# NERVE CONDUCTION STUDIES and EMG

# NERVE CONDUCTION STUDIES

Application of a depolarizing electrical pulses to the skin over a peripheral nerve producing:

(1) a propagated nerve action potential (NAP) recorded

at a distant point over the same nerve, and

(2) a compound muscle action potential (CMAP) arising from the activation of muscle fibers in a target muscle supplied by the nerve.


Recording Site: Abductor pollicis brevis
Stimulus Site
A1: Wrist
A2: Elbow
A3: Axilla
A4: Erb's point
Segment
Wrist-Elbow
Elbow-Axilla
Axilla-Erb's point

# NERVE CONDUCTION STUDIES

The aim of the NCS

- Peripheral nerves contain many nerve fibres of different diameters, degrees of myelination, and afferent or efferent connections. (The NCS studies the fastest 20% of these fibers).
- Aim of the investigation is to document focal or continuous abnormalities in the length of the mixed, motor or sensory nerve.
- Particular attention is paid to the following questions as the test progresses:
  - Is the fastest conduction velocity normal?
  - Is the CMAP normal in size and shape?

# Nerve Conduction studies

- Standard nerve conduction studies typically include motor nerve conduction, sensory nerve conduction.
- Sensory and motor nerve conduction studies involve analysis of specific parameters, including latency, conduction velocity, and amplitude.

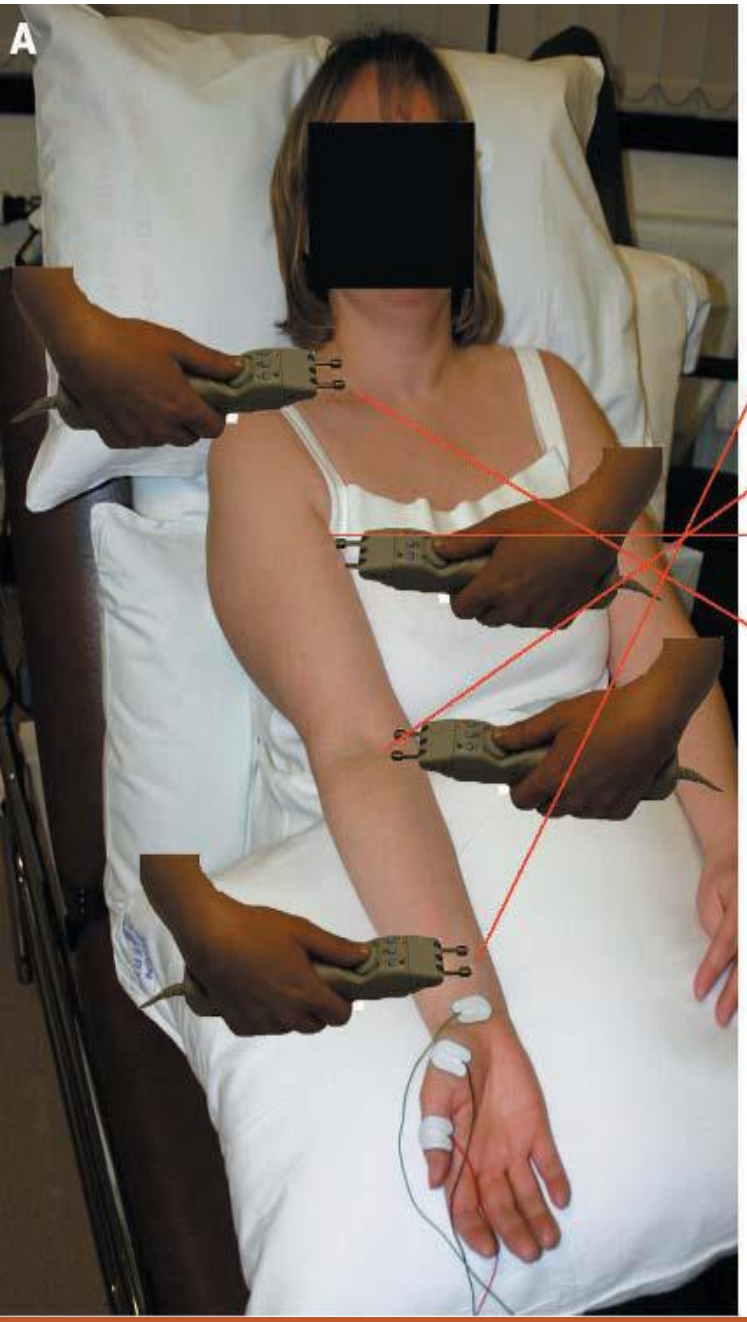
# Nerve conduction studies

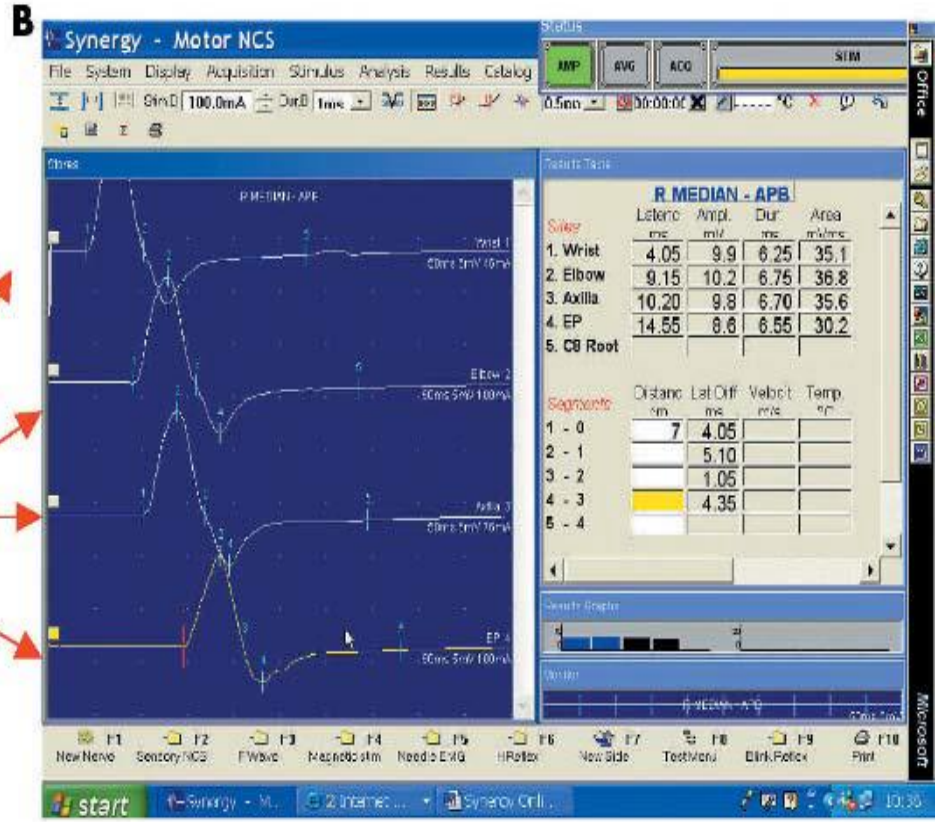
Based on the nature of conduction abnormalities principal types of peripheral nerve lesions can be identified:

