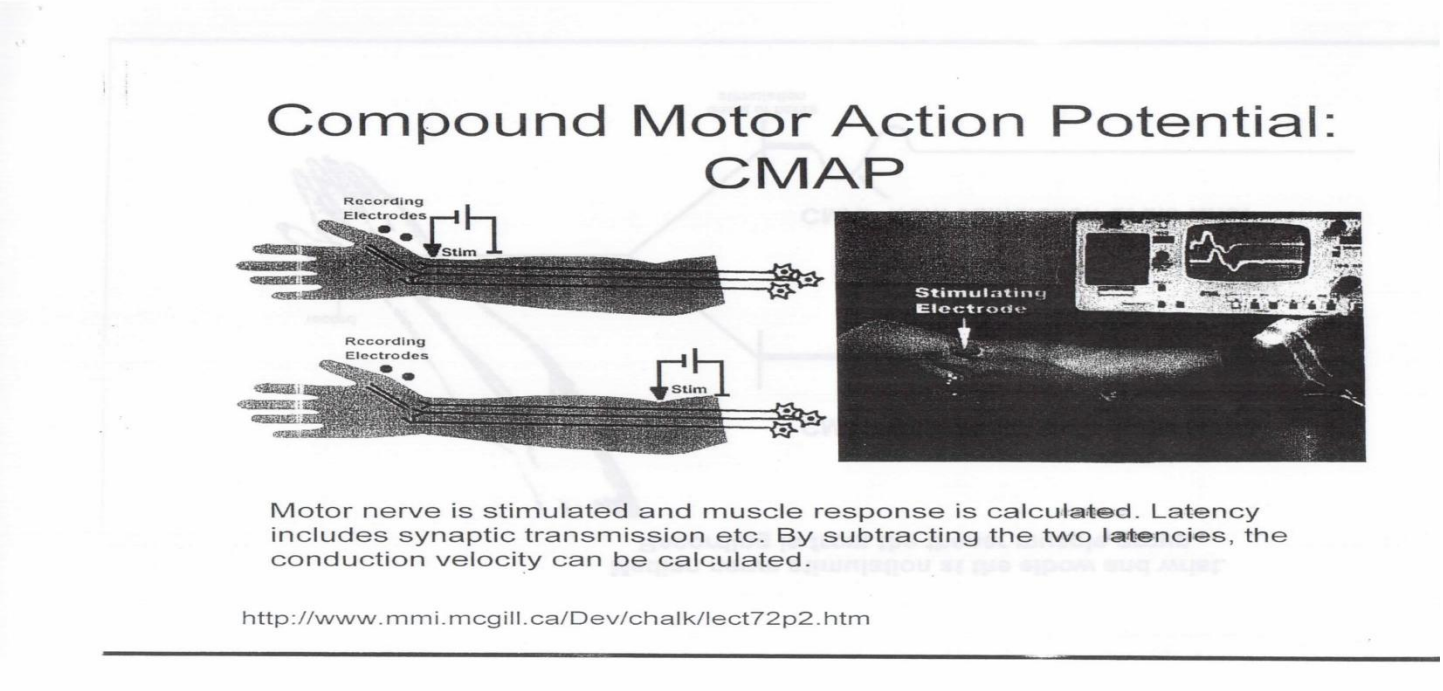


*Compound Motor action potential recording CMAP :

Here we have two electrodes → a fixed recording surface electrode on the muscle and a movable stimulating electrode .

Ex : If we want to examine the Median N →

here we stimulate twice ! once from the wrist and the other from the elbow and Record from The muscle (Thenar muscles)



Notice that the Record obtained from the wrist stimulation has a smaller Latent period than the one obtained from the elbow . **WHY** ?? because the distance is larger.

