ELECTROMYOGRAPHY (EMG)

Nerve conduction velocity (NCV)
Electromyography

- **Definition:** recording the electrical activity of the muscle
  - by placing electrodes
    - on the skin
    - or inserting electrodes into muscle;
  - Usually used to discern myopathies and neuropathies.

- **Indication:**
  - neuro-muscular diseases, diagnostic tool
  - in work medicine – evaluation, diagnosis
  - in sports medicine - evaluation
Background

- Function of the muscle is to convert the chemical energy into mechanical energy.

- In striate muscles the contraction is started by action potentials of the motor nerves (axons of spinal or bulbar motor neurons).

- Neuromuscular junction
  - Motor end plate
  - Synaptic cleft
  - Muscle membrane
**Motor unit:** motor neuron, its axon and all the muscle fibers innervated by this neuron.

Each motor neuron innervates a variable number of muscle fibers.

Size of the motor unit determined by the function of the muscle:
- fine movements of small strength - small motor units (4-6 fibers)
- coarse movements, great strength – large motor units (1000-2000 fibers)

If the neuron is stimulated, all the muscle fibers of its motor unit will discharge and contract.
Mechanisms to control the strength of contraction

Motor unit recruitment
- Increase the number of active motor units
  - Primary mechanism
  - in order of size of motor unit (initially the small ones)
- Increase the frequency of contraction (i.e. frequency summation)
  - Secondary mechanism
  - Small motor units – slow motor units
  - Frequency of stimuli ↑ - contraction ↑
Contraction types

- **Isometric contraction**
  - Length of muscle unchanged
  - Muscle tone changes
  - E.g. strengthening the fist, holding up an object

- **Isotonic contractions**
  - Length of muscle changes
  - Muscle tension unchanged
  - E.g. lifting weights
Normal EMG

At rest - basal muscle tone of normal individuals and background electromagnetic noise (A)

In case of minimal voluntary contraction, a few motor units discharge: some action potentials are recorded – simple recording (B)

In increasing voluntary effort, more motor units discharge, a higher number of motor unit potentials are recorded (but can be seen separately) - intermediary recording (C)
Normal EMG

In case of maximal contraction, most of the motor units discharge and a very high number of potentials are recorded, with no possibility to distinguish individual potentials - interference pattern (D).

In case of maximal contraction against resistance, a sinusoidal interference pattern appears - synchronous activity of spinal motor neurons – Piper rhythm (E).
Pathologic EMG

Neurogenic lesions:
• motor neuron/its axon destroyed
• Fewer motor units
• Reduced interference pattern

Myopathic lesions
• Muscle fibers destroyed
• Same no. of motor units
• Smaller motor units
• Interference pattern of smaller amplitude
Electromyograph

1. electrodes:
   • surface (skin) electrodes
   • needle electrodes

2. amplifier

3. recording display: oscilloscope, chart recorder, audio

4. stimulating and detection system (used in NCV).
Procedure - EMG

- Patient in restful position (spontaneous movements - other than commended - can disturb the measurement)
- Room temperature
- Faraday room
- Recording in different conditions
  - during rest or during graded voluntary effort
  - In agonist / antagonist muscles
Materials

- computer with BIOPAC software

- BIOPAC DAU (data acquisition unit) - MP150

- BIOPAC EMG cables SS2L:
  - red : positive
  - white: negative
  - black: ground

- electrode gel

- 6 single use electrodes
Objectives

- to record and observe the motor unit recruitment simultaneously with the increasing strength of muscle contraction

- to compare isometric contractions with isotonic contractions

- to study the activity of antagonistic muscles (biceps/triceps muscle)

- to record integrated EMG

- to compare the EMG trace of the left/right arm
The recording of motor unit recruitment - muscle contractions with increasing intensity (biceps muscle)
The activity of antagonistic muscles (biceps / triceps muscle); muscle contractions with increasing intensity

The recording of integrated EMG
The activity of antagonistic muscles (biceps / triceps muscle)
  - lifting and lowering weight

The recording of integrated EMG
Nerve conduction velocity (NCV)

The velocity of the nerve conduction can be calculated by measuring:
1. distance between stimulus (electrical stimulation of the nerve) and the place recording the muscular contraction.
2. time between the stimulus and the response

\[
\text{velocity} = \frac{\text{distance}}{\text{time}}
\]

Ulnar nerve: normal value of NCV 45-60 m/sec
Factors that influence of NCV:

- age: NCV of infants = \( \frac{1}{2} \) of the NCV of adults
- temperature: NCV decreases by several % for each C degree drop in body temperature
- nerve segment: proximal segments present higher values of NCV than distal ones
- nerve perfusion: ischemia reduces NCV

Decreased NCV (pathologic):

- neuropathies: toxic, alcoholic, diabetes mellitus
- compression of the nerve at the wrist - carpal tunnel syndrome
Nerve response data

left wrist

milliseconds

Volts

SC ΔT = 4.600 ms

SC ΔT = 4.600 ms

left wrist

0.000 5.000 10.000 15.000

milliseconds

3.517660

1.758830

0.000000

-1.75883