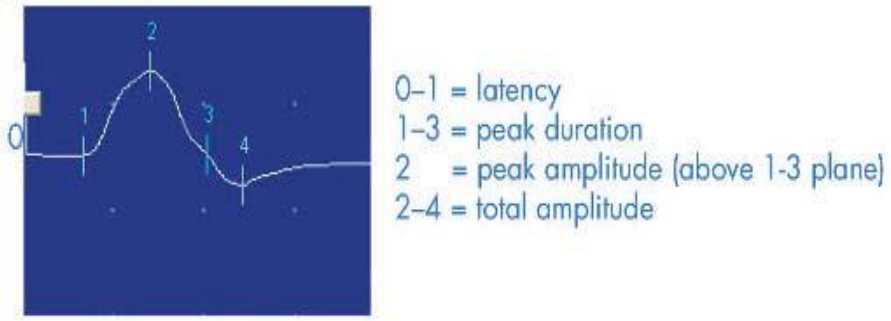
- ***Axonal degeneration / segmental demyelination.***
- ***Focal/ multifocal/ generalized***
- ***Purely / predominantly sensory or motor***
- ***the severity***

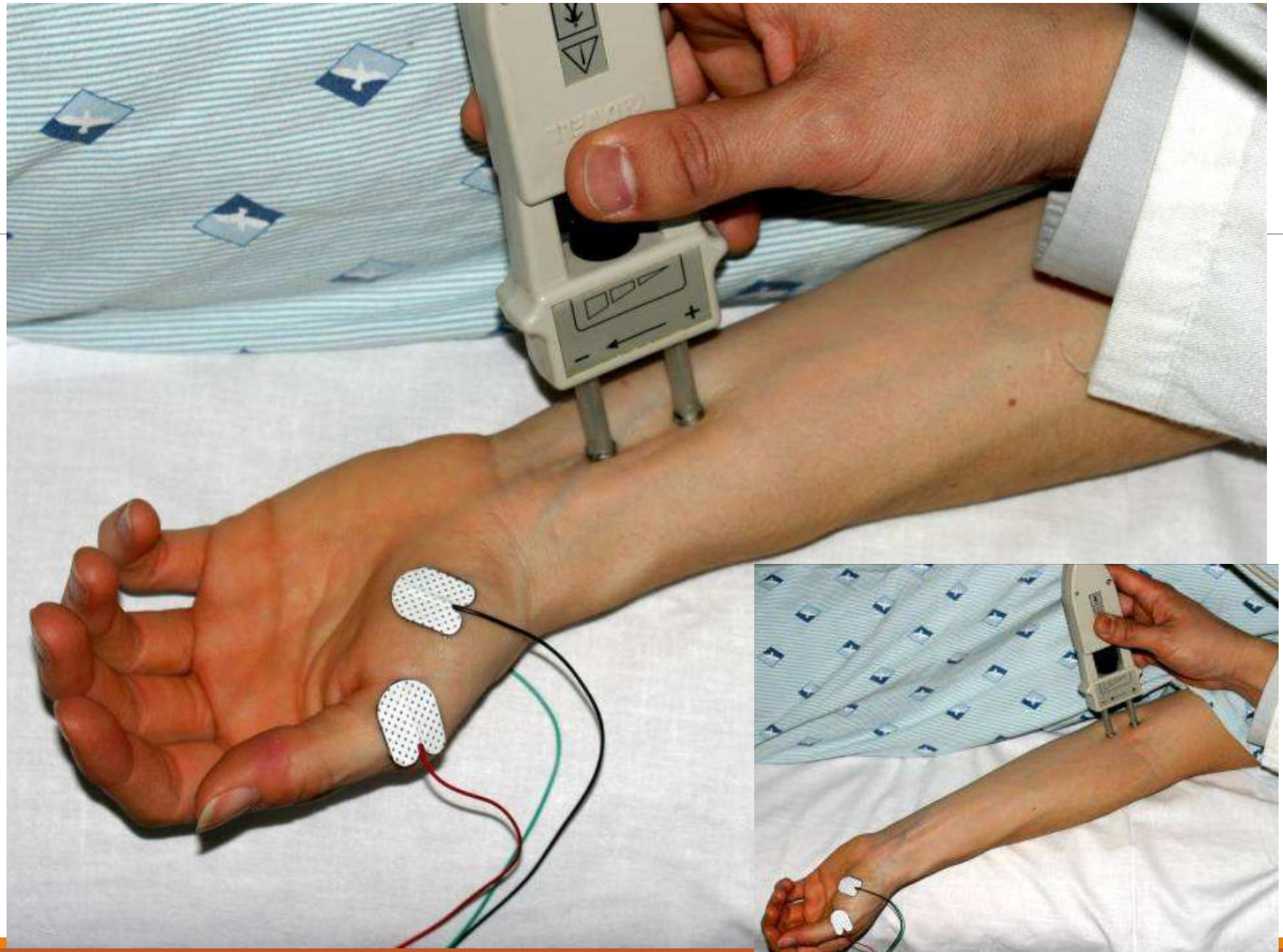
***Site of pathology***

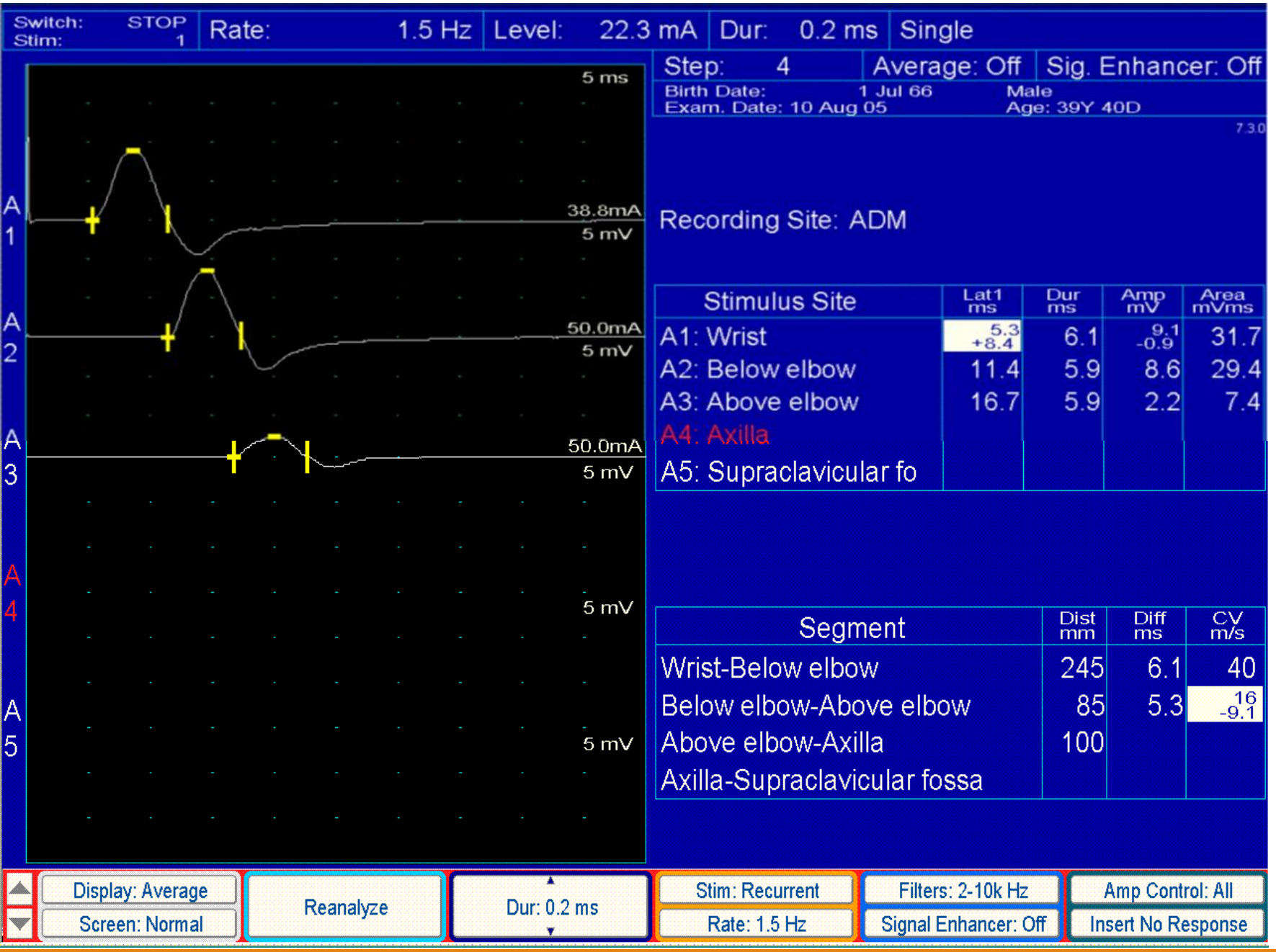
- ***Nerve (cell body, nerve root, peripheral nerves)***
- ***Muscle***
- ***NMJ***


A


B
Synergy - Motor NCS
File System Display Acquisition Stimulus Analysis Results Catalog
R MEDIAN - APB
Latenc Ampl. Dur. Area
1. Wrist 4.05 9.9 6.25 35.1
2. Elbow 9.15 10.2 6.75 36.8
3. Axilla 10.20 9.8 6.70 35.6
4. EP 14.55 8.6 6.55 30.2
5. C8 Root
Distanc Lat Diff Velocit Temp
1 - 0 7 4.05
2 - 1 5.10
3 - 2 1.05
4 - 3 4.35
5 - 4
F1 New Nerve
F2 Sensory NCS
F3 F Wave
F4 Magnetic stim
F5 Needle EMG
F6 H Reflex
F7 New Side
F8 Test Menu
F9 Blink Reflex
F10 Print
start


C
0
1
2
3
4
0–1 = latency
1–3 = peak duration
2 = peak amplitude (above 1-3 plane)
2–4 = total amplitude




Switch: STOP
Stim: 1
Rate: 1.5 Hz
Level: 22.3 mA
Dur: 0.2 ms
Single
Step: 4
Average: Off
Sig. Enhancer: Off
Birth Date: 1 Jul 66
Male
Exam. Date: 10 Aug 05
Age: 39Y 40D
7.3.0
5 ms
A 1
38.8mA
5 mV
A 2
50.0mA
5 mV
A 3
50.0mA
5 mV
A 4
5 mV
A 5
5 mV
Recording Site: ADM