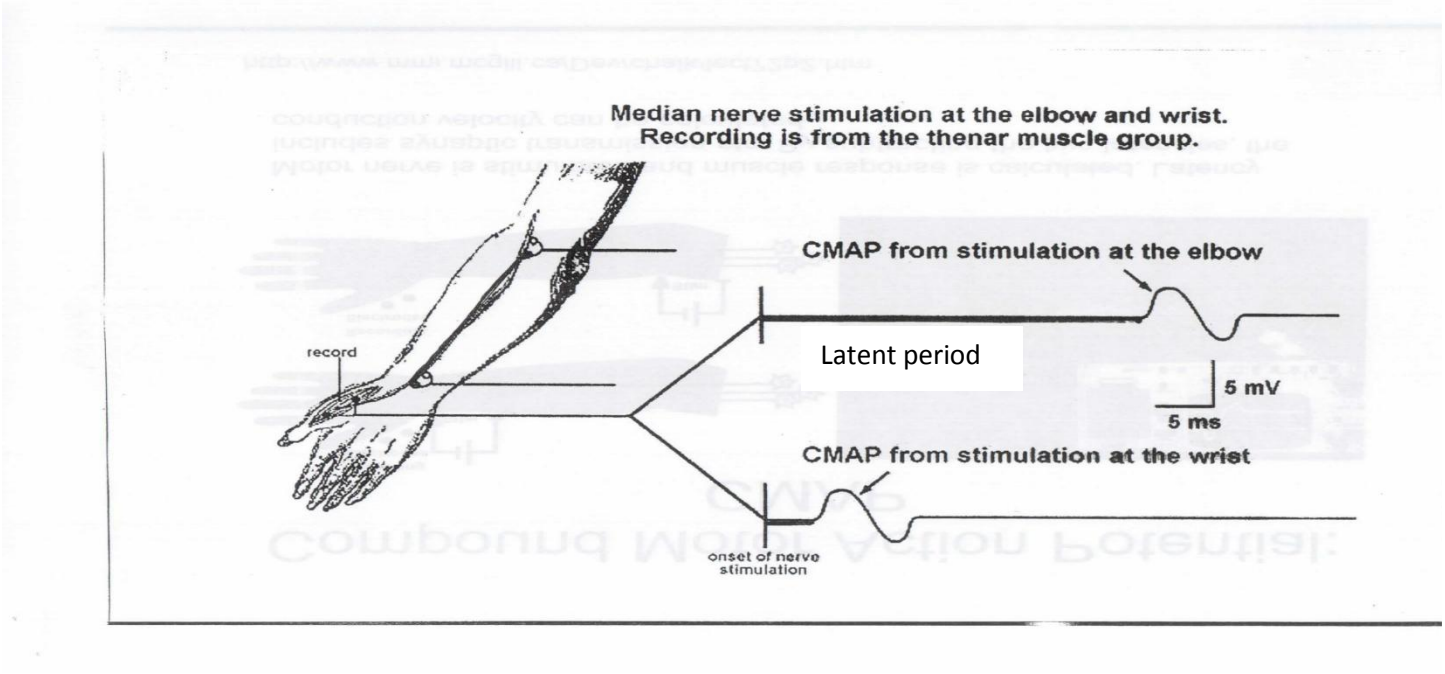
How to measure the conduction velocity of the median Nerve ?

Velocity = distance\time (m\s)

Distance : distance between the wrist and the elbow (cm) → m .

Time : difference in latent periods between the two recordings (latent period for the elbow's record – Latent period for the Wrist's record) in milliseconds → seconds

Check the slides ^_^



Why do we stimulate twice and do this complicated process ?!

*In the muscle there is neuromuscular junction that cause an extensive delay for the CMAP so if we took the whole record from the finger to the elbow for example the neuromuscular synapse and the spread of AP in the muscle will be taken into consideration in our calculations (and these lead to a delay \ Slower conduction velocity) so we need an area where the median nerve is pure without synapses or junctions !

Keep in mind that for a Stimulus to reach the CNS as fast as possible it has to pass through a minimum # of Synapses ☺

WHY ?!

Because In synapse there is a releasing of chemicals (neurotransmitters) that bind to the receptors and open the channels … and those all take time ! .. and that will make the

measurement incorrect (because we are calculating the conduction velocity + delay caused by the junctions)

Next slide ☺

This record from the ulnar nerve .. we first stimulate from the Wrist , second from the elbow and we record from the hypothenar Ms .There are 3 cases :

a)Normal : from Wrist we take shorter time to record CMAP , Elbow takes longer time to record the CMAP But Notice the amplitude ;) it's normal .

