Neurography, principles

Stålberg

Usefulness of neurography

- Polynuropathy
  - pathophysiology
  - severity
  - distribution to some extent
- Local neuropathies
  - localization
  - pathophysiology (conduction block)
  - severity

Neurography methods

- Standard motor neurography
  - F waves are included
- Standard sensory neurography
- Near nerve electrodes
  - Plantar digital nerves
  - Meralgia paresthetica
  - Inferior alveolar nerve
- Short segment studies
  - Sensory median nerve at the wrist
  - Motor ulnar nerve at the elbow

What physiological and anatomical functions motor neurography reflects

| Amplitude | 1. Number of Mus
          | 2. Size of Mus
          | 3. Diameter of muscle fibres
          | 4. Dispersion of CV
| Conduction velocity | 1. State of the myelin
                   | 2. Axon diameter (MU size)
| Duration | 1. Dispersion of CV
| Distal latency | 1. CV in distal segment
                | 2. Length of distal segment
| Decay | 1. Nm transmission time
       | 2. Conduction block

Conduction velocity

\[ CV = \text{segment length} / \text{conduction time} \]

- Fastest axons
- Reflects axon diameter
- Myelin structure
  - demyelination
  - remyelination
- Temperature
- Metabolic factors

Coefficient of variation at repeated measurements \(\pm 5-10\%\)

Muscle fibre and unmyelinated axon

(continuous propagation)

Myelinated axon

(saltatory propagation)
Disposable surface electrodes

Median nerve

Parameters of importance for neurography

**Technical**
- Stim strength
- Distance (sensory)
- Electrode type
- Temperature
- Muscle length

**Biological**
- # axons
- Size of MU
- N-m transmission
- Axonal diameter
- Myelination

Effect of electrode type

Effect of electrode size and placement
Effect of electrode size and placement

Effect of muscle length on the M wave

Normal temporal dispersion

Dispersion

dispersion = 100 * (duration_{proximal} - duration_{distal}) / duration_{proximal}

Changes along the nerve

- Decay (amplitude and area)
  - % drop compared to distal CMAP

- Temporal dispersion (duration)
  - % increase compared to distal CMAP
Motor nerve conduction study

- Amplitude:
  - # of axons
  - n-m transmission
  - muscle volume

Conduction block

- Distal latency

MCV – conduction block

- CV = 33 m/s
- dlat = 6.3 ms
- amplitude = 6.3 mV
- decay = 66%

Motor conduction block in Guillain Barré syndrome

- Peroneal nerve

Practical criteria of conduction block

- Motor decay abnormal without dispersion
  - Arm: >25% decay and <15% dispersion
  - Leg: >40% decay and <20% dispersion

- Reduced number of F waves

Demyelination
MCV - demyelinating lesion
- CV = reduced
  - decay = normal or increased
  - dlat = normal or increased
  - amplitude = normal or low

Demyelinating neuropathy
- CV reduced >30%
  - median nerve CV < 40 m/s
- distal latency > 7 ms
- normal or reduced amplitudes

Ulnar nerve short segment study

Reference line

Ulnar nerve inching - normal

Simulator
Retroepicondylar ulnar nerve lesion

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Slimmer’s palsy

Axonal degeneration

- Reduced motor and sensory amplitudes
- Conduction velocity normal or slightly reduced
  - median motor > 40 m/s
- Distal latency normal or slightly prolonged
- No decay

Axonal neuropathy,
  focal or generalized

MCV - Axonal lesion

- amplitude reduced
- CV = normal or slightly reduced
- dlat = normal or slightly prolonged
- decay = normal

Demyelinating or axonal neuropathy?
Velocity vs Amplitude

- CV = 48 m/s
- dlat = 3.5 ms
- amplitude = 2.3 mV
- decay = 2 %
Normal nerve

- 57 m/sec
- 5% decay

Nerve involvement

- general slowing
- 23 m/sec
- 25% decay

Change in CMAP shape in preg

Distal, general or proximal slowing

- Prox slow
- Intermed slow
- General slow
- Distal slow
Dispersion, across ulnar sulcus

Dispersion in CIDP

CMT, “no prox response”

CMT, “late prox response”

CMT, “late F-responses”

Sensory recordings
Orthodromic vs. antidromic SCS

Antidromic
- less painful
- larger amplitude
- muscle artifact in mixed nerves

Orthodromic
- no muscle artifact
- more painful
- lower amplitude

Sensory recordings
Types of recording electrodes

Latency
CV to first positive peak

Amplitude

Phase cancellation