Stimulus Site | Lat1 ms | Dur ms | Amp mV | Area mVms
A1: Wrist | 5.3 +8.4 | 6.1 | 9.1 -0.9 | 31.7
A2: Below elbow | 11.4 | 5.9 | 8.6 | 29.4
A3: Above elbow | 16.7 | 5.9 | 2.2 | 7.4
A4: Axilla
A5: Supraclavicular fo
Segment | Dist mm | Diff ms | CV m/s
Wrist-Below elbow | 245 | 6.1 | 40
Below elbow-Above elbow | 85 | 5.3 | 16 -9.1
Above elbow-Axilla | 100
Axilla-Supraclavicular fossa
Display: Average
Screen: Normal
Reanalyze
Dur: 0.2 ms
Stim: Recurrent
Rate: 1.5 Hz
Filters: 2-10k Hz
Signal Enhancer: Off
Amp Control: All
Insert No Response

# Abnormal features

| Axonal degeneration neuropathy features | Demyelinating Neuropathy features |
|---|---|
| • Low amplitudes | • Normal amplitudes |
| • Normal / slight delay in latency | • Significant delay in latency |
| • Normal / slightly low conduction velocity | • Significantly low conduction velocity |

# Comparing results

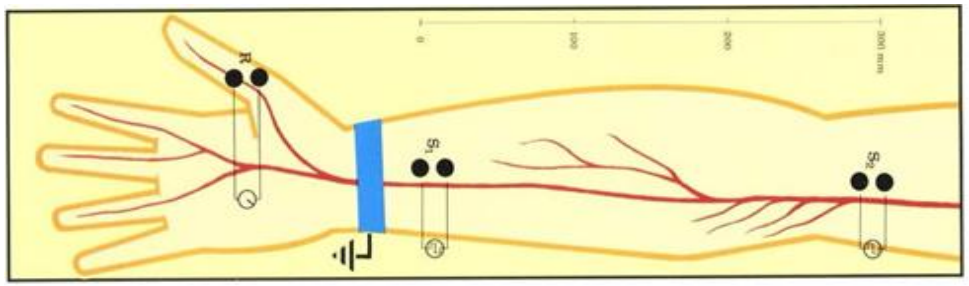
- Compare nerves same limb (hand median vs ulnar or radial)
- Compare left and right limb
- Compare upper and lower limbs
- Compare to previous results in same subject
- Compare to ‘normal’ reference values

# Normal values for conduction velocity

- ✓In arm
  - 50 – 70 m / sec.
- ✓In leg
  - 40 – 60 m / sec.