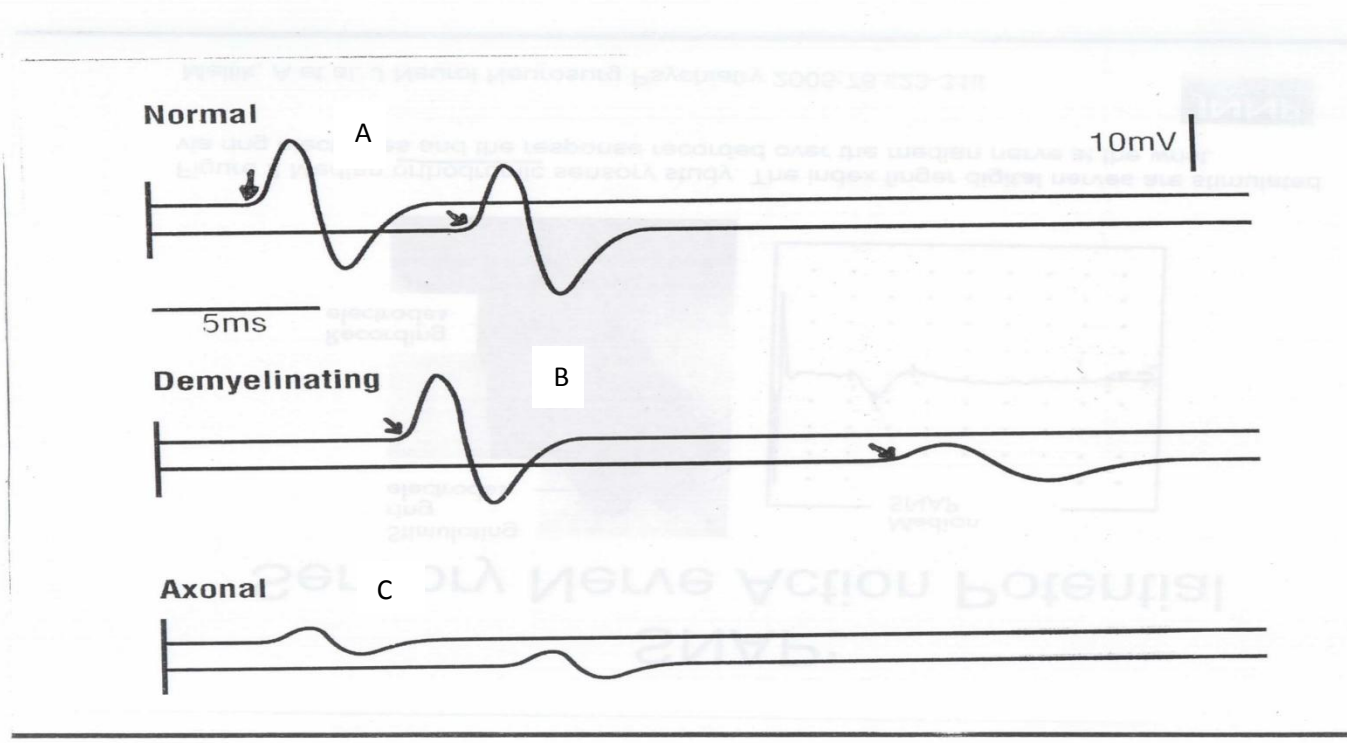
b)Demylination (same ulnar recording but from a patient) .. the latent period has elongated , the conduction velocity decreased for both (wrist and elbow records)

What are the factors that affect the conduction velocity ?

- Myelination
- Nerve fiber's diameter
  And here because the diameter is constant (same nerve) this indicates a loss in myelination causing a delay in transporting the AP

At The level of the elbow , we also have longer latent period (Demyelination) and the amplitude is smaller→ (some of the Nerve fibers are damaged (partial injury axonal loss))

(occurs when we have an injury like wrist drop , carpal tunnel syndrome .. etc)



ENG shows us: Conduction velocity, Myelination status and If the axons are healthy or abnormal (pathology).

*Major site of Median Nerve injury is (Wrist) carpal tunnel syndrome, Major site of ulnar N injury is medial epicondyle of humerus (so it's typically injured at the elbow because Ulnar N is superficial there),Major site of Radial N injury is radial groove at the shaft of the humerus and at axilla (people who use crutches , we advice them to put a cushion).

c) Axonal (other patient): The latent periods are the same but the amplitude is much more less .. Indicates a partial injury in the nerve (axonal degradation\loss) involving the wrist area until the elbow.

What Are the major Health problems in JORDAN ?

- Diabetes (33% of Jordan's population got Diabetes ☹)
- Hypercholesterolemia\ Hyperlipidemia
- Vitamin B12 deficiency

What causes Demyelination? (Very common case)

Diabetes: One of the Disorders of demyelination .

A problem in glucose entrance to the cell → caused by the resistance of the cells to glucose (insulin resistance Diabetes) Or No enough amounts of insulin are secreted by the pancreas .

Eating food.. Having Glucose in our blood ..glucose has to enter the cells(as a source of energy) and in order to enter the cells it needs Insulin … But Diabetes patient doesn't have the required amounts of Insulin .. so the Glucose cannot enter the cells (No energy source for the cells ☹) it stays in the blood causing Hyperglycemia (the patients are always thirsty and drink a lot amounts of water and large amounts of glucose are present in the patient's urine) but the cells are deprived from their nutrients .. so they will use Amino Acids and fatty acid as nutrients (Diabetes is a metabolic disorder) , a lot of toxic substance (Ketone bodies and acetests) will accumulate In the blood and affect the peripheral nerves leading to "peripheral neuropathy " → not healthy peripheral nerves \ (اعتلال الاعصاب المحيطية) usually diabetes patients lose sensations in their Hands and legs after 10-15years ☹)

-Also diabetes might cause a vasculitis

After Demyelination we got Axonal loss (early stages of neural pathology → demyelination then as an advanced result we get Axonal loss)

Next Pic Shows …

Ulnar Nerve recording from hypothenar muscles. stimulating from :*wrist …*below elbow …*above elbow…*from the arm.