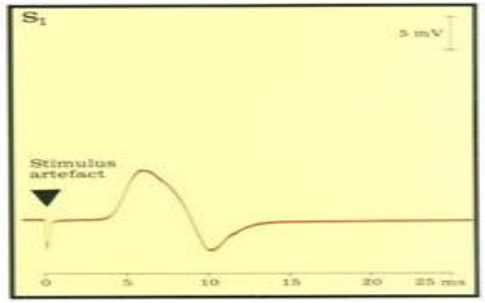
- MNCV will appear.
- It can also be calculated by formula
- MNCV (m/sec)= $\frac{Distance(mm)}{L1-L2(msec)}$
- L1 = latency at elbow.
- L2 = latency at wrist

Example:

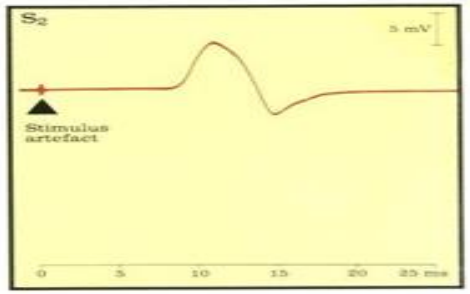


Distance= 24cm

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




Latency at wrist = 2.5 msec




Latency at elbow = 6.5 msec

MNCV =(24 × 10)÷ (6.5-2.5)

MNCV = 240/4.0 = 60 m/sec

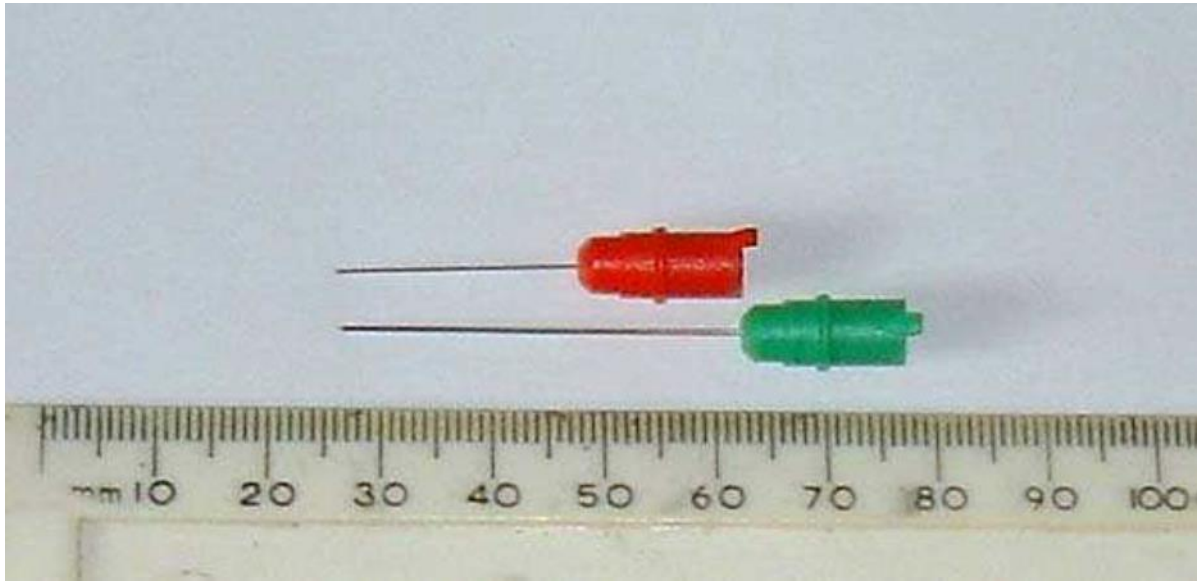
# Electromyography

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

A small-diameter needle is placed into a muscle to evaluate

- insertional activity,
- resting activity,
- voluntary recruitment,
- morphology,
- size of motor units,
- motor unit recruitment.

or by applying surface electrodes to the skin overlying muscle.


mm 10 20 30 40 50 60 70 80 90 100

## 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.

-decreased in atrophied muscle or fatty tissue.

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

## Spontaneous activity at rest

- Normal muscle should be silent after the needle is inserted

-The most common abnormal activities reported:

- Positive sharp waves (PSWs)
- Fibrillation potentials

**Fibrillation potentials:**

-Result from motor axonal loss not balanced by re-innervation.

- Low-amplitude fibrillation potentials suggest that denervation occurred in the remote past

-High-amplitude fibrillation potentials suggest an ongoing active denervation process.

-Fibrillations are not visible through the skin and are an electrical sign not a clinical sign.

**Positive sharp waves:**

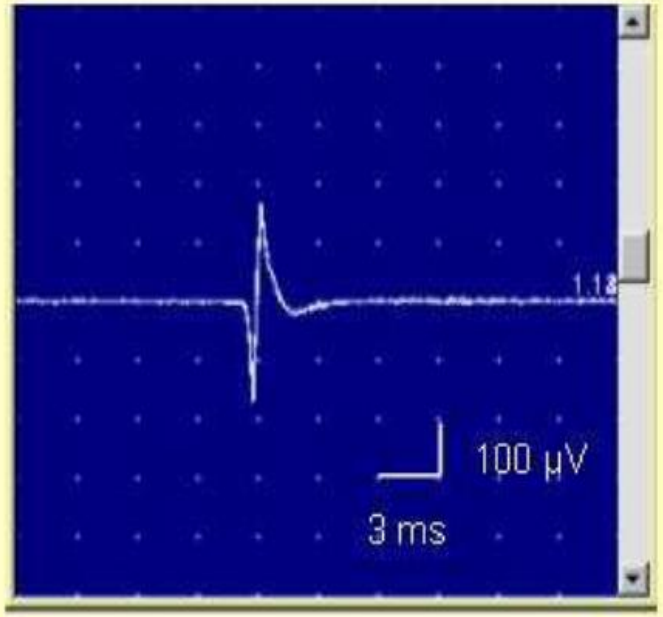
-have the same origin & significance as fibrillations.

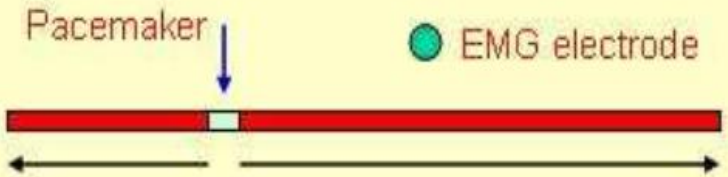
**Fasciculations:**

-Isolated discharges that recur at irregular intervals, usually in the order of several seconds.

-may be benign and they occur in motor neuron disease, radiculopathy and neuropathy.

## Fibrillation

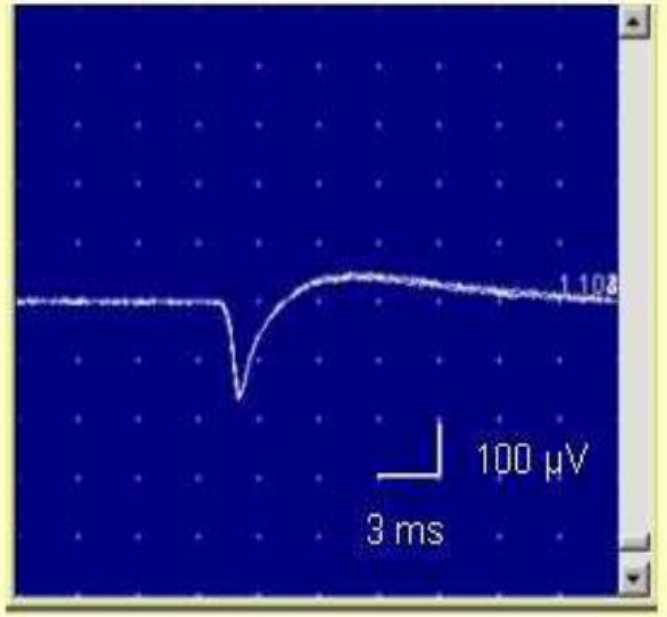


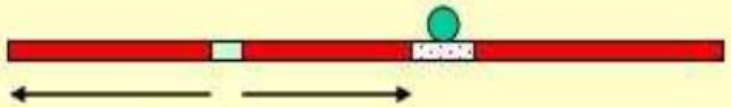




**Duration : < 2 - 4 ms**

**Amplitude : 25 – 500 µV**

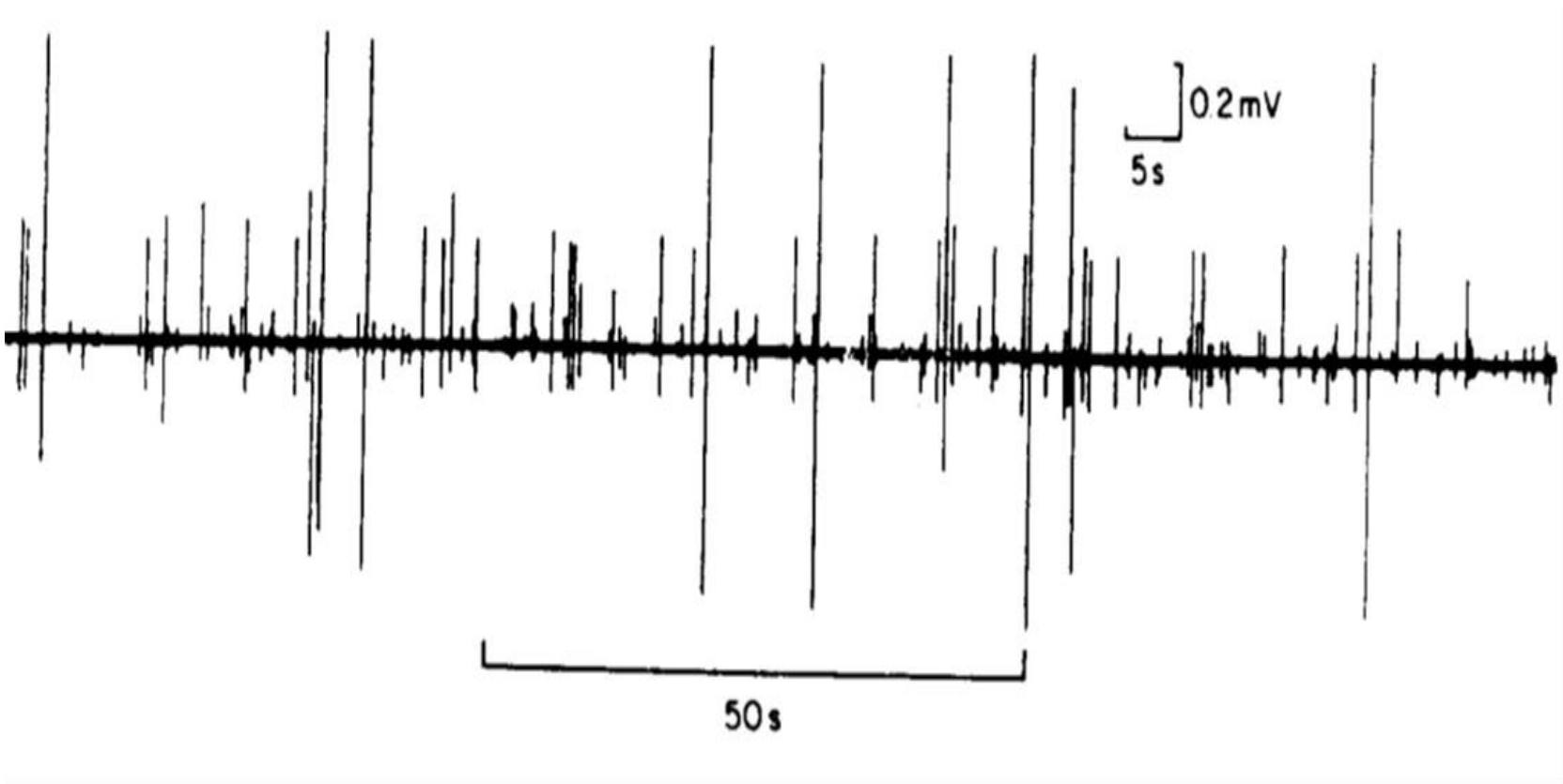
## Positive Sharp Wave



**Duration : 3 – 30 ms**

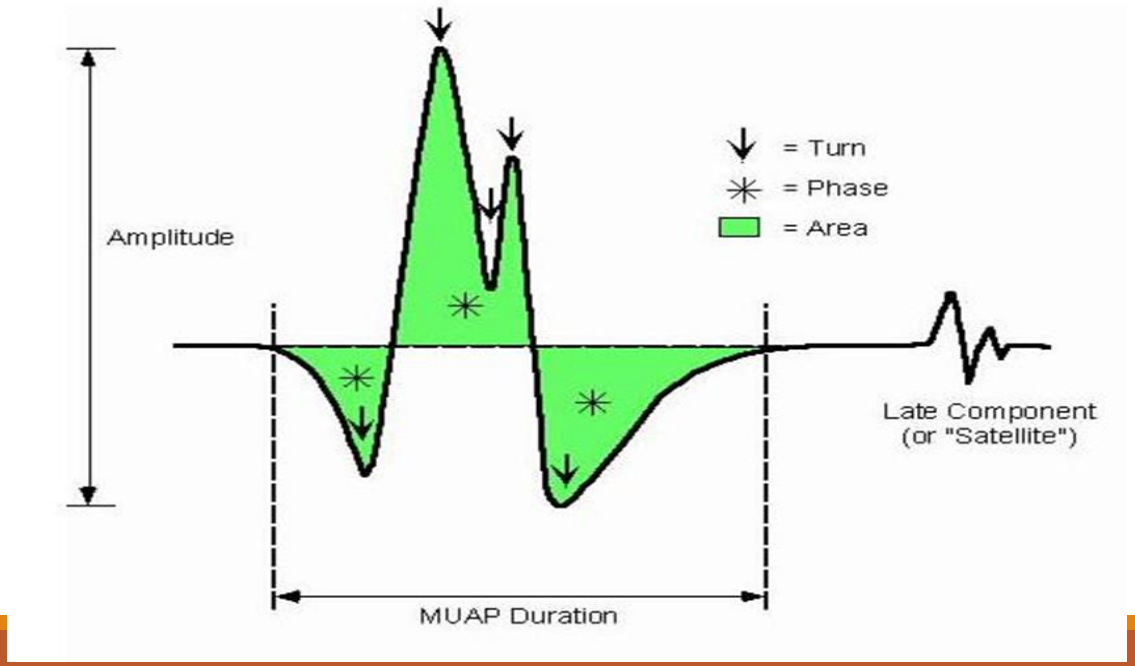
# Fasciculations:



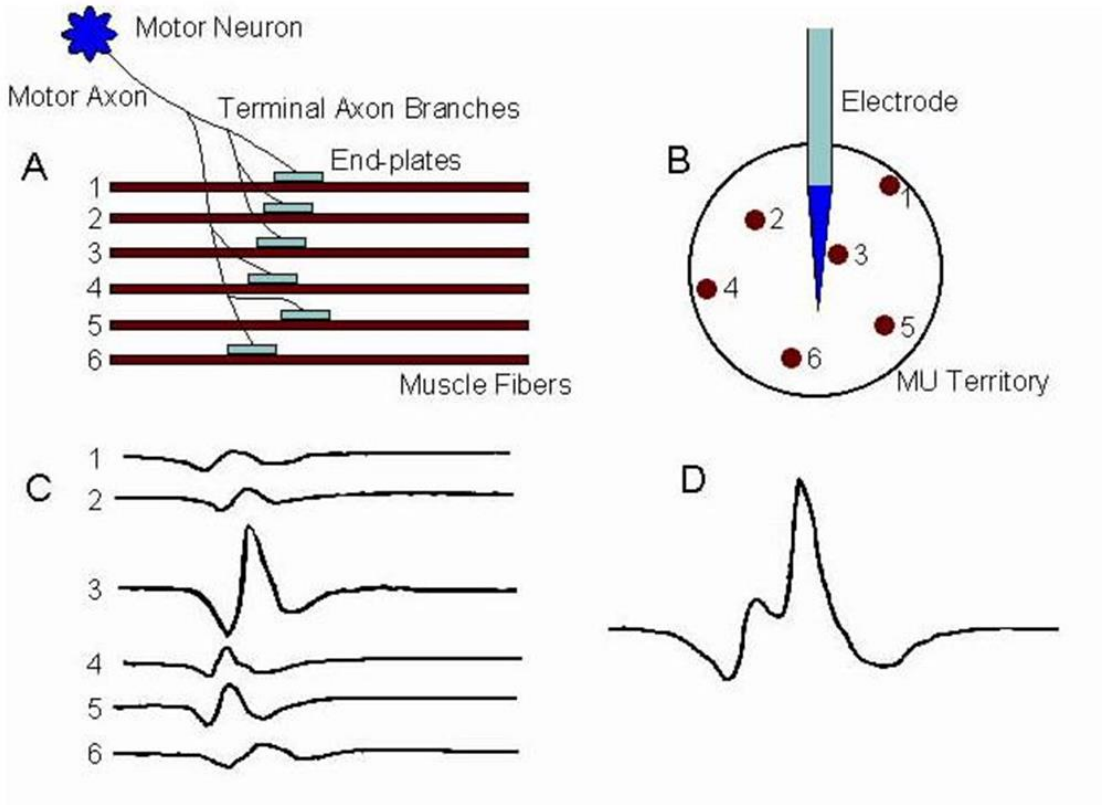
# ELECTROMYOGRAPHY (EMG)

**Voluntary Muscle contraction**

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



# MUP


Motor Neuron
Motor Axon
Terminal Axon Branches
End-plates
A
1
2
3
4
5
6
Muscle Fibers
B
Electrode
1
2
3
4
5
6
MU Territory
C
1
2
3
4
5
6
D

# MUP parameters

Motor units have a recruitment frequency of 6–10 Hz and are recognizable by the constancy of the waveform of each discharge.

Amplitude: (normal 300µV – 5 mV)

- Reflection of the total number of activated muscle fibres near the needle
- Very high amplitude in chronic neurogenic disorders
- Very low amplitude in myopathic disorders

Duration: (normal 3 – 15 mSec)

- Reflects the degree of synchrony of firing of the muscle fibres within the motor unit
- Very long duration MUPs in chronic neurogenic disorders
- Very short duration MUPs in myopathic disorders