2 Reorders from right and left arm to compare .

The report says : "Normal left ulnar N recording . Abnormal right ulnar N recording at the wrist , below and above the elbow with an indication of axonal loss \ partial injury of ulnar N "

And this is typical presentation of children who fall and broke their bone around the elbow.

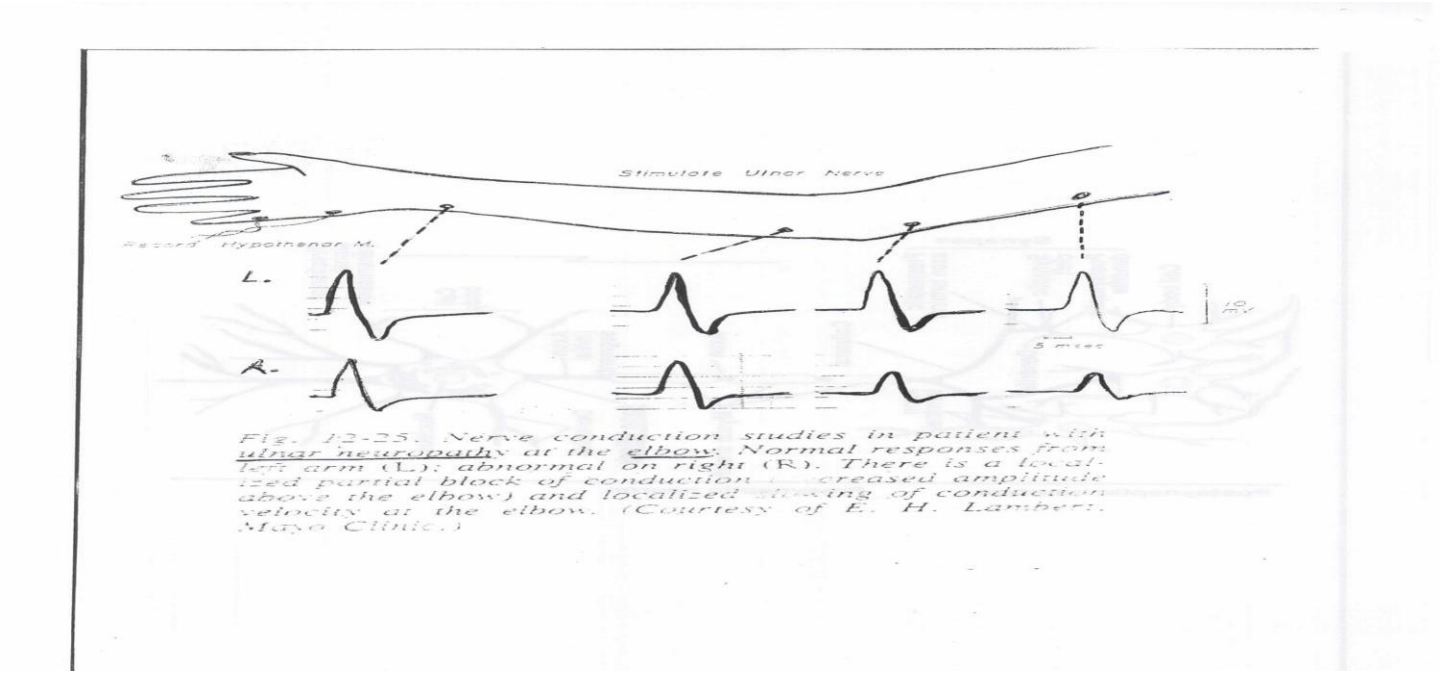


Fig. 12-25. Nerve conduction studies in patient with ulnar neuropathy at the elbow. Normal responses from left arm (L.); abnormal on right (R). There is a localized partial block of conduction [illegible] decreased amplitude above the elbow) and localized slowing of conduction velocity at the elbow. (Courtesy of E. H. Lambert, Mayo Clinic.)

Correction team notes

anatomy :-

Sheet #28: Page 3: It has Apex: within the lumen or cavity of the atrium >> from the apex there are tendon-like fibrous cords called (chordate tendineae), they are like parachute man. .... The cavity is the left ventricle.

physiology :-

Sheet #2 dr-iman: page 3 … the resting potential ranges from -90 to -45.

Page 5 … the narrow nerve fiber will having resting membrane potential -40 mV and the large one will have it as -70 mV.

Sheet #4 dr-iman: page 5... Add that diazepam is a common anti anxiety drug.

Page 6 … it's never fibers not nerve that is larger than neurons.

Page 7 … graded potential amplitude is 50 mV not threshold.

Page 10 … it's ENG machine not EMG.

sheet#2 also page 3, (10MV-15MV decrease not increase, which means becomes less negative).
sheet#4 the last page, increasing the voltage to 1MV not 1V.