# Normal MUPs

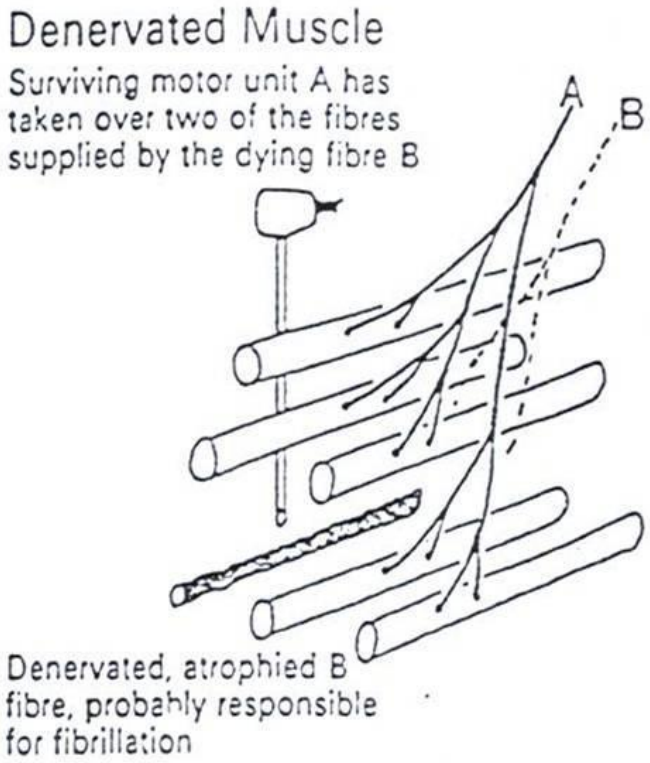
**Wave morphology:**

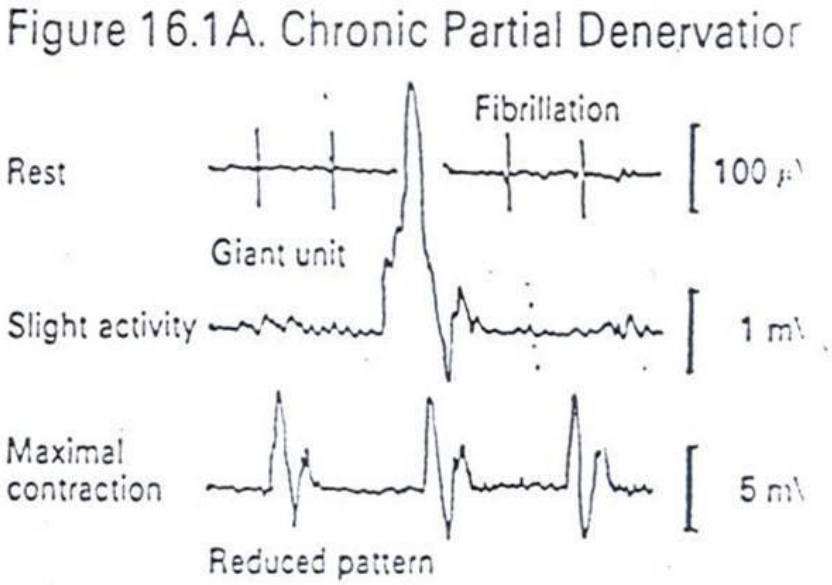
- Bi / Tri-phasic in normal MUPs.
- Polyphasic in neurogenic and myopathic MUPs.

**Recruitment (Interference) pattern:**

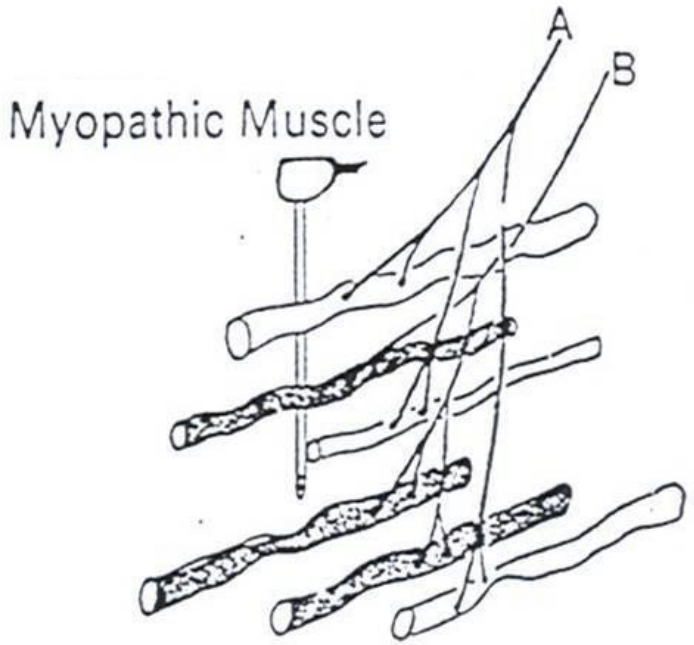
- Normally number of MUPs activated and their frequency rises with increased exertion until it become full with maximal voluntary contractions.
- Reduced and incomplete (partial) recruitment signifies neurogenic lesion.
- Early and full recruitment with a small voluntary force can be seen in myopathy.

# Neuropathic EMG changes

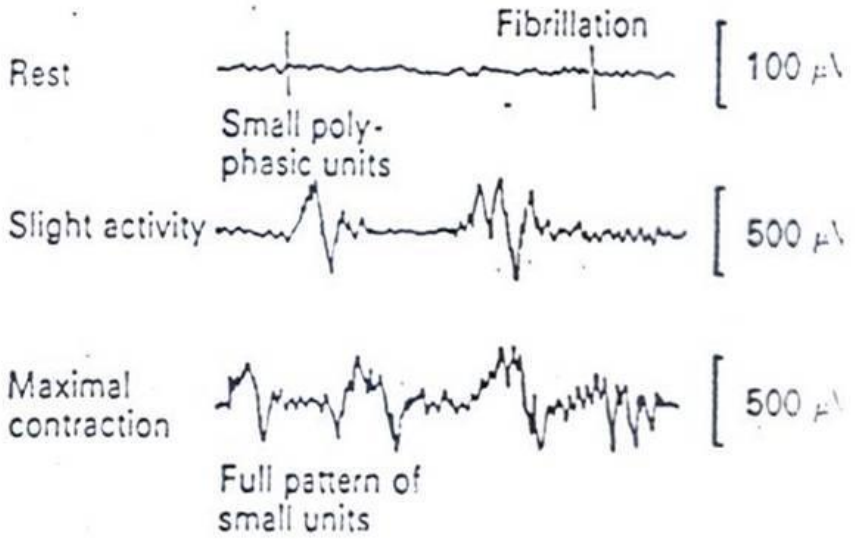


# Myopathic EMG changes

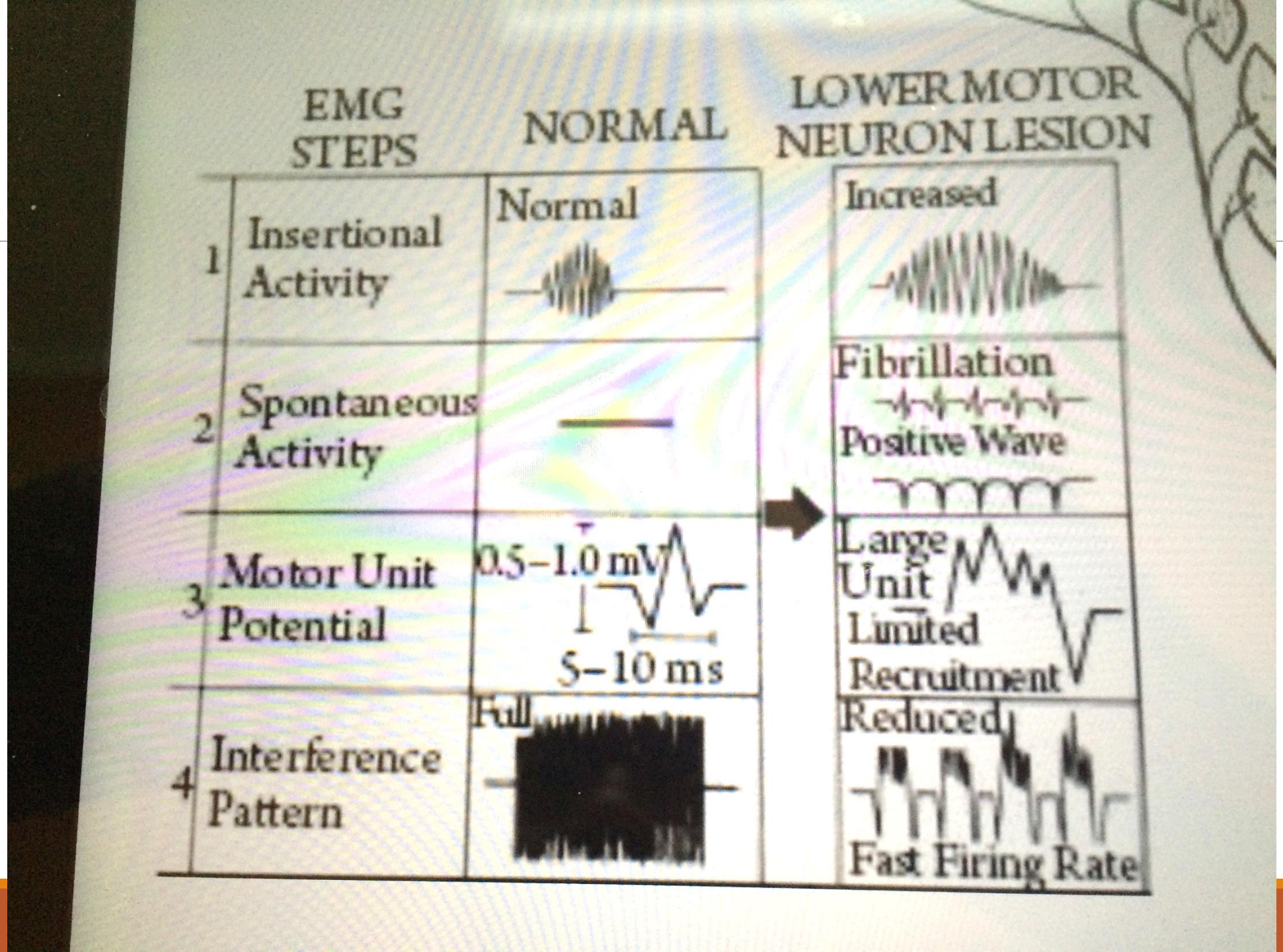


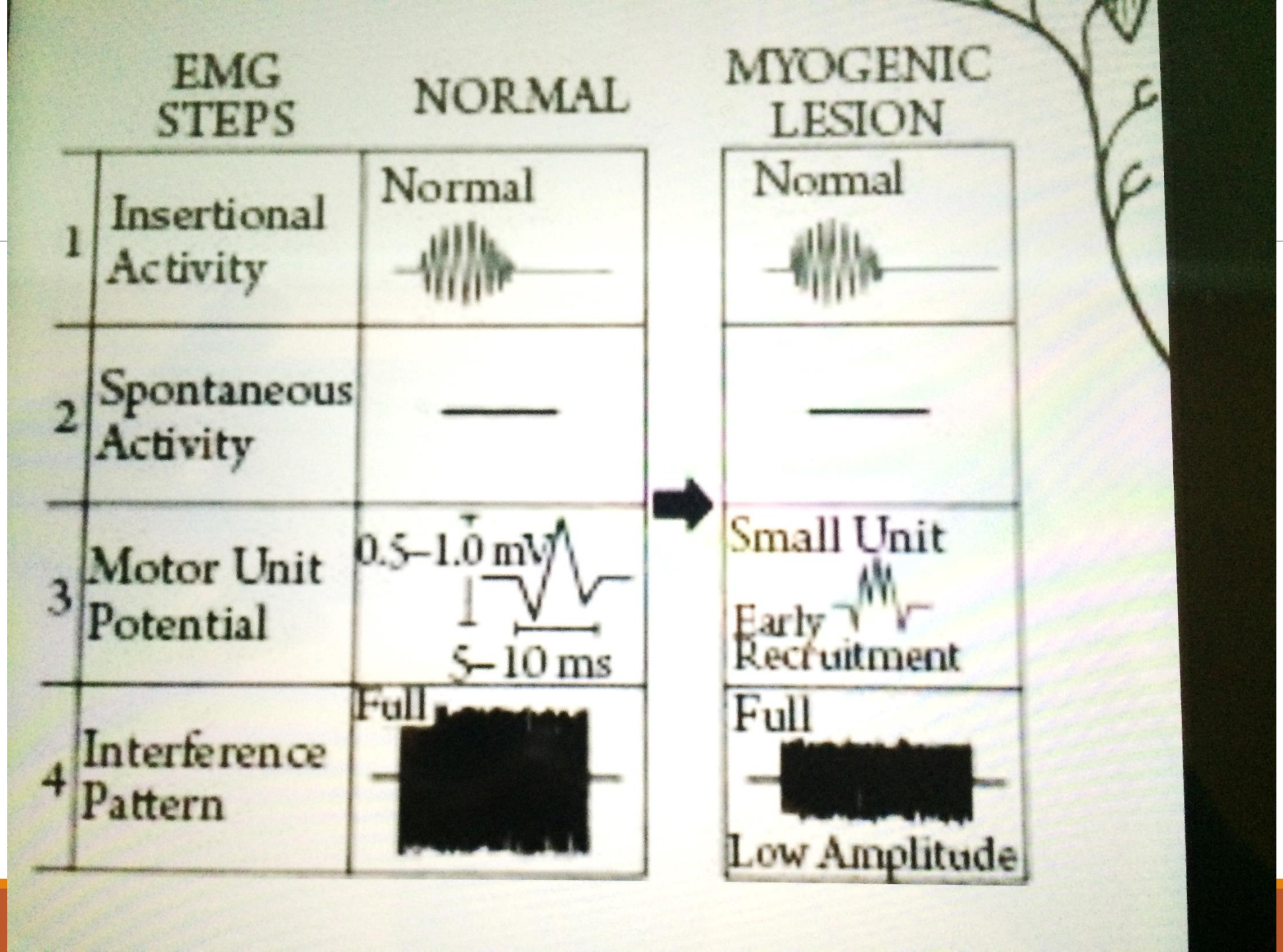

Muscle fibres supplied by both A and B are indiscriminately affected, although both nerve fibres are normal



# Analysis of a motor unit potential (MUP)

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


EMG STEPS
NORMAL
LOWER MOTOR NEURON LESION
1
Insertional Activity
Normal
Increased
2
Spontaneous Activity
Fibrillation
Positive Wave
3
Motor Unit Potential
0.5–1.0 mV
5–10 ms
Large Unit
Limited Recruitment
4
Interference Pattern
Full
Reduced
Fast Firing Rate


EMG STEPS
NORMAL
MYOGENIC LESION
1
Insertional Activity
Normal
Normal
2
Spontaneous Activity
3
Motor Unit Potential
0.5–1.0 mV
5–10 ms
Small Unit
Early Recruitment
4
Interference Pattern
Full
Full
Low Amplitude

# EMG case

Case 1: A 29 year old woman is referred for EMG studies because of difficulty in walking.

Her EMG reveals the following:

- MUP amplitude reduced
- Polyphasia present
- Early recruitment
- Fibrillations absent.

What is the diagnosis?

Myopathy (Muscle disease)

# Thank you for attention and listening!!

**Any Questions??**

**Any comments??**